DESIGN AND CONSTRUCTION OF DIGITAL LOCK USING A CHIP CARD

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OCTOBER, 2006.

DEDICATION

dedicate this work first to the Almighty God and to my parents; Mr. and Mrs. Okon and lso to my sister; Miss Priscilla Okon.

DECLARATION

I EMMANUEL OKON, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Emmanuel Okon
NAME OF STUDENT

10/10/06
SIGNATURE AND DATE

PROJECT SUPERVISOR

SIGNATURE AND DATE

HEAD OF DEPARTMENT

SIGNATURE AND DATE

EXTERNAL EXAMINER

SIGNATURE AND DATE

ACKNOWLEDGEMENT

Let me begin by acknowledging the indispensable mercies of God who has been, and is still the backbone of my studies in this institution and for sparing my life throughout the course of my education.

I wish to express my profound gratitude to my project supervisor, Mr. Abraham Usman for his understanding and support throughout my work despite several hiccups and bottle necks in the course of my project design.

Not also forgetting the valuable effort of my Head of Department, Engineer M. D Abdullahi, who has given me no reason to be remorseful as a student of this department.

I whole heartedly appreciate the love, care, prayers and support of my precious mother; Mrs. Helen Okon and my father Mr. O.E. Okon.

ABSTRACT

This work discusses the design and construction of a digital lock using a chip card. There are traditional ways of locking doors, security posts, gates etc but the safety of these methods are not guaranteed. Buglers or intruders can easily manipulate their way through these traditional locking systems. These systems stand the risk of key forgery and the use of the so-called "master key". Hence, the introduction of a digital lock with a chip card that cannot be easily forged or manipulated is designed.

In this design, CMOS IC's and other components were used to perform this function. The CD4063B was being used as a comparator to compare the output from the key (which has an IC built in the card), and the inbuilt logic circuit in the lock using the CD4001 IC's.

The circuit is powered through a 220/12V step down transformer which powers the lock and also automatically charges the rechargeable batteries in the lock. The lock is also able to operate with the batteries alone without being connected to an AC supply.

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CHAPTER ONE

1.0 INTRODUCTION

Locks and keys are changing with the times, but the function remains the same. Authorized people need access to certain areas, but intruders must stay out. Not surprisingly, technology is taking locks and keys in directions that were unimaginable just a few years ago.

Today, with the use of the so-called `master-key`, intruders and unauthorized persons can easily gain access to secured places through barriers with key locks. Many houses, banks, supermarkets, industries etc have been illegally broken into due to the fact that owners of the above mentioned places employed the use of key locks in their access control systems.

Consequently, there has been a need to construct a lock mechanism that will be almost absolutely reliable and provide the desired access to only authorized persons or users. Smart locks and keys are gaining popularity as an alternative to traditional means of entry to secured doors. They permit only authorized people into certain doors, at certain times. You've seen them if you've visited a hotel and been given a key that looks like a credit card.

The circuit design of this project is to show the ease and flexibility of the modern day locks. It is incorporated with low power consuming complementary metal oxide semiconductor (CMOS) integrated circuits (ICs).

1.1 AIMS AND OBJECTIVES

The purpose of this project was aimed at providing the following:

- A digital lock that will almost be impossible to break
- A more reliable security system in houses, banks, security posts etc

- Reduce the high rate of forgery of keys by burglars

1.2 METHODOLOGY

A prototype of a lock was used to demonstrate the working principle of this project. It consists of the power unit, the voltage monitoring circuit, the alarm system, the basic logic circuit and the mechanical motorized lock. For convenience, the mechanism of a drive in a VCD machine was employed to demonstrate the opening and locking principle of the design.

When the lock is powered either by an AC supply or by a battery, the lock is ready to be operated on. The voltage monitoring circuit is needed to aid the user on the level of power being consumed by the lock which in actual sense is relatively low. When the voltage drops to a certain level, one of the LED's turns off, and if there is a further drop in voltage, the alarm comes on to alert the user letting him know that the batteries need to be recharged. The beauty of this design in terms of low power consumption is with the introduction of proximity switches that cuts off the flow of current to the motor when the lock is fully opened or closed. This prevents wear and tear of the teeth of the motor and allows the LED's to be the only devices consuming power when not being operated on.

Most of my constraints came from the availability of the desired components to be used in design of this project. Nevertheless, I had to make do of the available to achieve the aim of the design with the help and advices from colleagues and my project supervisor.

1.3 ECONOMIC IMPORTANCE

The design and construction of mechanical locks are relatively inexpensive when compared to the modern day digital locks. There is no doubt on the fact that an environment attracts more population, investors and advancements when it is highly secured. Therefore, if the fear of cost in acquiring these digital locks and implementing them are kept aside, the birth of a very high economic growth would be the result.

If the use of these locks is as popular as it should be, it will reduce theft to the barest minimum and also frustrate the efforts of the normal road side master key forgers due to the high level of complexity in designing such a key in form of a chip card.

CHAPTER TWO

2.0 LITERATURE REVIEW

A lock is a mechanical device for fastening doors, chests and lids consisting essentially of a bolt guarded by a mechanism which can be released by a mechanical, hydraulic or electrical/electronic (actuator).

Locks and keys were known long before the birth of Christ – about 445BC. At this time, locks were made of wood. They were large and crude in design; yet their principle of operation was the forerunner of the modern pin-tumbler locks of today. As locksmiths and metal workers became proficient in their craft, they were invited to make locks and keys for the royal courts and for the churches and cathedrals of Europe.

2.1 DEVELOPMENT OF LOCKS

The simplest form of lock is a ward lock, which is essentially a bolt containing a notch known as a talon. The bolt is moved backwards or forwards by engaging a key in the talon. A back spring attached to the bolt holds it in place once it is released by the key. The tumbler or lever lock, similar to the ward lock, contains one or more pieces of metal of different heights, known as tumblers, levers, or latches, which intercept the bolt and prevent it from being moved until the tumblers are raised or released by the action of an appropriate key. The so-called pin-tumbler cylinder lock, or Yale lock, introduced in about 1860 by the American inventor Linus Yale, was the first device to employ a small, flat key in place of a large, cumbersome one.

