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Editorial

CLIMATIC 9/11

In the United States, 9/11 ("nine eleven") has become shorthand for September 11, 2001—the day terrorists crashed planes into the World Trade Center and the Pentagon. 9/11 showed how vulnerable the world's superpower is to cataclysmic attack. Events surrounding 9/11 may have also confirmed the existence of a global climatic catastrophe in the making.

In response to 9/11, the U.S. Secretary of Transportation grounded all commercial flights for three days. The skies over the U.S.—the most heavily trafficked in the world—became eerily quiet, and the contrail clusters normally visible above metropolitan areas and air corridors disappeared. During that period many people noticed that the days seemed brighter and warmer than usual, and for good reason: they were.

9/11 woke-up Americans to the dangers of Islamic terrorism, but it should also served to wake up people everywhere about the dangers of global dimming. Global dimming is the term climatologists use to describe the reduction in the global solar irradiance. In layman's terms, it means less and less solar energy is reaching the earth's surface.

Global dimming is thought to be caused by atmospheric pollution—in particular, by the increased presence of aerosol particles that are the products of modern industry and transportation. When there is a lot of aerosol in the atmosphere, cloud droplets become smaller and more numerous, which makes the droplets more reflective. The more aerosol particles (like those contained in jet contrails) there are in atmosphere, the more they change the properties of clouds that reflect sunlight. The more sunlight is reflected back into space, the less heat from the sun gets through the clouds to warm up Earth at ground level. Those super-reflective clouds can, moreover, alter rainfall patterns, thereby causing droughts. The 1984 Ethiopian famine can be explained, at least in part, as a consequence of global dimming.

The first scientific observations of global dimming were made in the late 1960s. In the following decades, independent research conducted around the world—from Russia to the Maldives—seemed to confirm the existence of the phenomenon, but nobody was really sure until 9/11. A study of the climate in the continental United States during the three-day grounding of America's air fleet showed that the absence of jet contrails (just one of many aerosol pollutants) in the atmosphere produced an immediate change in the earth's surface temperature.

Recent research indicates that the dimming trend may be reversing in Europe where governments have enacted the world's strictest clean air laws. That's good news, right? If other governments followed Europe's lead global dimming could be reduced worldwide and we'd all be better off, wouldn't we? Well, yes and no. You see, climatologists believe that global dimming has been partially masking the full effect of global warming. Solving the global dimming problem may exacerbate global warming. Consequently, global dimming and global warming need to be tackled in tandem. Addressing one problem while ignoring the other would actually make the unaddressed problem worse. Addressing neither problem would be tantamount to humanity committing suicide.

In a 1963 address, President John Kennedy said, "Our problems are man-made; therefore, they can be solved by man." Kennedy was right. And, fortunately, the world doesn't lack the way to eliminate global dimming and global warming. We know what to do. Eco-friendly technologies, the adoption of which could halt both global warming and global dimming, are available today. What the world does lack is the will to take the steps necessary to secure a brighter and cooler future.

Some scientists believe that we're just a decade away from reaching the point of no return. Will the world's business and political leaders find the will to act in time? That depends on us—on our will to exercise our power as consumers and voters.

Nathan D. Austin

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Development of a Single Phase Automatic Change-Over Switch

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Abstract

Most industrial and commercial processes are dependent on electrical power. In the event of power interruptions, the change-over from power supplied by a public utility to a generator is usually performed manually, often resulting in wasted time. Moreover, machine damage sometimes occurs because of human errors. These can cause significant financial losses. This paper presents the design and construction of an automatic phase change-over switch that switches electrical power supply from public supply to generator in the event of a power outage or insufficient voltage. The system uses an electronic control circuit involving integrated circuits, transistor and electromechanical devices.

Keywords: *Relay, public supply voltage, generator, switching, electronic control circuit, transistor.*

Introduction

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.

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. Fig 1 shows the generalized block diagram of the system. The approach used in this work is the modular approach where the overall design was first broken into functional block diagrams, where each block in the diagram represents a section of the circuit that carries out a specific function. The functional block diagram of Fig. 1 also shows the interconnection between these blocks. Each section of the block is analyzed below.

