DUAL SOCKET OUTLET TIMER FOR PREVENTING AND REDUCING ELECTRIC FIRE OUTBREAK

[*]Sani Tijjani[1], Mujahid Ado Alkassim[2], Abubakar Abdullahi Umar[3] and Isa Ibrahim[4]
[13 4]Department of Computer Engineering, Kano state Polytechnic, School of Technology, Kano, Nigeria.
[2] Department of Electrical Engineering, Kano state Polytechnic, School of Technology, Kano, Nigeria.
[*]EMAIL: saniubast@yahoo.com [*]MOBILE NO: +2348060576905

ABSTRACT
Electrical appliances and electronics equipment such as electric heaters, electric cooker, computers, television receivers, mobile phone chargers, power banks e.t.c are always connected to a socket outlet at our homes and offices. Leaving such equipment connected to a socket over a long period of time may lead to equipment failure or damage which can also lead to a fire outbreak. The aim of this paper is to design and implement a Dual socket outlet timer that automatically switch off an equipment or electric appliances connected to one or both of the two sockets automatically after a selected period of time ranging from 1 to 100 minutes. Thus, prevent and reduce the danger of electric fire outbreak.

KEYWORDS: Timer, Ripple Counter, Astable Multivibrator, Electronic relay and Socket Outlet.

INTRODUCTION

Electricity is a basic part of our life and it provides the energy for most powered items (Tijjani *et al.,* 2018). Today it is hard to imagine a life without electricity. Yet, using electricity can have dangerous consequences. Electric fire outbreaks occur frequently throughout the world, causing injury, claiming lives, and resulting in large losses of property (U.S. DH S, 2014). The residential electric fire outbreaks are mostly caused by faulty socket, electronics equipment or electrical appliances failure (Adekunle *et al.,* 2016). It was observed that some of the failures are as a result of leaving or forgetting those appliances connected to a socket outlet for a long time (SCDF, 2016).

The 1 to 100 minute Dual socket outlet timer is introduced to prevent and reduce the above problem by allowing the user to always select appropriate time before connecting an equipment or an electrical appliance to the socket in order to turn them OFF automatically after a selected period. The Dual socket outlet gives the advantage of allowing a user to connect an appliance or equipment to socket 1 and socket 2 and set the timing period independently. The work has the following practical applications:

- It can be used in the kitchen to provide an automatic cooking time of an electrical stove connected to the socket.
- It can also be used to provide automatic charging time to a handset charger, Lap top computer or power bank connected to the socket.
- It can be used at home to set the timer (e.g. 15 to 30 minutes) before going to sleep in order to switch OFF a TV set, Video set, Satellite receiver, Radio set automatically when the user is asleep.

A timer is a device used to measure the amount of time taken by a process or activities. It can also be defined as a device that starts or stops a machine working at a particular time (Oxford Dictionary, 2017). Many Electric timers were designed and implemented with different application. Some were short duration timers and others were long duration timers. For example, the visual display timer which is a short duration timer circuit designed to produce a time delay from 1 to 99 seconds and the elapsed time is displayed on the seven segment display (Jones, 1993). A timer for processing data blocks is proposed for a receiver of a mobile communications system (Yi, 2014).A fan controller was also designed that is capable of switching power to a fan between an "on" state and an "off" state in accordance with one or more programmable schedule design (Simard *et al.,* 2013). A system for automatically recording an event transmitted over a network is provided. A network client is programmed to automatically access a network server at first specify time, download the data from the server to specified destination or file, stop download at a specified time, and automatically disconnect from the network server (Lowell 2000).

Unlike (Tijjani *et al.,* 2018) that designed single socket outlet timer that can switch OFF the socket outlet automatically after selected period of time that range from 1 to 100 minutes. In this work, a Dual socket outlet timer is designed to switch OFF two socket outlets automatically independently after selected period of time that range from 1 to 100 minutes.

MATERIALS AND METHODS

The design and implementation of this work can be achieved by the following methods:

a) Design 555 Timer in Astable mode

An astable multivibrator, also called a free-running Multivibrator as it does not require any additional inputs or external assistance to generate a signal (Rahman, 2000).There is a need to design an astable multivibrator that can generate an approximately 8192 pulse (the dividing ratio of the 4020B ripple counter I.C input required) for any time select ranging from 1- 100 minutes. For simplification two astables can be design. One is used to generate an approximately 8192 pulse for any selected time from 1 – 10 minutes and another astable that can produce 8192 pulse for a range of time selected from 10 – 100 minutes.

