DESIGN AND CONSTRUCTION OF AN AUTOMATIC CHANGEOVER SYSTEM

BY

OZOEMENA KIZITO

2006/24425EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

NIGER STATE

NOVEMBER 2011

DESIGN AND CONSTRUCTION OF AN AUTOMATIC CHANGEOVER SYSTEM

BY

OZOEMENA KIZITO

2006/24425EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

NIGER STATE

NOVEMBER 2011

DEDICATION

To all staff of Donna Bella

DECLARATION

I, OzoemenaKizito declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

OzoemenaKizito

Name of Student

Engr. O.D. Ahmed

Name of Supervisor

Signature and Date

Signature and Date

Name of H.O.D

External Examiner

Signature and Date

Signature and Date

ACKNOWLEDGEMENT

I wish to acknowledge the mercies, blessings, and grace of Almighty God in giving me the wisdom, strength and good health in accomplishing life tasks.My appreciation goes to my parents, Mr. Joseph Ozoemena and Mrs Jane Ozoemena for their financial, moral support and love throughout my academic program. I also wish to acknowledge the support from my supervisor, Engr. Ozomata David Ahmedfor his advice, support and intelligence in helping me accomplish this project work.A project will never be accomplished unless there is a technical backing, I wish to extend my gratitude to my very good friend EromoseleOria-Usifo (D-Master) who stood by me through thick and thin and made sure the best was brought out of me during this project.I wish to also extend my gratitude to my technologist, Mr. SalihuDanladi for his technical support. I must not fail to thank my siblings, Melvina (Zozo), Ebuka (crespo), Ugochi (Candy) and Chidiere (mum's hand bag) for having always shown me what a loving family is.Ukamaka I see you.My Gratitude also goes to Uncle Akwele, Justice Raymond Ozoemena, Barrister ChijokeOzoemena, DrNnatchiOzoemena, Uncle OgbonnaAninweze,Ozoemena's family at large for being there for me one time or the other when I needed them the most.I must not fail to thank God for my friends, IdowuAbubakar(Kabass), AdebowaleOdukoya (Otos-Baba), Efretintin, 2jo, Nas, Raphyoso, justfemi, Baba-Dee, D.J Tamz,Omoba, Mary, Franca, kay, Ereboy(Emi) Tontebriggs, Nyore,Obinna, Bridge, Jamol, Henry,Obiscolalachi, F-baby,Effizy,Gbolz, D.j Cutie, and lot more I didn't mention, you all are so great and can't be forgotten. How can I forget you ChineloOtiji, thanks for being one of my motivations.Once again I owe all my thanks to God Almighty for with Him all things are possible and to Him be glory and praise now and forever, Amen.

ABSTRACT

This project deals with the design and construction of a device that would switch to an alternative source of power i.e. from PHCN to generator automatically and vice versa

The project was realized using a of step-down transformer, rectifiers, Resistors, Voltage regulators, 555 timers, Diodes, Capacitors, Relays, Light emitting diodes, Circuit breaker and Volt meter.

With the epileptic power supply in our country, the importance of this project cannot be under estimated both in small houses and big organizations, as it would help not only in saving stress and time, but also help in protecting household and office equipment, which is among the primary functions of engineering

The design, construction and testing of this automatic change-over system are discussed, also conclusion and recommendation based on the information gotten from the research carried out is given.

TABLE OF CONTENTS

TITLE PAGE i

DEDICATION iii

DECLARATION IV

ACKNOWLEDGEMENT V

ABSTRACT VII

TABLE OF CONTENTS VIII

LIST OF FIGURES XI

CHAPTER ONE

1.0 INTRODUCTION 1

1.1 PROJECT AIMS AND OBJECTIVE 3

1.2 TARGET BENEFICIARIES 3

1.3 METHODOLOGY 3

CHAPTER TWO

2.0 LITERATURE REVIEW 5

2.1 MANUAL CHANGE-OVER SWITCH 5

2.2 AUTOMATIC CHANGE-OVER SWITCH 6

2.3 THE PURE RELAY SWITCHING (AND CONTACTORS) 6

2.4 THE COMPONENTS OF AN AUTOMATIC CHANGE-OVER SYSTEM 8

2.4.1 THEORITICAL BACKGROUND OF TRANSFORMERS 9

2.4.2 THERITICAL BACKGROUND OF RELAY 11

2.4.2.1 DESIGN AND PRINCIPLE OF OPERATION OF A RELAY 12

2.4.2.2 TYPES OF RELAY 12

2.5 THEORITICAL BACKGROUND OF A 555 TIMER IC 14

2.6 THEORITICAL BACKGROUND OF A RESISTOR 16

2.6.1 RESISITOR VALUE AND COLOUR CODE 16

2.6.2 VARIABLE RESISTOR OR POTENTIOMETER 19

2.7 THEORITICAL BACKGROUND OF DIODE 20

2.8 THEORITICAL BACKGROUND OF CAPACITOR 20

2.9 VOLTAGE REGULATOR 21

2.9.1 THEORITICAL ACKGROUND OF VOLTAGE REGULATOR 21

CHAPTER THREE

3.0 COMPONENTS SELECTION AND COMPUTATIONAL RESULTS 23

3.1 SELECTION OF COMPONENTS 23

3.2	CIRCUIT BREAKER DESIGNS	23
3.3	RELAY DESIGNS	23
3.4	ELECTRONIC TIMER	24
3.5	RESISTOR	25
3.6	CONDUCTOR DESIGN	25
3.7	CONTROL CIRCUIT POWER SUPPLY	25
3.7.1	TRANSFORMER	25
3.7.2	RECTIFIER	27
3.7.3	CAPACITOR	27
3.7.4	VOLTAGE REGULATOR	27
CHAPTER FOUR		
4.0	TEST/OBSERVATION	29
4.1	RESULTS	30
4.2	DISCUSSION OF RESULTS OBTAINED	30
CHAPTER FIVE		
5.0	RECOMMENDATION AND CONCLUSION	31
5.1	RECOMMENDATION	31