The Yale lock consists essentially of a cylindrical plug placed in an outer barrel. The plug is rotated by a key and in turn moves the bolt of the lock by means of a cam. In order to rotate the plug, the inserted key must raise five pins of different sizes into corresponding holes in the plug. Five similar pins are contained in the upper part of each of the holes. If the pins are not raised to the circumference of the plug, the plug cannot be turned. The most common form of cylinder lock used in the home is the so-called night latch, operated by a key from the outside and a knob from the inside. Another type of lock that is increasing in use is the magnetic lock, which is essentially the same as a cylinder lock, except the pins need a suitably magnetized key to bring them into alignment so that the plug can be turned [1]

Of the various types of locks that are not operated by keys are the dial, or combinational locks which is the most common. A set of tumblers, or wheels, is actuated by a spindle that can be rotated by a graduated dial on the outer end of the lock. Spinning the dial according to the proper combination arranges the tumblers so that the bolting mechanism is released. Combination locks of intricate design, incorporating various electronic safeguards, are produced for safes and bank vaults, and can have more than 100 million changes of combination. They are sometimes safeguarded by a time lock, which only allows the vault to be opened at certain specific times.

The first mechanical locks, made of wood, were probably created by a number of civilizations at that time. Records show them in use some 4,000 years ago in Egypt. Fastened vertically on the post, the wooden lock contained moveable pins or "pin-tumblers," that dropped by gravity into openings in the cross piece or "bolt", and locked the door. It was operated by a wooden key with pegs or prongs that raised the numbers of tumblers sufficiently to clear the bolt so that it could be pulled back.

The earliest lock in existence is an Egyptian lock made of wood, found with its key in the ruins of Nineveh, in ancient Assyria. In construction it is the prototype of the modern cylinder lock. Locks and keys are also mentioned in the Old Testament, and the Greeks and Romans used locks of simple design. Medieval artisans designed locks of exquisite detail, the perforations and carvings often having no relation to the working of the lock.

New concepts for locking devices were developed in Europe in the 17th century. With the exception of the development of ward locks, however, little was done to improve the efficiency and convenience of locks until the late 18th century. In the 19th century ward locks were improved, and tumbler or lever locks, pin-tumbler or cylinder locks, and keyless locks were invented and improved. Subsequent development has focused on mass production, improvement of materials, and increasing complexity of the working mechanisms, including the increasing use of automatic electronic alarm and safety devices.

Early Braham locks utilized a series of sliders in a circular pattern to provide exceptional security. Braham is the oldest lock company in the world and is continuing to manufacture its famous mechanism 200 years later.

2.2 INVENTIVE INGENUITY

As lock-picking became an art in the 18th century, the inventor met the challenge of the burglar with increasingly complicated locking mechanisms. Among the new improvements were keys with changeable bits, "curtain closed-out" around keyholes to prevent tampering, alarm bells combined with the action of the bolt and "puzzle" or ring padlocks.

The early puzzle padlocks were oriented from three to seven rings of characters of letters which released the hasp when properly aligned. The dial locks were similar in operation, and both types were culminated to unlock to works or patterns of numbers or responsible persons.

At the left is the Eureka, a manipulation-proof combination lock with five tumblers for a bank vault used one time in the U.S Treasury Department. Patented in 1862 by Dodds, Mc Neal, and Urban of Canton, Ohio. The operating dial is a combination of letters and numbers and affords 1,073,741,824 combinations; to run through them all without interruption would take 2,042 years, 324 days, and 1 hour.

Many different kinds of locks were in parade in the 20th century. Today locks can either be key operated or keyless. In automobile ignition, electromechanical locks were developed to trip electrical circuit.

The exciting part of this project is that aside the fact that it is designed to respond to an electronic logic signal, it is designed to work with rechargeable batteries which can be charged in the inbuilt lock itself instead of externally. The simplified working principle of this design can be easily understood via the block diagram drawn below to have a general idea on how it operates.

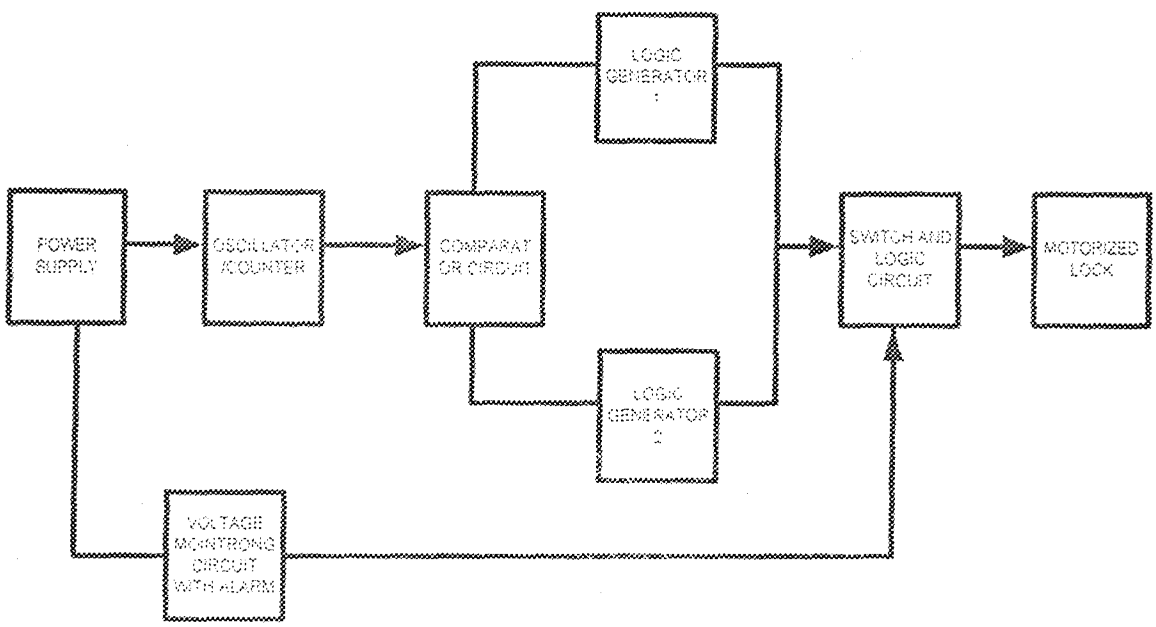


Fig 2.0 The functional block diagram of the circuit

There are still some limitations with the modern day locks that use code combinational mode of operation because humans have the tendency of forgetting their key codes which if they enter it after a number of times, would trigger on an alarm and they would now be regarded as thieves, whereas they happen to be the owners. Also, the best kind of digital combinational locks are the ones with more IC's (to increase the complexity of the lock against intruders), but these kinds would require more power consumption. However from reliability, the more the number of components the lower its reliability. The combinational locks constantly require power thereby, not saving power consumption.

