DESIGN AND CONSTRUCTION OF BRAKE FLUID LEVEL MONITOR

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DECLARATION

I do hereby declare that this thesis presented for the award of Bachelor of Engineering has not been presented either wholly or partially for the award of any other degree elsewhere.

Information derived from published or unpublished work of others has been acknowledged in the text.

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CERTIFICATION

I certify that this project work was carried out by **GHWELEKE .Y. JOSEPH** and that it has met the minimum standard demand acceptable by the department of Electrical and Computer Engineering Department of the Federal University of Technology Minna.

ENGR S.N. RUMALA	9/8/05
SUPERVISOR	DATE

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DATE

....

EXTERNAL EXAMINER

DATE

DEDICATION

I dedicate this project to my Lord and Savior Jesus Christ who is the symbol of the favor of God revealed to mankind.

And also my elder brother DR GHWELEKE CHARLES who unrelentingly sponsored my career through the University

ACKNOWLEDGMENT

I wish to express my profound gratitude to Almighty God for helping me to complete my studies in the university.

My heart felt appreciation goes to my supervisor and lecturer **ENGR S. N. RUMALA** whose effort has been to bring the best out of students. I appreciate the effort made by my departmental lecturers in seeing that I arrive at this stage.

I appreciate the encouragement and prayers from PASTOR CHRIS DAVID to see that I arrive at this stage. I appreciate the assistance received from JOHN HABILA to see that this project is completed.

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This acknowledgment will not be completed if I fail to appreciate the love, kindness and moral support from OLIVIA GHWELEKE and to my elder brother DR. GHWELEKE CHARLES who has taken it upon himself that this project is completed.

ABSTRACT

In considering the vital roll of brake fluid (hydraulic fluid) in the automobile industries (machines) and it's major roll in the application of brakes and clutches, the absence or inadequacy of this fluid in brakes an clutches will result a high accident rate. This is because a vehicle would stop poorly if the brake fluid is inadequate or will not stop at all if there is no brake fluid in the vehicle. It's important to keep a close watch on the level of this vital liquid.

This project BRAKE FLUID LEVEL MONITOR demonstrates the importance of Electrical / Electrons Engineering in the automobile industries. It is aim at continuously monitoring the level of brake fluid (hydraulic fluid) in the master cylinder of a vehicle and warns you (the driver) with an audio tone and a glowing LED indicating the absence or inadequacy of brake fluid in the master cylinder of the vehicle.

This will reduce brake failure as a result of constant brake fluid in the master cylinder and thereby reduces accident rate. This is achieved with the aid of a sensor probe in the master cylinder that senses the inadequacy of brake fluid. The glowing LED and the audio tone will stop only if the probe is fully immersed in the brake fluid.

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CHAPTER 1

1.0 GENERAL INTRODUCTION

Because a vehicle would stop poorly if at all should the brake fluid leak out, it's important to keep a close watch on the level of this vital liquid. Here's a circuit which will continuously feel for the presence of brake fluid in the master cylinder an warn you (the driver) with an audio tone and glowing LED should trouble arise. Switch S1 lets you silence the sounder (BUZZER), although LED will continue to glow as a constant reminder. Ideal for use in a central control panel for monitoring your vehicle's operating status at a glance.

For construction advice, for power use decoupler /regulator circuit attached to a source that is hot while the ignition switch is on. Almost any metallic object will do for a sensor probe, although a length of bare, 20 gauge copper wire works well. Carefully tap a hole in the master cylinder cap and insert this probe into the reservoir so that it will remain immersed in any normal level of fluid. For a metallic cap which grounds to the master cylinder case, you must insulate the probe to cap junction. For a master cylinder with dual reservoirs, either reservoir may be monitored, although the one supplying fluid to the rear brakes is the more important. At any rate insure that the hole you tape is above the fluid level, to prevent leaks and completely air-tight, to prevent the entrance of moisture-laden air (brake fluid readily absorbs moisture).

Finishing up, set the ''sensitivity Adjust'' variable resistor R_2 to its mid position. In some rare cases it may be necessary to increase / decrease sensitivity from this point. This circuit is only a back-up system and that the fluid level must still be periodically checked [1].

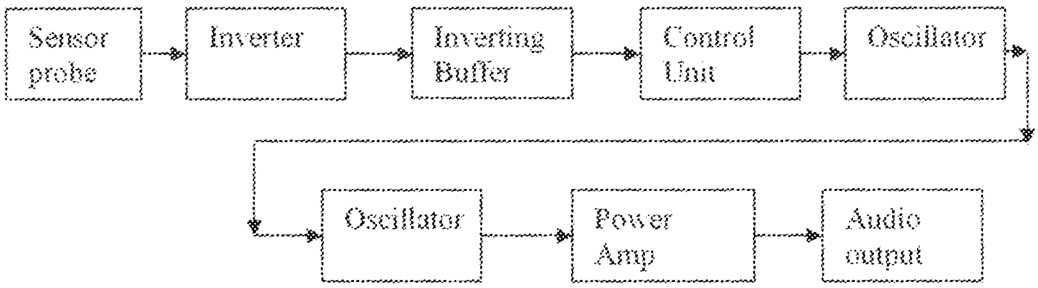


Fig. 1: BLOCK DIAGRAM OF LOW BRAKE FLUID MONITOR

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Fluid is a substance which deforms continuously when subjected to external shearing force. The study of fluid makes it a branch of Engineering science which deals with the behavior of fluid under the condition of rest and motion. The properties of fluid can be classified on the basis of spacing between the molecules of matter as follows

Solid state

Fluid state

Liquid state and Gaseous state.

