DESIGN AND CONSTRUCTION OF A SINGLE PHASE AUTOMATIC CHANGE OVER SWITCH

BY

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DECLARATION

I, Osoku Ikuwoga hereby declare that this project was wholly and solely conducted by me under the the supervision of Mr. O. J. Tola in the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

OSOKU IKUWOGA (2003/ 15256EE)

DATE

CERTIFICATION

This is to certify that the project was designed and constructed by Osoku Ikuwoga.

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DEDICATION

This project work is dedicated to my Lord and personal Savior Jesus Christ.

ACKNOWLEDGEMENT

I am indeed grateful to God who by His mercy and grace made me to pass through this University.

Sincere thanks to my lecturers in the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

Thanks to some of my colleagues who studied hard with me throughout my course of study. I am indeed grateful.

THANKS TO MY UNCLE AT HOME DR. EMMANUEL NAIRA ATANYI who had financially and morally supported me. I am grateful to the entire University community.

ABSTRACT

In Nigeria today, there had been a problem of constant power failure which is affecting many industries and firms in production and manufacturing of goods and services. Domestic activities also suffer this effect.

For this reason the design and construction of a device which will minimize this power failure to an extent is carried out.

The Automatic Change-over Switch is a device designed to switch from the utility e.g. PHCN to generator where there is power failure from the utility and it will switch back to PHCN when the utility is on.

The process by which this performs its function is by the means of relays which switches on and off automatically.

This project explains in detail the operation of the circuit and other systems involved.

TABLE OF CONTENT

CHAPTER ONE

1.1 INTRODUCTION

For more than a century mankind has depended on electricity to the extent that he

can now hardly survive without it.

Mr. Gordon Chapp a former General manager of the tenness Valley authority in the United States of America (U. S. A) once said that "if you would destroy a region, you destroy its power supply, if you would hold a region to a lower standard of living you can do it by placing a limit on its supply of electric power."

Since about 1879 when Thomas Edison invented electric bulb, man has mot relented in his endeavor to find other uses for electricity, he has used it as a labour saving device in agriculture, in medicine and in industry, for comfort and for preservation in the home, and indeed for the satisfaction of the widest possible spectrum of human needs in all that versatility of electric power has given him the greatest dominance he now exercises over nature.

However, electricity generation and distribution in a developing country like Nigeria is not without the problem of continual power outages. These outages cause a lot of loss socially, economically etc. for instance, in a hospital where electric power is needed to help a patient who is on a life saving device (e.g. an oxygen mask) to keep the patient living. But with power outage, the life of the patient if not restored back quickly, this will subsequently result in the death of the patients.

The use of generators now comes into focus as an alternative to the power supplied by Power Holding Company of Nigeria (PHCN) in case of Nigeria. Generators can be switched on either manually or by automatic means, to serve as alternative power source on the failure of power supply, from the utility.

Switching the generator normally, however, has the disadvantages of being tasking and time consuming, especially if the set is located some distance away from the point of usage (which is not common). Hence, there is the need to design an automatic change over switch.

From the McGraw Hill Dictionary of Science and Technical Terms, a change over switch is defined as "A means of moving a circuit form one set of connection to another." [1]

From this definition, it implies that an "Automatic Change Over Switch" is a means of moving a circuit from one set of connection to another by automatic means.

The automatic change over switch requires no human effort as compared with the normal change over switch. This makes it less tasking, and time saving as switching designed previously are quite expensive because it incorporate the use of high voltage contactors and relays to achieve switching.

However, this project is designed in order to minimize cost by using low voltage dc relays, and to achieve high efficiency.

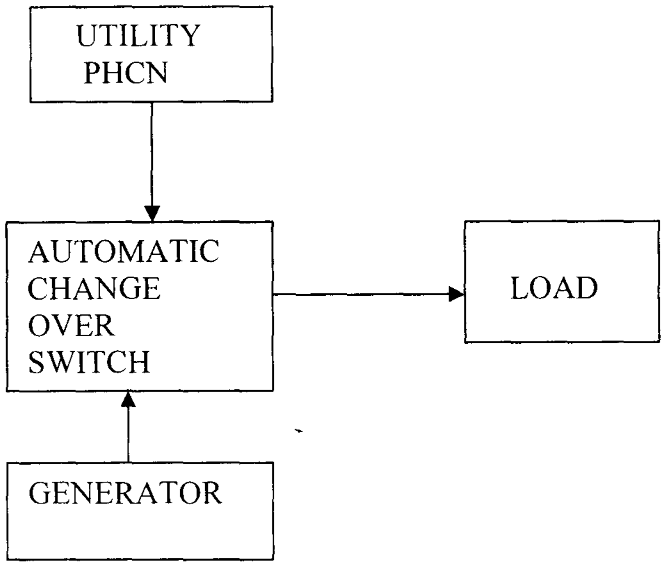

Fig 1.1 Block Diagram of the System

Fig. 1.1 shows the block diagram of the Automatic Change-over Switch connected to the generator, the utility and the load.

1.2 PROJECT OBJECTIVE

The aim of this project is to bring to a halt the failure of power supply at any time as this affects many activities in industries and commercial centre.

This can be done by the connection of this project design and construction of an Automatic Change-over switch in between the utility and a stand-by generator. It will be observed that during PHCN failure there will be a switch back to utility, by so doing there will be constant supply of electricity.

1.3 METHODOLOGY

Power Pack

The power pack is achieved by using a 220/12v transformer to step down the PHCN voltage to a suitable voltage for the relays.

Because the relays are dc type, bridge rectifying circuit was used to achieve a pulsating DC. After which a filter capacitor was connected to filter our AC. Free wheeling diodes are connected in parallel with the relays to overcome the effect of back emf produced by the relays.

Electronic Push Switch

This is achieved by the use of 555 IC in conjunction with external component like resistors, capacitors, a diode and relay. The dc supply is connected to pin 8 of the 555 IC while the resetting pin (pin 4) is connected to pin 8. Pin 1 being the ground is connected to the ground. A 0.01μF is connected to pin 5 to avoid any possible oscillation. Pin 7 and 6 are connected to a variable resistor connected in series to a 22KΩ resistor and a capacitor connected to them to achieve the desired time delay. The contact is now connected to 10 KΩ which is connected to the supply. The input pin (i.e. pin 2), is connected at the junction of the contact and the resistor.

