DESIGN AND CONTRUCTION OF CLAP ACTIVATED SWITCH

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DEDICATION

I dedicate this project to the glory of Almighty Allah and my mother Engr. (Mrs) I.K. Ogunfayo.

ATTESTATION/DECLARATION

I, Ogunfayo Ahmed Olaniyi, hereby affirm that this work was done by me and has never been presented anywhere else for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Ogunfayo

Ogunfayo Ahmed Olaniyi

11/01/2010

Signature and date

Dr. J. Tsado

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Signature and date

For;

Engr. Dr. Y.A. Adediran

May 6, 2010

Signature and date

ACKNOWLEDGEMENT

Firstly I appreciate Almighty Allah for His guidance and protection over me from the begin of my pursuit of this degree up to this moment. I also appreciate my mother Engr. (Mrs) I.K. Ogunfayo for her moral and financial support.

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Lastly, I also appreciate my friends on campus, who makes my stay on campus a glorious one.

ABSTRACT

This paper presents the design and construction of a clap activated switch device that will serve well in different phono-controlled applications, providing low expensive key and at the same time free from false triggering. The project involves the design of various stages consisting of the pickup transducer, signal amplification, pulse shaper and missing pulse detector (these are used for timing and clocking), bistable and switching circuit. The clap switch is used to switch ON and OFF two devices depending on the number of claps.

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CHAPTER ONE

INTRODUCTION

1.1 Clap Activated Switch

The clap activated switching device can basically be described as low frequency sound pulse activated switch that is free from false triggering. The input component is a transducer that receives clap sound as its input and converts it to electrical pulse. This pulse is amplified and used to drive integrated circuits components which changes output state to energize and also de-energize a relay causing the device to be able to switch larger devices and circuit[4].

The output state of the switching device circuit can only change when the circuit receives two or more claps within a time period that will be determined by the resistor and capacitor value in the circuit. The transducer (microphone) is connected to an amplifier circuit (operational amplifier) which is connected to a timing integrated circuit (555 timer). These timing ICs are wired as monostable multivibrators and their output is used to drive a decade counter integrated circuits (4017) that is wired as a bi-stable to drive a relay.

1.2 Objectives of Study

1) Alleviate the problem faced by the aged and physically challenged persons in trying to control some household appliances.
2) It also takes into consideration the illiterates that may have problems operating some "complex" household Remote Control Units (RCU).

3) This provides an introductory study on the basic principles involved in utilizing acoustic energy to control switching process.

4) This is achieved by converting the energy generated by the "hand clap" into electrical pulse, which in turn used to drive an electronic circuitry that includes a relay, which in turn switches ON or OFF any appliance connected through it to the main.

1.3 Methodology of Study

The electronic components and all other materials would be arranged on a board and coupled together. A variable resistor at the operational amplifier is used to set the sensitivity of the input transducer (Electret Microphone). The resistance and the capacitance values are calculated for the timing of the two 555timers (IC2 and IC3). Light Emitting Diodes (LEDs) are used to indicate the timing of the ICs.

At the output of the 4017 we have Light Emitting Diodes (LEDs) of different colours that indicates the present mode of the switch. The clap switch is then used to switch different kinds of home appliances with different power ratings to check for the effectiveness of the switch, the switching is done with relays which are coupled to the output of the 4017 expected to switch an appliance through a transistor.

1.4 Scope of Work

The main scope of this project is to design a circuit that switches on two different devices at different times which is controlled by clap (acoustic sound).

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

2.1.1 Switch

A switch is an electrical component which can break an electrical circuit, interrupting the current or diverting it from one conductor to another. A light switch is the commonly used to operate electric lights, permanently connected equipment, or electrical outlets. The first light-switch employing quick-break technology was invented by John Holmes in 1884 in the Shieldfield district of Newcastle-Upon-Tyne. Light switches are usually built into the walls of the house. Surface mounting is also fairly common though is seen more in commercial industrial and outbuilding settings than in houses[1].

For electrical safety considerations in many countries their design and installation is regulated either by law or by widely accepted industry standards. In practice however in most countries any requirements for permits or certification are widely ignored and replacing a light switch is considered a simple "do-it-yourself" task with the parts being widely available.

The dimensions, mechanical designs, and even the general appearance of light switches changes very slowly with time. Manufacturers introduce various new forms and styles, but for the most part decoration and fashion concerns are limited to the faceplates. Even the "modern" dimmer switch with knob is at least four decades old, and even in the newest construction the familiar toggle and rocker switch appearances predominate[1].

2.1.2 Clap Activated Switch

The Clap Activated Switch (Clapper) is a sound activated electrical switch, which is used to control one or more devices based on the number of claps it receives i.e. two or more claps. The switch was first issued by United States Patent on 9th of July, 1985 and first sold to the public on 1st of September 1986[2].

The early clap activated switches uses the basic electronics components, such as resistors, capacitors, transistors, light emitting diodes, diodes and the Electret Microphone. The electrets microphone picks up the sound of your claps, coughs, and the sound of that book knocked off the table. It produces a small electrical signal which is amplified by the succeeding transistor stage. Two transistors cross connected as a bistable multivibrator change state at each signal. One of these transistors drives a heavier transistor which controls a lamp. Some little modification were made to increase the efficiency of the switch.