In solids, the molecules are very closely spaced whereas in liquid the spacing between the different molecules is relatively large and in gases the spaces between the molecules is still large. It means that inter-molecule cohesive forces are large in solid, smaller in liquids and extremely small in gases. Solids possess compact and rigid form, liquid molecules can move freely within the liquid mass and the molecules of gases have greater freedom of movement so that the gases fill the container completely in which they are placed. A solid can resist tensile, compressive and shear stresses up to a certain limit where as a fluid has no tensile strength or very little of it and can resist the compressive forces only when it is kept in a container. When a fluid is subjected to a shearing force it deforms continuously as long as the force is applied. The amount of shear stress in a fluid depends on the magnitude of the rate of deformation of the fluid element. Liquid and gases exhibit different characteristics. The liquid under ordinary conditions are quite difficult to compress therefore may for most purposes be regarded as incompressible. where as gases can be compressed much readily under the action of external pressure, when the external pressure is removed, the gases tend to expand indefinitely.

A fluid is a substance which is capable of flowing or a fluid is a substance which deforms continuously when subjected to external shearing force. The characteristic of fluid are:

It has no definite shape of its own, but conforms to the shape of the containing vessel.

Even a small amount of shear force exerted on a liquid / fluid will cause it to undergo a deformation which continues as long as the force continues to be applied. A fluid may be classified as Ideal fluids and Real fluid.

An ideal fluid is one which has no viscosity and surface tension and is incompressible. In true sense, no such fluid exists in nature. Fluids which have low viscosities such as water and air can be treated as ideal fluid under certain conditions, this assumption helps in simplifying the mathematical analysis.

A real fluid is one which has viscosity, surface tension and compressibility in addition to the density and is actually available in nature [4].

2.1 BRAKE FLUID

Many brake system problems are caused by old or inadequate brake fluid. It is very important to always use a high quality brake fluid with a high dry boiling point rating, since if your brake fluid starts to boil, that can't be very good because over a time, moisture will enter and be absorbed into the brake fluid thereby lowering the boiling point temperature over a time. Some brake fluid tends to absorb moisture much more rapidly than others, fluids that absorbs moisture very quickly has much lower boiling point and encourages corrosion in the braking system, hence a fluid that absorbs moisture slowly is desirable for example, the ATE type 300 or Super Blue Racing and the Castrol LMA are two brake fluids that absorbs moisture very slowly and it is important to buy a brake fluid that comes in a metal can instead of plastic, since moisture will make its way into the brake fluid if it's in a plastic bottle [www.rpmnet.com/techart/pad_proc-shtml].

2.2 TYPES OF FLUID

Silicon based fluids: This fluid is very easy to compress and does not mix with water. When the water begins to boil, it can cause the system to air lock.

Glycol based fluid: This type of fluid are most widely used, this fluid will mix with water and its boiling point will drop considerably as the fluid mixes with the moisture in the brake system making it extremely important to completely purge the entire system very often.

Castrol LMA: It is very good at rejecting moisture and may be in your brake system for a couple of years. LMA (low moisture absorption) comes with plastic container.

Ford Heavy Duty DOT 3: it absorbs moisture quickly but has excellent dry boiling point, it comes with metal can.

ATE Super Blue Racing and ATE Type 200: These are the same brake fluid in two different colures (blue and amber respectively). BMW recommends this brake fluid for their cars because it, like castrol LMA absorbs moisture very slowly. The advantage over LMA is that ATE has a much better wet boiling point, it comes with a can.

Motul Racing 600: This brake fluid is exotics and expensive synthetic fluid with high wet and dry boiling points, it comes in plastic bottles.

MINIMUM WET AND DRY BOILING POINTS FOR DOT 2, 3, 4, AND 5 BRAKE FLUID IN DEGREES FAHRENHEIT

	DOT2	DOT3	DOT4	DOT5
Dry Boiling point	374	401	446	500
Wet boiling point	284	311	356	

All brake fluid (except DOT 5 Silicone) is non-compressible and does not boil while+ you are driving. The DOT 2 is for drum brakes and is obsolete. DOT 5 is for silicon brake fluid, it is not compatible with regular brake fluid, bubbles are introduced when pouring DOT 5 into the fluid cylinder and moisture gets into the system therefore will pool in low areas like your calipers and encourage rapid corrosion. DOT 3 and DOT4 fluid are compactable with each other and may be interchanged or mixed with no ill effects.