In order to design an astable multivibrator one important factor is the frequency, but here since the number of pulses needed are 8192 pulses for any time selected from 1 – 10 minutes, the frequency can be find using the following relation(Abrar, 2017).

$$F \times T \times 60 = 8192 \quad \text{...(1)}$$

Where,

F= frequency of generated pulse by the astable.

T x 60 = maximum time selected in seconds (i.e. 10 min).

8192 = pulse needed to be generated within the interval of the time selected.

Therefore,

$$F = \frac{8192}{10 \times 60} = 13.65Hz \quad \text{...(2)}$$

From the relation,

$$F = \frac{1.44}{(R_1 + R_2)C_2} \quad \text{...(3)}$$

For $R_2 >> R_1$

$$F = \frac{1.44}{(2R_2^{'} \times C_2)} \quad \text{...(4)}$$

Let C_2 =1 X 10^{-6} and R_{1} = 2.2K

$$13.65 = \frac{1.44}{(2R_2^{'} \times 1 \times 10^{-6})}$$

$$R_2^{'} = \frac{1.44}{(2 \times 10^{-6} \times 13.65)} = 527K \ldots\ldots (5)$$

$R_2^{'}$ = R_2 (fixed resistor) + R_3 (variable resistor)

527K = R_2+ R_3

Let R_2=3.9K

527K = 3.9K + R_3

R_3=527K-3.9K=488=470K…………………………………………………………... (6)

Now,

R_1=2.2k, R_2=39K,R_3=470K and C_2= 1µF

For design of 10 – 100 minutes 555 Timer in astable mode, all the method are the same with 1 – 10 minutes 555 Timer in astable mode above except for the value of C_2 which is 0.1 µF instead of 1µF. So 10 – 100 minutes capacitor is now called C_1(Abrar, 2017).

Now,

R_1 = 2.2k, R_2 = 39K, R_3 = 470K and C_1 = 1µF

In order to simplify the design above and reduce the cost, the two astables can be merged into a single circuit using a single 555 timer I.C with two way switch that allow to switch between 1-10 minutes astable and 10-100 astable to produce 1- 100 minutes astable as shown in Figure 1 below:

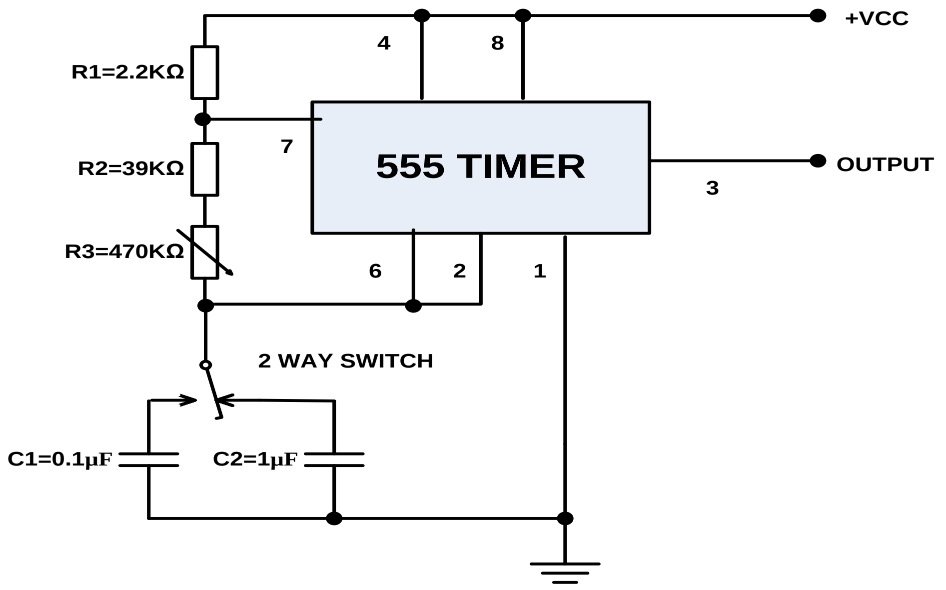

Figure 1: 1-100 Minutes astable

b) Counter Design

To design a counter that can count the generated 8192 pulses by an astable and turn off when the 8192nd pulse arrives. This can be achieved using 4020B ripple counter I.C by connecting the output of the astable (pin 3) to the clock input (pin 10) of the 4020B I.C. For the ripple counter to be set to zero a high voltage must be applied to the reset terminal (pin 11). Also in order to allow ripple counter to count the applied pulse the reset terminal must be kept low (Maini, 2007).