A manual change-over switch consists of a manual change-over switch box, switch gear box and cut-out fuse or the connector fuse as described by Rocks and Mazur (1993). This change-over switch box separate the source between the generator and public supply, when there is power supply outage from public supply, someone has to go and change the line to generator. Thus when power supply is restored, someone has to put OFF the generator and then change the source line from generator to public supply.

In view of the above manual change-over switch system that involves manpower by using ones energy in starting the generator and switching over from public supply to generator and vice-versa when the supply is restored. The importance attached to cases of operation in hospitals and air ports in order to save life from generator as fast as possible makes it important for the design and construction of an automatic change-over switch which would solve the problem of manpower and the danger likely to be encountered changeover. The electronic control monitors the incoming public supply voltage and detects when the voltage drops below a level that electrical or electronics gadgets can function depending on the utility.

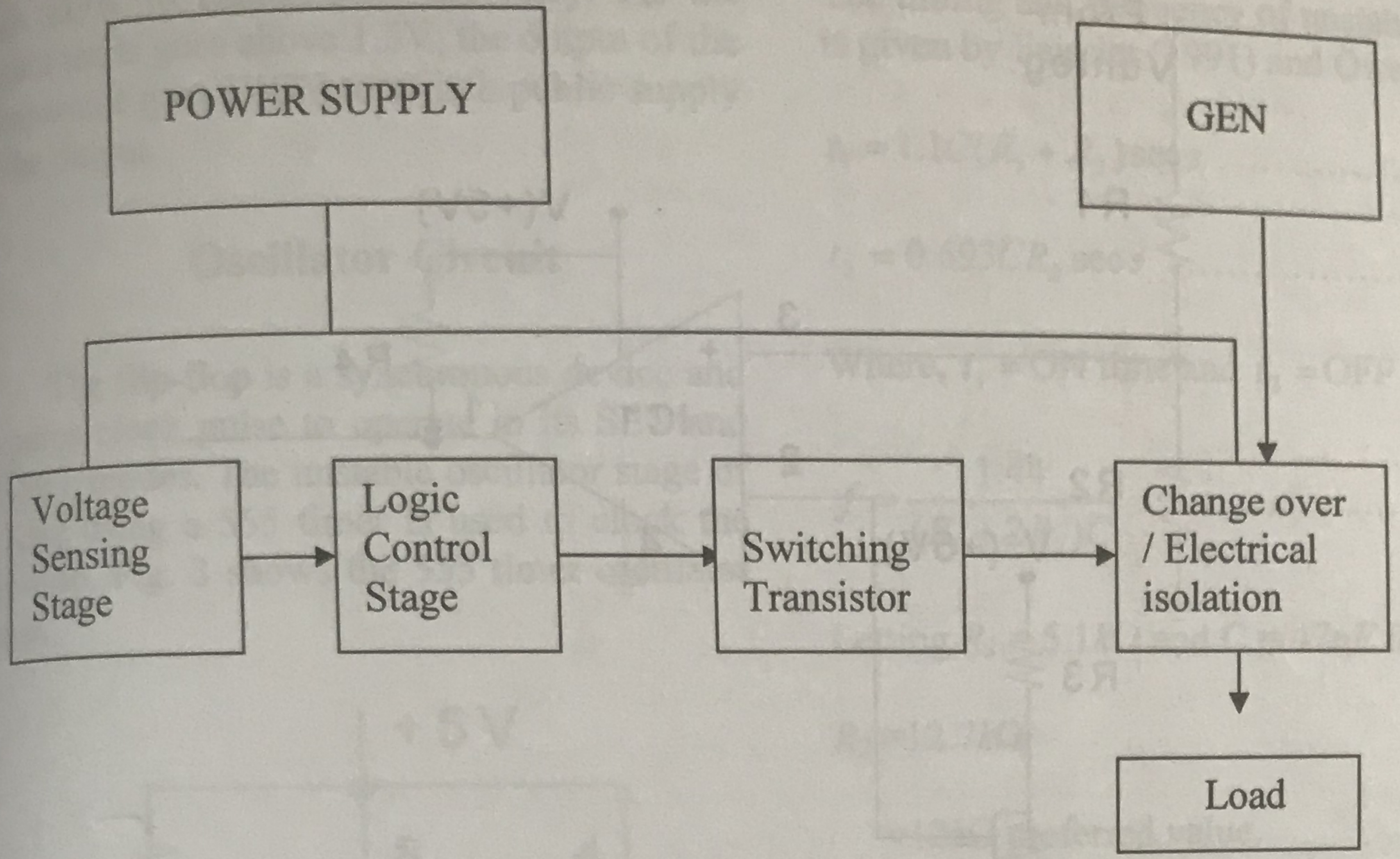

Fig. 1. Block Diagram of an automatic change over switch

supply. In this case 160V is the limit, which the system changes over from public supply or generator. The sensor stage monitors the unregulated voltage dropped across R1 and R2 as shown in Fig. 2.