POPULAR BRAKE FLUIDS AND THEIR BOILING POINTS

DRY WET:

Castrol LMA	DOT ¾	446	311
Ford Heavy Duty	DOT 3	550	290
ATE super Blue Racing		536	392
ATE Type 200		536	392
Motul Racing 600		585	421
Castrol SRF		590	518
Performance friction		550	284

2.3 THE HYDRAULIC BRAKE FLUID (DOT 3 SYNTHETIC)

The hydraulic brake fluid is a universal Dot 3 synthetic specially developed to meet specification FMVSS 116, Dot 3, SAEJ 1703, ISO 4925 and JAN 80. It mixes safely with all brake fluids and clutches and it is manufactured to SAE and Dot specifications. The hydraulic brake fluid is a synthetic liquid which is stable at high tempreture and harmless to natural rubber which can be deformed by contact with oil, petrol, paraffin or grease [hydraulic fluid can, 6].

2.4 PROPERTIES OF HYDRAULIC FLUID

The most important properties of hydraulic fluid (viscosity) is a measure of a fluid resistance to flow. A liquid such as gasoline which flows easily has a low viscosity and a liquid such as tar, which flows slowly has a high viscosity. The viscosity of a liquid is affected by changes in temperature and pressure. As temperature of a liquid increases, its viscosity decreases that is a liquid flows more easily when it is hot than when it is cold. The viscosity of a liquid increases as the pressure on the liquid increases. A satisfactory liquid for hydraulic system must be thick enough to give a good seal at pumps, motor and valves. A liquid that is too thin will allow rapid wearing of moving parts since leakage losses are greater with thinner liquid (low viscosity), on the other hand if the liquid is too thick (viscosity too high), the internal friction of the fluid will cause an increase in the liquids flow resistance through clearance of closely fitted parts and internal passages. This results in the pressure drops throughout the system, sluggish operation of the equipment and an increase in power consumption.

The viscosity index (V.I) of an oil is a number that indicates the effect of temperature changes on the viscosity of the oil. A low viscosity index signifies a relatively large change of viscosity with changes of temperature, the oil becomes extremely thin at high temperature and extremely thick at low temperature. A high viscosity index signifies relatively little change in viscosity over a wide temperature range. An ideal oil for most purpose is the one that maintains a constant viscosity throughout the temperature changes. An oil having a high viscosity index resists excessive thickening when the engine is cold and consequently promotes rapid starting and prompt circulation, it resists excessive thinning when the motor is hot and thus provides full lubrication and prevents excessive oil consumption. Other properties of hydraulic fluids are:

Lubricating power

Chemical stability

Freedom from acidity

Flash pint

Fire point

Minimum toxicity

Density and compressibility

Foaming tendency

Cleanliness

[www.tpub.com/fluid/ch1k.htm, www.tpub.com/fluid/ch1l.htm].

2.5 TYPES OF HYDRAULIC FLUIDS

The three most common types of hydraulic fluids are:

Water-based fire resistance

Petroleum-based fluid

Synthetic fire resistance.

The most common hydraulic fluids used in shipboard systems are the petroleum – based oils. These fluids contain additives to protect the fluid from oxidation (antioxidation), to protect system metals from corrosion (anticorrosion), to reduce tendency of the fluid to foam (foam suppressant) and to improve viscosity.

Petroleum – based fluids are used in surface ships, electrohydraulic steaming, deck machinery, submarines hydraulic system and aircraft automatic pilots, shock absorbers, brakes, control machines and other hydraulic systems using seal materials compatible with petroleum – based fluids.

Petroleum – based fluid contains most of the desired properties of a hydraulic fluid. However, they are flammable under normal conditions and can become explosive when subjected to high temperature. Nonflammable synthetic fluids have been developed for use in hydraulic systems where fire hazards exist [www.tpub.com/fluid/ch11.htm].

CHAPTER 3

DESIGN ANALYSIS AND CALCULATIONS

3.0 INTRODUCTION

This circuit is designed to monitor the inadequate or absence of brake fluid in the master cylinder of a vehicle [1].

3.1 THE POWER SUPPLY UNIT

Very many electronics system requires dc voltage for its operation. The mains supply is alternating ac voltage 220-240 V which is usually too high for electronic gadgets. Since this circuit is operating on a d.c Voltage source of 5V, there is need to design and construct a power supply unit which obtains its supply from the mains as ac voltage and step it down using a 12V step down transformer, this ac voltage is then converted to dc voltage using bridge rectifiers, a filter capacitor is connected to the dc voltage to store the dc voltage. This 12V dc voltage is regulated to 5V dc voltage using 7805 voltage regulator in order to achieve the required voltage needed to drive the circuit.