Therefore, in order to keep the reset terminal (pin 11) in low condition it is connected to a ground via a very high resistor R4 also in order to provide a high voltage any time the counter turn off to reset it, the reset pin 11 is connected to VCC via a low capacitor C3 (Maini, 2007). This make the combination of R4 in series with pin 11 connected between them as shown in figure 2 below.

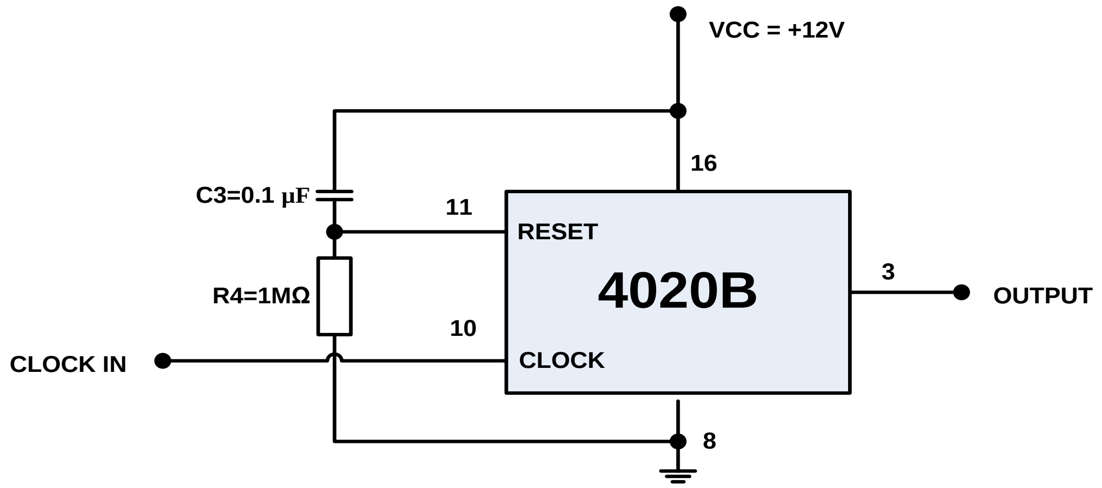

Figure 2: Ripple counter IC with reset components

The suitable value of R4 is 1M ohms and the suitable value of C3 is 0.1uF but any close value can do. The low capacitance was used because the rate of discharging need is low. Thus, when the counter is off, the capacitor C3 discharges toward pin 11 which instantly resets the counter. Also a very high resistance was used in order to prevent the discharging current from going and at the same time provide a low level to the pin 11 when the counter is switch ON (Maini, 2007).

c) Transistor switch design

A 2N3906 general purpose PNP transistor was used in designing the transistor switch. The circuit is shown in figure 3 below. The ripple counter output is directly connected to the base of transistor via R_B so that it can be switched ON or OFF by the counter output and the transistor provides enough current output to drive the relay (Vodovozov, 2010).

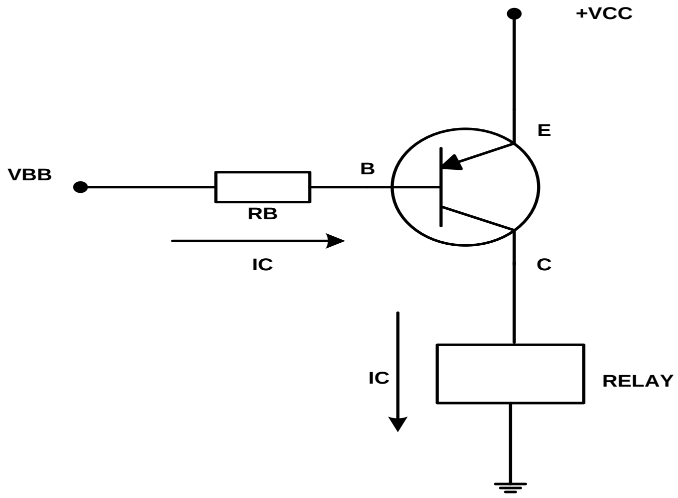

Figure 3: Transistor switch

Vcc = 12V

Relay = 6V, 180 ohms.