The voltage feeds an input on IC1 which compares this input with a fixed reference across VR1. The drop across R1 at 160v ac is set as the reference. Any voltage drop below this sends a LOW to the input of the D-flip flop to switch the transistor OFF in set mode. Once the transistor I switch OFF, the relay is de-energized and the contacts changeover. Two relays are connected in parallel RLA1 is a 10A relay which switches the BATTERY 12V to the ignitions coil (or starter coil) of the generator, and switches it OFF once public supply is back .The second relay RLA2 is a 30A relay that selects generator or public supply output to load as shown in Fig. 4

The generator output is the normally closed. Hence, once de-energized, the generator output is fed to LOAD and once energized (by the presence of public supply) the relay (normally open contact, connects public supply output to LOAD). The introduction of the 7474-segment logic device is to ensure perfect switching and eliminate fluctuation, which is synonymous with voltage comparators as explained by Faissler (1991). This could be very devastating, as the relays would be switching erratically. The switching stage switches the relay contact ON and OFF in the presence and absence of the public supply voltage. The output change-over power is determined by the relay contact ratings.

Comparator/Voltage Sensor Stage

The comparator/voltage sensor compares two voltages and give an output, which tell if they are equal or unequal. The comparator stage in this system is used to sense when the public supply voltage has dropped below a certain level. The input public supply voltage is converted to DC in the power supply stage and regulated to 12V and 5V for the power supply needed in the circuit. The unregulated voltage varies as the public supply input varies.

