DESIGN AND CONSTRUCTION OF AUTOMATIC CHANGE OVER SWITCH WITH CHARGER FOR MEDIUM SIZE GENERATOR

BY

MOHAMMED YUNUSA
2000/9870EE

DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING,
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,
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DEDICATION

This project work is dedicated to God, Almighty Allah the provider and sustainer of my life to him all praise belongs. This project is as well dedicated to my beloved parents and heart Alhaji Mohammed Alaro, Madam Abibat Alaro and Aminat Adeyemi respectively.

ATTESTATION/DECLARATION

I hereby certify that this project work was carried out in the department of Electrical and Computer Engineering Federal University of Technology, Minna Niger State by Mohammed Yunusa with matric number 2000/9870EE under the supervision of Mr. A.S. Mohamed.

09/10/2006

Mohammed Yunusa — Date

8/10/2006

Mr. A.S. Mohamed — Date

Engr. M.D Abdullahi — Date

H.O.D

External Examiner — Date

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ABSTRACT

It is a wonderful thing in the field of engineering to be associated with this project tilled construction and design of a single-phase Automatic Change over switch as equipment used in hospitals, hotels, manufacturing industries, broadcasting stations to mention but a few require constant power supply. Back-up power system is available to provide electricity following an interruption or failure of grid supplied power. This could be in form of a portable or stationary generator. This of course requires a constant fuel source such as diesel, and gasoline. Some are manually started and shut off, while others start/stop automatically. Based on this back-up of electric system is designed and constructed to start/stop. This project is written in the utmost belief that if thoroughly studies, proved valuable to those in search of general knowledge, that is, in construction, operation of an automatic changer over switch, and switching devices. However, this project covers the major element of design, operation and construction of an automatic single-phase changer over switch.

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CHAPTER ONE

INTRODUCTION

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 time.

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 very common in many parts of the country, some time due to lack of power supply from the main station that is used to supply power (PHCN). In other areas they are becoming more common on the power net work 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 a single-phase Automatic change over switch with charger. This helps a lot during power outages in such places like Hospitals, established large companies (e.g. telecommunications companies) and some of the Government establishments.

The project which has been design, constructed and tested gets initial supply from Power Holding Company of Nigeria (PHCN) and is then being rectified and connected to relays, via smoothening capacitor and voltage regulator, since when PHCN is in supply the relays use the energy supply from PHCN to operate.

The operation of the relay is the heart of this project work, because when PHCN is in supply, the relays concerned for the changing over from PHCN line would then change over immediately from generator to PHCN mains, the output will be the one coming from PHCN. This process repeats immediately the PHCN supply goes off, by changing over from PHCN 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 with main operated battery charger that generator will only be on when PHCN failed, but when PHCN is restored, immediately the generator will be off automatically by the action of the relay concerned.

Broadly speaking, this project uses a step down transformer, bridge, rectifier, a voltage regulator, an automatic push switch circuit and a main operated battery charger. The electronic push switch circuit is used for the ignition of the generator. This circuit starts the generator immediately PHCN supply goes off and the supply from the generator line then passed to the output by the work of change over relays concerned. This circuit uses the generator battery for stimulating the circuit to start the generator. Also the charger helps to charge the generator battery using PHCN supply to prepare it for action whenever there is power outage from PHCN.

CHAPTER TWO

2.1 LITERATURE REVIEW

A switch is a device for closing (making) and opening (breaking) of an electrical circuit. It does not provide protection against excess current flowing in the circuit, as FUSES and CIRCUIT BREAKER do. It must however, be designed to withstand excess current, during the period of time taken by the fuse or circuit breaker to operate and break the excess current flow [2, 3, 4, 6, 7, 9].

Historically, when electric motor were first introduced in the late 1800's for industrial use, the starting and stopping of motors was done through the use of a simple knife switch. This type of knife switch remained popular as a means of connecting and disconnecting line voltage directly to motor terminals for the basic reasons.

First, the open knife switch had exposed (live) parts which presented an extreme electrical hazard to the operator. In addition, any applications where dirt or moisture were present made this open concept too vulnerable to problems.

Second, the speed of opening and closing contract was determined solely by the operator. If the operator did not open or close the switch quickly, considerable arcing and pitting of the contacts soon lead to rapid wear and eventual replacement.

The third problem regarding knife switches was the material from which they were made. Most knife switches were made of soft copper which, after repeated arcing, heat generation and mechanical fatigue soon had to be replaced.

As industry demanded more electric motor at the turn of the century, certain improvements had to be made upon the knife switch to make it more acceptable as a controller.

First, the knife switch was enclosed in a steel case to protect the switch, and an insulated external handle was added to protect the operator.

Second, an operating spring was attached to the handle of the enclosure to assure quick opening and closing of the knife blade. The switch handle was designed so that one the handle was moved a certain distance at the same continuous speed each time it was operated.

Even with the improvements, the knife switch had one serious flow: the blade and jaw mechanism of the knife switch was used as a direct controller. Because of this persistent problem, the knife blade mechanism was discontinued as a means of direct control for motors, however it is still maintained for use disconnect. The disconnect is a device used only periodically to remove electrical circuits from their source of supply. Since disconnect is used less frequently in this situation, the mechanical life of the blade mechanism is not of major concern.

Another major reason for the discontinued use of the knife blade as a direct controller was the development of double-break contacts.

With double-break contacts, a device could be designed which would have a higher contact rating (current rating) in a smaller space than devices designed with single-break contracts. One such device was the manual contactor. When as set of No (normally open) double-break contacts are energized the movable contact are forced against the two stationary contacts to complete the electrical circuit. For all practical purposes, this moveable contact is a shorting bar between the two stationary contacts completing the electrical circuit. When manual contact is reenergized, the movable contacts are forced away from the stationary contacts and the circuit is again open. When NC (normally closed) double-break contacts are used, the procedure is reversed.

With the advent of the industrial revolution, automatically controlled devices replaced many jobs that were being done manually. This is to ensure standards, security, safety, stability and also durability [2, 9].

The period preceding 1868 was characterized by the development of automatic control systems by intuitive invention. Efforts to increase the accuracy of the control system led to slower attenuation of the transient oscillations and even to unstable systems. Improving performance was difficult because there was no real understanding of automatic. In 1868, J.C Maxwell formulated a mathematical theory related to control theory by using a differential equation model of a governor. Maxwell's study was concerned with the system performance.

The main impetus for the use of feedback in the united state was the development of the telephone system and electronic feedback amplifiers by Bode, Nyquist, and Black at the Bell Telephone laboratories. The frequency domain was used primarily to describe operation of the feedback amplifiers in terms of bandwidth and other frequency variables. It is black filed a patent on the feedback amplifier in 1927, but encountered doubt and opposition when he proposed self-regulation by negative feed back amplifiers.

David Parkinson, a 29 years old engineer at Bill Laboratories, was busy in 1940 designing an automatic line recorder which used the position of the recorder pen. Parking conceived, in a dream, the scheme of using the feedback potentiometer to aim anti aircraft guns. A proposal was developed and an engineering model was delivered to U.S. Army for testing on

December 1, 1941. Parkinson's gun control system became the m-9, which was coupled with the new radar system terms to provide an accurate defense against incoming air craft during World War II [9].

With the advent of sptruk and the space age, another new impetus was imparted to control engineering. It became necessary to design complex, highly accurate control systems for missiles and space probes.

However, Alimon B. Strowger was an undertaker in Kamsaa City. U.S.A. the story goes that these were a competing undertaker whose wife was an operator at the local (manual) telephone exchange. Whenever a caller asked to be put through to strowger, calls were deliberately put through to his competition. This obviously frustrated strowger greatly and he set about devising a system for doing away with the human part of the equated!