CHAPTER THREE

3.0 CIRCUIT DIAGRAM

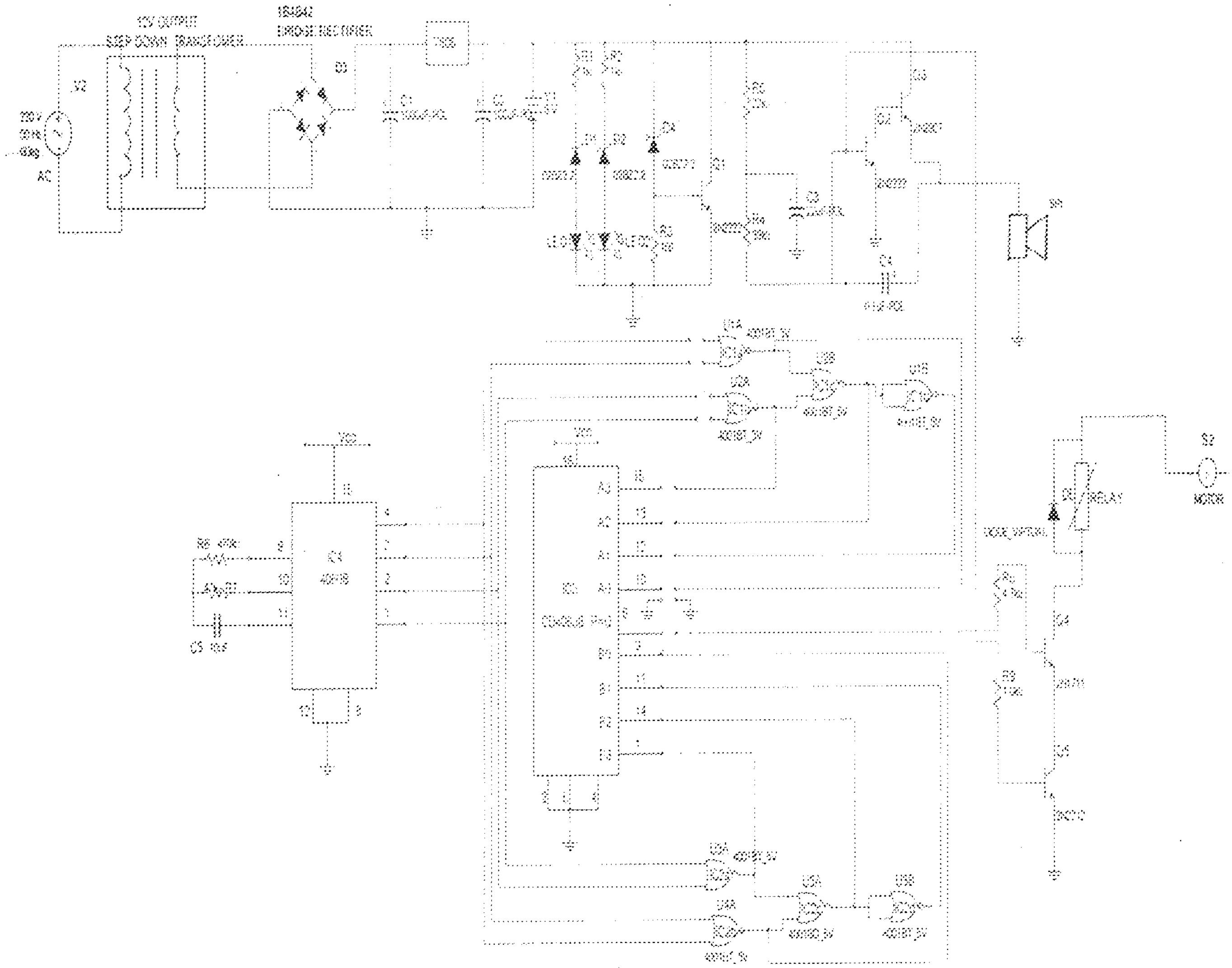


Fig 3.0 Design Circuit Diagram

3.1 DESIGN ANALYSIS

This work was aimed at producing a portable lock which opens with a special chip card that contains an IC. By simply inserting the key into the key slot, the circuit identifies the key and the motorized lock moves anticlockwise to unlock. When the key is removed, the position of the lock still remains until the close button is depressed for the lock to move in the clockwise direction.

Both the forward and the reverse movements are terminated by proximity switches. The proximity switches are strategically positioned to be closed/open by the locking axle.

A special battery monitoring circuit tells when the battery is low. When the terminal voltage V_T has fallen below 3V, it sends the lock to sleep. During this period the circuit cannot switch on until it is externally powered or the batteries are recharged.

There is provision for an AC plug and an AC charging circuit to recharge the batteries when they run low.

3.2 POWER SUPPLY

The general power supply from PHCN mains to users is 220V/50Hz . However, most electronic components and circuits require a low voltage direct current of about 5V – 15V. In this design, a regulated DC supply is incorporated.

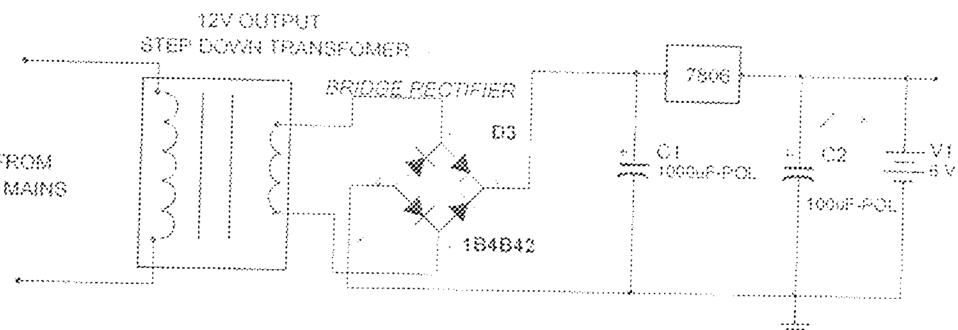


Fig 3.1 The Power Supply

The input is drawn from the 220 mains and then stepped down by the 12V transformer to 12V AC. The transformer is a 500mA transformer.

Theoretically, the arrangement of four diodes (so that two diodes conduct during the positive half cycle and the other two during the negative half cycle) as shown in fig 3.1 above will yield full wave rectification.

After rectification, the DC wave formation still retains some AC component (ripples) and this cannot be tolerated by the circuit components. Therefore these ripples should need to be removed, and this was done with the aid of a filtering capacitor. This process is called filtration.