The output pin (pin 3) is connected to a relay for starting the generator. A despicking diode is parallel connected to the relay to overcome the effect of back e.m.f.

The line terminal of the generator is connected to the normally close (N.C) of relay 2 while the line terminal of utility is connected to normally open of the same relay with a terminal of the load connected to the common.

The neutral of the generator is connected to the normally close of the relay 1 while the neutral of PHCN connected to the normally open of that same relay with the second terminal of the load connected to their common. There is a circuit breaker in series with the line to safeguard the load in case of overload effect.

The project may not be used for industrial purpose because most industrial machines are three phase based. That is to say this project can be used for laboratory, commercial and domestic purposes.

CHAPTER TWO

2.1 LITERATURE REVIEW

First sight of the change-over switch was during my visit to a bank some years back. This was designed and constructed to be operated normally for the bank stand-by generator.

This system of manual change over switch box switch gear box and connector fuse or cut out fuse. This change over switch box operates the source between the generator and PHCN. This shows that when there is power supply outage from PHCN somebody has to go and put off the generator and then change the source line from generator to PHCN. All this process is taking place inside the change over switch box system.

The switch gear is used to protect the equipment of the building. This shows that there is high voltage from the PHCN when in supply the fuse inside the switch gear will blow off. This will separate 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 PHCN source and switch gear.

In view of the above manual change over switch system that involves manpower by using one's energy in starting the generator and switching from PHCN to generator and vice versa. When the PHCN power supply is being restored and also in the case of operation in hospital, sometimes save some lives from danger by getting the supply from generator as fast as possible.

This was what gave me the impetus to design and construct the automatic change over switch which would solve the problem of manpower and the danger that may be connected during operations in hospital.

Subsequently, in this project, I planned to use power relay but I could not find one. In view of this, I then used 12V DC relay which involved the use of transformer and rectification process. The use of transformer and rectification would not have come into play if it were power relay since power relay can withstand the AC supply directly.

Based on this project, the maximum power rating capacity was found to be 2.4 KVA. This shows that a generator of power rating from 0.24 KVA – 2.4 KVA can be used for this project, since voltage and current rating from data book was found to be 2.4 VDC and 10A contact rating of the relay respectively.

2.2 HISTORICAL BACKGROUND

Power change-over are sometimes inclusive in the buildings electrical wiring. One of the known contributors to electricity was Benjamin Franklin who proved lighting is electrical rod in 1752 [2]. Another was George Ohm who postulated the Ohm's law (V=IR) Yet another was the development of a bulb in 1879 by Thomas Edison [2].He also establish the first power plant in 1881[2]

The first standard commercial electricity supply was made in 1897 known as the electric code [3]. The first successful hydro power project was Niagara falls in the USA [2]. In the beginning of the twentieth century, difference companies in the USA started manufacturing and development of electric building wiring devices, such as the cutter manufacturing company located in Philadelphia and the

National Electric Company (NEC), the produced electric element such as circuit breakers, fuse boxes, power changers and lots more [3]. Their technologies were based on modern electronic controls.

Kon Doh and Toyoshi from Japan in 1975 patented a unique change-over type loading assembly which was designed for non utility power generators. They were installed in high rise buildings or other facilities in or order to deal with situations such as power failures [3]. This invention was concerned with a loading device assembly for dry type testing equipment in which series of resistors made of metal member used for testing purpose without regards for water resistance. The invention was quite significant, but it does not employ advantages of modern electronics.

2.3 PROJECT OUTLINE

The first chapter opens with the power supply in developing countries; how switching was carried out manually and then how automatic switching replaced the manual switching because of its advantage over the later. The advantage this project has over other automatic change over switch incorporate the use of power relays which saves cost.

The second chapter is generally on the theory of the design; it started with different types of switching, then to relays, their functions as used in this project and the types of relays.

The electronic push switching determines the number of seconds (5 seconds in this work) which is required to start the generator and remove the "kick starter" from the circuit.

The third chapter goes in depth with the component calculation and how the values of the component used were determined and the power rating of this project (i.e. 0.24 KVA – 2.4 KVA) was also determined.

Chapter four deals with the construction, casing and packaging of the project. The fifth chapter concludes the whole work with the conclusion and recommendation of the project since in every project there is need for improvement, this aspect is very vital.

THEORY OF OPERATION

2.4 SWITCHING APPARATUS FOR POWER CIRCUIT

DEFINITION: Switching apparatus can be defined as a device for opening and closing or for changing connection of a circuit.

The classification of switching apparatus in this scope includes switches, fuses, circuit breakers and contactor.

However, the focus is on switches since it applies to this work.

2.4.1 SWITCHES

The types of switches normally applied in power circuit include:

i. Disconnecting

ii. Load switch

iii. Safety switch

iv. Transfer switches for emergency power

i. DISCONNECTION SWITCHES

Is used for changing the connection in a circuit or for isolating a circuit or equipment from the source of power for all voltage classes. Interlocking is generally provided to prevent operation when the switching is carrying current. Latches may be required to prevent the switch from being opened by magnetic forces under heavy fault current.

ii. AN INTERRUPTER OR LOAD-BREAKER SWITCH

This is generally associated with unit substation supplied from the primary distribution system; it is a switch combining the functions of disconnection switch and a load interrupter for interrupting, at rated voltage, current not exceeding the conditions current rating of the switch.

iii SAFETY SWITCHES

For services of 600V and below, safety, switches are commonly used. These are endorsed and may be fused or infused. This type of switch is operatable by a handle from outside the enclosure and is so interlocked that the enclosure cannot be opened unless the switch opens or the interlock thereafter is operated. The application of fussed enclosed switches is limited to a current rating not in excess of 80% of the current rating of the same switch without fuses.

IV AUTOMATIC TRANSFER SWITCHES

Of double throw construction used for emergency and stand-by power generation system. These transfer switches do not normally incorporate over current protection. They are available in rating from 30 – 300A. For reliability most automatic transfer switches rated above 100A are mechanically held and are electrically operated from the power source to which the load is to be transferred.