Strowger developed a system of automatic switching using an electromagnetic switch based ground electromagnets and pawls. With the help of his nephew (Watter S. Strowger) he produced a working model in 1888 (US patent NO 447918, 10/6/1891). In this sector, a moving wiper (with contacts on the end) moved up to and around a bank of many other contacts making a connection with any one of them.

Strowger did not invent the idea of automatic switching; it was first invented in 1879 by Cannoly & Mc Tigthe but Strowger was the first to put into effective use. Together with Joseph B. Harn's and Moses A. Meyer, Strowger formed his company, Strowger Automatic Telephone Exchange' in October 1891.

In the late 1890's Almon B. Strowger retired and eventually died in 1902. In 1901, Joseph Harn's licensed the Strowger selectors to the Automatic Electric Co (AE); the two companies merged in 1908. The company still exists today as AG Communications Systems, having undergone various corporate changes and buyouts along the way [10]

The knowledge of automatic control had gone a long way helping engineers and technicians to improve performance of changeover switch by making it automatic using contactors or relays as the case may be.

The like of Archilong Alamiyene and Vitus Paul Nwaleze (Students of the Federal University of Technology Minna) and some others employed electromagnetic relays rated RV, 10A D.C for the design construction of automatic change over switch.

In this project, I incorporated into the power supply a voltage regulator to make it regulated power supply and also a changer is included for changing the secondary battery lightning the ignition of the generator. This improvement actually adds much to the integrity of the device as it always makes the battery to be operation prepared.

2.1 THEORETICAL BACK GROUND OF THE PROJECT

The theoretical background of this project is based on the principles of operations of a regulated power supply, a relay operating principle, and electronic push switch circuit, and a battery charger.

As shown in figure 2.1.0 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 solid-state 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 four (4) diodes to convert AC voltage into pulsating DC voltage. The filter helps to remove the fluctuation or pulsating (called ripples) present in the output voltage supplied by the rectifier of course, no filter can in practice, gives an output voltage as ripple free as that of a dc battery but it approaches 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 transformer veins or the load varies. [1,8].

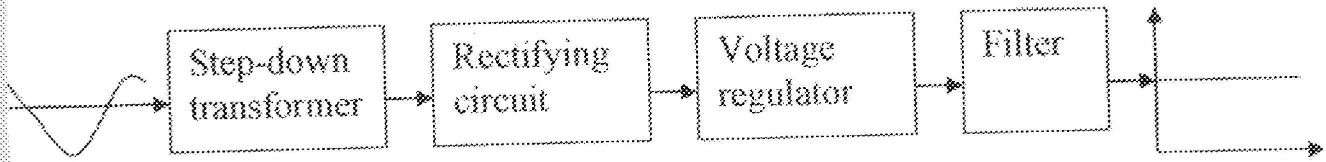


Figure 2.1.0 Block Diagram of the Regulated Power Supply

The relay operating principle 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 figure 2.1.1 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 several hundred volt range. Relays with a 6, 12, 24, 18, 115 and 230 volt design are the most common. Today designs offer a number of general purpose relays that require as little as 4 milliampares at 12V DC making them IC compatible to TTL and CMOS logic design (gates). These relays are available in a voide range of switching configurations [2,3,4,5,6,7]

Fig. 2.1.1
Fig. 2.1.1

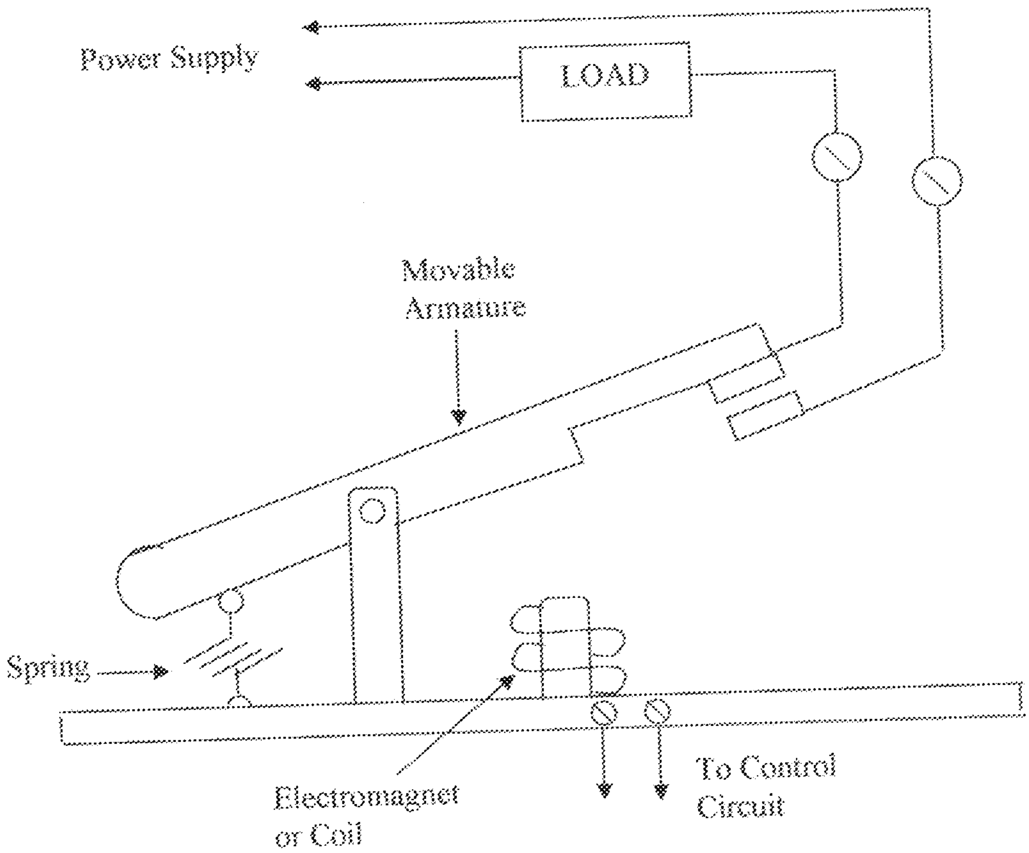


Fig 2.1.1 Electromechanical Relay

The current needed to operate 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 = V/R. [8]

The Electronic Push Switch Circuit consist of D.C voltage source, a resistor and LED in series, a capacitor in series with a relay, all connected as shown in the figure 2.1.2 below.

The primary purpose of the D.C voltage source (12V Secondary battery) 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 follow: $R = \frac{V_s - V_f}{I_f}$

When: R is the use of the resistor

V_s is the supply voltage

V_f is the forward voltage of the diode

I_f 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 second day battery. 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 the 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: $V_c = 2V/3$ after time T.

V_c is the capacitor voltage

V is the supply voltage of the secondary battery.

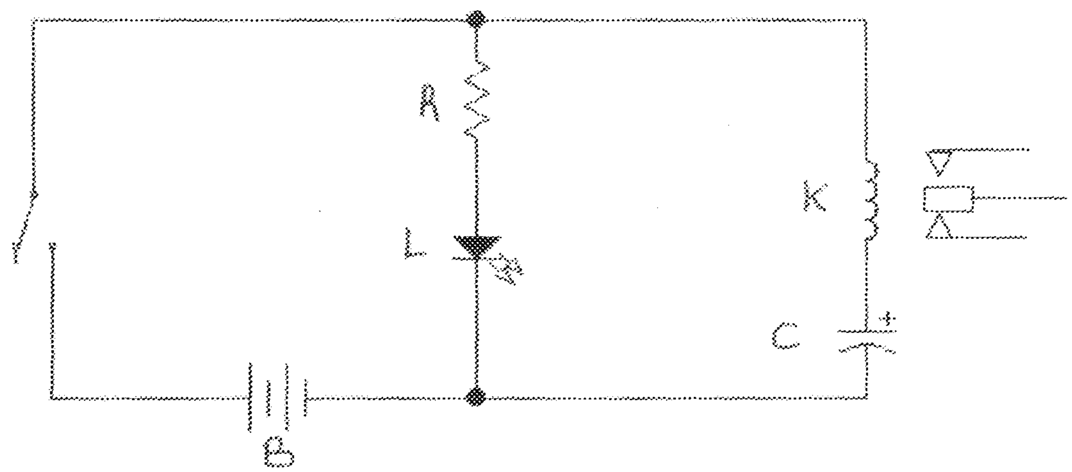


Fig. 2.1.2 Electronic Push Circuit

Where: R is a resistor

L is light emitting diode

B is a secondary battery

K is a relay

C is a capacitor (electrolytic). [7,8].