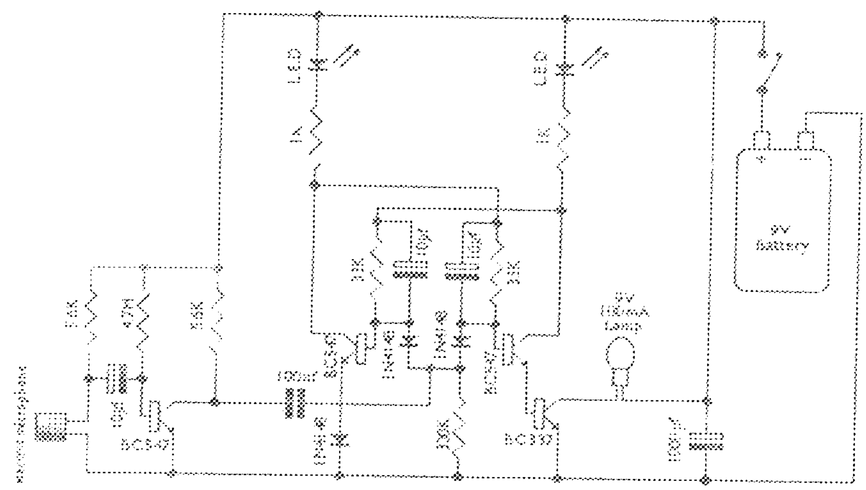

Fig 2.1 The Early Clap Switch

The later clap activated switches replaces the bistable with two 555 timers and a decade counter (4017 IC). The two 555 timers are connected in monostable mode, the amplified pulse from the microphone is use to trigger the two 555 timers and the output of the first is used as V_{CC} for the second. The output of the second 555 timer is then used to clock the decade counter (4017), which is connected in a mode that makes the outputs goes high sequentially. The first output goes high as soon as the decade counter is connected in the circuit, the next sequential output not needed is connected to the reset pin of the decade counter (4017), this resets the IC if it`s the next to go high and makes the IC go back to its initial state (as if it was just connected to the circuit).

When the clap activated switch receives the first clap, the amplified signal of the microphone triggers the first 555 timer, but because the second 555 timer is not connected to V_{CC} it is not triggered. The output of the first 555 timer after the first clap serves as the V_{CC} for the second 555 timer. When the second clap comes before the output of the first 555 timer goes low, the second 555 timer is trigger and its output goes high which clocks the decade counter (4017 IC). This makes the next sequential output goes high which is used to activate a relay which switches ON the device connected to it.

2.1.3 Limitations

The early clap activated has some limitations which lead to design of the later ones. The following are the limitations;

1) The clapper can sometimes be triggered by coughing, a dog's bark, or clapping that emanates from televisions and stereo speakers set at high volume, making it somewhat inconvenient for households with dogs and loud appliances
2) It is used to operate only one device at a time.
3) It is used to switch low power devices.

The later clap activated switch was designed to eliminate all this limitation but my design is to further modify the later design. The following are reasons for my design;

1) To switch on one or more devices at the same time.
2) To reduce false triggering of the switch.
3) To make the switch expandable depending on the number of devices it is meant to switch.

2.2 THEORETICAL BACKGROUND

2.2.1 Transducer

A transducer is a device or sensor that changes energy from one form or system to another. A microphone as a transducer changes acoustical energy into electrical impulses. The input of major concern in electronic amplifying and wave-shaping circuits is the signal into the circuit and the output of major concern is the amplified or processed signal out. Electronic equipment requires a suitable input transducer to produce the electrical signal and a suitable output transducer to transform the electrical output into light or whatever the application demands.

A microphone is made up of a diaphragm, which is a thin piece of material that vibrates when it is struck by sound wave. This causes other components in the microphone to vibrate leading to variations in some electrical quantities thereby causing electrical current to be generated. The current generated in the microphone is the electrical pulse, which is used to a form that is used to drive all other parts of the clap switch.

2.2.2 The Operational Amplifier (741)

An **operational amplifier**, which is often called an **op-amp**, is a DC-coupled high-gain electronic voltage amplifier with differential inputs and, usually, a single output. Typically the output of the op-amp is controlled either by negative feedback, which largely determines the magnitude of its output voltage gain, or by positive feedback, which facilitates regenerative gain and oscillation. High input impedance at the input terminals (ideally infinite) and low output impedance (ideally zero) are important typical characteristics [5].

The amplifier's differential inputs consist of V_+ input and a V_- input, and generally the op-amp amplifies only the difference in voltage between the two. This is called the *differential input voltage*. Operational amplifiers are usually used with feedback loops where the output of the amplifier would influence one of its inputs. The output voltage and the input voltage it influences settles down to a stable voltage after being connected for some time, when they satisfy the internal circuit of the op amp.

In its most common use, the op-amp's output voltage is controlled by feeding a fraction of the output signal back to the inverting input. This is known as negative feedback. If that fraction is zero (i.e., there is no negative feedback) the amplifier is said to be running *open loop* and its output is the differential input voltage multiplied by the total gain of the amplifier, where V_+ is the voltage at the non-inverting terminal, V_- is the voltage at the inverting terminal and G is the total open-loop gain of the amplifier.