These switches provide protection against failure, continuity of power to critical load can also be disrupted by:

a. An open circuit within the building area on the load side of then in-coming services.
b. Over load or fault condition.
c. Electrical or mechanical failure of electrical power distribution system within the building.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 REGULATED D.C POWER SUPPLIES

If the A.C source of 230V is to be used to power a 12V automatic change over switch or any system, a special device is required to convert the 230V to 12V DC. Such a device is called 12V power supply.

It is worth mentioning here because the regulated DC power supply used for this project is one incorporating a step down transformer of 220/ MV ratings a bridge rectifier used to convert a positively and negatively swinging voltage source to a varying voltage source whose voltage is always positive. Fig 2(a) shows the resulting output voltage wave form when the input voltage to the rectifier is varying sinusoidal, ideal diodes are assumed in this case. A capacitor to serve as the filter placed in parallel to a rectifying diode see fig. 2 (b). It is assumed in this case that the reader has a reasonable knowledge about regulated DC power supply as it will until not be discussed in detail here.

The outstanding feature of regulated and shown in its entirety in fig. 2 (c) is that the output voltage, V_0 is in sensitive to most circuit parameter variation that occurs.

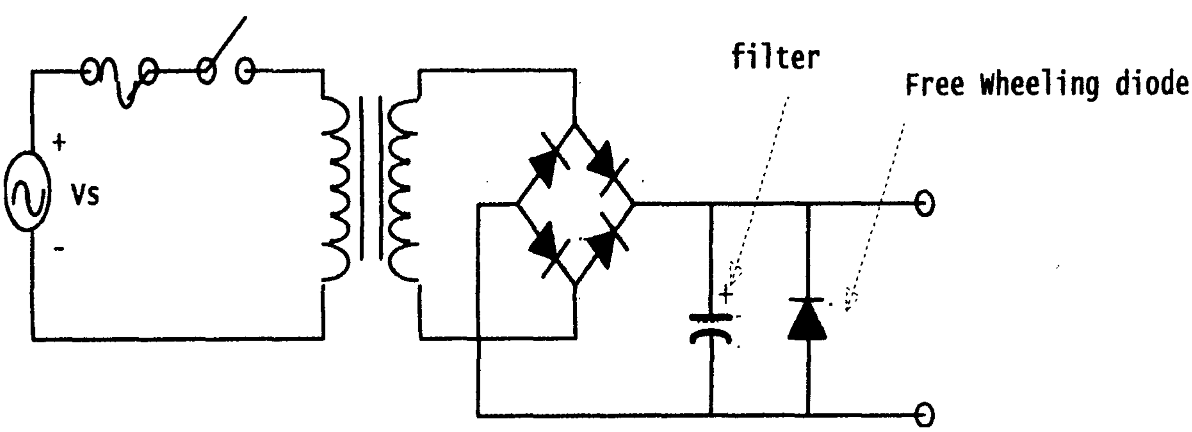

Fig. 2c Circuit diagram of a regulated DC power supply

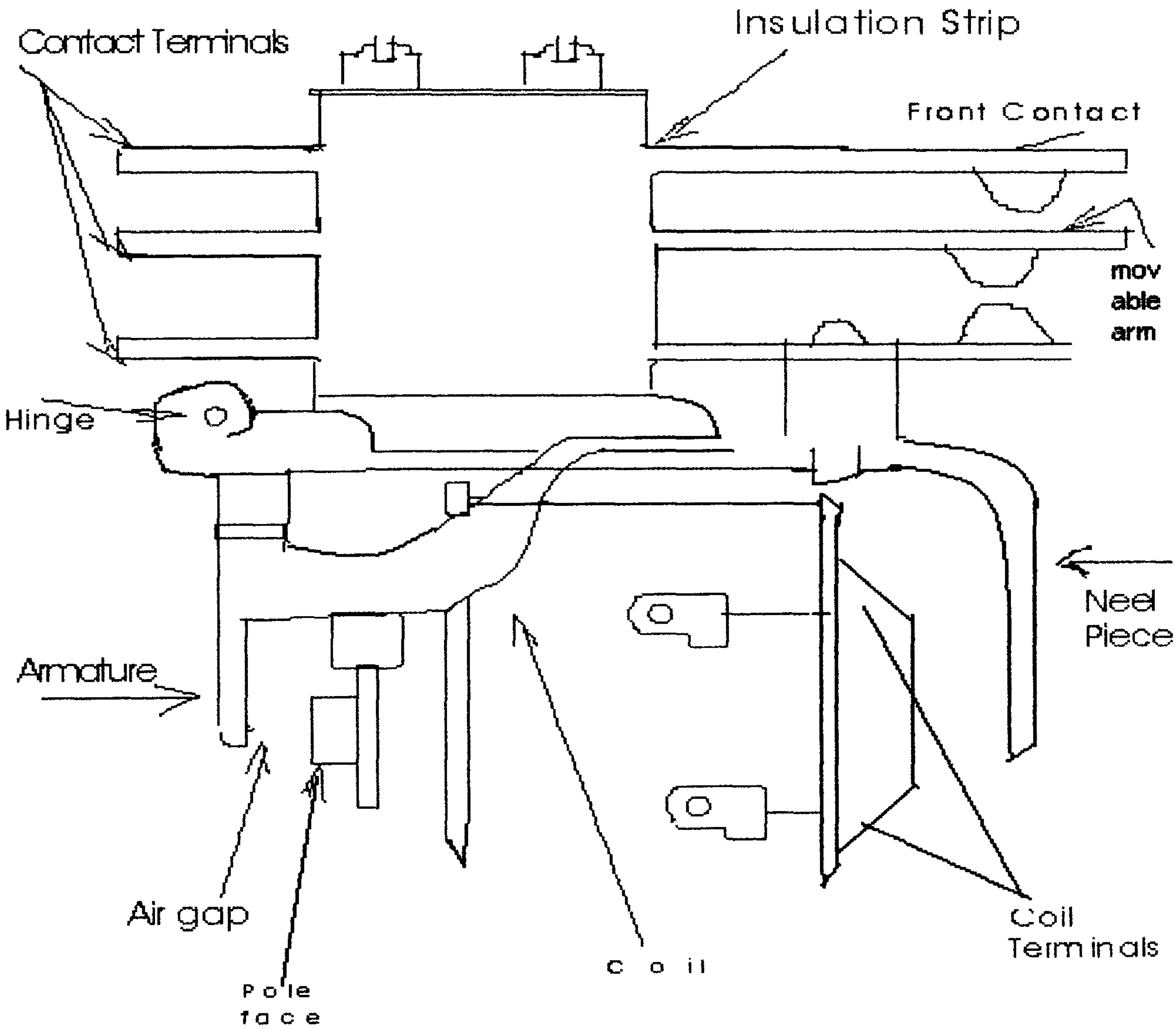

Fig. 2.3.1(b) Structure of a conventional relay

3.2 RELAYS

The primary functions of these electromechanical components namely relay is the transmission and control of electric current accomplished by mechanical contacting and actuating devices in recent years, solid state (non mechanical) switching devices have come into wide use and their applications are extending rapidly.