Main Operated Battery Charger

A battery is an electrical device that is used for putting energy into a battery. The battery charger charges the a.c from the power line into d.c suitable for charger. However, d.c generator and alternators are also used as charging sources for secondary batteries.

In general, a main-operated battery charger consists of the following elements:

1. A step-down transformer for reducing the high a mains voltage to a low a.c voltage.
2. A half-wave or full-wave rectifier for converting alternating current into direct current.
3. A charger-current into the battery under charge.
4. A device for preventing the reversal of current i.e. discharging of the battery through the charging source when the source voltage happens to fall below the battery voltage.

In addition to the above, a battery charger may also have air circuitry to monitor the battery voltage and automatically adjust the charging current. It may also terminate the charging process when the battery becomes fully charged. However, in many cases, the changing process is not totally terminated but only the charging rate reduced so as to keep the battery on trickle charging these requirements have been illustrated in fig 2.1.3

Most of the modern battery chargers are fully protected against the following eventualities:

a) They are able to operate into a short-circuit.

b) They are not damaged by a reverse-connected battery.

c) They are operating into a total flat battery [1,7]

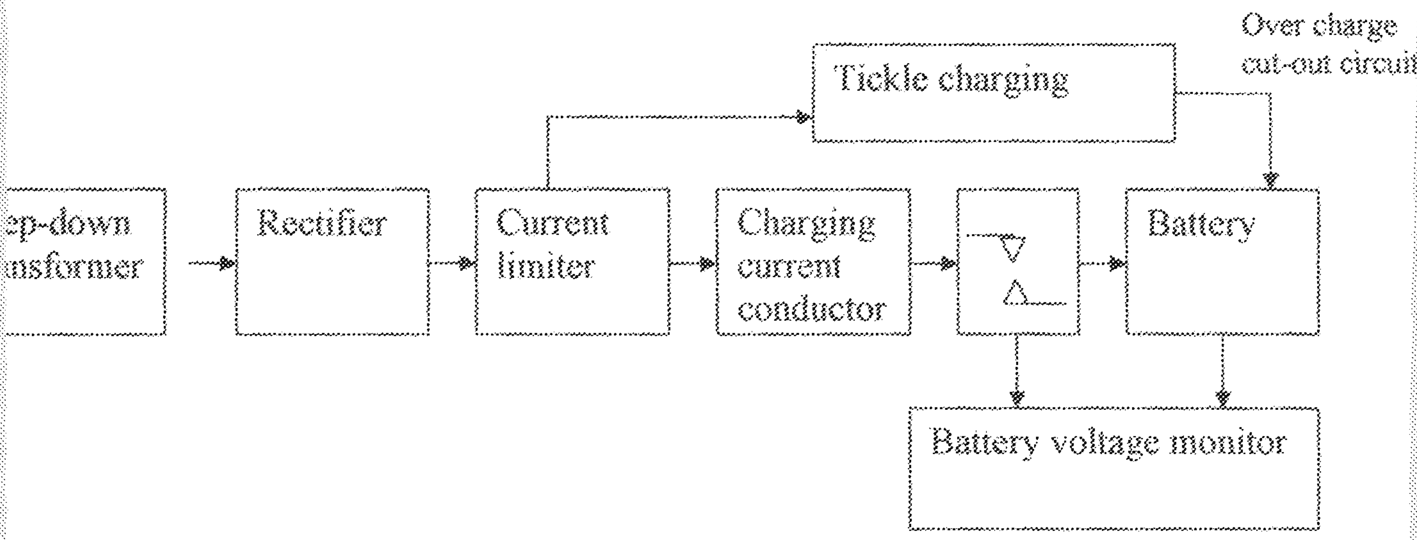


Fig 2.1.3 Mains Operated Battery Charger

CHAPTER THREE

SYSTEM DESIGN AND IMPLEMENTATION

3.0 REGULATED POWER SUPPLY

The purpose of regulated power supply unit is to provide constant 12V, d.c to power the control circuit. No matter how much current is drawn by the load, the voltage is expected to be constant. Also, variation in ac line voltage, temperature and/or time passes should not affect the output voltages of the regulated power supply.

Fig 3.0 below shows the block and circuit diagram of the regulated power supply respectively.