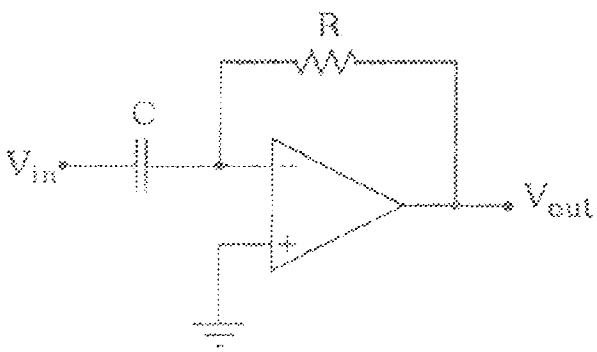

Fig2.2 Operational Amplifier

2.2.3 Timing Integrated Circuits (555 Timer)

The 555 is an integrated circuit (chip) implementing a variety of timer and multivibrator applications. The IC was designed and invented by Hans R. Camenzind. It was designed in 1970 and introduced in 1971 by Signetics (later acquired by Philips). The original name was the SE555/NE555 and was called "The IC Time Machine". The 555 gets its name from the three 5-kohm resistors used in typical early implementations. It is still in wide use, thanks to its ease of use, low price and good stability. As of 2003, 1 billion units are manufactured every year. The 555 timer is one of the most popular and versatile integrated circuits ever produced. Depending on the manufacturer, it includes over 20 transistors, 2 diodes and 15 resistors on a silicon chip installed in an 8-pin mini dual-in-line package (DIP-8)[6].

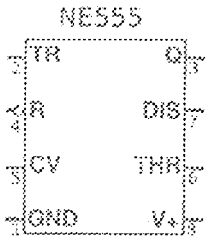

Fig. 2.3 **The schematic diagram of 555 Timer**

Table 2.1 **Pins connection of 555 Timer**

Number	Name	**Purpose**
1	Ground (GND)	Low level (0V)
2	Trigger (TR)	A short pulse high → low on the trigger starts the timer.
3	Output (Q)	During a timing interval, the output stays at V_{cc}
4	Reset (R)	A timing interval can be interrupted by applying a reset pulse to low (V)
5	Control Voltage (CV)	It allows access to the internal voltage divider (2/3 V_{cc})
6	Threshold (THR)	The threshold at which the interval ends (it ends if U.thr → 2/3 V_{CC}).
7	Discharge (DIS)	Connected to a capacitor whose discharge time will influence the timing interval.
8	Vcc	The positive supply voltage which must be between 3 and 15V

The 555 timer has three operating modes which are the monostable mode, the astable, and the bistable mode. The monostable which is used in the course of the project will only be discussed.

2.2.3.1 The Monostable Mode

In the monostable mode, the 555 timer acts as a "one-shot" pulse generator. The pulse begins when the 555 timer receives a trigger signal. The width of the pulse is determined by the time constant of an RC network, which consists of a capacitor (C) and a resistor (R). The pulse ends when the charge on the C equals 2/3 of the supply voltage. The pulse width can be lengthened or shortened to the need of the specific application by adjusting the values of R and C [6].

The pulse width of time t is given by

$$T = RC \ln(3) = 1.1RC \qquad \text{------------------equation 1}$$

T is the time it takes to charge C to 2/3 of the supply voltage.

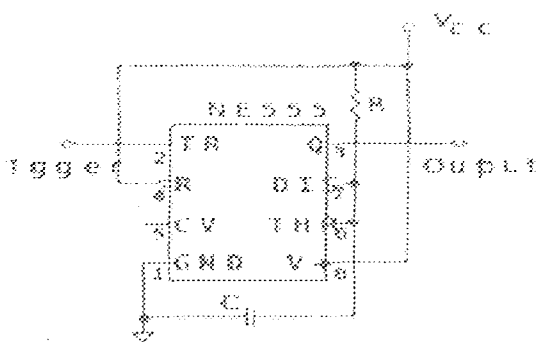

Fig 2.4 Diagram of Monostable Mode

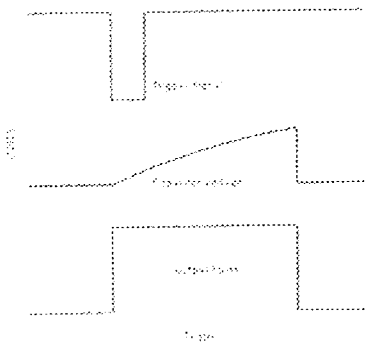

Fig 2.5 The graph of relationship between the trigger signal, the voltage on the C and the pulse width of 555 timer

2.2.3.2 The Missing Pulse Circuit

This circuit is a one-short that is continually retriggered by incoming pulses. A missing pulse that prevents retriggering before a timing cycle is complete causes the output to go LOW until a new input pulse arrives. The retriggering is made possible by transistor, which acts to rapidly discharge the timing capacitor should a pulse arrive when the timer is already running [6].

2.2.4 Decade Counter

The 4017 IC is a 16-pin CMOS decade counter from the 4000 series. It takes clock pulses from the clock input, and makes one of the ten outputs come on in sequence each time a clock pulse arrives.

Pinout

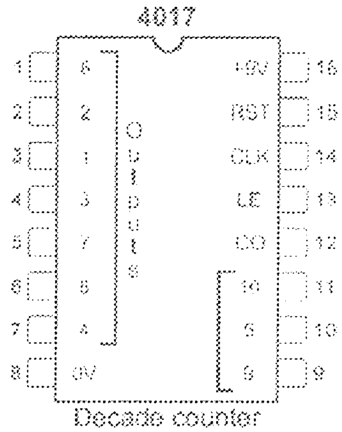

Fig 2.6 The schematic of decade counter

Table 2.2 Pin connection of a decade counter

Pin Number	Name	Purpose
1	6	The 6^{th} sequential output
2	2	The 2^{nd} sequential output
3	1	The 1^{st} sequential output
4	3	The 3^{th} sequential output
5	7	The 7^{th} sequential output
6	8	The 8^{th} sequential output
7	4	The 4^{th} sequential output
8	0V, V_{DD}	The connection to the 0V rail
9	9	The 9^{th} sequential output
10	5	The 5^{th} sequential output
11	10	The 5^{th} sequential output
12	CO	Carry out output - outputs high on counts 0 to 4, outputs low on counts 5 to 9 (thus a transition from low

		to high occurs when counting from 9 back to 0)
13	LE	Latch enable - latches on the current output when high (i.e. the chip counts when LE is low)
14	CLK	Clock in (this is down with a negative going pulse i.e. from High to Low)
15	RST	Reset - sets output 1 high and outputs 2 through 10 low, when taken high
16	+9V, V_{CC}	The connection to the $+V_{CC}$ rail (voltage between +3V and +15V)