3.2 RELAY TYPES

The simple diagram of a relay shown in fig. 2.31 (a) illustrates the basic element that constitutes an electromagnetic relay (EMR).

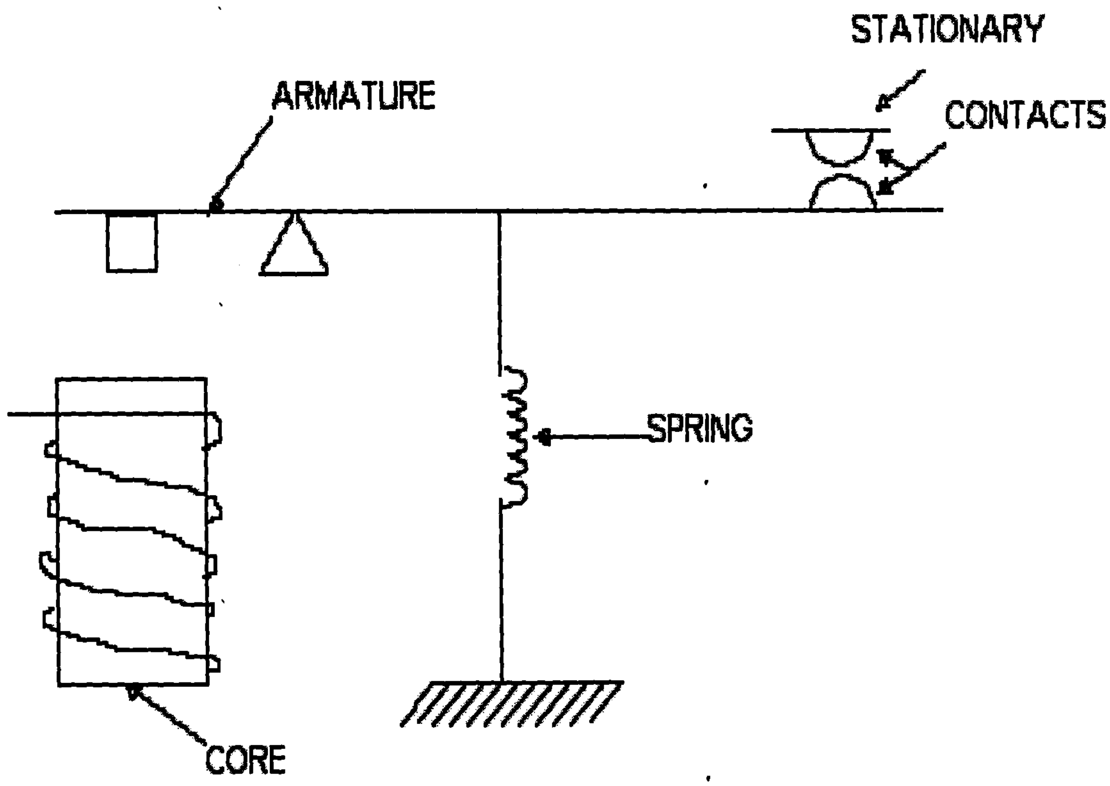

Fig. 2.3.1 Simple diagram of a single-pole double throw normally open relay

The most common EMR types are as follows:

i. GENERAL PURPOSE: Design construction, operational characteristic and rating are adaptable to a wide variety of uses.

ii. LATCHING: Contact lock in other the energized or de-energized position until reset either manually or electrically.

iii. POLARIZED (OR POLAR): operation is dependent upon the polarity of the energizing current. A permanent or magnet provides the magnetic bias.

iv. DIFFERENTIAL: Functions when the voltage current or power different between its multiple winding reaches a predetermined value. Other types include telephone, stepping interlock, sequence, time delay and marginal relay.

The switching system is a device in the circuit that is operated automatically. The contact of a switching device is operated when current flows through the coil, this will result in the attraction of the armature.

The contacts found in the relays used in this project are:

i. Normally closed contact (NC)

ii. Normally open contact (NO)

In this design, five (5) relays are incorporated for use into the design for the purpose of switching.

The relays are used to alternate PHCN and generator. When PHCN is supplying power, relays 1, 2, 3 and 4 are energized and their controls close on the mains terminal for the supply of electricity to the load. At this time, the contacts on the generator terminals are open.

However, when there is utility failure from PHCN, relays 1, 2, 3 and 4 de-energized (since no current from the rectified DC source flows into them). The contacts of the generator terminals are closed as a result of the generator terminals are closed as a result of this and the contacts of the utility line are opened, which is illustrated in fig. 3.1.The electronic push switch will then start the generator and its supply will only be allowed to pass though the load by the relay concerned. This process is called "Automatic change over switching".

The relays used have rating of 12V and 0.03A for the coil and 24V, 10A for the contact detail.

ELECTRONIC PUSH SWITCH

The circuit of the electronic push switch consists of two relays labeled 4 and 5, three resistors, two capacitors and two free wheeling diodes with battery inclusive in the presence of 555 IC (used as a timer).