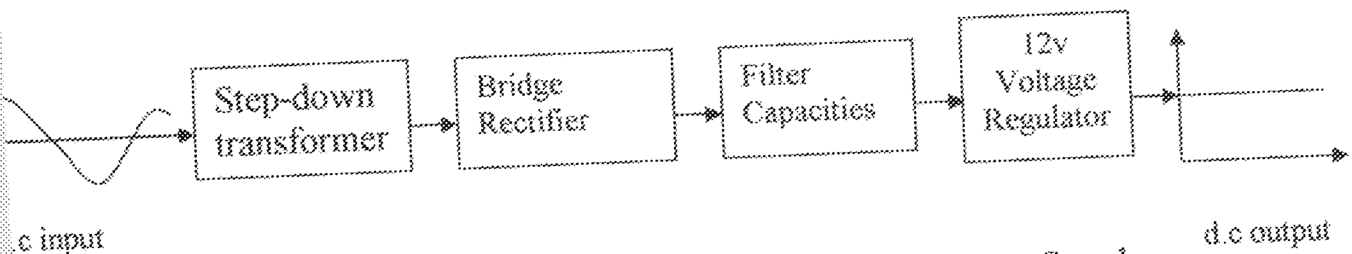


Fig 3.0a Block Diagram of the Regulated Power Supply

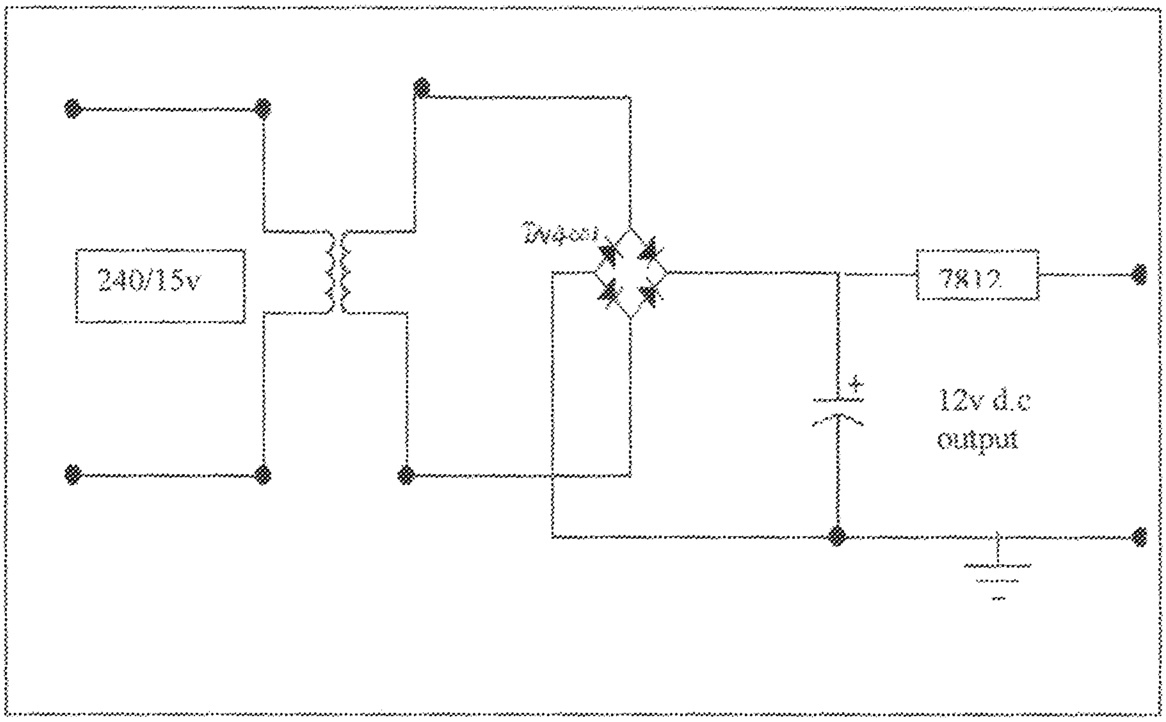


Fig 3.0b Circuit Diagram of the Regulated Power Supply

3.0.0 TRANSFORMER (TX)

The transformer is a step down type rated 240/15V, 1A. This implies that whenever 240V a.c mains supply is applied to the primary of the transformer, a 15V, a.c will be obtained at the secondary of the transformer.

From the rating of the transformer, the voltage transformation ratio (k) can be calculated as follows

$$K = \frac{\text{Secondary Voltage (Vs)}}{\text{Primary Voltage (Vp)}}$$

Where: $Vs = 15V; and V_p = 240v$

$$\Rightarrow K = \frac{15v}{240v} = \frac{3}{48}$$

$$\Rightarrow Vs = \frac{3v_p}{48} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The transformer form factor, $f = \frac{Vrms}{Vdc}$ [1]

$$\Rightarrow f = \frac{V_{max}/\sqrt{2}}{2V_{max}/\Pi} = \Pi/\sqrt{2}$$

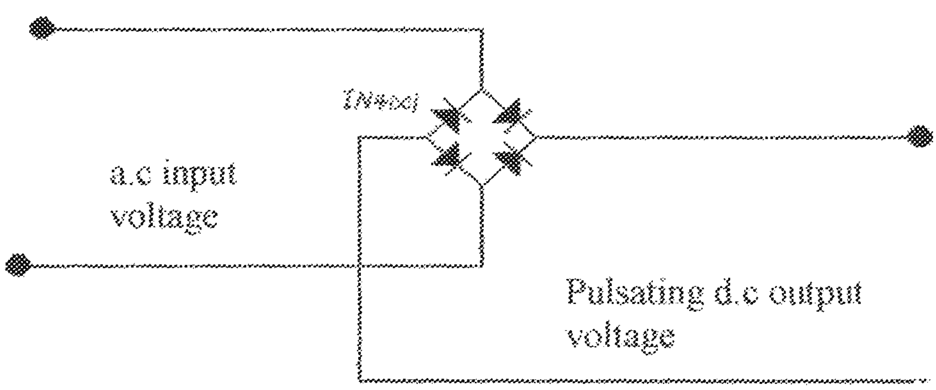
$$= 1.11$$

3.0.1 Bridge Rectifier

This circuit employs four diodes to convert a.c voltage into pulsating. The following advantages where in selecting it in this design.

1. No centre tap is required on the transformer.
2. It is suitable for high-voltage applicant.
3. Much smaller transformers are required.
4. It has less peak inverse voltage (PIV) rating perdiode.

The circuit diagram for a bridge rectifier is as show in figure 3.0.1 below.



Rectifier Design Calculation

1. Rectifier efficiency, $\eta = \frac{d.c power}{r.m.s power} \times 100\%$[1]

$$\Rightarrow \eta = \frac{d.c voltage, V_{dc}}{r.m.s Voltage, V_{rms}} \times 100\%$$

Using the rating of the transformer,

$Vrms = 15V$

$V_{dc} = V_{rms}$ /form factor (f)

$= 15 \times \frac{2\sqrt{2}}{\Pi} V$

$= 13.50V$

$\Rightarrow \eta = \frac{13.50}{15} \times 100\%$

$\cong 90\%$

2. Ripple content of the pulsating d.c output, $V_L(a.c)$?

$$V_L(a.d) = \sqrt{V_L^2 - V_L^2(DC)} \qquad [1]$$

Where: $V_L = V_{rms} = 25V$

$V_L(dc) = 13.50V$

$\Rightarrow V_L(dc) = \sqrt{15^2 - 13.50^2}$

$= 6.54V$

3. Ripple factor λ?

$$\lambda = \frac{V_{L(ac)}}{V_{L(DC)}} \quad [i]$$

$$= \frac{6.54}{13.50}$$

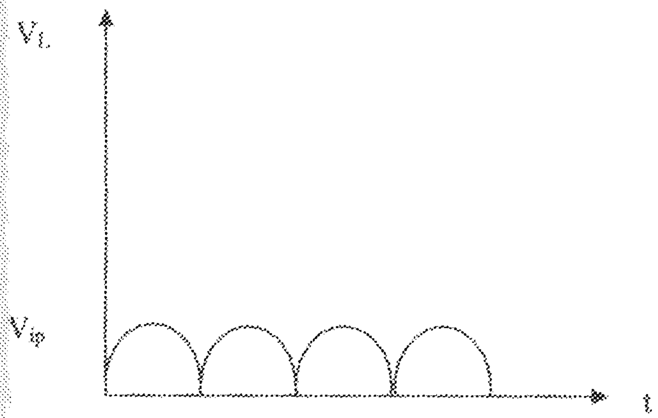
$$= 0.484$$

$$= 48.4\%$$

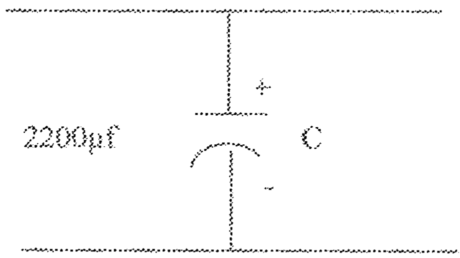
3.0.2 Filter Capacitor

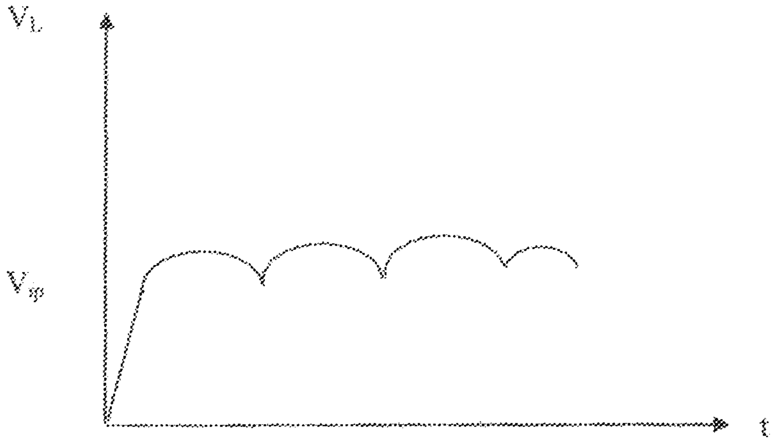
The main factor of the filter capacitor is to minimize the ripple content in the rectified output voltage. This capacitor, C is connected across the rectifier output and in parallel with the voltage regulator, as shown in figure 3.0 to achieve filtering action. This type of filter is known as *Capacitor Input Filter*.