5.2 CONCLUSION 31

REFERENCES 32

LIST OF FIGURES

FIG 1.1BLOCK DIAGRAM OF THE AUTOMATIC CHANGE-OVER SYSTEM 4

FIG 2.1 STEP DOWN TRANSFORMER 9

FIG 2.2 AN IDEAL TRANSFORMER 10

FIG 2.3 PHYSICAL VIEW OF A RELAY 11

FIG 2.4 LATCHING RELAY WITH PERMANENT 13

FIF 2.5 A 555 TIMER IC 14

FIG 2.6 A MONOSTABLE 555 TIMER CIRCUIT DIAGRAM 15

FIG 2.7 A STABLE 555 TIMER CIRCUIT DIAGRAM 15

FIG 2.8 RESISTOR 16

FIG 2.9 A LINEAR RESISTOR 18

FIG 2.10 VARIABLE RESISTOR 19

FIG 2.11 DIODE 20

FIG 2.12 CAPACITOR 20

FIG 2.13 SYMBOL OF A CAPACITOR 21

FIG 2.14	A REGULATOR	22
FIG 3.1	THE DELAY CIRCUIT	24
FIG 3.2	COMPLETE AUTOMATIC CHANGE OVER SWITCH CIRCUIT DIAGRAM	28

CHAPTER ONE

1.0 INTRODUCTION

The need for continuous power supply and its reliability has increased rapidly over the years, especially in all those areas where uninterrupted power supply is a must. Modern systems are power dependent. Their complexity has increased as continuous information and communications are needed to control automated process, be in industries, commercial complexes, hospitals, hotels or even modern residences. The need, as such, for independent standby power system has therefore increased manifold. The power distribution, control, monitoring and protection of standby power systems need to be integrated.

Power instability in developing countries creates a need for automation of electrical power generation or alternative sources of power to back up the utility supply. This automation is required as the rate of power outage becomes predominantly high. Most industrial and commercial processes are dependent on power supply and if the processes of change-over are manual, serious time is not only wasted but also creates device or machine damage from human error during the change-over connections, which could bring massive losses.[1]

Standby generator systems, for example are required to serve:-

Sensitive Loads- are supplied by UPS systems. The period of non-availability of power, before the standby supply takes over, is bridged by battery banks. Typical loads are computers, hospital equipments, micro processor controlled industrial machines etc.

Critical Loads- thesemostly involve standby generator systems which supply power to lighting systems, air conditioning, elevators etc in Airports, Hotels and commercial complexes.

Essential Loads- thesealso use standby generator systems mostly in process industries as they relate to high restarting times or high down times. Automatic transfer from mains supply to standby supply is vital for all the above kinds of loads.[2]

In the event of power failure, the standby power is usually expected to take over automatically. Electrical starting equipment, battery bank and diesel generator are required for the automatic operation. The automatic transfer is achieved mostly by automatic mains failure systems. The process of on-load transfer has to be monitored and controlled for a smooth Changeover and within safety limits of all elements of the system. This is achieved by an Automatic Changeover Switch.

Changeover switches find a wide application wherever the reliability of electrical supply from the utilities is low and they are used in lighting/motor circuits wherever continuity of supply is necessary, for switching to an alternative source from mains supply and vice versa. They are switch disconnectors with independent manual operation capable of making, carrying and breaking currents under normal circuit conditions which may include operating overload conditions and also carrying currents under specified abnormal circuit conditions such as those of short circuit for a specified time.

Automatic changeover switch (also known as automatic transfer switch ATS) is an integral part of a power generation process, allowing smooth and immediate transfer of electric current between multiple sources and load. When the generator is in operation, the transfer switch prevents any feedback current to the load. It also ensures that the different power sources are synchronized before the load is transferred to them. The transfer switch senses when there is interruption if the mains supply remains absent. Fluctuations and voltage drop below a particular level within a specified time in the mains supply will also cause the automatic transfer switch to transfer the load to the generator. The starting of the generator is done by a relay which switches the battery voltage to the ignition coil of the generator. In about a few seconds when the generator is producing full power, the transfer switch disconnects the load from the mains supply and connects it to the generator supply, restoring electricity to the load. The transfer switch continues to monitor the mains supply and when it is restored, it switches the load from the generator back to the mains supply. Once the generator is disconnected, it goes through a cool down routine and shuts down automatically.[3]

1.1 PROJECT AIMS AND OBJECTIVES

The aims and objectives of this project is to

1. Design and construction of an automatic changeover switch that will switch load from the mains power supply (PHCN supply) to a back-up power supply (generator) with simplicity.

2. Introduction of a circuitry that will sense power outage and at the same time sense fluctuation in power supplied to the load at any point in time.

1.2 TARGET BENEFICIARIES

This project will provide a lasting solution to the heavy losses incurred by commercial institutions, industries, hospitals, airports, etc caused by poor power change-over. It will also be of use in our households because poor power change-over also causes damage to our household equipment e.g. electronics like television, radio, video players and electrical appliances like refrigerators, air conditioners, fans, etc. Poor power change-over can also lead to loss of human life and this project will be designed to eliminate these losses.

1.3 METHODOLOGY

The starting of the generator is done by a relay which switches the battery voltage to ignition coil of the generator, while the main power relay switches the load to either public supply or generator. When there is no supply from the MAINS, the main contactor is disengaged (lines from utility are open) and the voltage relay will close the auxiliary contact to the timer. The timer auxiliary contact will close, thus energizing the main magnetic coil of the generator contactor to the load. Upon sensing supply again from mains, the auxiliary normally open contact (which closes when there is voltage) will de-energize the generator contactor and time in the timer (few seconds), normally open contact will latch and energize the mains contactor coil and closes it. There is also interlocking such that the main contactor will not close if generator contactor is closed and vice versa.

The block diagram depicted in figure 1.1 shows the interaction between the power sources, the control system and the load.