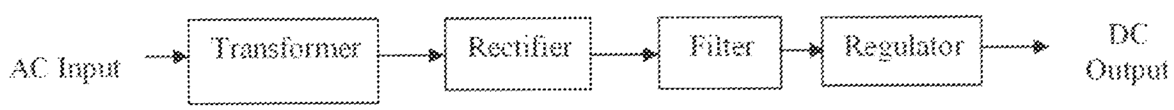


Fig 2: BLOCK DIAGRAM OF 5V POWER SUPPLY.

The power supply unit uses a core-type step down transformer that transforms the high ac voltage 220-240 V to a voltage as low as 12 V ac. The transformer consists of two coils that possess high mutual inductance which are electrically separated but magnetically linked through a path of low reluctance and a laminated steel core; the two coils are insulated from each other and the steel core [7].

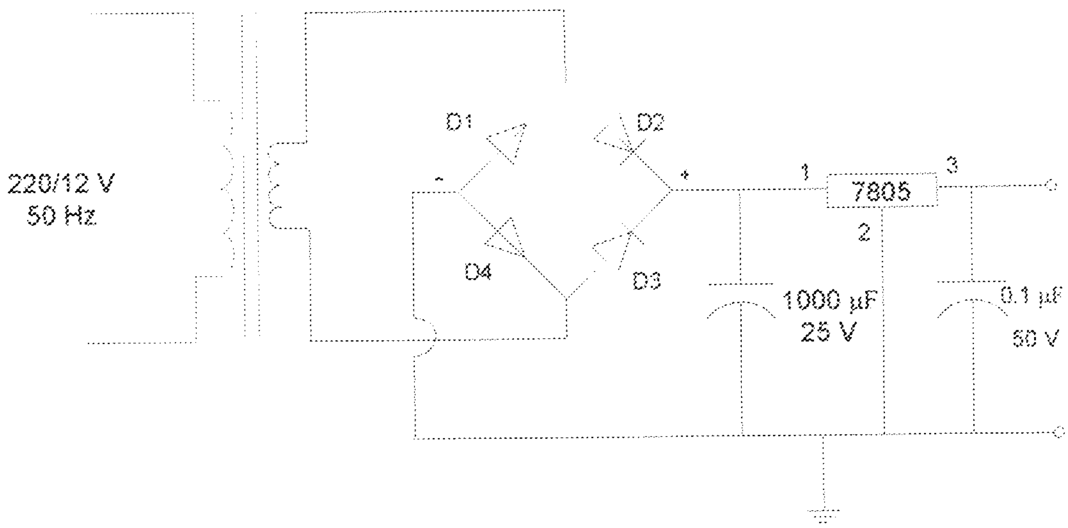


Fig 3: CIRCUIT DIAGRAM OF 5V POWER SUPPLY

3.2 THE PROBE UNIT SPECIFICATION

This is a 20-gauge copper wire, it is immersed in the master cylinder of a vehicle containing hydraulic brake fluid. The probe is majorly to sense the inadequate or absence of brake fluid in the master cylinder and then warns you with an audio tone and a glowing LED [1].

3.3 SPECIFICATION OF THE NAND GATE QUADRUPLE 2 - INPUT UNIT

This provides the positive quadruple 2-input NAND function. It uses a low voltage of about 3-15V dc, but for this circuit, it is designed for 5V dc

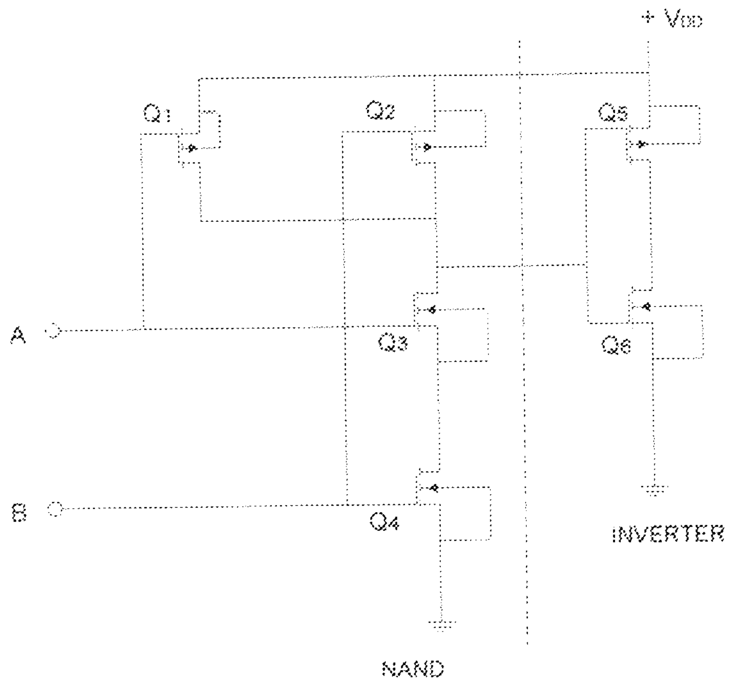


Fig 4: ARCHITECTURE OF THE CMOS (4011) NAND GATE QUADRUPLE 2-INPUT [10]