$$I_C = I_L = \frac{V_{CC}}{R_{AL}} \quad \text{……} \quad (7)$$

Where,

R_{AL}=relay resistance

I_C=collector current

I_L=load current

$$I_C = \frac{12}{180} = 0.66 = 66.7mA \quad \text{(8)}$$

$$I_B = \frac{I_C}{hfe} \quad \text{(9)}$$

The hfe of 2N3906 from data book is 100.

$$I_B = \frac{66.7mA}{100} = 0.66mA \quad \text{(10)}$$

Also

$$R_B = \frac{(V_{BB} - V_{BE})}{I_B} \quad \text{(11)}$$

V_{BB} = 5V (High Voltage)

V_{BE} = 0.7V (Voltage drop across base-emitter junction)

Hence,

$$R_B = \frac{(5-0.7)}{0.66mA} = 6.4K\Omega \quad \text{(12)}$$

$R_5 = R_B = 6.8K\Omega$

d) Relay self-latch switch design

Relays are electrically activated switches and the relay shown below is a 12V double-pole relay connected in a self-latch mode. When switch S1 press (close) a +12VVcc applied to Q1, IC1, IC2 and also to relay through power diode D1. When S1 releases (open), the relay keep the 12V Vcc to the whole circuit by self-latches via contact NO-2 and activate the socket outlet via contact NO-1.

The diode D1 is used to allow current to flow to the relay in only one direction and diode D2 is a freewheely diode used for transistor protection against reverse current (Scherz and Monk, 2013).

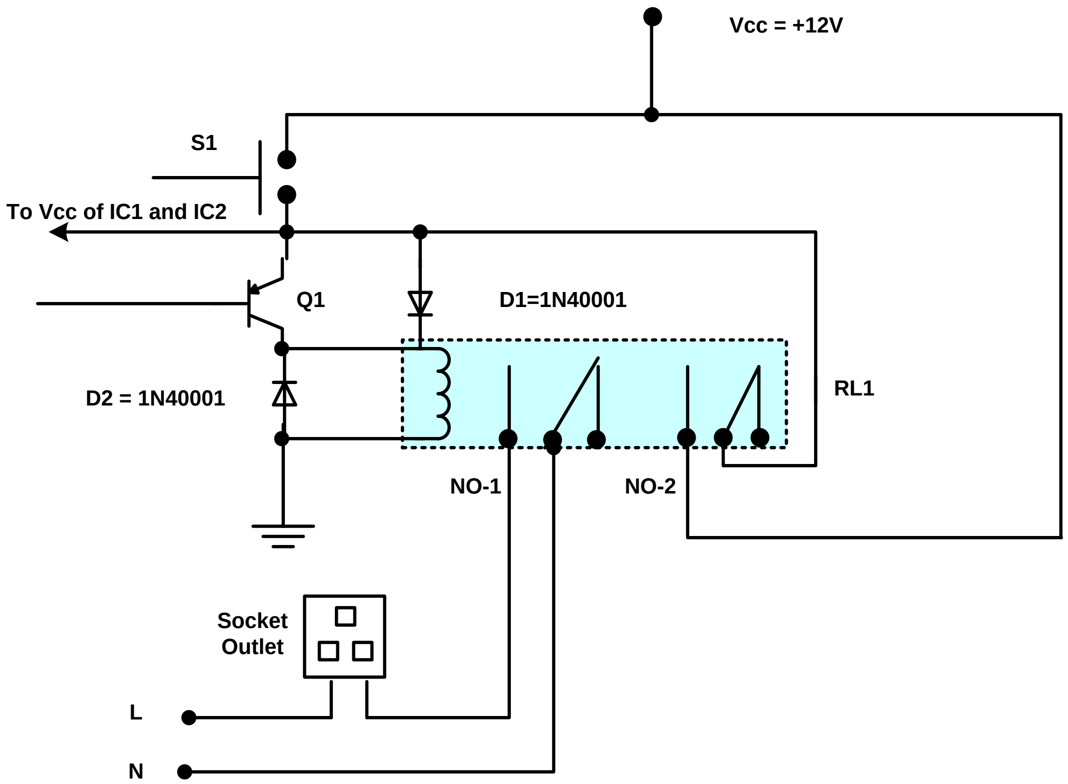

Figure 4: Relay self-latch circuit

By combining the sub-unit designed above (i.e. astable multivibrator, ripple counter, transistor switch and self-latch relay switch) a single timer can be produced. Duplicating the complete timer circuit, arranging them in a way that timer 1 control socket 1 and timer 2 control socket 2 a Dual socket outlet timer can be produced as shown in figure 5 below. The operating voltage of the complete circuit is 12V DC which can be powered by battery, solar or regulated power supply unit.