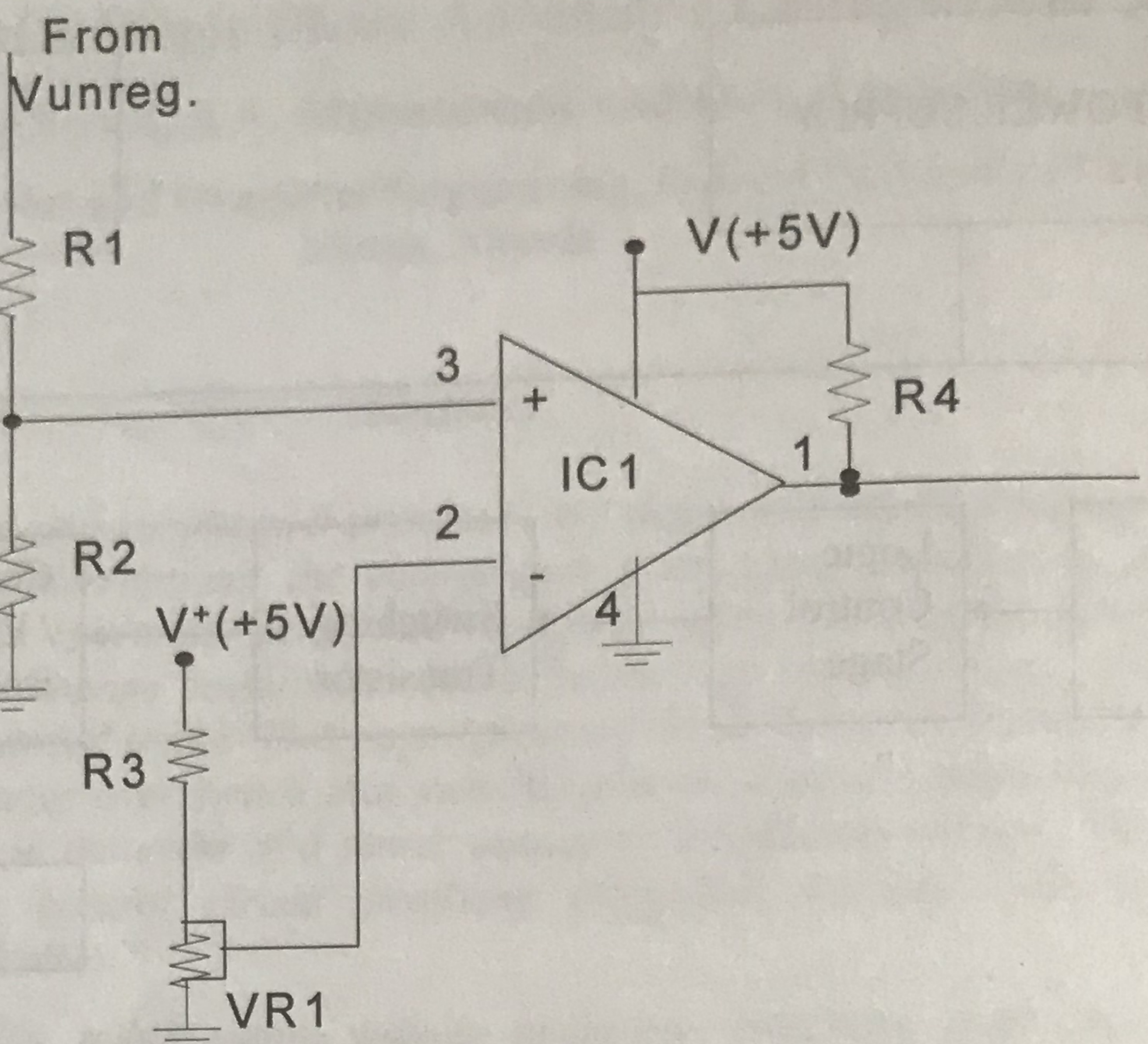

Fig. 2. Comparator stage

Design Calculations

From Fig. 2: R_1 and R_2 form a potential divider, to reduce the unregulated voltage to a low voltage of less than 5V. At 160V ac input let VR2 = 1.5V

But, $VR_2 = \frac{R_2}{R_1 + R_2} V^+$ 1

Where VR_2 is the drop across R_2 and V^+ is the unregulated voltage. From Table 1 it can be seen that $V^+ = 11V$ at 160VAC input.

Let $R_1 = 100k\Omega$

$R_2 \doteq 15.7k\Omega$

$= 15k\Omega$ Preferred value

$R_1 = 100k\Omega$, $R_2 = 15k\Omega$

R_3 and R_4 form another potential divider for the reference. Letting a maximum adjustable reference of 3.5V and setting $R_3 = 1.5k\Omega$

$VR_4 = \frac{R_4}{R_4 + 1.5k} V^+$ 2

$R_4 = 3.5kV$

$= 5kV$ preset (preferred value)

R_3=1.5kV and R_4= 5kV preset.

For the comparator,

$V_{OUT} = A_O V_{in}$ 3

Where A_O = open loop voltage gain (usually 20,000 or more (Horowitz and Winfield 2002)).

And, $V_{in} = V^+ - V^-$ 4

V_{OUT} will drop to V^+ for the slightest positive difference in voltage since A_O is often very large (in order of 20,000).

As the public supply input drops below 1.5V reference, the output of the comparator goes LOW to change-over the relay. As the output tends goes above 1.5V, the output of the comparator goes HIGH to switch public supply to the output.

Oscillator Circuit

The flip-flop is a synchronous device and requires clock pulse to operate in its SET and RESET modes. The unstable oscillator stage of 1 KHz using a 555 timer is used to clock the flip-flop. Fig. 3 shows the 555 timer oscillator stage.