The CMOS (4011) NAND gate is constructed from enhancement-mode MOSFETS of both polarities connected as switches rather than followers. Both inputs must be high on the series pair Q_3 Q_4 and to turn off both of the pill-up transistor Q_1 Q_2.This produces a low at the output that is, it is a NAND gate. Q_5 and Q_6 constitute the standard CMOS inverter. The logic circuit uses both P-channel MOSFET and N- channel MOSFET devices in the same chip. It gives the advantage of drastic decrease in power dissipation (12 nW per gate) and increase in speed of operation and has a low power dissipation [7, 10].

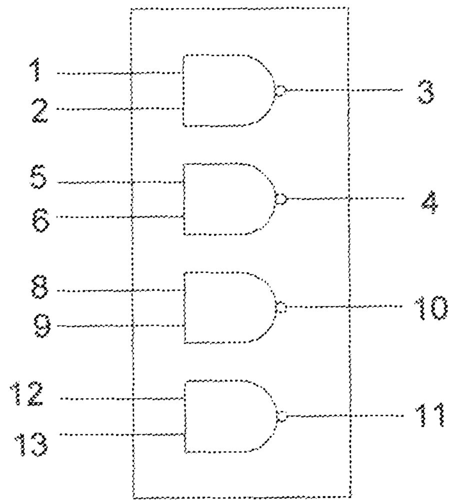


Fig 5: FUNCTIONAL DIAGRAM [CMOS4011].

The outputs are fully buffered for highest noise immunity and pattern insensitivity of output impedance. Its maximum current I_{max} is 5mA at a voltage of 5V dc and a speed range of 2M Hz to about 100M Hz.

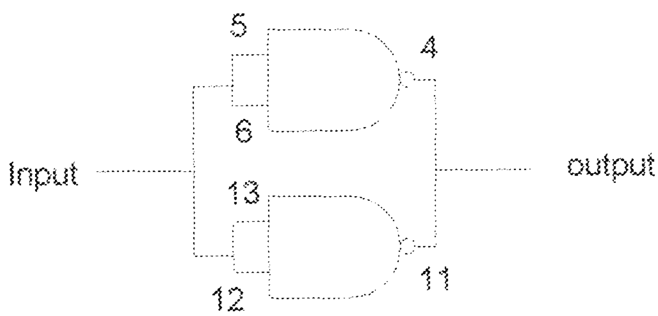


Fig 6: DIAGRAM OF INVERTING BUFFER [9].

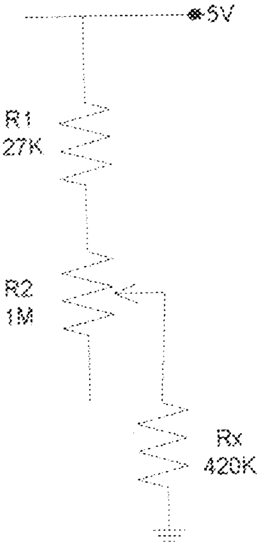


Fig 7: REFERENCE VOLTAGE $V_{ref.}$ DIAGRAM

Applying voltage divider theorem

$$V_{IL} = \frac{R_X V}{R_T}$$

$R_T = R_1 + R_2 + R_X$

Where

R_X is the Resistance of hydraulic fluid which is (420 KΩ)

Therefore, $R_T = 27000 + 10^6 + 420000$

$= 1447000\ \Omega$

$= 1.447\ M\Omega.$

Also,

V_{IL} is the low level input voltage for CMOS 4000 series and it uses minimum voltage of 0V and maximum voltage of 1.5V for a 5V power supply [2].

$$\therefore V_{IL} = \frac{420 \times 10^3 \times 5}{1447000}$$

$= 1.45V.$

$V_{IL} = 1.5V$

Also

$$V_{IH} = \frac{(R_X + R_2)\,V}{R_T}$$

Where

V_{IH} is the high level input voltage for CMOS 4000 series and it uses a minimum voltage of 3.5V and maximum voltage of 5V for a 5V power supply [2].

Therefore,

$$V_{IH} = \frac{(420 \times 10^3 + 10^6)\,5}{1447000}$$

$$= \frac{7100000}{1447000}$$

$$= 4.907$$

$$= 4.9V.$$

The required voltage that will cause the inverter low is between 1.5V and 4.9V.

The High level output voltage is 4.95V for a 5v power supply. This is the output voltage of the inverting buffer for a CMOS 4011 logic circuit [2].