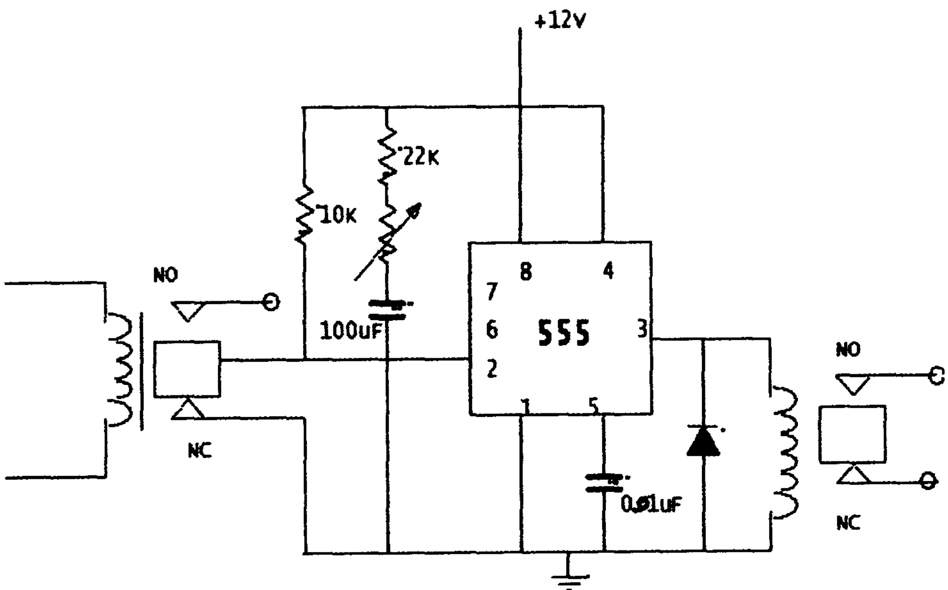

Fig. 2.4 Electronic Push Switch

HOW 555 IC OPERATES TO ACHIEVE TIME DELAY

In fig. 2.6 we see the 555 IC configured to operate as a non table multivibrator. Note that pin 6 (threshold) and pin 7 (discharge) are connected together and placed at the junction of R1 and C1, the external R/C components. Note also that pin 2 (trigger) is pulled High through a 10 KΩ resistor, R2. Switch S1, a normally open push button, acts as our trigger control. When it is momentarily pressed, a negative-going pulse is placed on pin 2. let us see how the circuit works.

When power is first applied, pin 6 and 7 are pulled High through R1. as a result, the upper comparator output a High that reset the flip-flop (step 1 fig. 2.7). The lower comparator outputs a Low, which is placed on the flip-flop's S input. Thus the Q input is Low, as is pin 3. Q is high, however, and transistor Q turns on. Now notice how C1 is connected directly across the transistor. Hence with Q1 conducting it shorts out C1 and brings the junction of R1 and C1 Low to ground. The outputs of the flip-flop stay the same, nonetheless, and pin 3 remains Low.

The trigger input is initially held High through R2. When S1 is pressed, a negative-going pulse arrives on pin 2 the lower comparator's output now goes High (the upper comparator's output is still Low), causing the flip-flop to set (step 3).

As a result, Q goes High and so does pin 3. The timing cycle begins. At the same instant, Q goes Low and turns off transistor Q1. Now C1 is free to charge through R1 and the voltage begins to rise at pin 6 and 7.

When the voltage across C1 reaches two-thirds of the supply voltage the upper comparator outputs a High, the flip-flop is reset, and Q and pin 3 go Low (step 4). The output of the lower comparator is Low, since pin 2, after being triggered has turned to a High through R2. The timing cycle now ends. At the same instant, Q goes High, once again turning on Q1. As a result, C1 is quickly discharged through the transistor. When a negative trigger pulse again appears, the timing cycle begins anew.

A comment is in order regarding triggering and reset. Once the circuit is triggered by a negative-going pulse, the output will go High and remain High until the set time has elapsed (fig. 2.8). even if the circuit is triggered again during this time it will have no effect on the output. Second, the output timing pulse can be terminated at any time bringing pin 4 (reset) Low, thus resetting the flip-flop.

Determining monostable output time.

The High output time for 555 monostable is determined by the simple formula:

$t = 1.1 \times R1 \times C1$

Where t = time in second

1.1 = a constant

R1 = resistance in ohms

C1 = capacitance in farads

INTERNAL VIEW OF 555IC

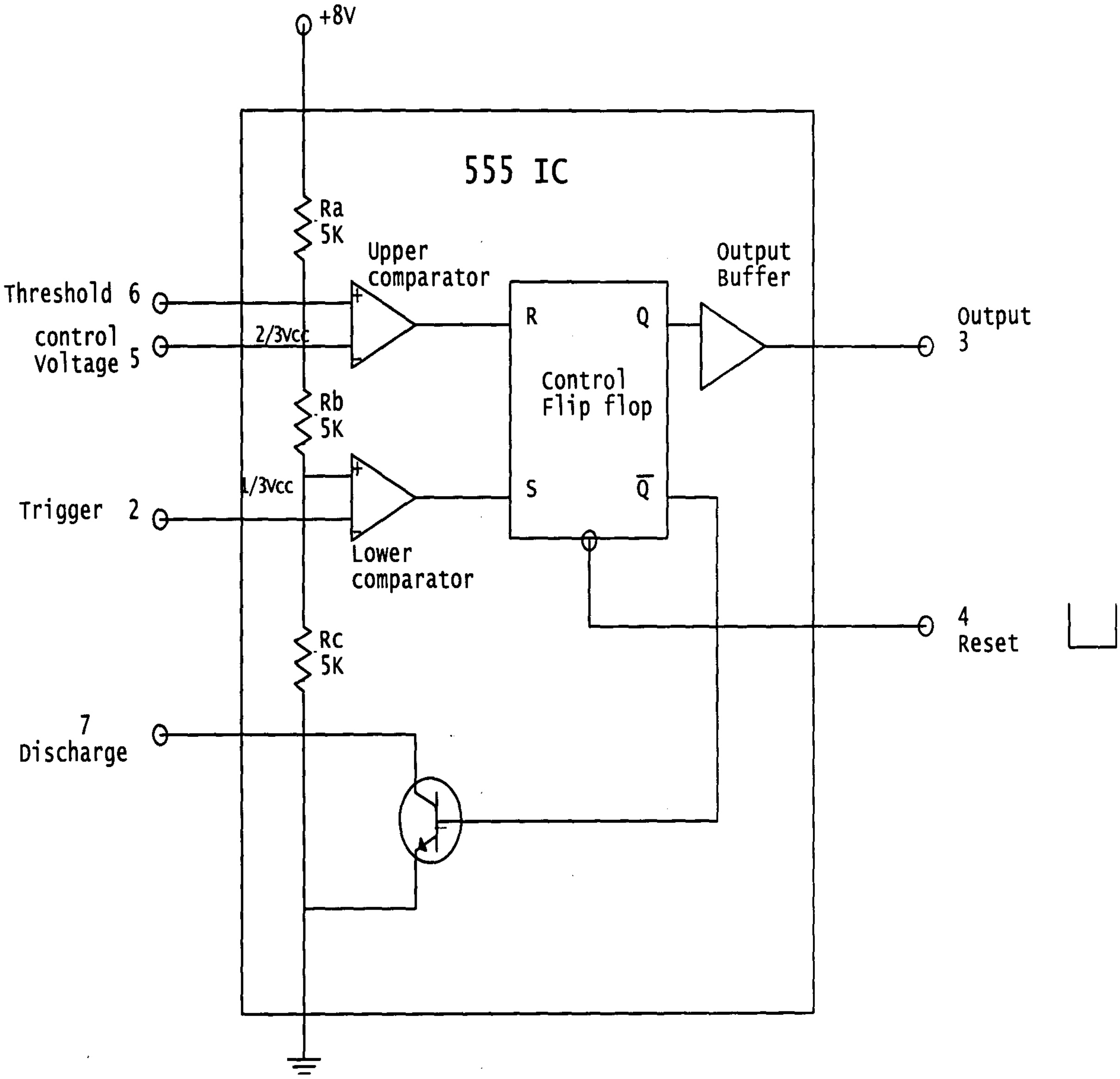

Fig. 2.5 Internal view of 555 IC

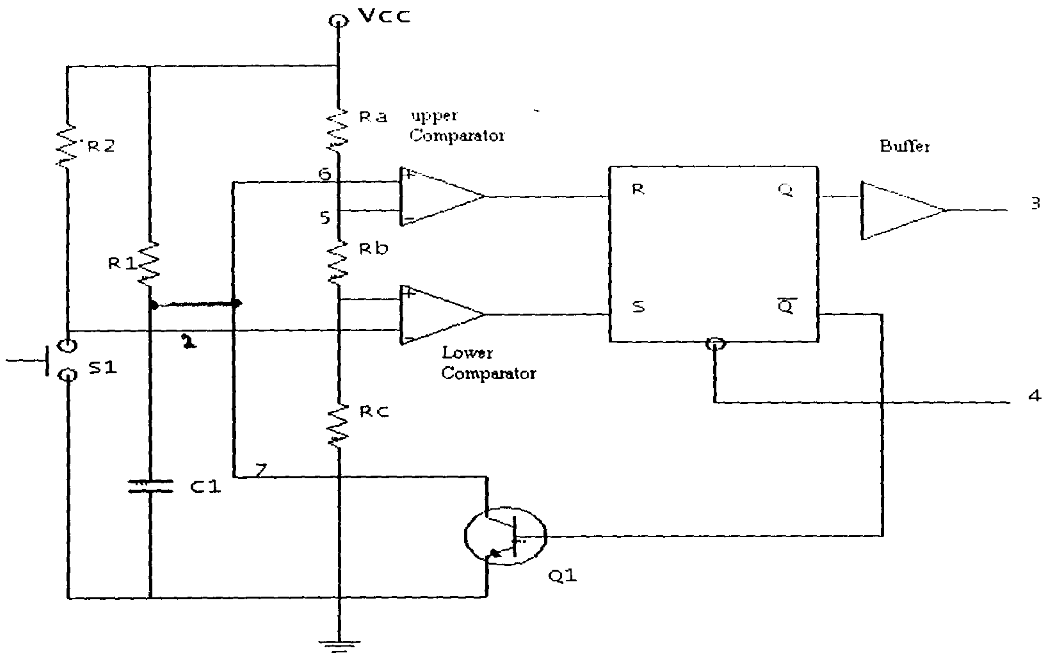

Fig 2.6 555 IC configured for monostable multivibrator

Stages	**Lower comparator**	**Upper comparator**	**R**	**S**	**Q**	$\overline{\mathbf{Q}}$	**Q1**	**Pin 3**
1	0	1	1	0	0	1	ON	0
2	0	0	0	0	0	1	ON	0
3 (trigger)	1	0	0	1	1	0	OFF	1
4 (Rising $^2/_3$ Vcc)	0	1	1	0	0	1	ON	0

Fig. 2.7 the Truth Table of Monostable Multivibrator

PULSE TRAIN OF ABOVE EXPLANATION

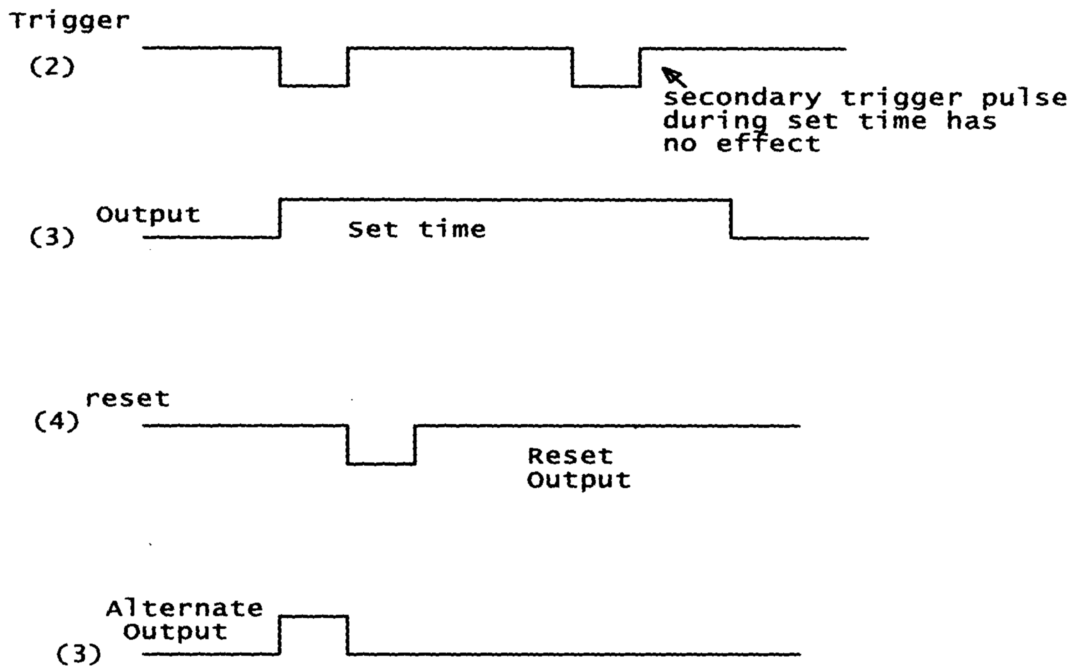

Fig. 2.8 Pulse Train of the Monostable Multivibrator

TRANSFORMER DESIGN CALCULATION

Considering the power of each relay the maximum coil current that will be drawn by the relay becomes:

$V = IR$

$V = 12V, \qquad R = 400\Omega$

$\therefore I = {}^{12}/_{400} \qquad = 0.03A$

Hence the power rating becomes:

$P = IV = 0.03 \times 12 = 0.36W$

Since there are four relays connected on the power supply side, the power draw by the relays becomes:

$4P = 4 \times 0.036 = 1.44W$

$\therefore$ Transformer of 1.44VA or higher is needed for this design.

RECTIFIER DESIGN CALCULATION

A diode peak inverse voltage rating (PIV) of 100V was chosen as the rectifier from the data book. The type of diode used is the IN4002.

The demand diode has the following parameters.

Type	IN4002
Maximum forward voltage V_{fmax}	100V

The demand diode has the following parameters.

Type	IN4002
Maximum forward voltage V_{fmax}	100V
Continuous forward voltage	0.9V

Type	IN4002
Maximum forward voltage V_{fmax}	100V
Continuous forward voltage	0.9V
Peak forward voltage	2.3V
Maximum reverse current	50μA
Continuous for current	1A
Peak forward current	25A

RELAY DESIGN CALCULATION

The contact detail of relay is found in the data book. Printed circuit boards (PCB) mounting miniature relay with single pole change over contact rated 10A, 24V DC coil voltage is 12V. The relay is fully enclosed and contacts are silver.

Coil detail: 10A contact rating

Normal voltage: 12V

Coil resistance: 400Ω

Operating voltage range: 9V – 15V must release voltage 1.2V

Using the contact detail of the relay, the power rating can be calculated thus:

$P = IV$

$= 24 \times 10$

$= 0.24KW$

Coil detail having the voltage of 12V for the relay and coil resistance of 400Ω.

$I = V/R = {}^{12V}/_{400}\Omega\ 0.03A$

Hence the power rating of the generator to which this project can handle is 0.24VA.

Hence the power rating of the generator to which this project can handle is 0.24VA.

SWITCH CIRCUIT CALCULATION

Using time delay of 5 sec

To achieve this:

Let $R1 = 22000 + x$

But $t = 1.1 \times R1 \times C1$

$\therefore 1.1\,(220K + x) \times 100 \times 10^{-6} = 5$

$1.1 \times 10^{-4}\,(22000 + x) = 5$

$(22000 + x) = {}^{5}/_{1.1 \times 10^{-4}} = 45454.5$

$X = 45454.5 - 22000$

$X = 23454.5$

$= 23\ K\Omega$

OVERLOAD PROTECTION CALCULATION

The rating of the circuit breaker = 25A

The maximum power supplied = $P_{max} = IV$

$= 220 \times 25$

$= 5500VA$

$\therefore$ Maximum power to be consumed = 5500W

To calculate the minimum load resistance we use:

$P_{max} = I^2 R1min$

$25^2 R1min = 5500$

$R1min = 5500/625 \quad = 8.8\ \Omega$

$R1min = 8.8\ \Omega$

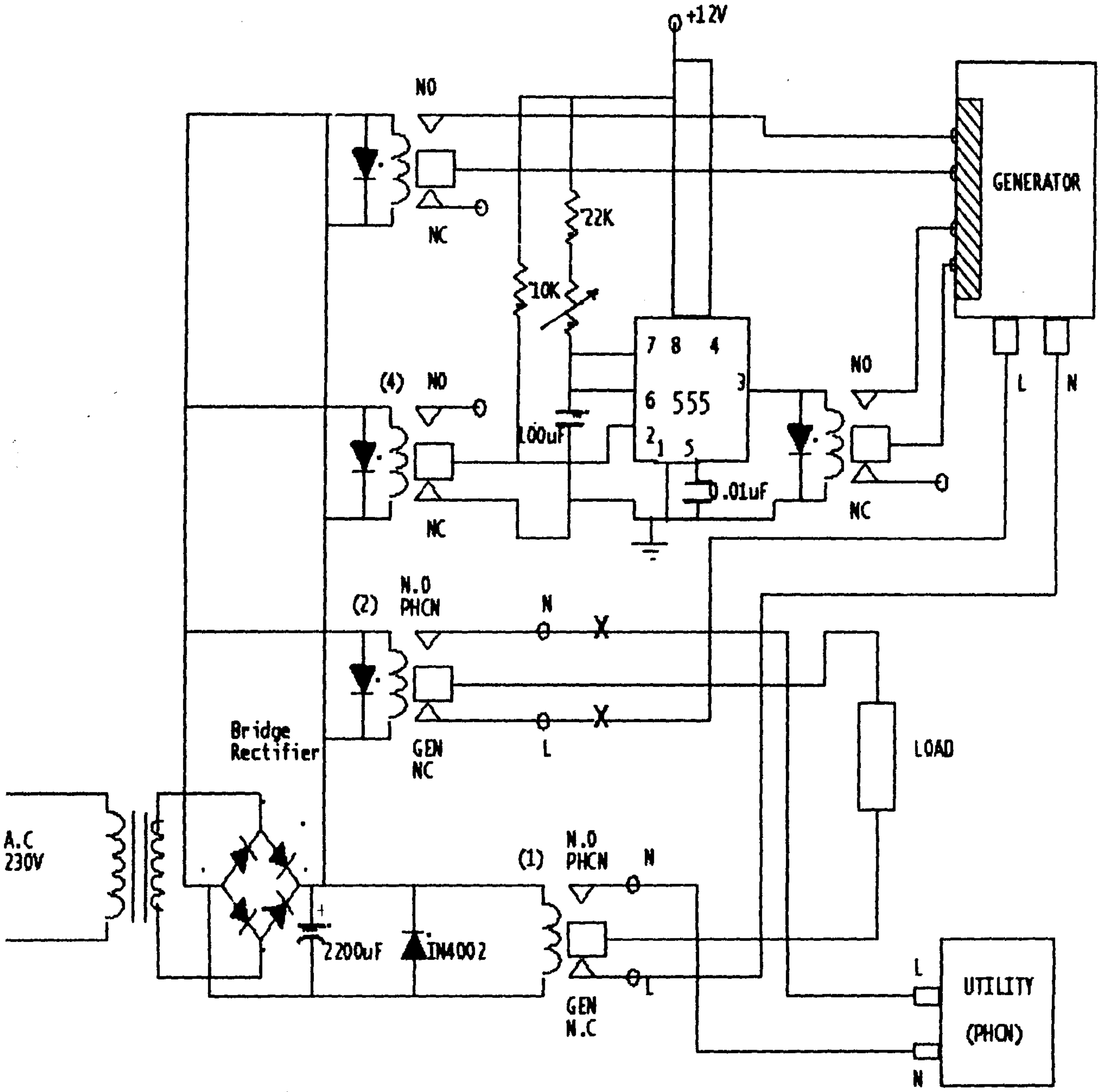

Fig. 2.9 Circuit diagram of single phased automatic change over switc

3.3 CONSTRUCTION

The circuit as shown in fig.2.9 was initially built with connection to a solderless bread board, using connection wires, which gives room for changes to be made if need be and for errors to be located. The system was tested and was functioning to expectation. The whole circuit was later transferred to the Vero board also known as the electronic card where component leads were kept at a minimum, to prevent accidental short circuit. The transfer was achieved with the aid of the circuit layout. Hence the component were mounted and soldered to the Vero board in such a way that anybody looking at the overall circuit can identify different sections with ease.

In reality, the construction was carried out in stages with the 240/12 volts transformer being the first component fixed. The rectifier circuit and its accessories called the rectifier circuit was next to mount. The output voltage of the rectifier, powers the relays by giving it different current of 12V, which is used to change over the contact of the relay. The electronic push switch was mounted as well.

3.4 CASING AND PACKAGING

A metal material was used in casing the circuit. The knowledge of engineering drawing was applied in dimensioning and cutting of the material. The edges were joined together through welding and screwing.

CHAPTER FOUR

TEST RESULT AND DISCUSSION OF RESULT

4.1 TEST

This project was tested by connecting power cable to the socket from the utility. And also the source from PHCN to PHCN input of the project. The ignition terminals were connected to a multimetre, and a battery (12DC) was in turn connected to the terminals of the input of the project.

Though a generator was not available to test with, however the generator input was connected to a stabilizer

When PHCN was supplying, the plug to PHCN was switched on. The indicator shows that PHCN is supplying the load.

When PHCN source was switched off and the PHCN supply was switched on. The indicator shows that PHCN is supplying the load.

When PHCN source was switched off and the PHCN input of the project was switched off, the multimetre deflected for about 5 seconds and then returned back to its initial position of null deflection. This indicates that the ignition was to allow the generator supply its power. The multimetre's deflection for 5seconds and returning back to its original state indicate the ignition was made immediately PHCN went off and then disengages the generator. This is to ensure that the ignition coil is not destroyed due to continuous passage of current through it. By this time, it is expected that the generator is running and would have been supplying power to the load.

By switching on the second power from another phase connected to the generator input terminal, the generator glowed showing the generator was supplying.

4.2 RESULT

The real time it took the ignition to come 'on' and disengage was about 1 second. Ten tests were carried out and can be seen in the table below.

TABLE 4.1

NUMBER OF TESTS	TIME INSECONDS
1	4.60
2	4.80
3	4.60
4	4.60
5	4.70
6	4.60
7	4.60
8	4.60
9	4.40
10	4.30

Average is 4.6 seconds.

This was due to imperfect function of some component in the circuit.

DISCUSSION OF RESULT

The project has been designed and constructed not without hitches. However, the aims and the object was achieved.

The institution of Electrical Engineering (IEE) regulation stipulates that; for the safe utilization of electrical energy, the fluctuation about normal voltage at any time must not exceed ± 6%.

In Nigeria, the normal domestic supply voltage (i.e. for a single phase, line to neutral) 220V. By interpretation, it means that the supply voltage is

$$\frac{6 \times 220}{100} = 13.2V$$

± 13. 2 + 220 are:

$$220 + 13.2 = 233.2\ V$$

And

$$220 - 13.2 = 206.8V$$

The supply voltage to this project, therefore, should be in the range of 206. 8V approximately 207V – 233V. from this calculation, it shows that the project is safe to be applied to sensitive single phase appliance so rated.

CHAPTER FIVE

5.1 CONCLUSION

The design and construction of an automatic change over switch has not been without its own problems. The problems encountered were in the area of the electronic push switch since precision is needed for the project to function as expected. It is worthy of note that the circuit exactly 5second delay could not be achieved due to imperfect function of some components

For a relay to function properly, there must be a good working control unit put in place and this was achieved by selecting the right value components while building the project.

It is also important to know the power rating of the generator that is intended to be used as an alternative power source before considering the relays to use in designing this project. For this design, 10A relays were used, as a result, a generator with a rating higher than 2.4 KVA cannot be used since this will damage the contact of the relay.

The system is also reliable with a value of 0.946 that is, it is 94.6 % efficient.

5.2 RECOMMENDATIONS

For the project to carry a higher power rating generator, the project has to be modified. This includes the uses of relays of higher current rating since the contact rating of the relay is the major determinant of the performance of the system.

It is recommended also that the contact rating of the relay be slightly higer than the equipment is supposed to be used for.

Also, any student or person who is intending to carry out this project is expected to have basic knowledge of electronics and be able to apply them.

I will also want to recommend that the number of students under a particular supervisor be reduced; this is to ensure that the supervisor has adequate time to these students and hence proper supervision.

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