Filtering is done by the $1000\mu F$ capacitor and the value is as given by the manufacturers of the regulator. It is meant to arrest spikes that arise due to switching operations in the circuit and other impurities that may arise.

These ripples are shown in fig 1.3

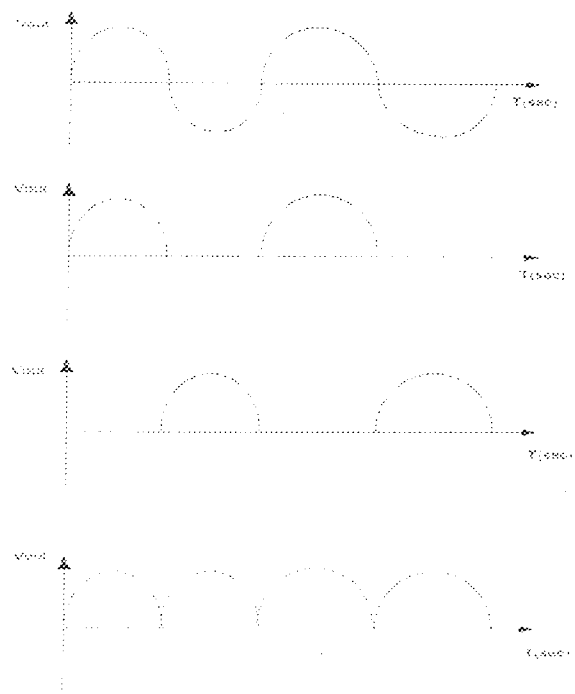


Fig 3.2 Ripples formed by DC wave

3.2.1 RECTIFICATION

This is done by the bridge rectifier. Four IN4001 diodes are used here and these diodes are known to have a potential voltage of 50V and current of 1000mA hence their choice. The input is the 12Vac while the output 12Vdc. The DC output is pulsating; hence not smooth for use in the circuit.

3.2.2 SMOOTHING

This is done by the tank capacitor and an electrolytic capacitor is chosen for this purpose. The capacitor is rated 1000 μF by 25V. The capacitor was chosen based on the stipulation that RL > 1/f for effective smoothing. With R_L = load resistance which is about 30 Ω and f = frequency of the AC signal whose normative value is 50Hz

RC > 1/f, 30C > 1/50

$$C > \frac{1}{50 \times 30}$$

$$C > \frac{1}{1500}$$

$$C > 6.67 \times 10^{-4}$$

$$> 666.7\mu F$$

Hence, 1000 μ f was chosen since it is the nearest market value.

3.2.3 REGULATION

The regulator chosen here is an IC regulator 7806 which can supply up to 500mA and a fixed output of 6V. It also has an input range of between 8V and 37V. Hence, it can tolerate the input and also provide the desired output. IC regulators especially the 78 series are easy to use and are very stable. The regulator also has the advantage of providing thermal cut off at 125°C

3.2.4 BATTERY DC INPUT

The battery used here are nickel Cadmium Rechargeable batteries. These are charged by the DC output of the AC mains supply. As long as the terminal voltage drops below regulator output, the cadmium cells will be charged automatically. 1.5V X 4 cells are connected in series to get 6V and each is about 300mA. These cells can run the system conveniently with long life.

3.3 VOLTAGE MONITORING CIRCUIT

The voltage monitoring circuit monitors the terminal voltage and indicates when the voltage has dropped below 5.6V. It also indicates when at 4.2V, but the alarm is activated below 2.7V. At 2.5V, it inhibits the motor from moving to avoid damage.

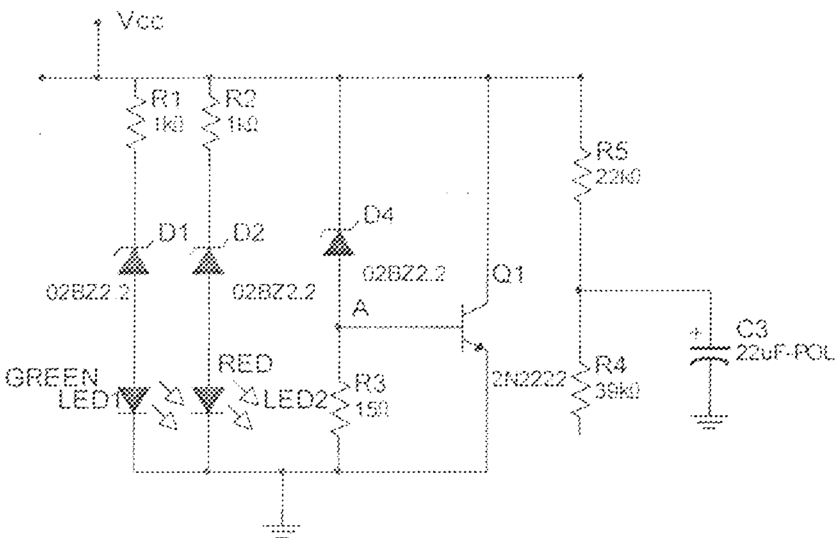


Fig 3.3 Voltage monitoring circuit

The green LED indicates that the voltage is above 5.6V and still sufficient. At 4.2V, the voltage is still good but the green LED goes off leaving the red LED on. The voltage at terminal A is less than the threshold voltage of 2.7V hence the PNP transistor will switch ON thereby; grounding the alarm circuit. Anything lower than this, deactivates the motor control network.

3.4 ALARM CIRCUIT

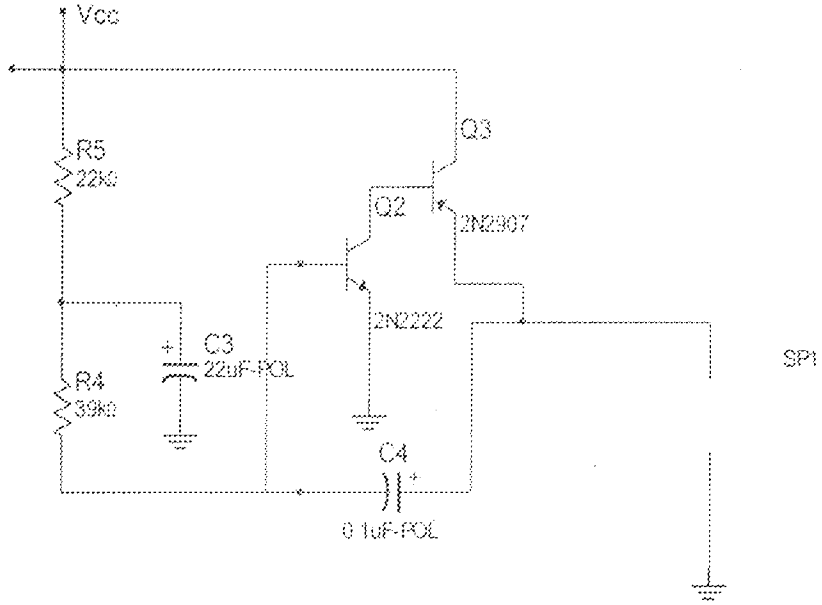


Fig 3.4 Alarm Circuit diagram

The alarm is a high pitch alarm generator. This circuit was build with discreet components to minimize voltage consumption. The transistors are connected in a bi-stable mode. It generates a constant high pitch at a period of $0.69R_1C_1$ for high and $0.69\ R_2C_2$ for low. That is,