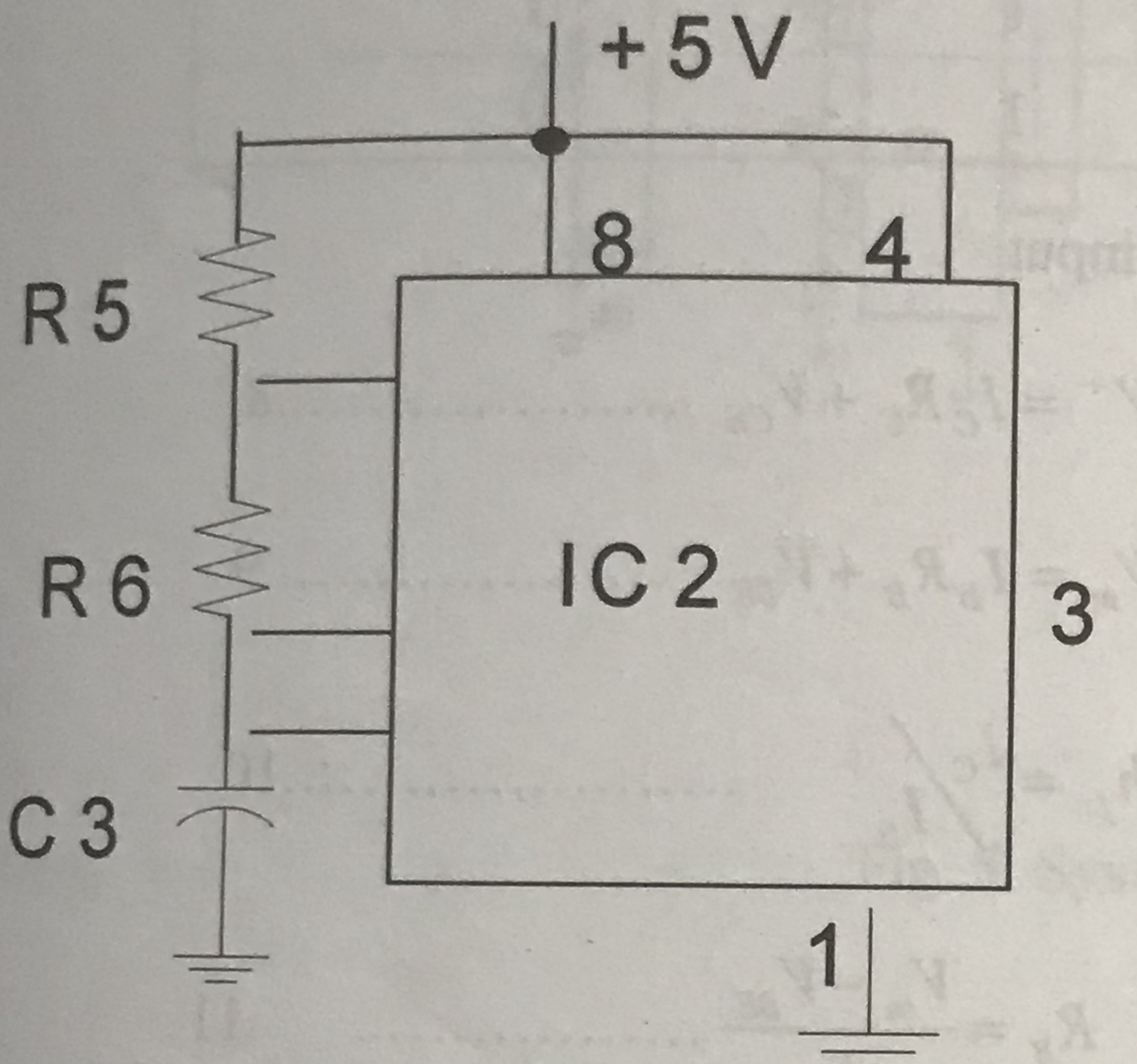

Fig. 3. Unstable oscillator stage

The timing and frequency of unstable oscillator is given by Faissler (1991) and Owen 1995:

$$t_1 = 1.1C(R_1 + R_2)\sec s \quad \ldots\ldots\ldots\ldots 5$$

$$t_2 = 0.693CR_2 \sec s \quad \ldots\ldots\ldots\ldots 6$$

Where, t_1 =ON time and t_2 =OFF time.

$$f = \frac{1.44}{(R_1 + 2R_2)C} \quad \ldots\ldots\ldots\ldots 7$$

Letting $R_1 = 5.1k\Omega$ and $C = 47nF$ for $F=1\ kHz$)

$R_2 = 12.7k\Omega$

$=12k\Omega$ preferred value.