2.2.5 Transistors As A Not Gate

A transistor to be used as a NOT gate must work at two points, the saturation point and the cut-off point and must be a common-emitter configuration. At saturation the transistor is said to be ON, this is done by applying a voltage at the base which makes a base current (I_B) pass through a biasing base resistor (R_B) and the output voltage (V_{CE}) is equal to 0 (logic 0). At cut-off the transistor is said to be OFF by removing the voltage applied to the base, no current passes through the biasing base resistor, the output voltage (V_{CE}) is equal to VCC (logic 1). At this point the collector current (I_C) is 0 [7].

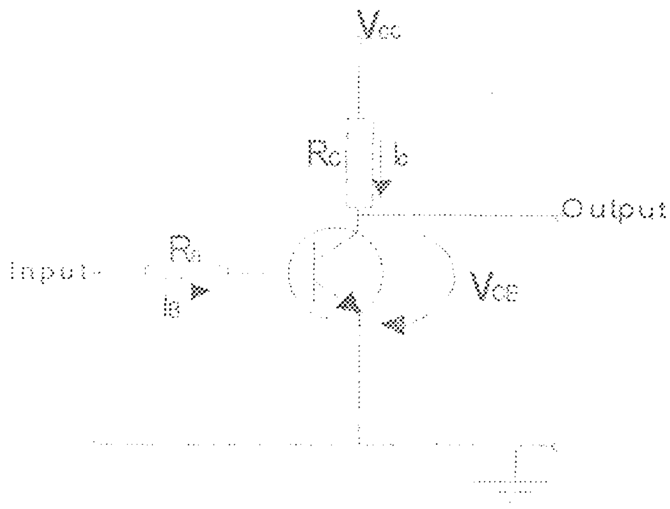

Fig 2.7 The diagram of transistor as a NOT gate

Mathematical Illustration;

$V_{CE} = V_{CC} - I_C R_L$ ....equations 2

When I_B flows, I_C flows which makes $I_C R_L = V_{CC}$ and $V_{CE} = 0$

When I_B is not flowing $I_C = O$, which makes $I_C R_L = 0$ and $V_{CE} = V_{CC}$

2.2.6 J-K FLIP FLOP

The flip-flop IC used is a dual JK flip-flop which is edge-triggered, it is a sequential circuit which keeps its output at a particular state until an input pulse is received to change the state. It has two inputs which are the J and the K inputs, and to output which are Q and $\overline{Q}$ (the Q is the main output of the flip-flop while $\overline{Q}$ is the inverted output) [3].

When J is HIGH and K is LOW, the output Q goes HIGH while the inverted output goes LOW and the flip-flop is said to be set. When J is LOW and K is HIGH, the output Q goes LOW while the inverted output goes HIGH and the flip-flop is said to be reset. For the purpose of this project the main output Q is the only output useful. These actions happens which a positive going pulse clocks the flip-flop [3].

Table 2.3 Truth Table of a J-K Flip-flop

INPUTS			OUTPUTS			
			Past State		Present State	
Clock	J	K	Q	Q	Qn+1	Qn+1
	0	0	1	0	No change	
	0	1	0	1	0	1
	1	0	1	0	1	0
	1	1	0	1	Toggle	

2.2.7 RELAY

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier [8]

A simple electromagnetic relay is an adaptation of an electromagnet. it consists of a coil of wire surrounding a soft iron core an iron yoke, which provides a low reluctance path for magnetic flux, a moveable iron armature, and a set, or sets of contacts. When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energised, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing

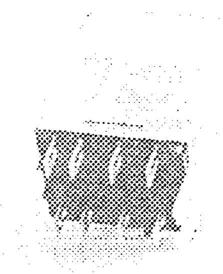

Fig 2.8 A Alternating Current Relay

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 THE DESIGN

The device is expected to control switching process by sensing hand claps, but must avoid being triggered by false signals, such as voice and mechanical noise impulse. The circuit is expected to perform a particular task after responding to a number of claps in a set time. The following is the number of claps and the task it performs

- 1 clap sets the switch to a common mode.
- 2 claps turns device 1 on.
- 3 claps turns device 1 off.
- 4 claps turns device 2 on.
- 5 claps turns device 2 off.

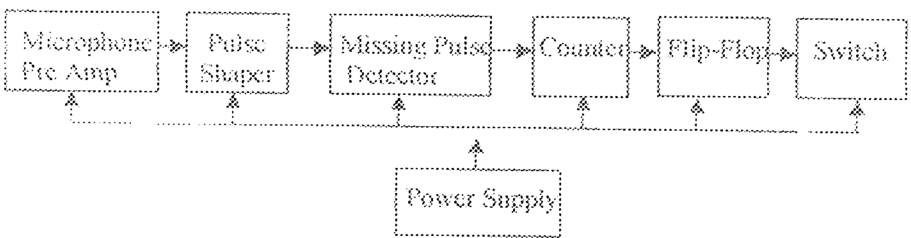

Fig 3.1 Block Diagram of Clap Activated Switch

3.2 The Microphone Pre-Amplifier

This microphone has a stage of amplification built in, the power for this built in amplifier is supplied by connecting a resistor to a positive source of voltage, and the changes in current get reflected as changes in voltage across this resistor according to the familiar relation V = I x R. A larger resistor will give you a larger voltage, but then, the current into the device gets reduced which brings down the gain. The value of 10KΩ seems to work all right.