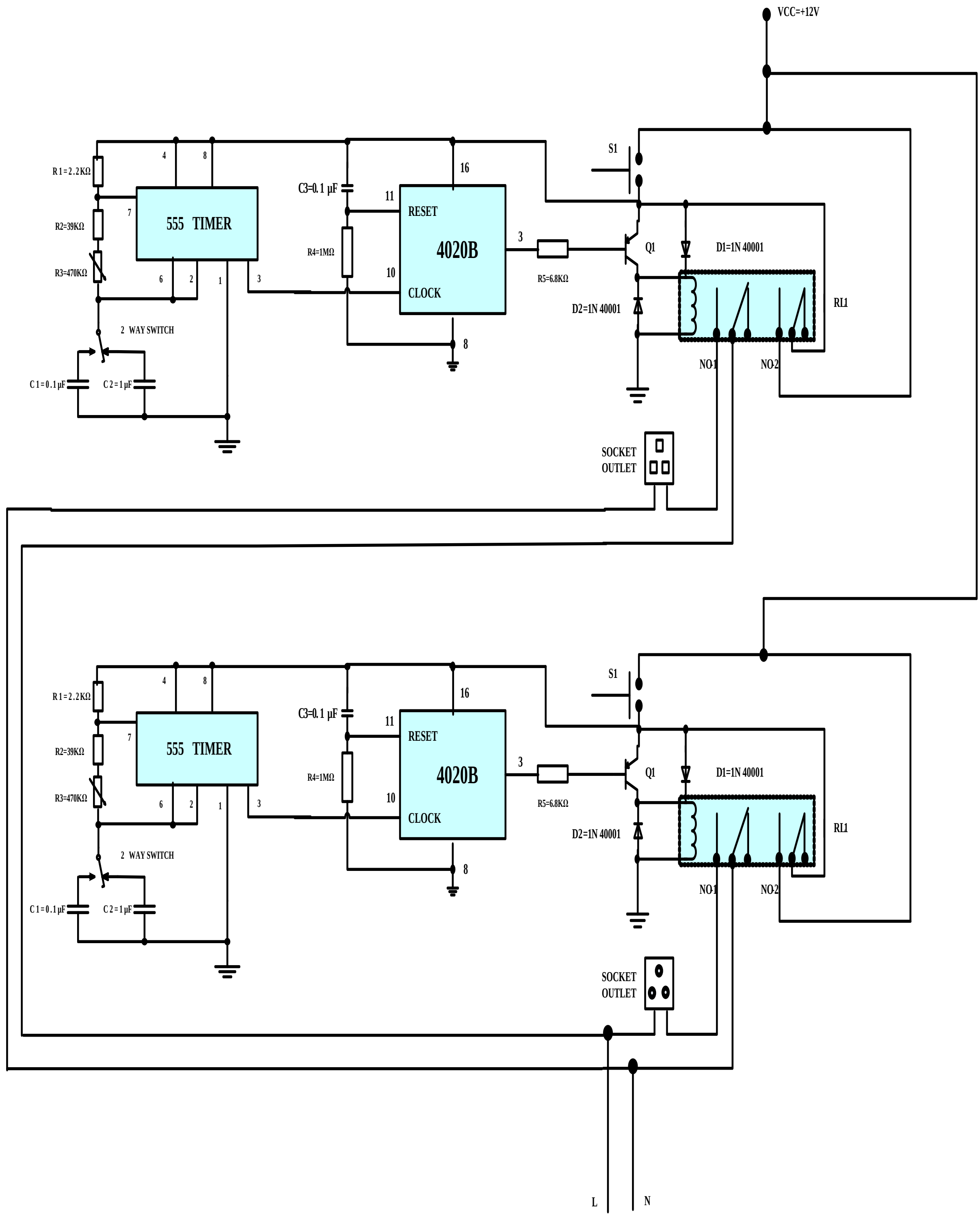

Figure 5: Complete circuit of 1 to 100 minutes Dual socket outlet timer

The figure 6 below show the front elevation of complete 1 to 100 minutes Dual socket outlet timer case.