This filter circuit depends, for its operation on the property of a capacitor to charge up during conducting half-cycle and to discharge during the non-conducting half-cycle. In simple words, a capacitor opposes any change in voltage. When connected across a pulsating d.c voltage, it tends to smooth then out or filter out the voltage pulsations (or ripples). The filtering action of the simple capacitor filter in a full-ware rectifier is shown in figure 3.0.2 below.



Rectified pulsating d.c input





Minimized pulsating d.c output

Figure 3.0.2 Filter Capacitor

Effect of Increasing Filter Capacitance

It has been found that increasing the capacitor size:

1. Increases Vdc toward the peak rectified output voltage;
2. reduces the magnitude of ripple voltage;
3. reduces the time of flow of current pulse through the diode;

4. Increase the peak current in the diode.

Filter design calculation

1. Minimized pulsating d.c output of the capacitor, Vdc ?

$$V'_{dc} = \frac{V_{2P}}{1 + I'_{dc}/4fcV_{ip}} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(1) \qquad [i]$$

$$I'_{dc} = V'_{dc}/R_L \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(2) \qquad [i]$$

$$\Rightarrow V'_{dc} = \frac{V_{ip}}{\left[1 + V'_{dc}/4fcR_{Lvip}\right]} \;\ldots\ldots\ldots\ldots\;(3)$$

F = line frequency = 50H₃

C = capacitance of the capacitor = 2200 HF

R_L = Effective resistance of resistance of the relays $= \frac{400}{4}\Omega$

$\Rightarrow R_L = 100\Omega$

Vip = Peak rectified output voltage

$\Rightarrow Vip = \sqrt{2}V_{(ac)}$

$= \sqrt{2} \times 15$

$= 21.21V$

$$\Rightarrow Vd'c \; \frac{21.21}{\left[1 + V'_{dc}/4 \times 50 \times 220 \times 100 \times 21.21\right]}$$

$$\Rightarrow V^1_{dc} = \frac{V_{ip}}{\left[1 + V^1_{dc} / 4fcR_L Vip\right]}$$

$$\Rightarrow 0.001072(V^1_{dc})^2 + V^1_{dc} - 21.21 = 0$$

$$\Rightarrow V^1dc = -1 \pm \sqrt{\frac{1 + 0.001072x421.21}{0.001072x2}}$$

$$\frac{-1 \pm 1.044485}{10.72x10^{-4}x2}$$

$$\Rightarrow V^1dc = \frac{0.4449}{10.72x10^{-4}x2}$$

$$\cong 20.75v$$

2. Ripple factor of the pulsating, filtered d.c output, λ?

$$\lambda \cong \frac{1}{\sqrt[4]{3}} FCR_L \quad [1]$$

$$\lambda \cong \frac{1}{\sqrt[4]{3x50x20x10^{-6}x100}}$$

$$\cong 1.312x10^{-2}$$

$$\cong 0.01312$$

$$\cong 1.312\%$$

3. Ripple content of the filtered output, $Vr(rms)$?

$$V_r(rms) = \gamma V^1dc \quad [1]$$

$$\Rightarrow V_r(rms) = 0.01312x20.75 \text{ volt}$$

$$= 0.272 \text{ volt.}$$

3.0.3 12 VOLT VOLTAGE REGULATOR

A 7812 voltage regulator integrated circuit was used to reduce voltage variation between no-load and full-load conditions to zero or at least minimum possible value. This is shown in figure 3.0.3 below.

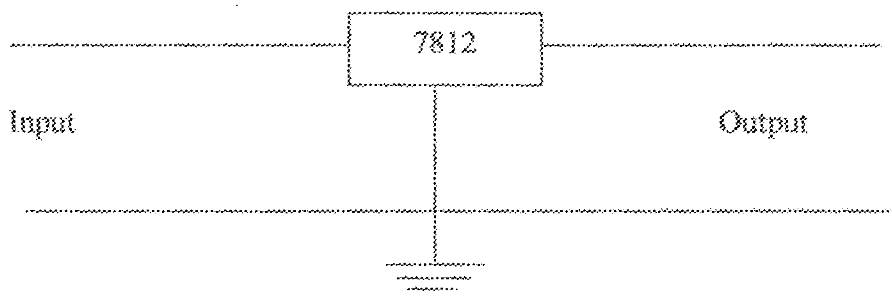


Fig 3.0.3 Voltage Regulator

To ensure constant 12v output, the input voltage ranges from 14v to 35v.

3.1 CONTROL CIRCUIT

This is the section of the project work that ensures changing over between Power Holding Company of Nigeria (PHCN) source and Generator source. It comprises of two major subsection, Electromechanical Relay Switching and Electronic push circuit.

3.1.0 Electromechanical Relay Switching

A general-purpose Electromechanical Relay which are common to commercial and industrial applications are used in this project. These are basically mechanical switch operated by a magnetic coil. They use d.c for their operation that is to open or close the contacts from mill volts to the

4. The minimum PHCN supply required, V_{rms}?

From equation (3), $\dfrac{V_{ip}}{\left[1+V^1dc/4fcR_LV_{ip}\right]}$

For $V^1dc = 14v$

V^1dc is the secondary voltage of the transformer.

$$\Rightarrow V_{ip} = 14\left[1+\frac{14}{4\times 50\times 2200\times 10^{-6}\times 100\times v2p}\right]$$

$$\Rightarrow 22V_2p^2 = 14\times 22v_2p + 7\times 14$$

$$\Rightarrow 22v_2p^2 = 308V2^1p + 98$$

$$\Rightarrow 22V^2{}_2p - 308V_2p - 98 = 0$$

$$\Rightarrow V_2p = \frac{308\pm\sqrt{308^2+4\times 22\times 98}}{44} \text{ volt}$$

$$\Rightarrow V_2p = \frac{308+321.70}{44} \text{ volt}$$

$$= \frac{629.70}{44} \text{ volt}$$

$$= 14.31 \text{ volt}$$

$$\Rightarrow V_{ac} = \frac{V_{ip}}{\sqrt{2}} = \frac{14.31}{\sqrt{2}} \text{ volt}$$

$$= 10.12 \text{ volt}$$

$$\Rightarrow V_{rms} = 10.12\times\frac{48}{3}\left(ieV_{ac}\times i/k\right) \text{ volt}$$

$$\cong 162 \text{ volt.}$$

several hundred volts. The circuit diagram of the relay is as show in figure 3.1.0 below.

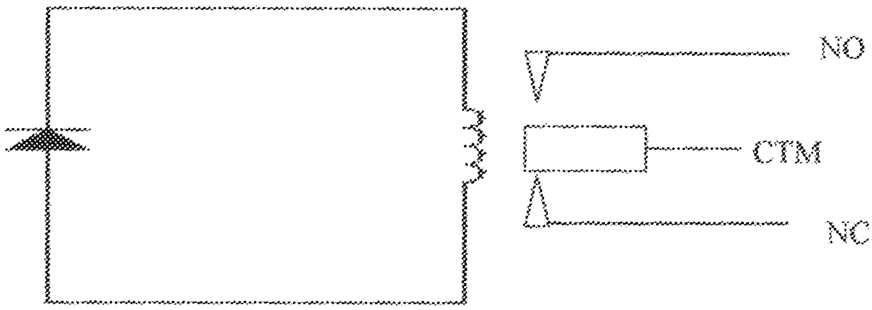


Fig. 3.1.0 Switching Relay

The diode D_f connected across the input terminals of the relay is a free-wheeling diode to present reverse current from the coil of the relay across the regulator.

CTM ⇒ Common Terminal (the moving part of the switch).