The output of the microphone is then coupled to the inverting terminal of the operational amplifier through a coupling capacitor which makes the amplifier a differentiator inverting amplifier. The non-inverting terminal of the operational amplifier is then biased to ½ of V_{CC} by connecting two 10KΩ resistances in series across the non- inverting terminal. The gain of the amplifier is the multiplication of the feedback resistance and capacitance. A variable resistor of 100KΩ and a fixed resistor of 10KΩ are connected in series at the feedback which makes the feedback resistance to be in the range of 10KΩ to 200KΩ. The increase in amplification increases the sensitivity of the clap activated switch and vice versa which is made possible by adjusting the variable resistor. The output is used to trigger the pulse shaper circuit.

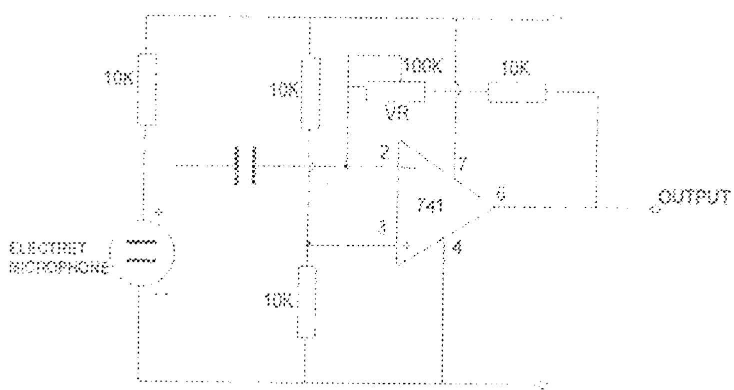

Fig 3.2 Microphone Pre-Amplifier

3.2.1 Calculating the Amplification

Amplification A $= -R_f \times C$

Rf $=$ $10 + VR$ (VR is a variable resistance)

A $= -[(10 + VR) \times 10^3] + (10 \times 10^{-9})$

It shows from this equation that as the value Variable Resistance increases the amplification increases. The negative sign shows that the output is inverted.

3.3 Pulse Shaper

The pulse shaping circuit as shown in Fig. 2.3 is a monostable multivibrator used to convert the uneven analogue waveform of the amplified output of the microphone (transducer) to a digital waveform. The output of this circuit is used to trigger the missing pulse detector circuit and also used to clock the decade counter (4017 IC). The timing of this circuit is short because it has to send a number of pulses to clock the decade counter depending on the task before the missing pulse detector output goes low.

The transistor at the output of the circuit is used to NOT the output pulse, this is because the output pulse goes from LOW to HIGH (positive pulse) but the clocking of the decade counter and the triggering of the missing pulse detector needs a HIGH to LOW pulse (negative pulse).

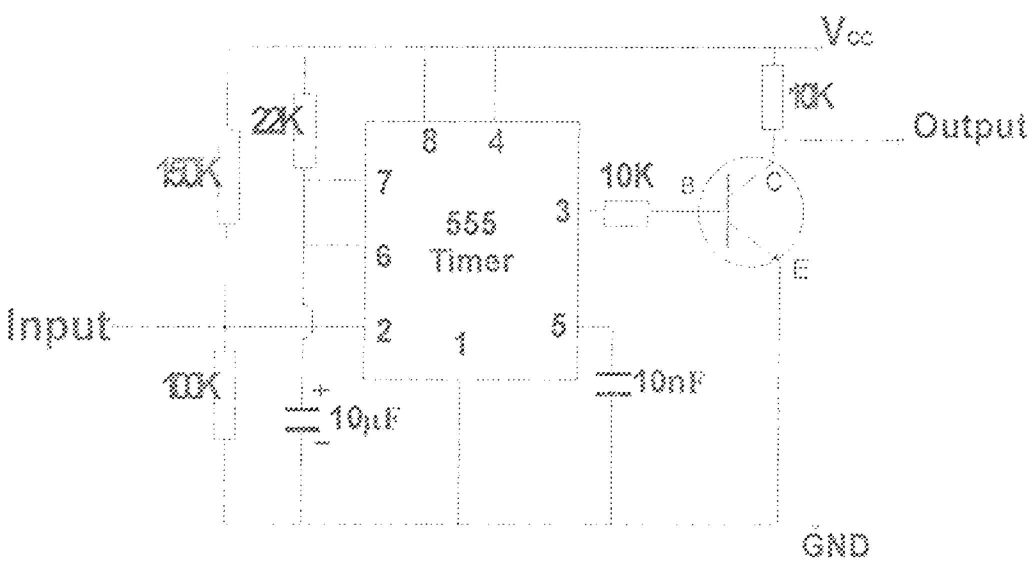

Fig 3.3 Circuit Diagram of Pulse Shaper

3.3.1 Design Calculation of the Pulse Shaper

To calculate the timing:

$T = 1.1 \times R \times C$

$T = 250ms$ (chosen)

$C = 10\mu F$ (chosen)

$R = {}^{T}/_{1.1 \times C}$

$$R = \frac{250 \times 10^{-3}}{1.1 \times 10 \times 10^{-6}}$$

$R = 22.73k\Omega$

R is approximately $22k\Omega$

3.4 Missing Pulse Detector

The missing pulse detector circuit receives a series of pulses from the output of pulse shaper circuit at the trigger pin between the response times to keep the output of the circuit LOW. The output is used to clock the JK Flip-flop (4027 IC) when the output goes from LOW to HIGH. It is also used to set and reset the decade counter (4017 IC). The response time of the missing pulse detector has to be longer than the timing of the pulse shaper, so that we can have a longer time for retriggering.