$0.69\ R_1C_1 = 0.69 \times 22 \times 10^{3} \times 22 \times 10^{-6}$

= 0.33396 for the high period

and

$0.69R2C2 = 0.69 \times 39 \times 10^{3} \times 0.1 \times 10^{-6}$

= 0.002691 for the low period

The two complementary transistors 2N2709 PNP and 2N2222 NPN control the output. They are also double to act as an amplifying system for the alarm.

3.5 OSCILLATOR/COUNTER STAGE

The self clock oscillator used in this design is a 14 stage counter (4060B). It generates clock pulses at a frequency of

$$f = \frac{1}{2.3C_t X R_t}$$

Where $C_t = 10\mu f$ and $R_t = 47k\Omega$

Hence,

$$f = \frac{1}{2.3C_t X R_t}$$

$$f = \frac{1}{2.3 \times 10 \times 10^{-6} \times 47 \times 10^{3}}$$

$$= \frac{1}{1.081}$$

$$= .925069$$

$$\approx 925 \times 10^{-3} Hz$$

The output frequency at any stage is given by $\frac{f_{osc}}{2^n}$, where f_{osc} is the oscillating frequency and n is the output stages from 0-13

The logic required for the lock can be generated using any 4 output. Hence, there are $14C_4$ ways in which it can be selected which shows the diversity of the product.

$$nC_r = \frac{n!}{r! \ (n-r)!}$$

$$= \frac{14!}{4!(14-4)!}$$

$$= \frac{14 \times 13 \times 12 \times 11 \times 10!}{4 \times 3 \times 2 \times 1}$$

$$= 1001 \text{ ways}$$

Aside the one selection used now, 1000 ways are left.

In this design, pins 4, 1, 2, and 3 have corresponding outputs Q_6, Q_{12}, Q_{13} and Q_{14}. The wave form characteristics of these arrangements will show: -

At Q_6 $\quad f_{out} \cong \dfrac{0.925}{2^6} \cong 0.015Hz$

At Q_{12} $\quad f_{out} \cong \dfrac{0.925}{2^{12}} \cong 2.26 \times 10^{-4}Hz$

At Q_{13} $\quad f_{out} \cong \dfrac{0.925}{2^{13}} \cong 1.129 \times 10^{-6}Hz$

At Q_{14} $\quad f_{out} \cong \dfrac{0.925}{2^{14}} \cong 5.65 \times 10^{-5}Hz$

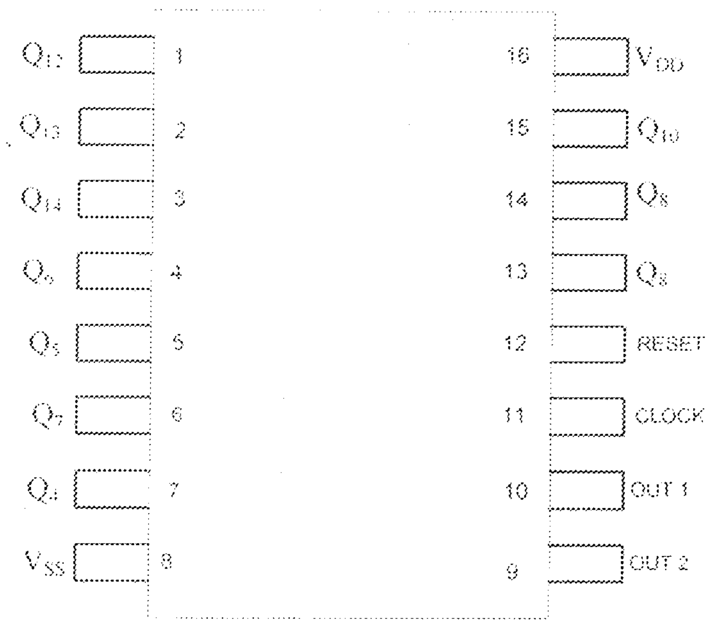
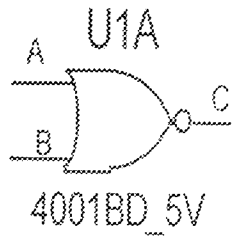


Fig 3.5 Pin arrangement of MC 4060B

3.6 THE NOR GATES/LOGIC BLOCKS

To enhance the understanding of this stage, Lets generate a NOR function truth table



A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

Table 3.0: Truth Table for a NOR gate

CD4001 CMOS IC is used in this logic circuit. It is a Quad NOR gate. The same chip is used in all the logic blocks

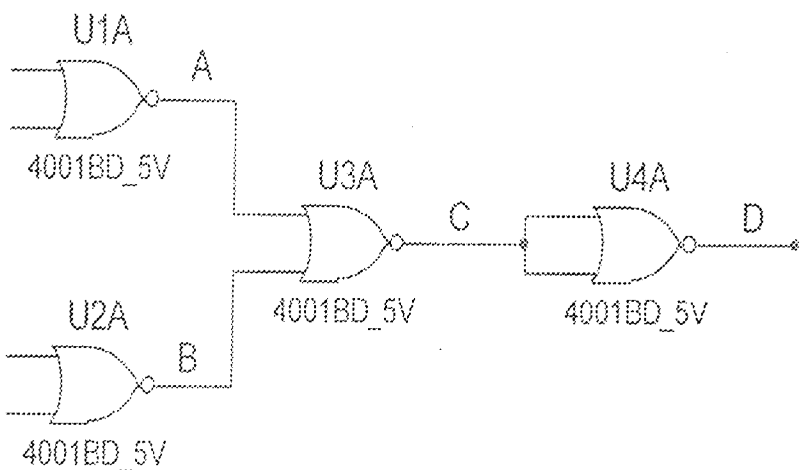


Fig 3.6 The logic arrangement of the CD4001 IC

For the first stage outputs A and B are only high when both of their inputs are low. Hence because of the low frequency at which the inputs are generated, the output will show long time periods. The outputs which are fed into the third NOR gate are further reversed giving a different wave shape.