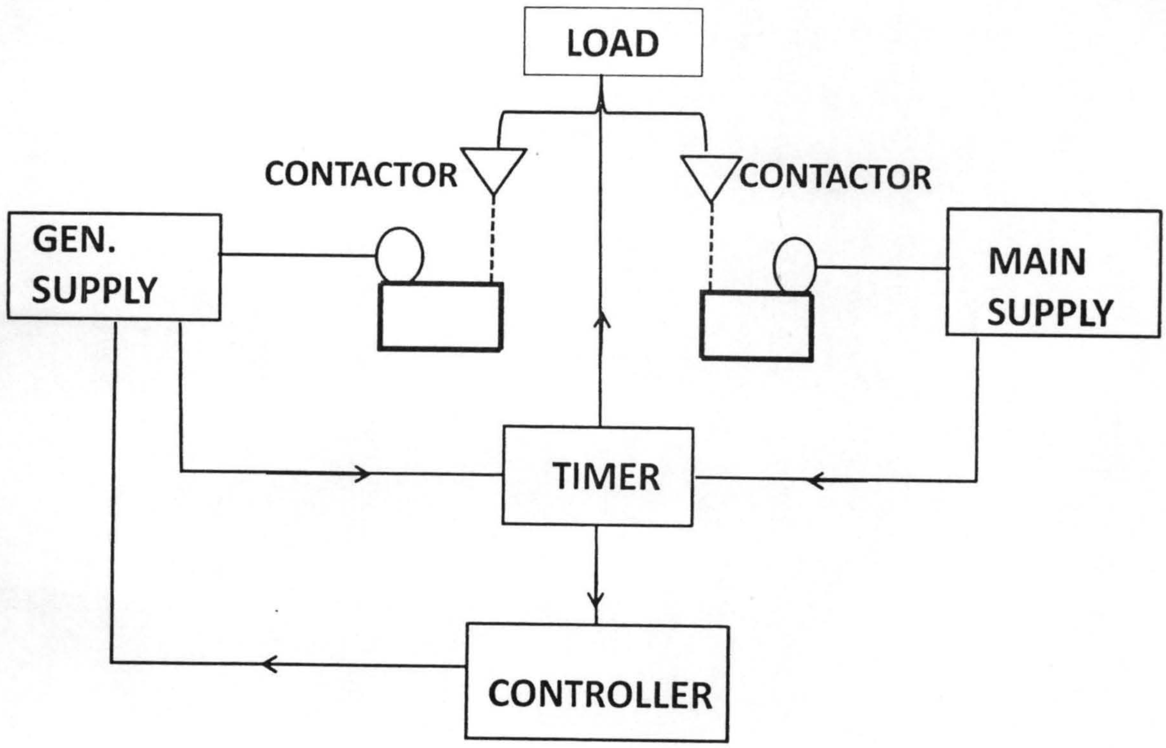


Fig. 1.1: The block diagram of the Automatic Change-over Switch

CHAPTER TWO

2.0 LITERATURE REVIEW

The purpose of this project is to design and construct this unique equipment that provides a solution to the erratic power supply problem we are facing in Nigeria today. The automatic changeover switch can be described as a unique switching system, which can be used to change from one power supply to another as well as maintaining constancy in the supply to a particular network or load. This equipment to be designed and constructed in this project will interface between two different electrical power sources (e.g.the mains supply and the generator).[1]

The main source of supply to the unit is obtained directly from the public supply (PHCN). The Relaying & Triggering system serves as an interface between the public supply and the load; hence the load is not directly coupled to the public supply. The triggering unit is also coupled with the Generator output to provide a connection between the generator and the load. When there is power outage from the public supply, the relay and triggering unit sense the failure in supply and immediately trigger the ignition switch of the generator.

Power change-over switches are of two different mode of operation. Namely:

2.1 MANUAL CHANGE-OVER SWITCH (MANUAL MODE OF OPERATION)

In this mode of operation when there is any mains failure i.e. PHCN outage, there is need for a personnel to start the generator manually and wait till the generator attains synchronous speed. Only after the generator attains synchronous speed can the operator transfer the load to the generator. In the event that the main supply is restored the operator has to transfer the load back to the mains supply and turn off the generator. This is done by manually releasing the changeover breakers. To ensure safety of this operation, the two breakers of the change-over switch must be interlocked. This involves quite a number of personnel as this operation is quite cumbersome. Restoration of power is usually a prolonged process which causes delay. The process may also result in heavy losses and damage could be done to sensitive loads during this manual process.[1] [4]

2.2 AUTOMATIC CHANGE-OVER SWITCH (AUTOMATIC MODE OF OPERATION)

In this mode of operation when there is any mains failure, there is no need of the employment of the personnel as the change-over switch will start the generator automatically upon it sensing power from the mains supply and thereafter switches the load to the generator supply upon it attaining synchronous speed. Upon restoration of the mains supply, the switch again senses it and transfers the load back to the mains supply.

The type of automatic changeover switch used which differs from the other (semiconductor controlled switching type) in terms of the type of load transfer or switching panel is the **pure relay switching type.**[4][5]

2.3 THE PURE RELAY SWITCHING (AND CONTACTORS)

This design of load transfer panel makes use of mainly relays and contactor combination. Its operation is based on the hierarchical rank of contactor relays. It consists of some relays which serves several purposes. These are -

1. Mains contactors- it carries the bulk of the load with the aid of its auxiliary. When the mains supply (PHCN supply) is ON, the mains contactor responds to the input by closing its contacts which enables it to get energized causing indicator lamps on the panel to illuminate. Illumination of these lamps indicates that the mains supply is ON.

2. Mains auxiliary contactor- it is usually present in the generator circuit. When there is power outage in the mains supply, the contacts of the mains auxiliary contactor which are in the generator circuit close thereby sending a signal to start the generator.

3. Generator contactor- after starting the generator automatically, the load is then transferred to the generator via the generator contactor.[1]

4. Generator auxiliary contactor – it is the generator auxiliary contactor that is responsible for ensuring that only a power source gets to the load at a point in time. When there is mains supply failure, it breaks the mains supply line to the load before the generator line is activated. Upon restoration of the mains power supply, the generator auxiliary again breaks the generator line before the load is transferred to the mains supply.[6]

Because this design makes use of relay and contactor combination, it is said to have the following advantages:

- It can switch alternating currents.
- It can switch high voltages.
- It is useful when high currents are to be used.
- It can switch many contacts at once. This quantity makes them flexible.

It has the following drawbacks:

- Poor sensing ability to fluctuations due to the fact that relays do not function optimally at low voltages.
- Switching time in the event of mains power supply outage is slow because switching is done on the basis of energizing and de-energizing of the relay coils.
- Relays generate a lot of heat during switching actions which could cause short circuits which are very hazardous.

- Relays draw a lot of power from the supply thereby increasing the overall power consumed by the load.