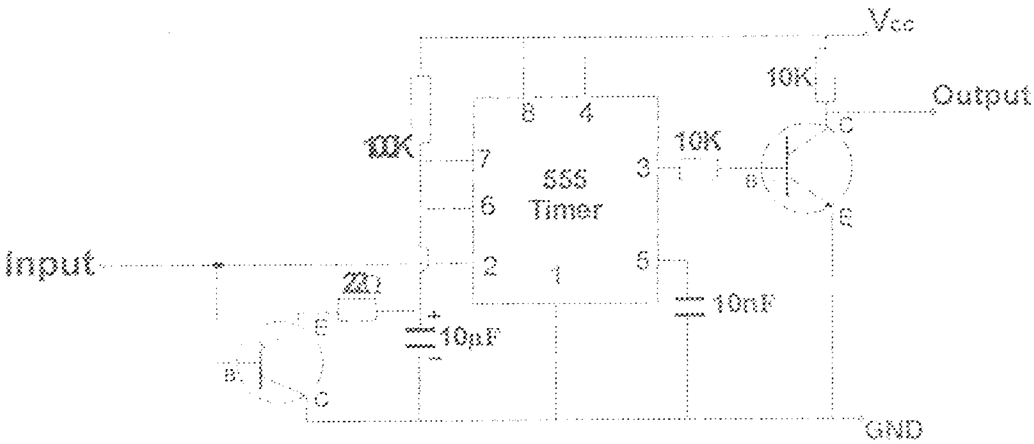

Fig 3.4 Circuit Diagram of Missing Pulse Detector

3.4.1 Design Calculation of the Missing Pulse Detector

To calculate the response timing

$T = 1.1 \times R \times C$

$T = 1s$ (chosen)

$C = 10\mu F$ (chosen)

$R = {}^{T}/_{1.1 \times C}$

$$R = \frac{1}{1.1 \times 10 \times 10^{-6}}$$

$R = 90.91k\Omega$

R is approximately $100k\Omega$

3.4.2 Calculation for the Transistor

Supply Voltage $V_S = 12V$

From the Data Sheet; $h_{fe} = 400$ and $I_{C(max)} = 100mA$

Base Resistance $R_B = ?$

$$R_B = \frac{V_S \times h_{fe}}{5 \times I_{C(max)}}$$

$$= \frac{12 \times 400}{5 \times 100 \times 10^{-3}}$$

$= 9600\Omega$

$= 9.6K\Omega$

The value of $10K\Omega$ is chosen for the base resistance R_B.

$R_C = 10k\Omega$ (chosen)

$I_C = ?$

$$I_C = \frac{V_{CE}}{R_C}$$

$$= \frac{12}{10 \times 10^3}$$

$$= 0.0012A$$

= 1.2mA which is far less than the maximum collector current I_C.

3.5 Decade Counter

The first sequential output of the decade counter is on as soon as the circuit is powered and this is known as the standby. The inverted pulses of the pulse shaper circuit clocks the decade counter which makes the outputs of the decade counter comes on sequentially. The long pulse of the missing pulse detector circuit sets the decade counter for the period it`s been clocked since a LOW sets the decade counter. The counter resets after the output of the missing pulse detector circuit goes HIGH and by this time, the pulse shaper must have finished clocking the decade counter.

A Light Emitting Diodes (LED) is connected to the sequential outputs of the decade counter in series with a limiting resistor. The corresponding LED comes on as the output goes high, this is to indicate the high output at a particular time. The 10nF capacitor adds a short delay to the reset of the decade counter.

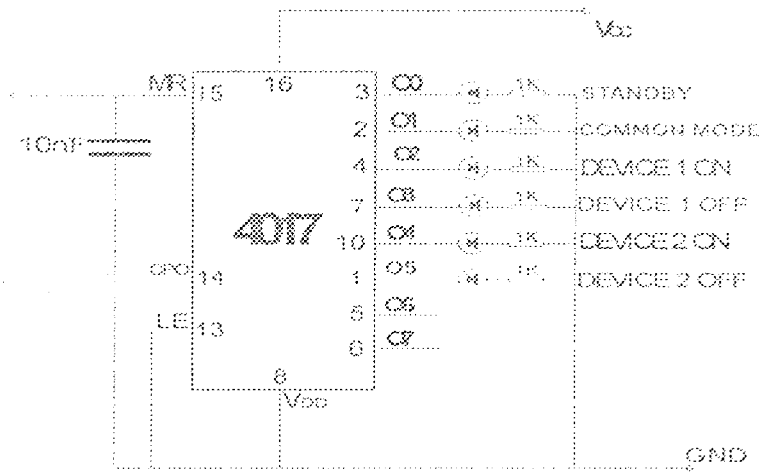

Fig3.5 Decade Counter Circuit

3.5.1 Calculation for the Decade Counter

Calculation of the LED limiting resistance

From the data sheet, $I_{f(max)}$ = 20mA (maximum current across LED)

R_{LED} = The LED current limiting resistance

V_{CC} = 12V

V_F = 2V (the maximum forward voltage drop)

$$R_{LED} = \frac{V_{CC} - V_f}{I_f}$$

Choosing I_F = 10mA

$$R_{LED} = \frac{12 - 2}{10 \times 10^{-3}}$$

$$R_{LED} = \frac{10}{0.01}$$

R_{LED} = 1000Ω = 1kΩ

3.6 The J-K Flip-flop

The JK Flip-flop is connected to the output of the decade counter in such a way that the output of the decade counter to switch a device is ON is connect to the J input of the flip-flop, and the output of the decade counter to switch a device OFF is connected to the K input of flip flop. The clock of the flip-flop is connected to the output of the missing pulse detector. The clocking of the flip happens at the point when the missing pulse detector misses a pulse (the circuit does not receive any pulse) and the inverted output goes from LOW to HIGH.