The two logic blocks, both the one used in the chip card and the one in the lock are expected to generate the same output.

3.7 COMPARATOR

The comparator used here is a 4bit logic comparator CD4063. It can be expanded as it has inputs for cascading. In this work, only 4bits are required.

The P inputs receive the outputs from the chip card logic circuit which the Q input receives from the lock (inbuilt) logic blocks. The two inputs are compared by the comparator and if they are equal, the P = Q output goes high, but if they are not equal the P < Q or P > Q outputs goes low depending on their states. In this design, those pins are neglected.

The CD 4063B is a 4-bit magnitude comparator designed for use in computer and logic applications that require the comparison of 4-bit words. The logic circuit determines whether one 4-bit word (Binary or BCD) is less than, equal to, or greater than a second 4 bit word.

The CD 4063B has eight comparing inputs (A3, B3, through A0, B0), three outputs (A<B, A=B, A>B) and three cascading inputs (A<B, A=B, A>B) that permit system designers to expand the comparator function to 8, 12, 16, ---4N bits. When a single CD 4063B is used, the cascading inputs are connected as follows: (A<B) = low, (A=B) = high, and (A>B) = low.

For words longer than 4bits, CD 4063B devices may be cascaded by connecting the outputs of the less significant comparator to the corresponding cascading inputs of the more significant comparator. Cascading inputs (A<B, A=B, A>B) on the least significant comparator are connected to a high and a low level respectively.

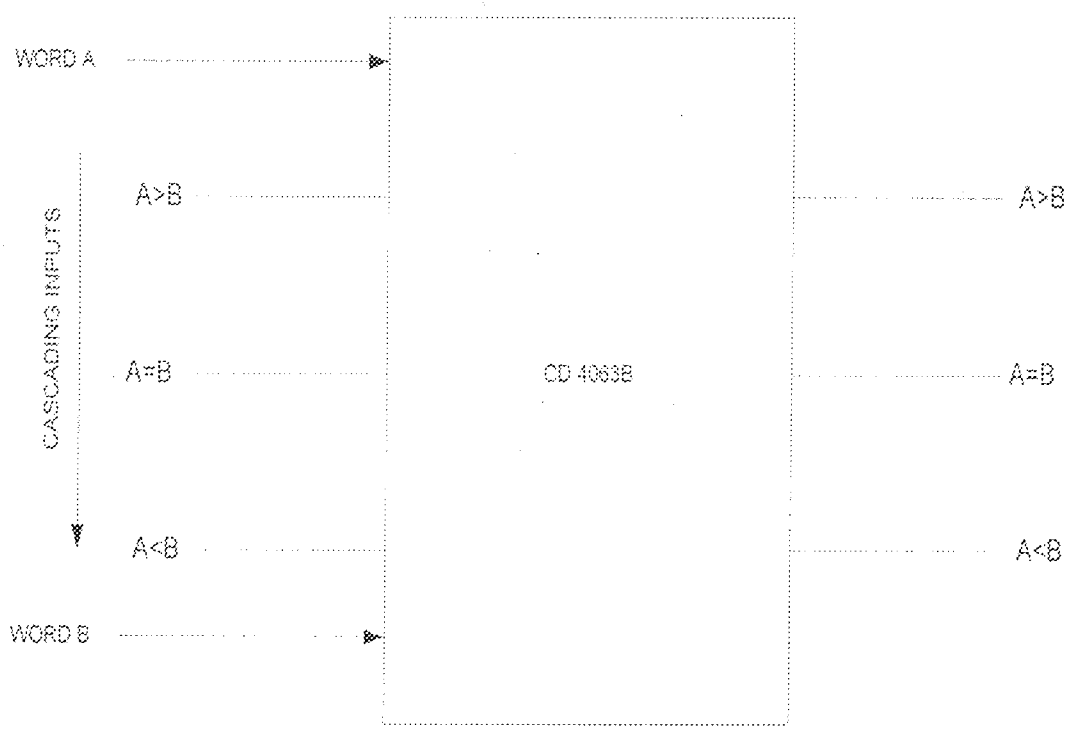


Fig 3.7 Schematic diagram of the CD 4063 comparator

When the output P = Q is high, it enables the input to the transistor.

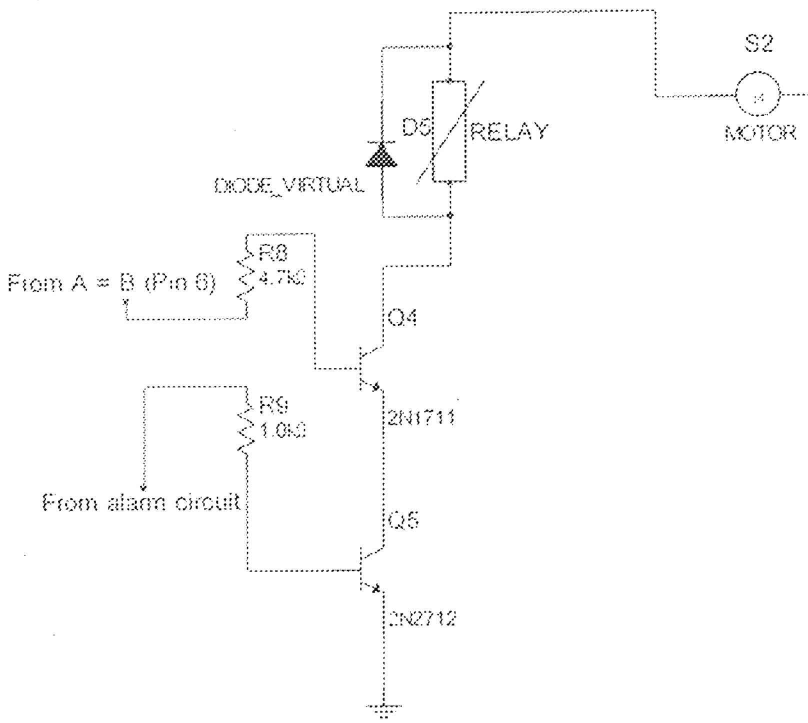
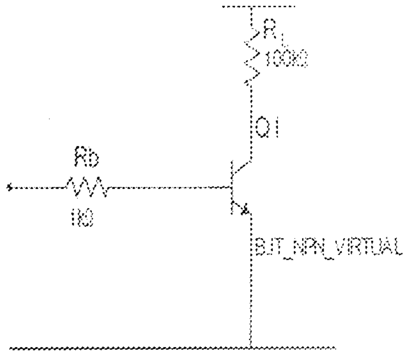


Fig 3.8 Transistor gate arrangement

The arrangement shown is a combination of a PNP and an NPN transistor. This combination is necessitated by the fact that one of the inputs B which is from the battery monitoring circuit is active low.