In times like this, there is really no new invention rather what we have now are just improvement and innovation on fundamental principles of obtaining the desired results. Hence, the automatic changeover switch that is designed and constructed is an improvement on what others have done over the years. A past project was designed such that is being supplied from just three power sources.

The present design is such that it would take two different sources simultaneously and also give preference to this power sources with the unique ability to ensure that there is always power supply to the load at all times.[7]

2.4 THE COMPONENT OF AN AUTOMATIC CHANGEOVER SYSTEM.

In the course of achieving this project the following component were used: (a) A step-down transformer. (b.) Rectifiers (c.) Resistors (d.)Voltage Regulators (e.) 555 timers (f.) Diodes (g.)Capacitors (h.)Relays (i.)Light emitting Diodes (j.) Circuit breaker (k.) volt meters.

2.4.1 THEORETICAL BACKGROUNDOF TRANSFORMER

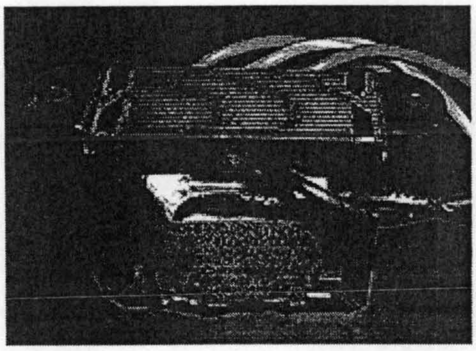


Fig. 2.1 A Step down transformer

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or *primary* winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the *secondary* winding. This varying magnetic field induces a varying electromotive force (EMF), or "voltage", in the secondary winding. This effect is called mutual induction.

If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (V_s) is in proportion to the primary voltage (V_p), and is given by the ratio of the number of turns in the secondary (N_s) to the number of turns in the primary (N_p) as follows:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) voltage to be "stepped up" by making N_s greater than N_p, or "stepped down" by making N_s less than N_p.

In the vast majority of transformers, the windings are coils wound around a ferromagnetic core, air-core transformers being a notable exception.

Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of power grids. All operate with the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for household ("mains") voltage. Transformers are essential for high-voltage electric power transmission, which makes long-distance transmission economically practical[9] [10]

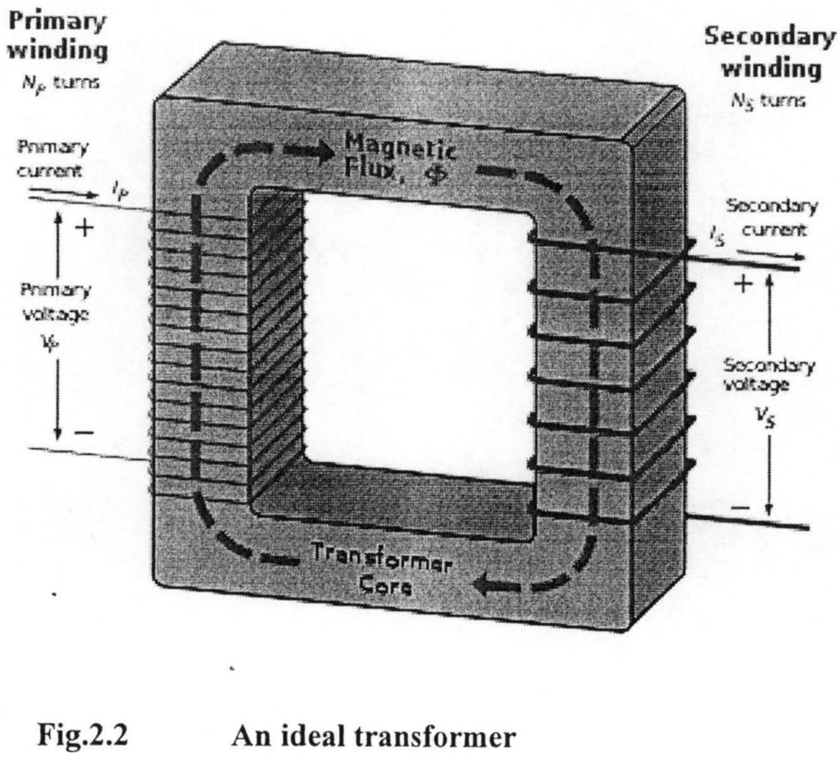


Fig.2.2 **An ideal transformer**

2.4.2 THEORETICAL BACKGROUNDOF RELAY

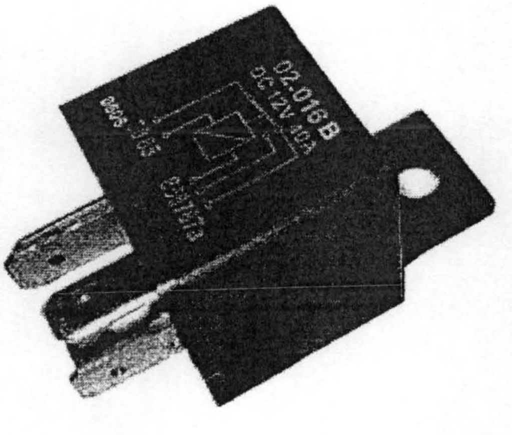


Fig 2.3 A physical view of Relay .

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor is called a contractor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

2.4.2.1 DESIGN AND PRINCIPLE OF OPERATION OF A RELAY

A simple electromagnetic relay consists of a coil of wire surrounding a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts. The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts, it is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit.

When an electric current is passed through the coil it generates a magnetic field that attracts the armature and the consequent movement of the movable contacts either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components.