Hence, $R_5 = 5.1k\Omega$, $R_6 = 12k\Omega$ and $C_3 = 47nF$.

Flip Flop/ Switching Transistor Stage.

The flip-flop acts as a logic control while the transistor acts as a switching circuit. Fig 4 shows the circuit diagram of the flip-flop and switching transistor stage.

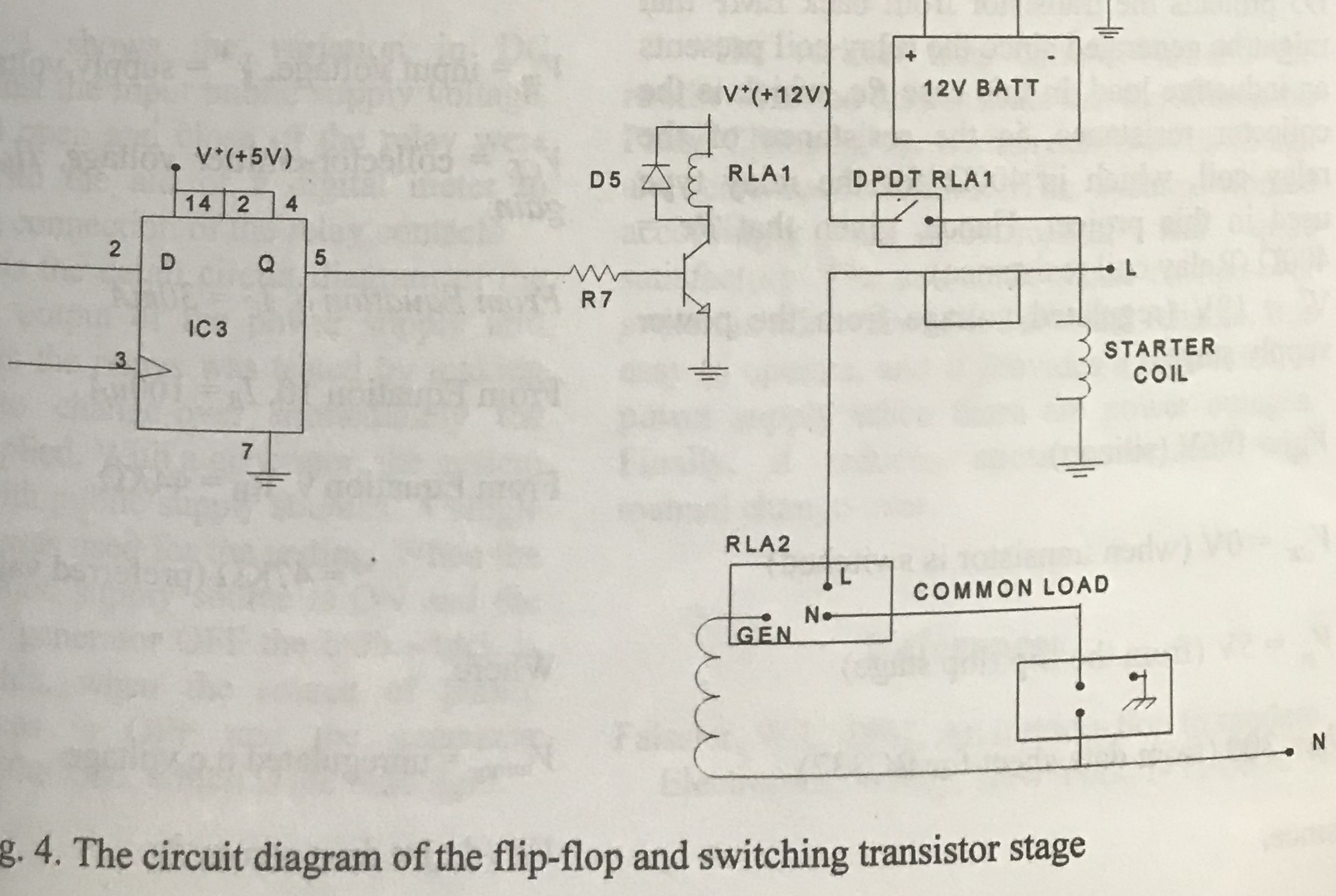

Fig. 4. The circuit diagram of the flip-flop and switching transistor stage

Logic Control

The logic control is built around a D-type flip-flop. It is the flip-flop that tells the system when to switch to generator or public supply. The operation of the system is described in the truth table below. The logic control circuit operates in its set and reset mode. When the rising edge of the unstable clocks the flip-flop, the flip-flop shifts data from the data (D) input to the Q output to OFF the generator and connect public supply to the comparator output. When the voltage drops the comparator sends a LOW to the flip-flop input which switches the generator ON and changes over the output to generator.

Table 2. Flip flop truth table

Mode	D input	Ck	Q	Q	R
Set	1		1	0	1
Reset	0	X	0	1	1
Hold	X	X	0	1	0

X …Don't care Q and Q …Outputs; D …Data input

Transistor Switching Circuit