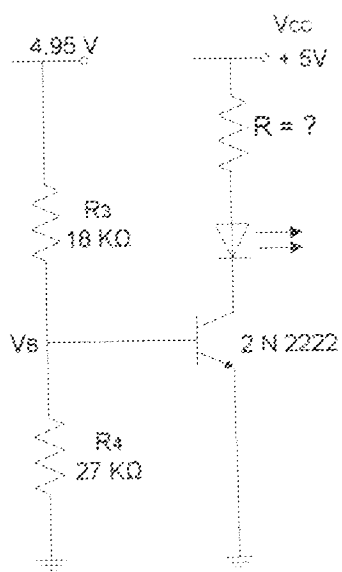


Fig 8: DIAGRAM OF THE CONTROL UNIT.

Applying voltage divider theorem,

$$V_B = \frac{R_4 \times 4.95}{(R_3 + R_4)}$$

$$V_B = \frac{27 \times 10^3 \times 4.95}{(27+18)\,10^3}$$

$$= \frac{27 \times 4.95}{45}$$

$$= \frac{133.65}{45}$$

$$V_B = 2.79V.$$

This is the required voltage that will switch on the transistor.

For the current limiting resistor,

$$R = \frac{V_{CC} - V_D}{I_d}$$

where ,

$V_{CC} = 5V.$

V_D = Diode voltage 1.7V

I_d = Diode current 10mA

$$R = \frac{5 - 1.7}{10 \times 10^{-3}}$$

$$= \frac{3.3}{10 \times 10^{-3}}$$

$$R = \frac{3.3 \times 10^3}{10}$$

$$= \frac{3300}{10}$$

$$R = 330\ \Omega$$

3.4 ASTABLE MULTIVIBRATOR ARCHITECTURE

The NE555 is a highly stable controller capable of producing timing pulses.

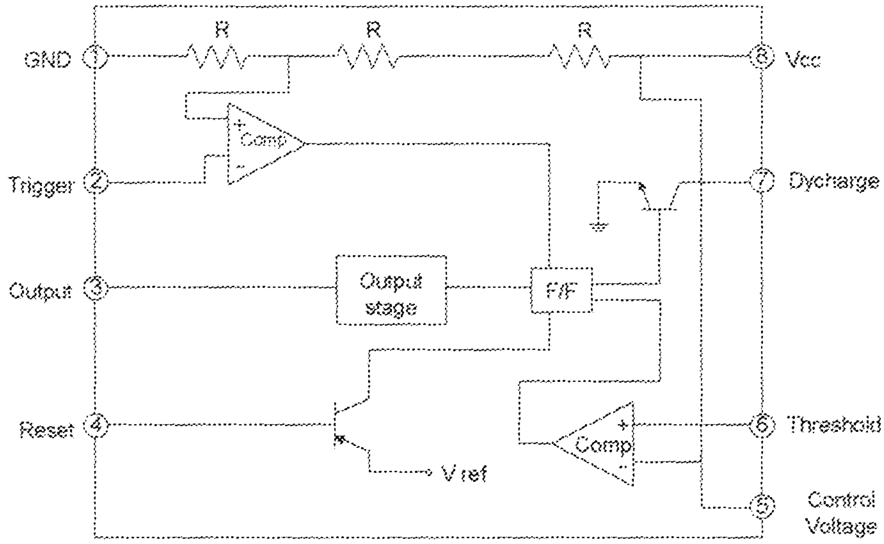


Fig 9: THE NE 555 INTERNAL BLOCK DIAGRAM.

In the astable operation, the trigger terminal and the threshold terminal are connected so that a self-trigger is formed, operating as a multivibrator. When the timer output is high, its internal discharging trigger turns off and the capacitor C_1 increases by exponential function with the time constant. $(R_A + R_B)*C$. When the Vc_1 or the threshold voltage reaches $2V_{CC} / 3$, the comparator output on the trigger terminal becomes high, resulting the F/ F and causing the timer output to become low. This in turn turns on the discharging trigger and the C_1 discharges through the discharge trigger when the Vc_1 falls below $V_{CC} / 3$.The comparator output on the trigger terminal becomes high and the timer output becomes high again. The discharging trigger turns off and Vc_1 rises again. The section where timer output is high is the time it takes for the Vc_1 to rise from $V_{CC} / 3$ to $2V_{CC} / 3$ and the section where the timer output is low is the time it takes for the Vc_1 to drop from $2V_{CC} / 3$ to $V_{CC} / 3$.