2.4.2.2 TYPES OF RELAY

A. Latching relay: These are also called "impulse", "keep", or "stay" relays. When the current is switched off, the relay remains in its last state. This is achieved with a solenoid operating a ratchet and cam mechanism, or by having two opposing coils with an overcenter spring or permanent magnet to hold the armature and contacts in position while the coil is relaxed. This type of relay has the advantage that one coil consumes power only for an instant, while it is being switched, and the relay contacts retain this setting across a power outage.[1][7]

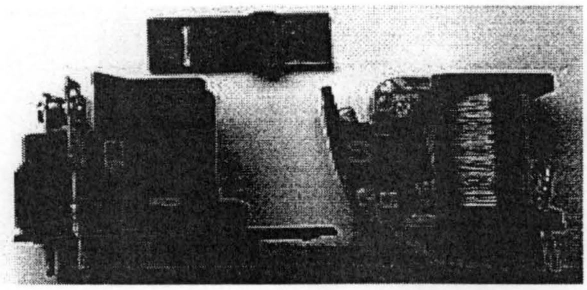


Fig. 2.4 Latching relay with permanent

B. Contractor relay: Contactor is a very heavy-duty relay used for switching electric motors and lighting loads, although contactors are not generally called relays. Continuous current ratings for common contactors range from 10 amps to several hundred amps. A motor starter is a contactor with overload protection devices attached. The overload sensing devices are a form of heat operated relay where a coil heats a bi-metal strip, or where a solder pot melts, releasing a spring to operate auxiliary contacts. These auxiliary contacts are in series with the coil, If the overload senses excess current in the load, the coil is de-energized. Contactor relays can be extremely loud to operate, making them unfit for use where noise is a chief concern.[1][7]

2.5 THEORETICAL BACKGROUNDOF A 555 TIMER IC

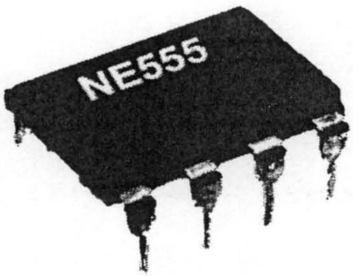


Fig. 2.5 A 555 timer IC

The 555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200mA. 555 timer has the following features: Turn-off time less than 2μs, Max. Operating frequency greater than 500kHz, Timing from microseconds to hours, Operates in both astable and monostable modes, High output current, Adjustable duty cycle, TTL compatible, Temperature stability of 0.005% per °C. It can be useful inPrecision timing, Pulse generation, Sequential timing, Time delay generation, Pulse width modulation

The 555 has three operating modes:

- Monostable mode: in this mode, the 555 functions as a "one-shot" pulse generator. Applications include timers, missing pulse detection, bouncefree switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) and so on.
- Astable – free running mode: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security

alarms, pulse position modulation and so on. Selecting a NTC as timing resistor allows the use of the 555 in a temperature sensor: the period of the output pulse is determined by the temperature. The use of a microprocessor based circuit can then convert the pulse period to temperature, linearize it and even provide calibration means.[4] [5]

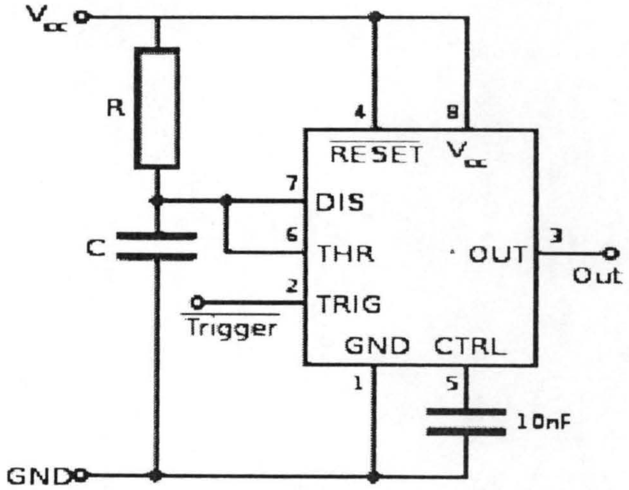


Fig. 2.6 Amonostable 555 timer circuit diagram

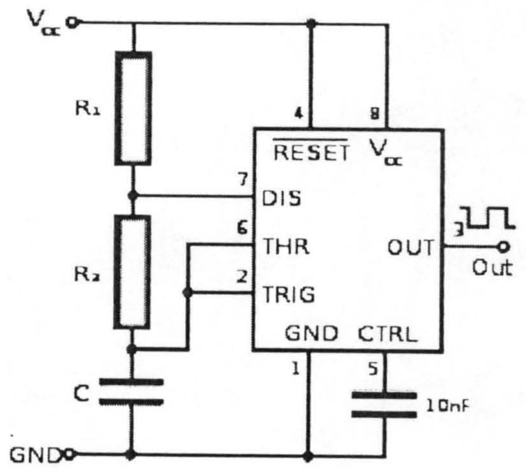


Fig. 2.7 A Astable 555 timer circuit diagram

2.6 THEORETICAL BACKGROUNDOF A RESISTOR

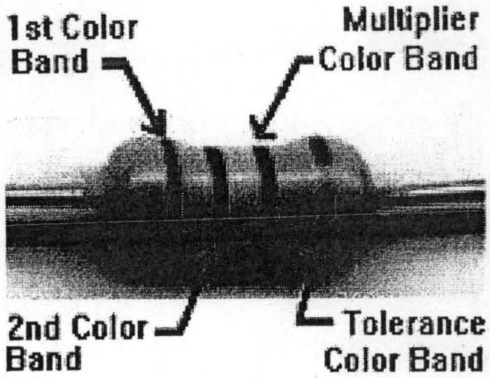


Fig. 2.8. Resistor

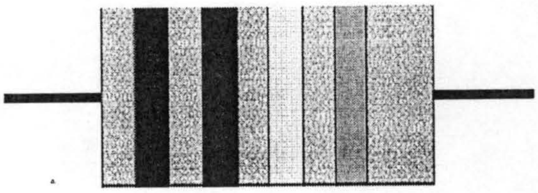
2.6.1 RESISTOR VALUE AND COLOUR CODE

Resistance is measured in ohms, the symbol for ohm is an omega (Ω), 1 Ω is quite small so resistor values are often given in kΩ and MΩ.

Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Most resistors have 4 bands:

- The first band gives the first digit.
- The second band gives the second digit.
- The third band indicates the number of zeros.
- The fourth band is used to shows the tolerance (precision) of the resistor, this may be ignored for almost all circuits.