When the terminal voltage of the battery has fallen below 3V, the battery monitoring circuit sends a high output which switches off the circuit and cuts off power to the motor. This is to avoid heating up of the motor since the terminal voltage as of that time couldn't have driven the motor.



$R_L = 100\Omega$

$V_{CC} = 3V$

$V_{CE} = 0.2V$

Hence, $I_C = I_L = \dfrac{V_{CC} - V_{CE}}{R_L}$

$= \dfrac{3 - 0.2}{100\Omega}$

$= 2.8 \times 10^{-2}$

$= 28mA$

$I_C \approx 10\ I_B$ (desing rule)

$I_B = \dfrac{28mA}{10}$

$= 2.8mA$

$V_{IN} = 2.5V, \quad V_{CE} = 0.7V$

$$R_B = \frac{V_{IN} - V_{CE}}{I_B} = \frac{2.5 - 0.7}{2.8mA}$$

$= 642\Omega$

$\approx 680\Omega$

3.8 THE KEY UNIT

In this circuit, the key is so called because it virtually behaves like the normal mechanical key in this circuit design. What it does is to complete the circuit whenever it is slotted in as been explained in the preceding unit. It is a twin circuit but one of it is in the circuit while the other is hard wired. The input and output of the circuit are terminated in a socket. In this design, what is used as the key is a quad 2 – input NOR gate. The inputs of these are supplied by CMOS 4060; it is fed with a 4 bit code which in turn produces output code. These output code is what is fed and the comparison is only done when the key is inserted into the circuit.

3.9 MOTOR CONTROL NETWORK

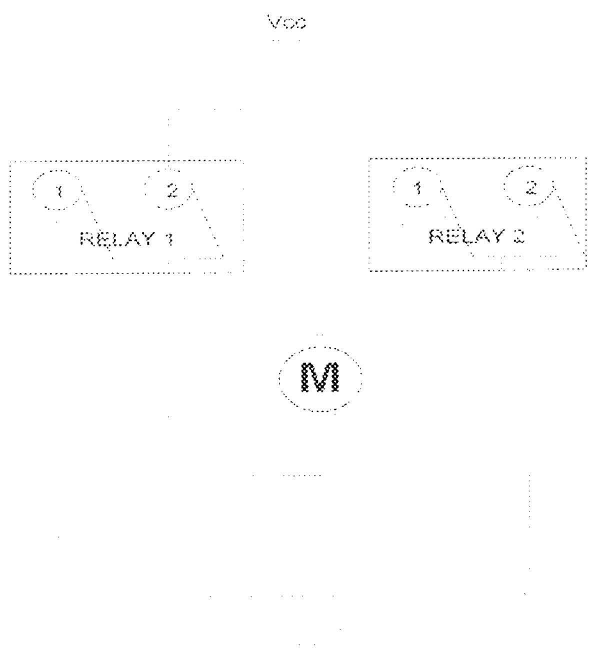


Fig 3.9 Diagram of the relay mechanism

Relay 1 and Relay 2 control the direction of movement of the motor. A relay is an electromagnetic switch which has two positions, the normally close (NC) and the normally open (NO).

When the relay is at rest, the NC switch is closed and NO is open when the relay is energized by the passage of current through the coil.

In this operation, the NC of Relay 1 and NO of relay 2 are connected to ground while the NC of relay 2 and NO of relay 1 are connected to Vcc. When the relay is resting, the NC of relay 1 supplies to ground while NC of relay 2 supplies Vcc

When the motor is energized, it reverses the connections. NO of relay 2 supplies +Vcc while the NC connects to +Vcc. Hence, the motor is put in reverse direction thereby closing the lock [5, 6].

CHAPTER FOUR

4.0 TEST, RESULT AND DISCUSSION

The connection of the different components according to design were all tested on bread board first and the results were taken to confirm its major objective. It was further transferred to a Vero board and soldered.

4.1 POWER UNIT

The power units consist of 240/12V transformer, a bridge rectifier, a filtering capacitor, a regulator (7806), and a 100uF capacitor. For the transformer, when the primary winding is connected to the AC mains supply, the output of the secondary was 12V. The 12V terminal then soldered to the Vero board. The AC output terminal was connected to the bridge rectifier and soldered. The output of the rectifier was then tapped across it and a filtering capacitor was soldered. In the connection of the 7806 regulator, the first leg was connected to the output of the filtering capacitor; the middle leg was grounded while the third leg was connected to an equally grounded 100μf. The output of all these connected to the circuit.

4.2 THE OSCILLATOR

The design specification for MC 4060 is that Rex, Rx and Cx should be connected to pin 11, 10 and 9 in that order while pin 8 and 12 should be grounded. It also state that the output should be tapped from pin 1, 2, 3 and 4 all these where strictly adhered to.

4.3 KEY

This takes its input from the oscillator. The IC itself was pre-tested before connecting. One of the two IC's actually forms the key unit but the other though connected in the same way, was in the major lock`s circuit.

4.4 COMPARATOR

The comparator is basically a complementary MOS. It was first tested by checking its Vcc. Once it was certified okay, it was then mounted on a pre-soldered surface mount device (SMD). The output of the two keys were connected to pin 1, 9, 11, 14 , 10, 12, 13, and 15 while the output was taken from one of the three cascading output A=B to be precise.

4.5 CASING CONSTRUCTION

The Casing is metallic in nature. Its size is made to fit the completed circuit. Plastic was selected for the rechargeable battery compartment for better handling. Holes and cuts were made for the outlets of the keys and for ventilation to avoid overheating of the components and most especially the transformer. The dimension of the casing is 4cm x 3cm x 2cm.