When the pulse shaper receives the last pulse to perform an operation, the corresponding output of the decade counter comes ON. The flip flop does not perform any operation until the missing pulse detector goes HIGH (the circuit does not receive any) pulse. The short delay from the 10nF capacitor of the decade counter makes the flip-flop perform its operation before the decade counter returns to standby.

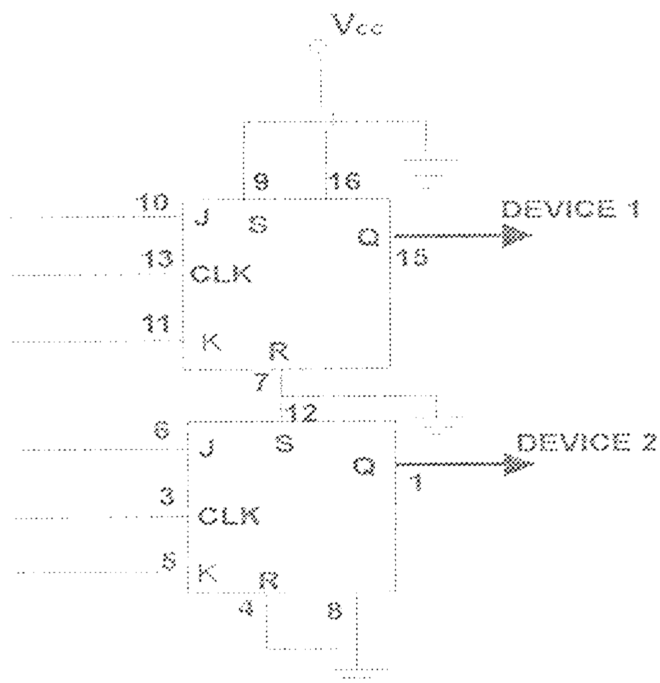

Fig 3.6 The Flip-flop Circuit

3.7 The principle of Operation

This circuit can switch two or more devices on and off in response to a series of rapid handclaps. The claps are picked up by an electret microphone and amplified by an operational amplifier (IC1). IC1 is configured as an inverting amplifier, with its gain and hence the sensitivity of the circuit adjustable via trimpot VR1. Its output is then fed into a pulse-shaping stage based on a 555 timer (IC2). The 555 is configured as a monostable multivibrator, with its trigger input (pin 2) normally biased to about $0.4V_{CC}$ by the 150kΩ and 100kΩ resistors.

When a loud enough sound is detected, pin 2 will be pulled below $1/3V_{CC}$, triggering the monostable. The output (pin 3) will immediately swing high, causing transistor Q1 to conduct. The result is a 250ms low-going pulse at the collector of Q1. The output from the pulse-shaper stage is fed into a missing-pulse detector based on a second 555 timer (IC3), which is also configured as a monostable multivibrator. However, this monostable circuit differs from the first because it includes a "retrigger" function.

Retriggering is made possible by transistor Q2, which acts to rapidly discharge the 10nF timing capacitor should a pulse arrive when the timer is already running. This means that once triggered, IC3's output will remain high as long as additional trigger pulses are received within its set timing period. Pulses from Q1's collector are also applied to the clock (CP0) input of a 4017 decade counter (IC4). In the initial state, output 0 (pin 3) of the counter is high, illuminating LED1. The first pulse advances the count and lights LED2, indicating that the circuit is active and ready to receive a handclap "command".

Each time another pulse (clap) is received before IC3`s timing period expires, the process repeats, incrementing the counter by one. When IC3`s timing period is allowed to expire (ie, no claps have been detected for 1s), the output (pin 3) will go low, turning off transistors Q3 & Q4.The rising voltage on the collector of transistor Q3 clocks two J-K flipflops (IC5a & IC5b), with the result at their Q outputs dependent on the state of the O2-O5 counter outputs. Considering all the possible logic states of a J-K flipflop, the "commands" will therefore be:

- 2 claps: turn Device 1 on
- 3 claps: turn Device 1 off
- 4 claps: turn Device 2 on
- 5 claps: turn Device 2 off

Finally, the rising voltage on the collector of Q4 resets the counter, ready for the next clap sequence. The addition of a 10nF capacitor between the reset input (pin 15) and ground, which in conjunction with the 10kΩ resistor adds a short delay to the reset signal. This ensures that the counter is not reset until after the J-K flip-flops have been clocked. If desired, the circuit could easily be expanded by adding more flip-flops and counters.