This resistor has red (2), violet (7), yellow (4 zeros) and gold bands. So its value is 270000 Ω= 270 kΩ

A **linear resistor** is a two-terminal, linear, passiveelectroniccomponent that implements electricalresistance as a circuit element. The current flowing through a resistor is in a direct proportion to the voltage across the resistor's terminals. Thus Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than 9 orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinks. In a high voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

Practical resistors include a series inductance and a small parallel capacitance; these specifications can be important in high-frequency applications. In a low-noise amplifier or pre-amp the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology. A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.[6] [8]

FIG. 2.9 A LINEAR RESISTOR

2.6.2 VARIABLE RESISTOR OR POTENTIOMETER

A potentiometer informally, a pot, is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider, current divider or other devices. If only two terminals are used (one side and the wiper), it acts as a variable resistor or rheostat. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick.[4] [5]

Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load (see infinite switch). Instead they are used to adjust the level of analog signals (e.g. volume controls on audio equipment), and as control inputs for electronic circuits. For example, a light dimmer uses a potentiometer to control the switching of a TRIAC and so indirectly control the brightness of lamps.[6] [9]

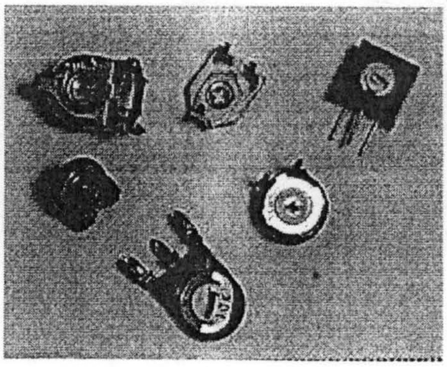


FIG. 2.10 VARIABLE RESISTORS

2.7 THEORETICAL BACKGROUNDOF DIODE

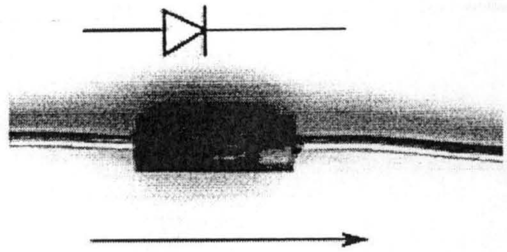


Fig. 2.11. A Diode

A diode is an electrical device that conducts electricity in one direction, it neither conducts in a forward direction with zero resistance nor it offers infinite resistance in the reverse direction. In the forward direction, the forward current does not start flowing until the voltage applied to the diode exceeds its threshold or knee voltage, while in the reverse direction; there is no infinite resistance because it will always have some reverse saturated current prior to breakdown .

2.8 THEORETICAL BACKGROUNDOF CAPACITOR

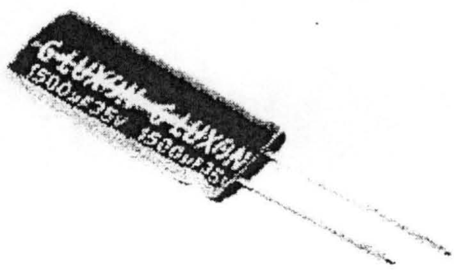


Fig. 2.12 A Capacitor

A capacitor essentially consists of two conducting surfaces separated by a layer of an insulating medium called dielectric. The conducting surrounding will be in form of either circular plates or be a spherical or cylindrical shape. The purpose of a capacitor is to store electrical energy by stress in the dielectric, and it is measured in farad.[7]

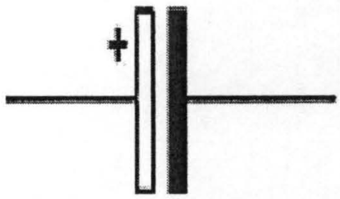


Fig. 2.13 Symbol of a capacitor

2.9 VOLTAGE REGULATOR

The DC output is regulated to 12Vdc using a regulator of 7812. A 12vdc regulator is use to regulate a constant DC supply to the Relay, because the relay operate at 12vdc.

2.9.1 THEORETICAL BACKGROUNDOF VOLTAGE REGULATOR

A **voltage regulator** is an electricalregulator designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedbackcontrol loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC orDC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line [13].

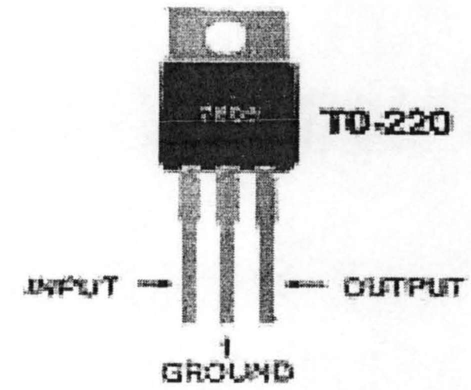


Fig. 2.14 A regulator

CHAPTER THREE

COMPONENTS SELECTION AND COMPUTATIONAL RESULTS

3.1 SELECTION OF COMPONENTS

This design is intended to power a load of 10kVA

Using the formula = P = IV

Where:

Voltage = 230V

I is Full load current

I = P/V

Calculating current

I = 10KVA/230 = 43.48A

3.2 CIRCUIT BREAKER DESIGN

The breaker to be used for the power circuit must have a rating of more than 15A. For this design, a 30 Amps circuit breaker will be used.

For the control circuit, the breaker to be used will be a 6Amps single pole breaker. This is because the current in the control circuit is measured in mA

3.3 RELAY DESIGN

Relays with the following parameters is used for the design:

D.C rating 10A/12V

A total of four relay were used to accomplished the functionality of the changeover system.

Two relays are responsible for changing over, while the other two are responsible for the starting and turning off the generator.

3.4 ELECTRONIC TIMER

These components work with single phase voltages. Their operating voltage should be:

$$\frac{415V}{\sqrt{3}} \approx 240V$$

A 555 timer IC is introduce for time delaying of the change over, and the 555 timer is connected in Bistable Mode.