NC ⇒ Normally closed CTM is connected to this when the relay coil is not powered (or energized).

NO ⇒ normally open. CTM is connected to this when the relay coil is powered (or energized).

Relay design calculation

Relays of ratings 10A, 12vdc and 400 ≈ and also a relay rated 10A, 6v d.c 400 Ω were used.

The current needed to operated the 12v dc relay, pult in current,

$$Ip = \frac{\text{Rated voltage } Vr}{\text{Rated Resistance, } Rr}$$

Where Vr = 12v Rr = 400 Ω

$$\Rightarrow I_r = \frac{12}{400} A$$

$$= 0.03A$$

$$= 30 \times 10^{-3} A$$

$$= 30mA$$

For 6v d.c relay:

$$I_r = \frac{6}{400} A$$

$$= 0.015$$

$$= 15 \times 10^{-3} A$$

$$= 15mA$$

3.1.1 ELECTRONIC PUSH CIRCULT

The circuit consists of a relay, a capacitor, resistors (2), a Light Emitting diode (LED), a switch, and a Rv battery. The circuit diagram is as shown in fig. 3.1.1 below.

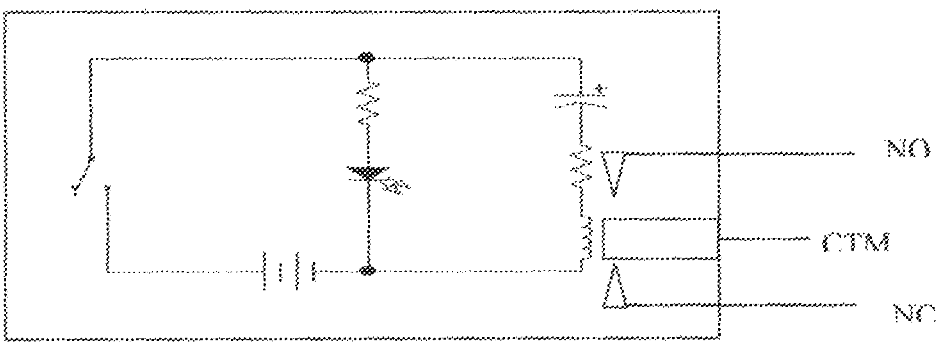


Figure 3.1.1 Electronic Push Circuit

The circuit is designed to make a fast ON and show OFF relay hold for the ignition of the generator.

However, when the supply is complete the current which flows is enough to trigger the relay, since the capacitor offers little or no resistance in the beginning the current starts to fall as the capacitor changes up and eventually drop below the holding current of the relay in this circuit. The holding on time of the relay is the time constant which is given by T=RC in second [2]. This is the delay time. If switching time required =3.1 second and the resistance value in series with capacitor is R. The capacitance of the capacitor required can be calculated as follows.

$CR = 3.1\,\text{Second}$

$\Rightarrow C = \frac{3.1}{R} S$

Where R= Ri + Rr (resistance of the relay).

$\Rightarrow R = (1000 + 400)\Omega$

$= 1400\Omega$

$\Rightarrow C = \frac{3.1s}{1400\Omega}$

$= 0.02214F$

$= 2214 \times 10^{-6} F$

$\cong 2200\mu f$

3.1.2 12v Battery Charger

The battery charger uses full-ware pulsating direct current for charging the battery. The pulsating rectified voltages from the bridge rectifier pass through a voltage regulator, LM317T to the charging currents, Ich determining resistor Rs. This current, Ich is directed to the battery under charging. When the battery is fully charged, it drives current in the circuit, moving diode D to be reverse-biased. The current flows through Dz to the variable resistor Rr which resistor R. At this point in time, the transistor conduct and the transistor output at the collector is connected to the ground of the LM 317T. Which makes it behave like an open circuit to the incoming current and the charging is therefore stopped. The circuit diagram of the charger is as shown in figure 3.1.2 below.

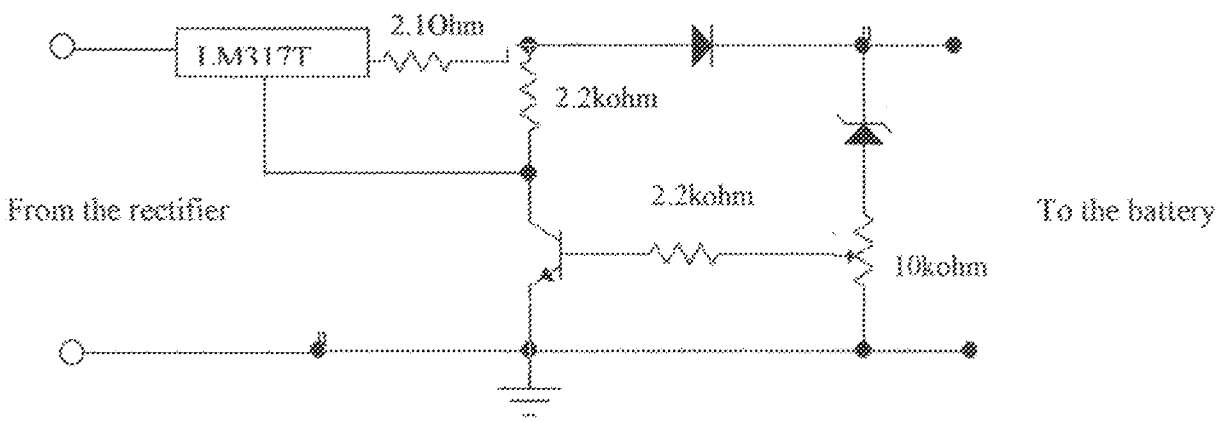


Fig 3.1.2 Mains Operated Battery Charger

Charger design calculation

1. For LM317T, $V_{RS} = 1.25V$

$\Rightarrow$ For charging current of O.6A

$$\Rightarrow R_S = \frac{1.25\Omega}{0.6} \cong 2.1\Omega$$

2. for the transistor C9014, $\beta = 347, Ic\max = 130A$

And Vbe = 0.6v

$$\Rightarrow I_B = \frac{130mA}{347} = 0.374mA$$

3. For $R_B = 2.2\Omega$

$$\Rightarrow V_p = (0.6 + 0.824)v$$

$$= 0.824v$$

$$\Rightarrow V_p = (0.6 + 0.824)v$$

$$\cong 1.42v$$

$$\Rightarrow V^1p = (6.0 - 1.42)v$$

$$\cong 4.58v$$

4. To calculate Rp,

$$\frac{R_v - R_p}{R_p} = \frac{4.58}{1.42} = 3.225$$

$$\Rightarrow R_p = \frac{R_v}{4.225}, R_v = 10 \times 10^3\Omega$$

$$\Rightarrow R_p = \frac{10}{4.225} K\Omega$$

$$\cong 2.37 K\Omega$$

3.2 Circuit Operation

Figures 3.2 (a) and (b) below show the complete block and circuit diagram of the project work respectively.

The single phase automatic change over switch consists of, primarily 10A, 12V dc and 6V d.c relays and the power supply unit. The power supply unit consists of a step down transformer, a bridge rectifier with a filtering capacitor and a regulator. The power supply unit power the relay to change state from normally close to normally open, such that the normally close is now normally open and vice versa.

Two relays are responsible for the change over, relay 1 and relay 2. relay 3 is to connect the battery 80 connected to a charger that charges it while PHCN to the network of the automatic electronic push switch circuit, which also represent the kick starter of the generator. Relay A is to shut down the generator. Relay 5 coil is used to represents the inductor in the automatic electronic push switch circuit.

PHCN source is connected to the normally open of Relay 1 and Relay 2. The primary side of the transformer is connected to PHCN source so that when PHCN is on, the power supply unit activates the relays which successfully make contact that is change from normally close state to normally open state, thereby connecting PHCN to the load. The load is connected to the common point of relay 1 and relay 2.