The switching transistor switches the relay, which selects between the generator and the public supply. The transistor as a switch operates in class A mode as described by Theraja and Theraja (2002). The relay is switched on when the flip-flop is in SET mode. A base resistor is required to ensure perfect switching of the transistor in saturation. Diode D5 protects the transistor from back EMF that might be generated since the relay coil presents an inductive load. In this case *Rc*, which is the collector resistance, is the resistance of the relay coil, which is 400Ω for the relay type used in this project. Hence, given that *Rc* = 400Ω (Relay coil resistance).

V^+ = 12V (regulated voltage from the power supply stage)

$V_{BE} = 0.6V$ (silicon)

$V_{CE} = 0V$ (when transistor is switched)

$V_{in} = 5V$ (from the flip flop stage)

$h_{fe} = 300$ (from data sheet for BC337)

since,

$$V^+ = I_C R_C + V_{CE} \quad \ldots\ldots\ldots\ldots\ldots\ldots 8$$

$$V_{in} = I_B R_B + V_{BE} \quad \ldots\ldots\ldots\ldots\ldots\ldots 9$$

$$h_{fe} = {}^{I_C}\!/_{I_B} \quad \ldots\ldots\ldots\ldots\ldots\ldots 10$$

$$R_B = \frac{V_{in} - V_{BE}}{I_B} \quad \ldots\ldots\ldots\ldots\ldots\ldots 11$$

Where, I_C = collector current, I_B = base current

V_{in} = input voltage, V^+ = supply voltage

V_{CE} = collector-emitter voltage, H_{fe} = *current gain.*

From Equation 8, $I_C = 30mA$

From Equation 10, $I_B = 100uA$

From Equation 9, $R_B = 44K\Omega$

$= 47K\Omega$ (preferred value)