In bistable mode, the 555 timer acts as a basic flip-flop. The trigger and reset inputs (pins 2 and 4 respectively on a 555) are held high via Pull-up resistors while the threshold input (pin 6) is simply grounded. Thus configured, pulling the trigger momentarily to ground acts as a 'set' and transitions the output pin (pin 3) to Vcc (high state). Pulling the reset input to ground acts as a 'reset' and transitions the output pin to ground (low state). Pins 5 and 7 (control and discharge) are left floating.[4] [5]

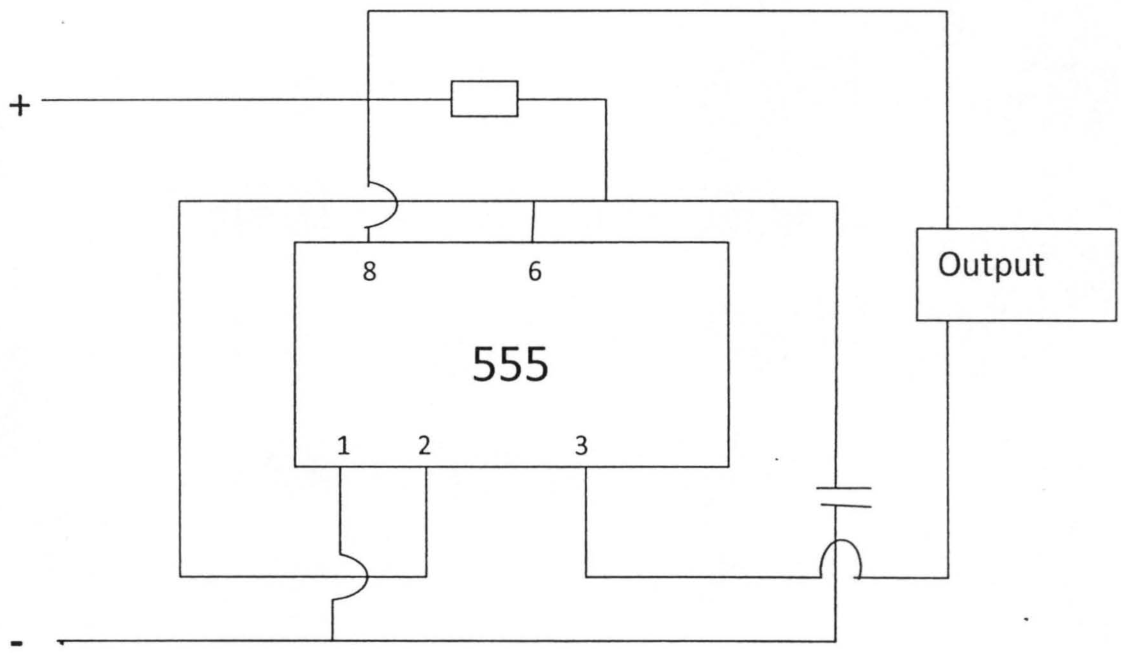


Fig. 3.1The Delay Circuit

3.5 RESISTOR

A 500kohms variable resistor is use in the delay circuit, this is use to regulate the current needed to charge the circuit, the higher the current the quicker the charging of the capacitor vice via.

3.6 CONDUCTOR DESIGN

An approximation sometimes used for design of copper conductor is:

$25mm \times 25mm$ of the conductor will carry 1000A of current.

Since Full Load Current is approximately 43.48A,

Conductor dimension is

$$\frac{625mm^2 \times 43.48A}{1000A} = 27.175mm^2$$

$$r = \sqrt{\left(\frac{A}{\pi}\right)} \qquad \text{-- Eq.3. 1}$$

$$r = \sqrt{\left(\frac{27.175}{\pi}\right)} = 8.65mm$$

Cable diameter is; $d = 8.65 \times 2 = 17.3mm$

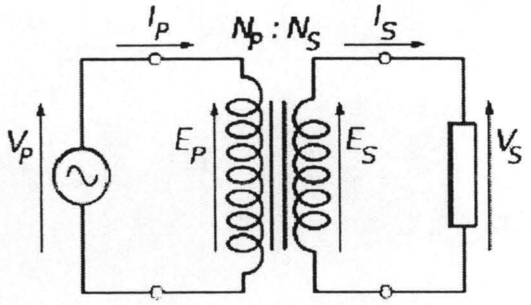
3.7 CONTROL CIRCUIT POWER SUPPLY

The control circuit consist of Transformer, Rectifier, Capacitor, Regulator.

3.7.1 TRANSFORMER

A step down transformer of 220/15volt, 500mA is used to power the control circuit.

Ideal power equation



$$\frac{V_P}{V_S} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

The ideal transformer as a circuit element

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power:

$$P_{\text{incoming}} = I_{\text{p}} V_{\text{p}} = P_{\text{outgoing}} = I_{\text{s}} V_{\text{s}}, \quad \text{------------------------- Eq.3. 2}$$

giving the ideal transformer equation

$$\frac{V_{\text{s}}}{V_{\text{p}}} = \frac{N_{\text{s}}}{N_{\text{p}}} = \frac{I_{\text{p}}}{I_{\text{s}}}. \quad \text{---Eq. 3.3}$$

Transformers normally have high efficiency, so this formula is a reasonable approximation.

If the voltage is increased, then the current is decreased by the same factor. The impedance in one circuit is transformed by the *square* of the turns ratio.[29] For example, if an impedance Z_s is attached across the terminals of the secondary coil, it appears to the primary circuit to have an impedance of $(N_p/N_s)^2 Z_s$. This relationship is reciprocal, so that the impedance Z_p of the primary circuit appears to the secondary to be $(N_s/N_p)^2 Z_p$.

3.7.2 RECTIFIER

A bridge rectifier is use to convert from the ac supply to DC supply.

A bridge is arrangement of diodes, this arrangement gives a full wave rectification of the DC.

3.7.3 CAPACITOR

A 2200uf/35V capacitor is use to filter the ripples from the D.C supply in order to obtain a pure DC output voltage.

3.7.4 VOLTAGE REGULATOR

The DC output is regulated to 12Vdc using a regulator of 7812. A 12vdc regulator is use to regulate a constant DC supply for the control circuit and also for the relay to operate,