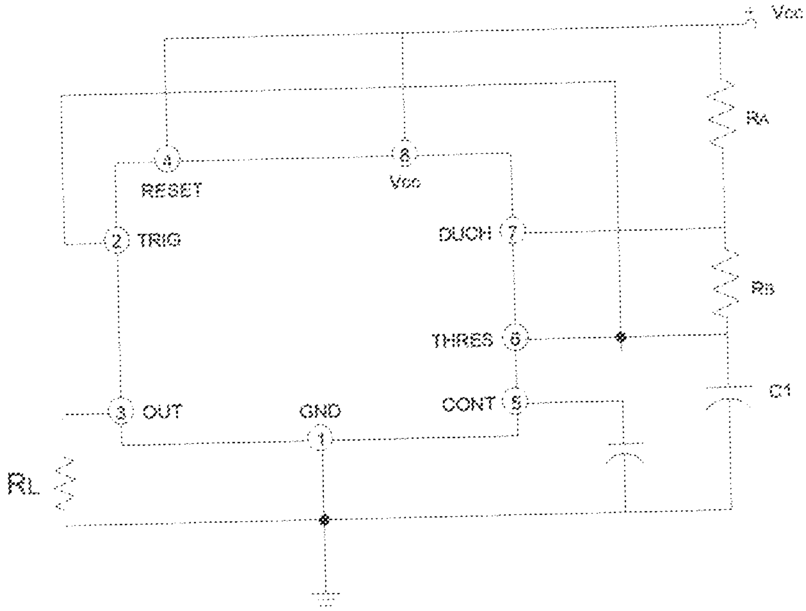


Fig 10: CIRCUIT DIAGRAM OF ASTABLE MULTIVIBRATOR

When the timer output is high, the equivalent circuit for charging capacitor c_1 is

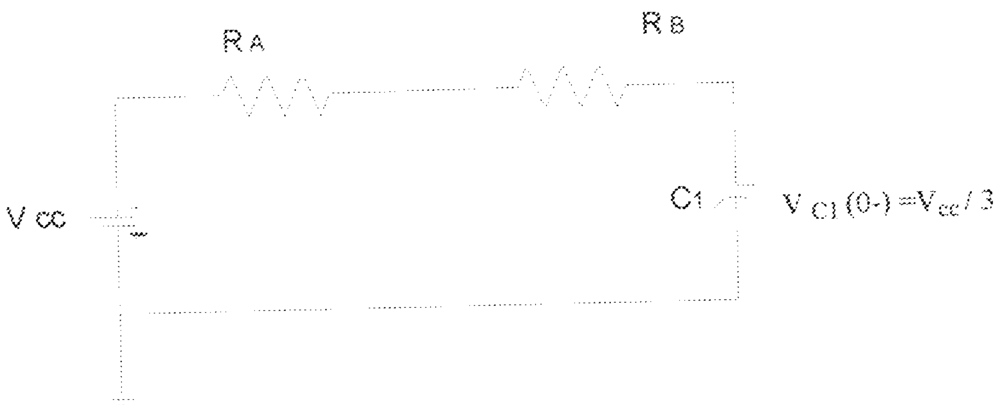


Fig11: CIRCUIT DIAGRAM FOR CHARGING CAPACITOR C_1 WHEN TIMER OUTPUT IS HIGH.

$$C_1 \frac{dv\, c_1}{dt} = \frac{V_{CC} - V(0-)}{R_A + R_B} \quad \ldots\ldots\ldots\ldots (1)$$

$$Vc_1(0+) = \frac{V_{CC}}{3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$Vc_1{}^{(t)} = V_{CC}\left(1 - \tfrac{2}{3} e^{-[\,t/(R_A + R_B)C1]}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Since the duration of the timer output high state (t_H) is the amount of time it takes for the $Vc_1(t)$ to reach 2Vcc / 3

$$Vc_1(t) = \tfrac{2}{3} V_{CC} = V_{CC}\left(1 - \tfrac{2}{3} e^{-[t_H/(R_A + R_B)C1]}\right) \ldots\ldots\ldots\ldots (4)$$

$$t_H = C_1 (R_A + R_B) \ln 2 = 0.693 (R_A + R_B) C_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The equivalent circuit for discharging capacitor C_1, when timer output is low is

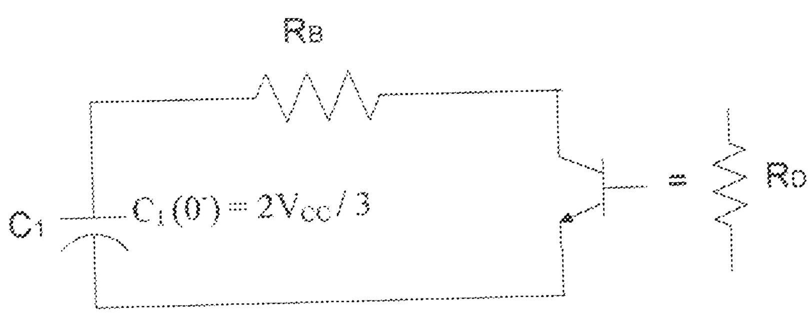


Fig 12: CIRCUIT DIAGRAM FOR CHARGING CAPACITOR C_1 WHEN TIMER OUTPUT IS LOW

$$C_1 \frac{dv_{C1}}{dt} + \frac{1}{R_A + R_B} Vc_1 = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$Vc_1(t) = \tfrac{2}{3} V_{CC}\, e^{\,t/(R_A + R_B)C1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Since the duration of timer output low state (t_L) is the amount of time it takes for the $Vc_1(t)$ to reach $V_{CC}/3$.

$$\tfrac{1}{3} V_{CC} = \tfrac{2}{3} V_{CC}\, e^{\, t_L/(R_A + R_D) C1} \quad \text{.............................. (8)}$$

$$t_L = C_1 (R_B + R_D) \ln 2 = 0.693 (R_B + R_D) C_1 \quad \text{................ (9)}$$

If $R_B >> R_D$

In relation to discharging trigger.