At PHCN outage, the relays relax, that is, come back to their initial state, thereby connecting generator source to the load.

Also at PHCN outage, relay 3 connects the battery to the electronic push switch circuit which represents the ignition-starter of the generator. When voltage is across the electronic push switch circuit it momentarily makes contact for a time domain and then relaxes. The time for the starter of any automobile works. That is, it makes contacts between two wires connected at the brushes of the ignition key. When a key is turned clockwise it eventually starts the generator by joining the wires on the brushes together for at least 3.1 seconds. Relay 4 shuts the generator down by connecting the plug head to the chassis of the generator. This is achieved when PHCN is restored (ON). However, the battery charger makes use of the power the PHCN to charge the using for the powering of the electronic push switch circuits, before PHCN outage.

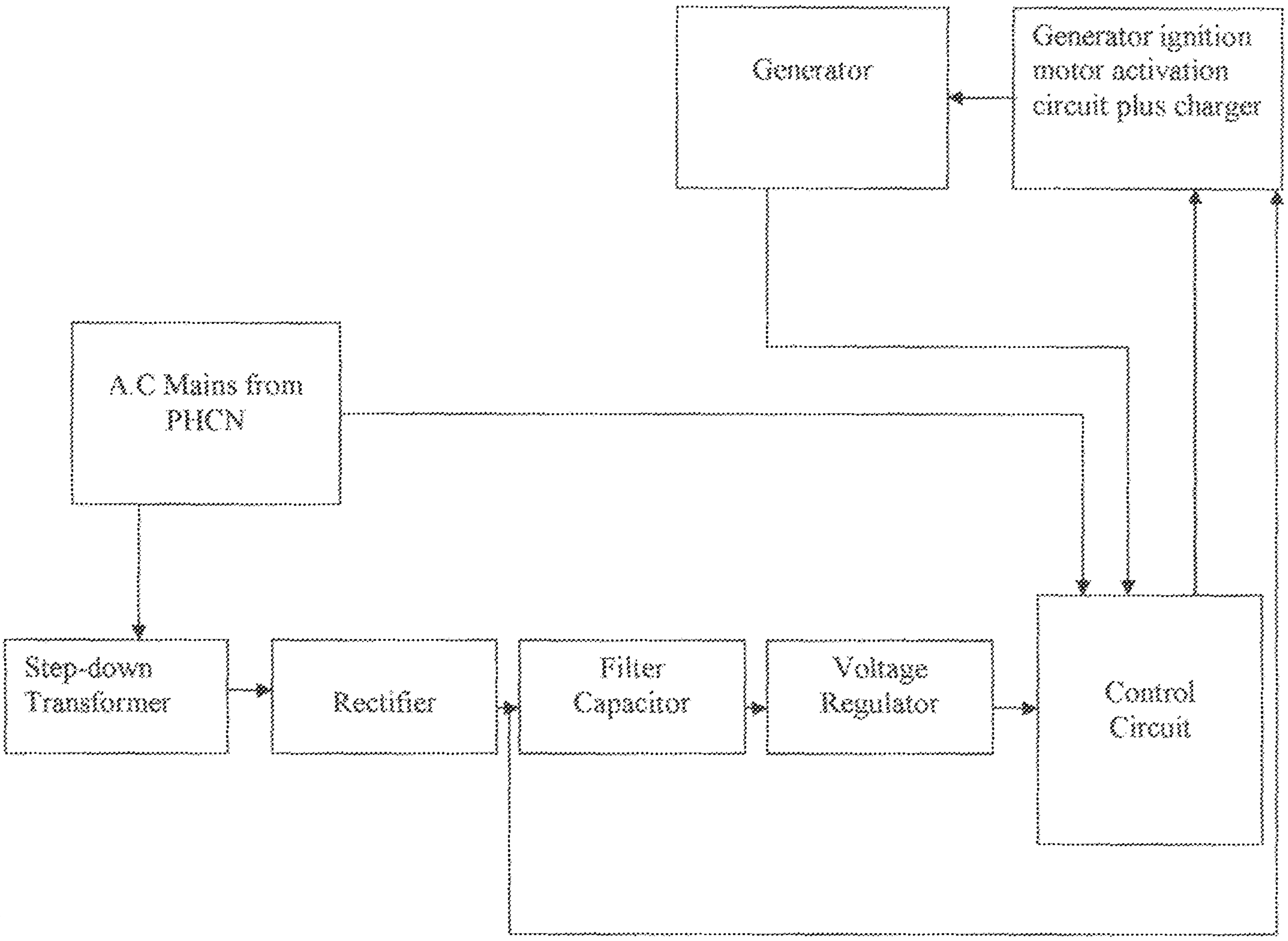


Fig 3.2a Complete Block Diagram of the project work

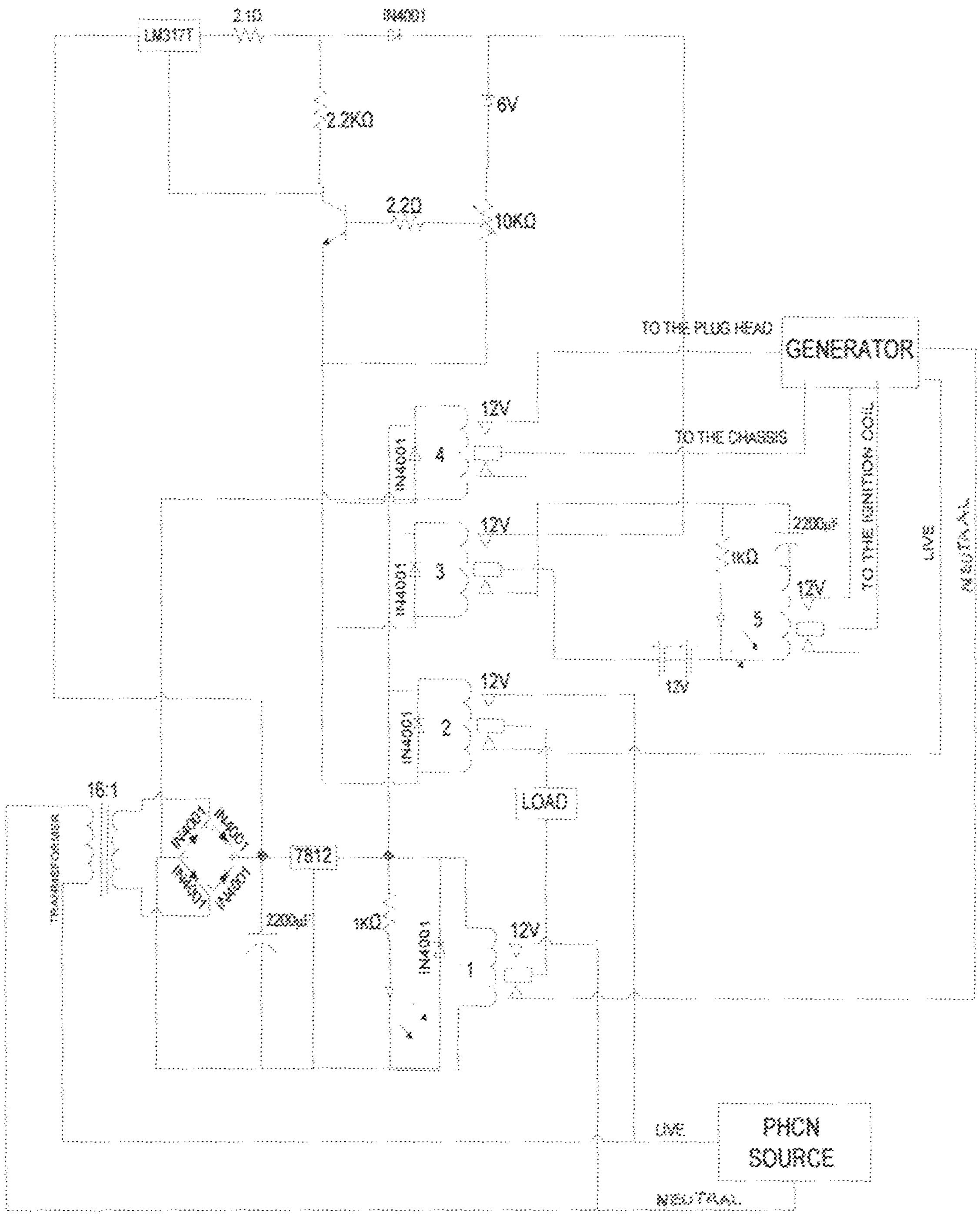
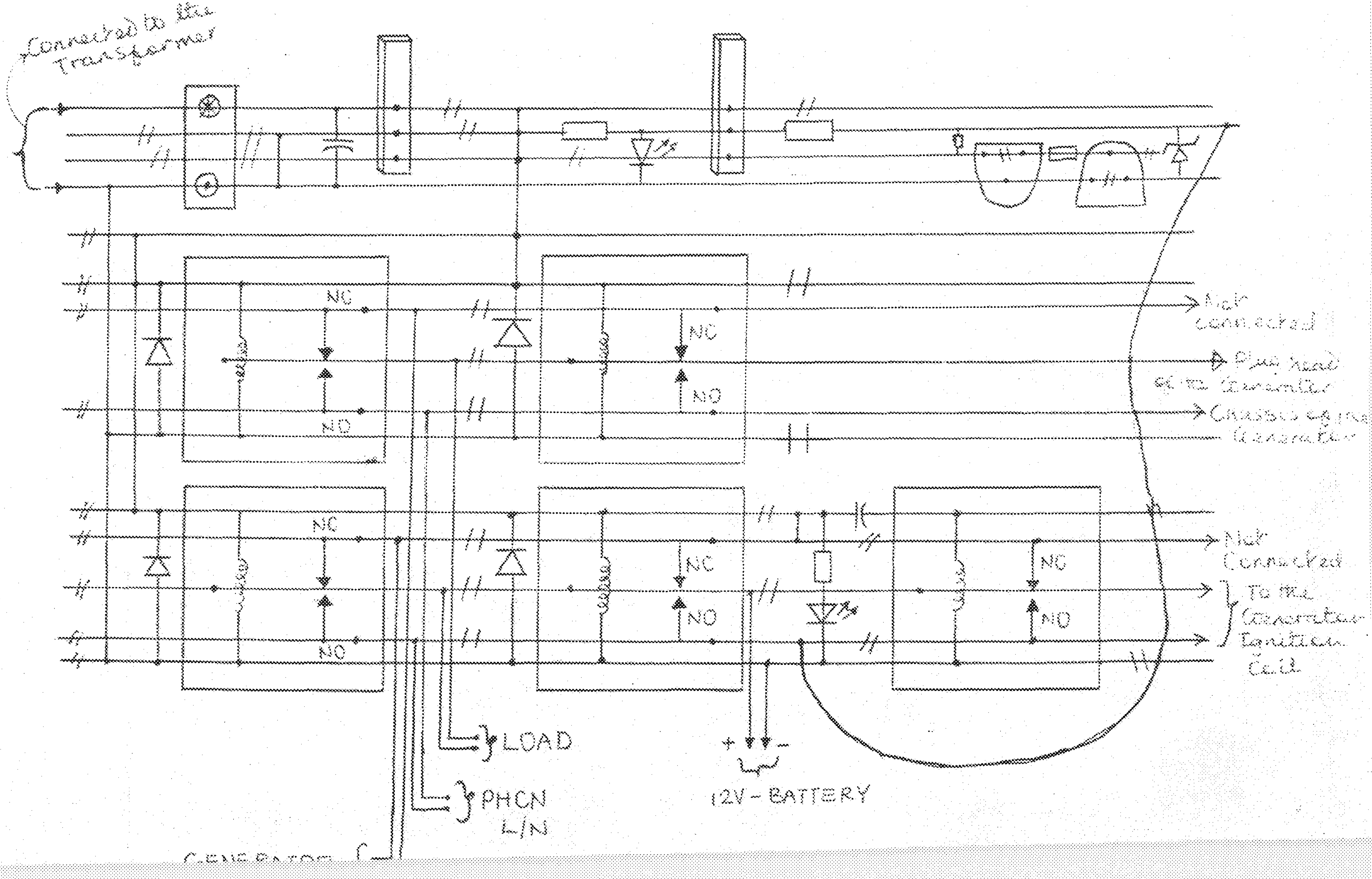


Fig 3.26 Complete circuit diagram of the project work


Connected to the Transformer
NC
NO
Not connected
Plug head of the Generator
Chassis of the Generator
Not Connected
To the Generator Ignition Coil
LOAD
PHCN
L/N
+
-
12V - BATTERY

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

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), 12 v battery, connectors, connecting wires, are lamp holder and one electric bulb, 12v d.c relays (five), two 2200 t.f 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.

CONSTRUCTION DETAILS

The circuit layout was carefully planned and each section of the bread board was clearly identified. The circuit was first built on the bread board, which makes it easier to locate errors. It was later on transferred to vero board (Electronic board) to prevent accidental short circuit.

The first component fixed was the transformer that drops voltage (step down) from 240v to is V.A positive voltage regulator of 12 v was then used after rectification and filtering to stabilize the d.c voltage at 12v so used to activate the relays. The regulator was used in building the power supply to allow for easy adjustment and self protecting against short circuits, over heating etc. The mounting of all the electronic push switch circuit was done in good manner and uses separate battery to start the ignition so constructed. This is followed by the soldering of the changing unit.

Below is the diagram for the circuit layout.

TESTING AND RESULT