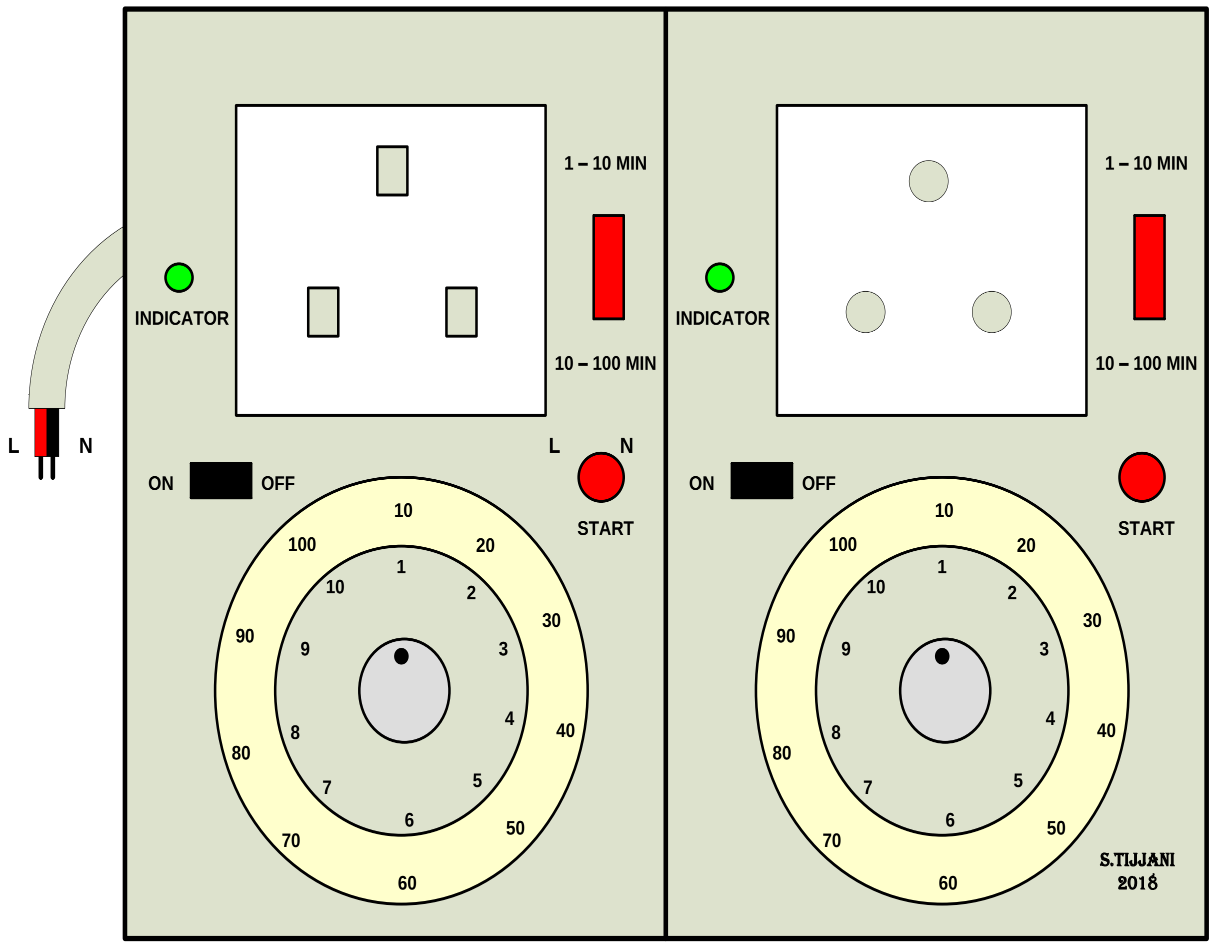

Figure 6: Front elevation of 1 to 100 minutes Dual socket outlet timer

RESULT

The timer section can be tested to make sure the switch ON time is the same with the time select (by varying variable resistor R3) using a stop watch. The results obtained are tabulated in table 1 below:

Table 1: Switch ON Time obtained using Stop watch

S/N	Timer 1			Timer 2		
	Time Select (Minutes)	**Recorded Time (Minutes)**	**Capacitance (µF)**	**Time Select (Minutes)**	**Recorded Time (Minutes)**	**Capacitance (µF)**
1	2	2.07	0.1	2	2.12	0.1
2	4	3.52	0.1	4	3.54	0.1
3	6	6.18	0.1	6	6.13	0.1
4	8	7.57	0.1	8	8.06	0.1
5	10	10.13	0.1	10	9.59	0.1
6	20	19.54	1	20	20.46	1
7	40	41.25	1	40	39.30	1
8	60	58.23	1	60	58.23	1
9	80	80.12	1	80	83.14	1
10	100	96.02	1	100	98.02	1

From the results obtained in table 1 above, the time selected slightly differs from the recorded time; this is due to the tolerance of the electronic components used, like resistors and capacitors. But most recorded time obtained is approximately the same as the time selected. Hence, this work successfully produced a Dual socket outlet timer that can switch OFF the socket outlet automatically after selected period of time that ranges from 1 to 100 minutes.

CONCLUSION

This work is designed to automatically switch OFF an equipment or electrical appliances connected to it after a selected period of time that ranges between 1 to 100 minutes. Thus, reduce the hazard of equipment failure or over heat that may cause a fire outbreak when an equipment or electrical appliances are connected to an ordinary socket outlet over a long period of time. Therefore, this work has the importance of providing the safest means of using a socket outlet. The following recommendations are made for improvement of the work:

- An alarm can be added in a way that it makes a sound to notify the user after a selected period that the socket switches off.
- Two LED indicators can be added in a way that Green LED indicates timing and the Red LED indicates not timing.
- A seven segment display can be added to allow the user to see the elapsed time on the display.

REFERENCES

A. Adekunle, A. Asuquo, N. Essang, I.I. Umanah, K.E. Ibe, Ayo Bamidele Alo (2016). Statistical Analysis of Electrical Fire Outbreaks in Buildings: Case Study of Lagos State, Nigeria. *Journal of Sustainable Development Studies.* 9, 76-92.

Abrar, M. M. (2017). Design and Implementation of Astable Multivibrator using 555 Timer. *IOSR Journal of Electrical and Electronics Engineering*,12(1), 22-29.

Dictionary, O.E. (2017). Oxford english dictionary, Version 9.1. Oxford university Press.

Jones, L. (1993).*Basic Electronics for tomorrow world*. Cambridge low edition.

Lowell, R. W. (2000). U.S. Patent No. 6,012,086. Washington, DC: U.S. Patent and Trademark Office.

Maini, A. K. (2007). *Digital electronics: principles, devices and applications*. John Wiley & Sons.

Rahaman, M., Anik, S. K., Mondal, P., Sharif, S., & Ahad, M. T. (2015). Analysis & Design of Different Astable Multivibrator Circuits For Various Applications in Communication System. *International Journal of Scientific Research Engineering & Technology*, *4*(3).

S.Tijjani, M.A. Alkasim, A.S. Muhammad, A.A. Umar, A.S. Yunusa and I. Ibrahim (2018). Socket outlet timer for preventing and reducing electric fire out break. *National conference of research in science, engineering and Technology*. Husaini Adamu Federal polytechnic, Kazaure jigawa state.

SCDF The life saving force (2016). Fires Involving Batteries of Electric Bicycles, Personal Mobility Devices, Powerbanks and Laptops (2008 – 2015). *Fire Analysis Report*. 2(1), 1-16.

Scherz P. and Monk S (2013). *Practical Electronics for Inventors*. McGraw Hill New York Third edition.

Simard, P., Langevin, P., Meilleur, B., & Boisvert, D. (2013). *U.S. Patent No. 8,441,155*. Washington, DC: U.S. Patent and Trademark Office.

U.S. Department of Homeland Security (2014). Residential Building Electrical Fires. *Tropical fire report series*, 14(13), 1-11.

Vodovozov, V. (2010). *Introduction to Electronics Engineering*. Ventus publishing.

Yi, S. J., Yeo, W. Y., & Lee, S. Y. (2014). U.S. Patent No. 8,724,480. Washington, DC: U.S. Patent and Trademark Office.