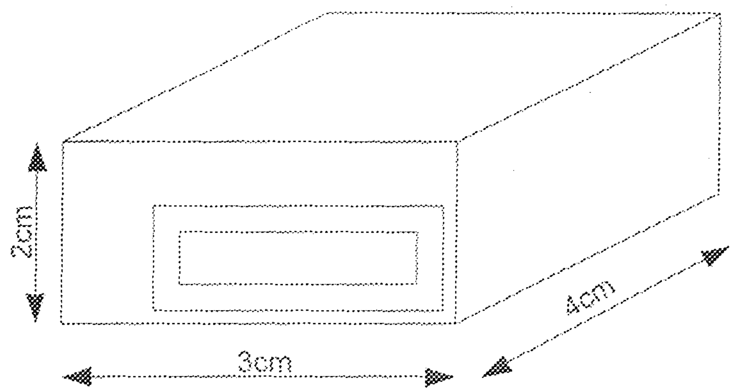


Fig 4.1 Casing Dimension

4.6 PREVENTIVE MEASURES TAKEN

i. All unused input (pins) on the IC's were grounded.

ii. Possibilities of short circuits were reduced by minimizing the joints on all the wires used.

iii. The soldering iron used in soldering was of low wattage (30W)

iv. The use of IC sockets was employed to avoid direct application of heat to the IC's during soldering.

4.7 RESULT

The circuit performed its function as it was designed to. After all the necessary testing were done and implemented, the lock operated as was designed to. Though with some limitations, some adjustments were made to achieve the final desired results.

4.8 LIMITATIONS

i. The reliability of the components in the market is very low. CMOS IC's which discharge when touched are counted like medicinal tablets by the sellers

ii. Required tools and components needed for specific construction are relatively scarce.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The design and construction of a digital lock using chip card as the key was successfully carried out. Based on the scope of this project, the set objectives of the design as desired such as the reliability, user friendliness, system accessibility and most importantly security, has been achieved.

Most of the retailers of these components were found in most cases to have little or no knowledge of the nominal values of the available components, thus the identification of components took some time thereby causing some delay and modifications.

Amongst the list of challenges, is financial constraint. But astuteness and a lot of ingenuity was applied to make prudent use of what was available to get the required result. So, with a reasonable degree of economics efficiency and practical conformity, the aim outlined in chapter one has been achieved

5.2 RECOMMENDATIONS

It is hereby recommended that this design should be used in houses, banks and industries where only authorized persons are allowed with their respective access.

The university should make available some vital electrical components for sale to increase their availability and terminate delays in such designs and constructions. The reliability of components in the market is usually very low. In the case of CMOS IC's low. In the case of CMOS IC`s which discharges when touched are treated like groundnut seeds by the sellers and this reduces the required efficiencies of these components.

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APPENDIX I

OVERALL CIRCUIT DIAGRAM

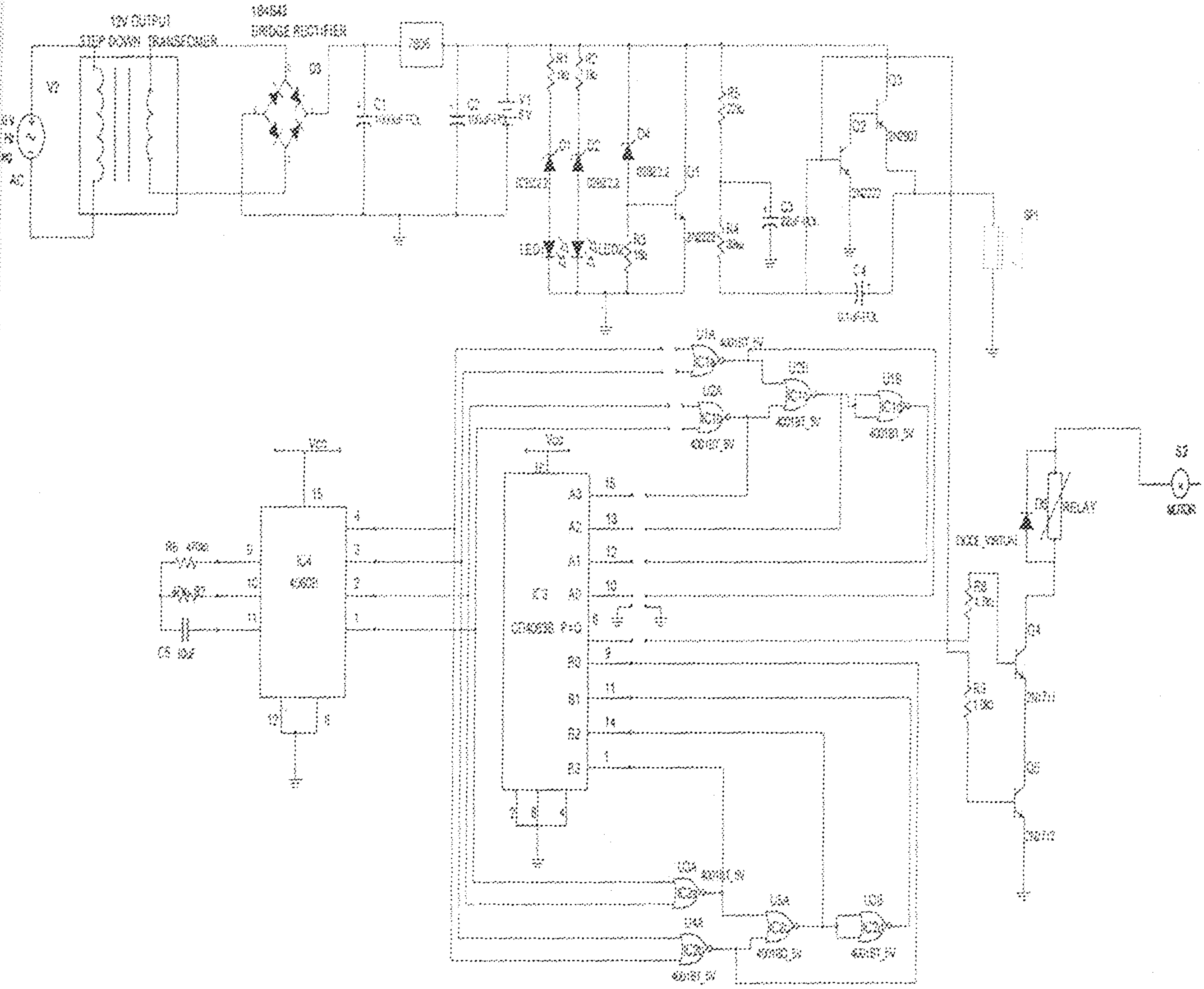

Fig: Design Circuit Diagram