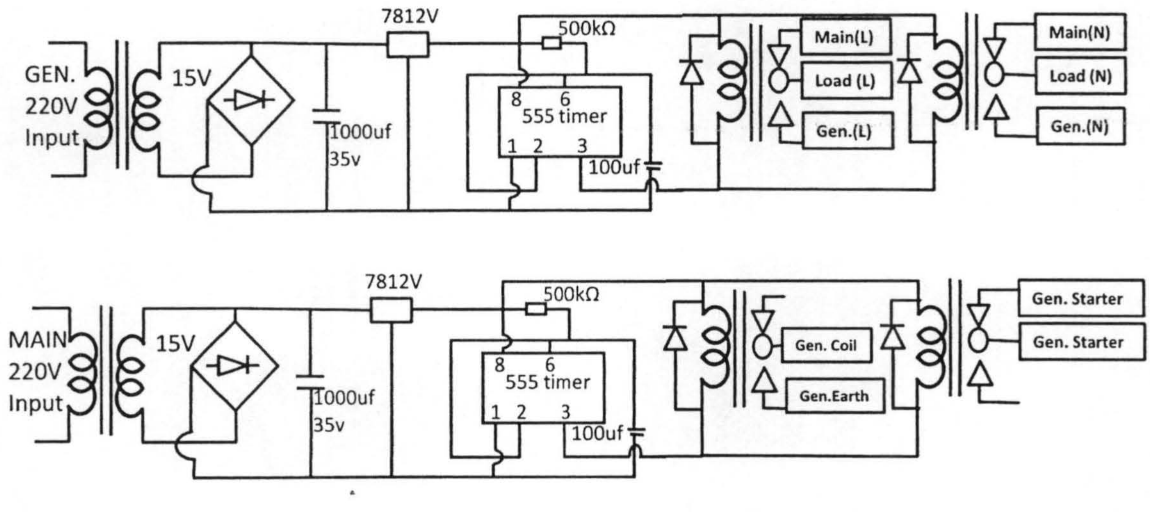
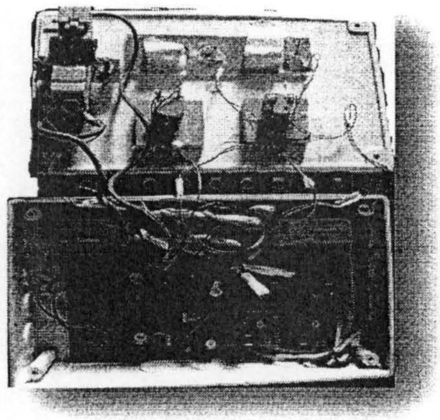
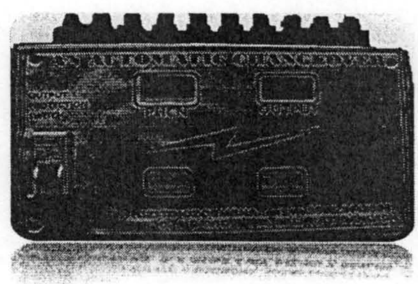


Fig. 3.2 **A complete Automatic change over switch circuit diagram.**



Inside view



Final Construction

CHAPTER FOUR

4.0 TEST/OBSERVATION

The control circuit of the Automatic change-over switch was tested on a Single-phase supply by connecting wires to both the Mains and Generator connectors. It was observed that with the selector switch on the Mains side in the ON position, the mains contactor was energized immediately. When the selector switch was turned to the OFF position representing Mains failure, the Generator contactor was energized with the selector switch on the generator side in the auto position. When MAINS was restored by switching the Mains selector switch back ON, the mains contactor was immediately energized again.

During normal operation, automatic change-over switch suppliespower to the load from MAINS. But when the MAINS supply goes out the Generator immediately starts, but the automatic change over delay for about 30 seconds before changing over to the Generator supply. The purpose of this delay is to allow the generator run for a while to gain its maximum capacity before the load is connected to it.

In the course of running on Generator, the Main(PHCN) is restored, the Generator do not turn off immediately, there will be another delay for about 30 seconds before the Generator is then turn of and automatically change over the MAIN supply. The delay is to make sure the MAIN (PHCN) is stable before the automatic change over is done.

4.1 RESULTS

All tests were carried out at a voltage of 240V a.c.

SOURCE(S)	DELAY TIME	OUTPUT VOLTAGE (V)
PHCN	30 seconds	234.9
GENERATOR	30 seconds	237.4

4.2 DISCUSSION OF RESULTS OBTAINED

The testing and result obtained above show that;

Output voltage from the generator is greater than the output voltage from the mains. The above observation shows that there is always a drop in voltage from the nominal value. This voltage drop is as a result of the number of relays that comes into operation during this mode when the unit is powered.

It was also observed that the delay time were actually 30secs as adjusted.

CHAPTER FIVE

5.0 RECOMMENDATION AND CONCLUSIONS

5.1 RECOMMENDATION

The automatic changeover switch is needed in every home because of the following advantages:

- its reliability
- its durability
- it is affordable
- Its ability to provide immediate automatic switching from the public power source to other sources.

It is recommended that further work be done on this changeover switch on a larger scale, for instance an automatic change-over switch that can cater for an estate.

5.2 CONCLUSIONS

The automatic changeover switch has immense advantage in every area where power is required. It is a fact that there is hardly any aspect of human life where electrical power is not required, at homes, offices, hospitals, etc.

It finds a wide application scope wherever the reliability of electrical supply from the utilities is low and is used wherever continuity of supply is necessary, for switching to an alternative source from main supply and vice versa.

REFERENCES

1. S. H. Darlington, National Semiconductor, Megraw-hill Publishing Company Ltd. (1994) pp105-110.
2. http://www.wikipedia.com/wiki/voltage_regulator
3. A. P Melvino, Electronics Principles, 6th Edition, TatuMc Grans-Hill Publishing Comppany Ltd pp 92-97.
4. T. I Floyd, Electronics Fundamentals, Circuits, Devices and Application, 7th Edition, Pearson Education International, New Jersey pp 806-815.
5. P. H Beards, Analogue and Digital Electronics, 2nd Edition, Pitman and Sons Ltd, London (1982) pp 375-378.
6. A. Stagnant, A Practical Technology of Power Transformer, 10th Edition (1973) Butterworth Group London 155-157.
7. http://www.wikipedia.com/wiki/autotransformer
8. B. L. and A. K Theraja, A Text Book of Electrical Technology, S Chand (6th Edition), New Delhi pp 1025-1030.
9. Prof. F. O. Usifo, Research Project Implementation Made in Electrical and Electronics Engineering 11th Edition, ECAS Nig. Ltd. Pp 156-157
10. E. Hughies, Electrical Technology, Longman Group, England (1985) pp 191-197
11. V. K Mehta, Principles of Electronics, S Chand (4th Edition), New Delhi pp 345-350
12. Power Electronics Lecture Note
13. G. S. Brown, Electrical Engineering Know it all, Longman Group(2nd Edition), England pp 289-300