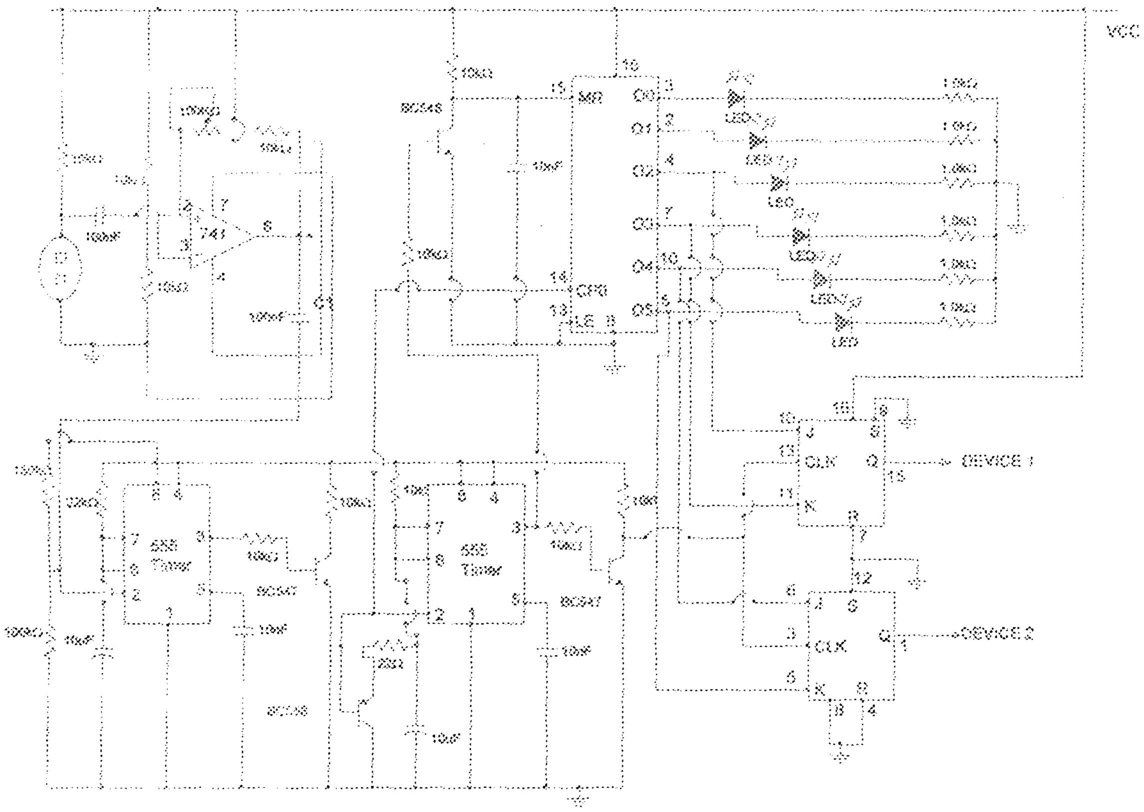

Fig 3.7 The Circuit Diagram of Clap Activated Switch

CHAPTER FOUR

TEST AND RESULT

4.1 TEST AND RESULT

The microphone pre-amplification circuit and the pulse shaper circuit were first constructed on the breadboard and a Light Emitting Diode is connected to the output of the monostable mode 555 timer of the pulse shaper. The circuit was power with a battery and a finger tap sound was inputted very close to the electrets microphone and the Light Emitting Diode at the output of the 555 timer comes ON for a short time. This result shows that the circuit is working perfectly and so the circuit was soldered on the vero-board.

The missing pulse detector circuit and the decade counter circuits were also constructed on a bread-board and Light Emitting Diodes is connected to the sequential outputs of the decade counter. The circuit was power with a battery and a trigger signal is sent to the input of the missing pulse detector circuit with a switch. It was noticed that the sequential outputs of the decade comes on one after the other sequentially. This result shows that the circuit is working perfectly and so it was soldered on the vero-board with the previous circuits.

The flip-flop circuit is then soldered with the other circuits on the vero-board and a relay is soldered in connection to the whole circuit at the output of`the flip-flop. The whole circuit was the tested and the following result happened when a finger tap signal was send into the circuit through the electrets microphone;

Action	Result
2 finger taps	The plunger of the relay connected to the first flip-flop for device 1 clicks from normally close to normally open.
3 finger taps	The plunger of the relay connected to the first flip-flop for device 1 clicks from normally open to normally close.
4 finger taps	The plunger of the relay connected to the second flip-flop for device 2 clicks from normally close to normally open.
5 finger taps	The plunger of the relay connected to the first flip-flop for device 1 clicks from normally open to normally close.

Table 4.1 Response Test

A vibration test was carried out on the circuit by striking the circuit on a surface and it was discovered that the common mode LED came on, which shows that a more vibration might likely turn on device 1 when it is off. A noise test was also carried on the circuit by slamming the door which gave the same result as that of the vibration test.

A power ratings test for the device the which the clap activated switch will switch is also carried with common home appliances and the following result emanated;

S/N	Test description	Watts	Result
1	Lightning bulbs connected across the device	60	Device switches accurately
2	Fluorescents connected across the device.	100	Device switches accurately.
3	A CD cassette player tape recorder connected across device.	150	Device switches accurately.
4	Combination of light bulb and tape player connected across device.	210	Device switches comfortably.
5	Combination of light bulbs	300	Device switches comfortably.
6	Combination of light bulbs	460	Device switches but bounced several times

Table 4.2 Power Rating Test

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSIONS

The clap activated switching device function properly by responding to both hand claps at about three to four meter away and finger tap sound at very close range, since both are low frequency sounds and produce the same pulse wave features. The resulting device is realizable, has good reliability and it's relatively less expensive. The device is also made to be expandable by connecting more flip flops and decade counter to switch more devices.

5.2 RECOMMENDATION

- It is recommended that this device should be mounted on a surface with minute vibration and the location where it is used have less noise.
- It is also recommended that the device is used to switch devices with power ratings of not more than 300Watts from the result of device power test performed.

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