Where,

V_{unreg} = unregulated d.c voltage

VR_2(d.c) = drop across R_2

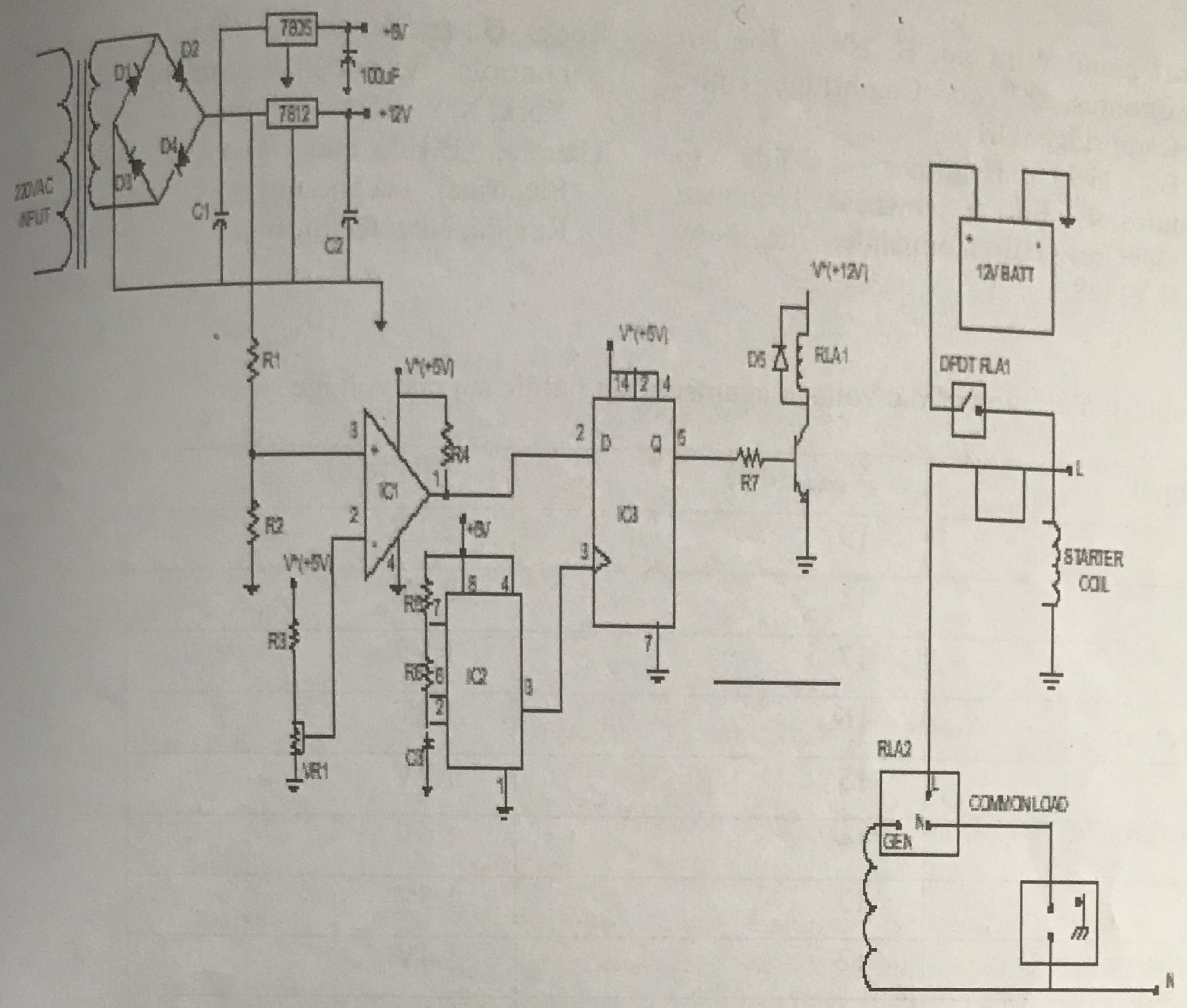

Fig. 5. System circuit diagram

Performance Evaluation

Table 1 shows the variation in DC voltage against the input public supply voltage. The Normal open and close of the relay were identified with the aid of a digital meter to avoid wrong connection of the relay contacts

Fig. 5 is the detail circuit diagram of the system. The output of the power supply unit which powers the relays was tested by making the relays to change-over immediately the power is supplied. With a generator, the system was tested with public supply sources. A single electric bulb was used for the testing. When the supply of public supply source is ON and the source of the generator OFF the bulb which is the load lights, when the source of public supply sources is OFF and the generator switched ON the load, which is the bulb light.

Conclusion

The various tests carried out and the results obtained demonstrate that the Automatic Phase Change-Over Switch achieved its design and construction aims. The system worked accordingly to specification and quite satisfactory. The automatic phase change-over switch is relatively affordable and reliable. It is easy to operate, and it provides a high level of power supply when there are power outages. Finally, it reduces stress associated with manual change-over.

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Table 1. Variation of d.c voltage against input public supply voltage

AC input	V_{unreg} (d.c)	VR_2 (d.c)
240	19	2.1V
230	18	2.0V
220	17	1.9V
210	16	1.8V
200	15	1.7V
190	14	1.6V
180	13	1.5V
170	12	1.4V
160	11	1.3V
150	10	1.2V