When all the soldering had been completed on the vero board the whole 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 colored LED standing as PHCH ON/OFF indicator, the second yellow colored 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 to 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 shorting down of the generator was tested using the ignition activated circuit constructed to start and short down the ignition of a motor car (in good order). Since Generator and automobiles uses the same ignition starting and shorting principle.

PROJECT CASING

Any Equipment needs a container to protect it and make it safe for use. The causing of the project constructed is made of wood of rectangular shape box having the dimension 21cm x 10cm xx 11cm. The woods were jointed together by nails and painted with silver paint.

Necessary drillings 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 indicator, PHCN indicator and the load.

PROBLEMS ENCOUNTERED

Unavailable 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.

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 circuit constructed.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

CONCLUSION

The objective of this project an automatic change over switch has been achieved (with negligible error) to a very satisfactory extent. If has its aim of providing a constant power supply to equipments mostly during operation in hospitals and safe liver, communication companies and various homes. The loss associated with an electrical service interruption due to power failure is of great concern as power interruption in a machining operation loss of production and loss from damaged products. This project hence avoid a disorderly shut down which can be both hazardous and costly.

Relays which are mainly the heart of this project, provides 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 safety utilization of electrical energy, the fluctuation normal supply voltage at any time must not exceed $\pm$ 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 sensitive domestic and industrial establishment.

RECOMMENDATION

The project has clearly demonstrated the necessity for all engineering students, technicians and contractors having a fore knowledge and proper understanding of the change over switch and improving 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.

In ideal situation 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, battery and other means. And this case depends on the rate of the capacity of the appliance.

However, in order to make further improvement, the following recommendation should be considered.

i. High current and voltage rated relays should be employed.

ii. Long relay trip alarm.

iii. Short circuit trip alarm.

iv. Ground fault trip alarm.

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