$t_L = 0.693\, R_B\, C_1$

If the timer operation in astable

$T = t_H + t_L$

$= 0.693 (R_A + R_B) C_1 + 0.693\, R_B\, C_1$

$= 0.693 (R_A + 2R_B) C_1$

The period T, is the sum of the charge time and discharge time. The frequency is the reciprocal of the period.

$$F = \frac{1}{T}$$

Therefore

$$F = \frac{1.44}{(R_A + 2R_B) C_1} \quad \text{.................................... (11)}$$

Where

$R_A = 10k\,\Omega$

$R_B = 2\,(10K\Omega) = 20K\Omega$

$C_1 = 47nF = 47 \times 10^{-9}$ F

$$F = \frac{1.44}{(10k + 20k)\, 47 \times 10^{-9}}$$

$$F = \frac{1.44}{(30k)\,47 \times 10^{-9}}$$

F = 1021.3 Hz

F= 1K Hz.

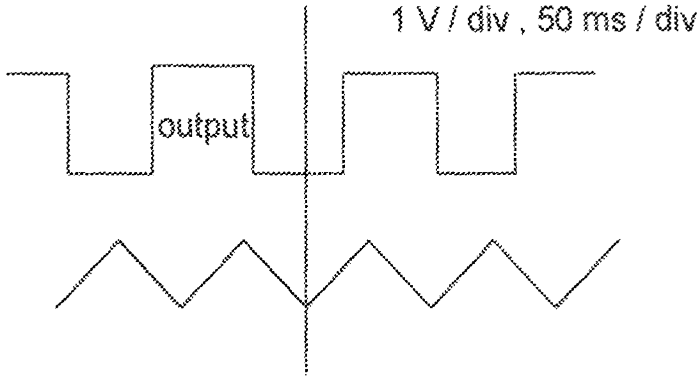


Fig 13: DIAGRAM OF ASTABLE OUTPUT WAVEFORM

[www.fairchildsemi.com].

3.5 LM 386 POWER AMPLIFIER

A power amplifier is designed for use in low voltage, especially battery operated amplification. For minimum parts count, C_1 and C_2 can be omitted. With pins 1 and 8 open circuit the gain is internally set to 20 dB. With a 10µf capacitor between pins 1 and 8 the gain is increased to 200 dB and the gain can be set to anything between these limits by placing a resistor in series with this capacitor. For example 1.2 kΩ resistor here sets the gain to 50 dB. The capacitor on pin 7 sets the power supply rejection ration from 6dB with no connection of 50 dB at 1k Hz with 10µf [2].

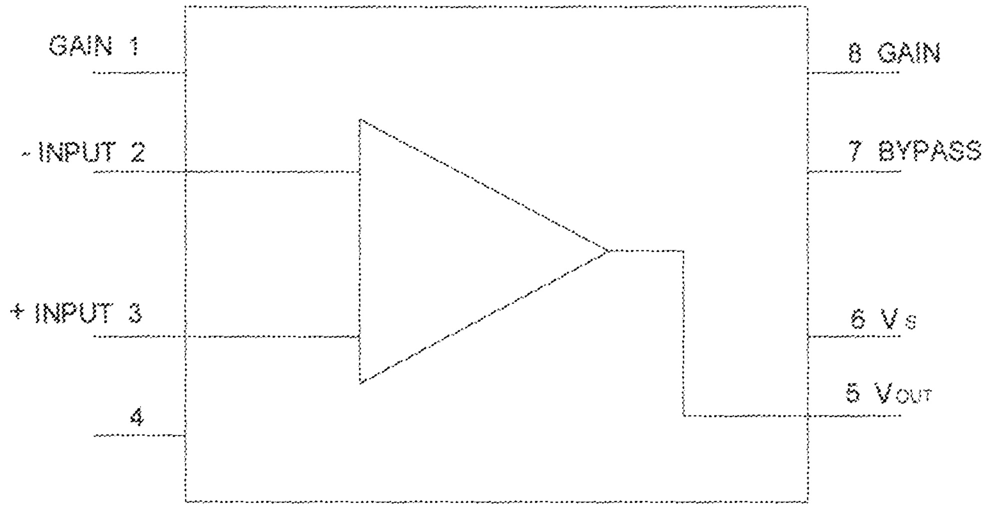


Fig14: PIN OUT DIAGRAM OF LM 386 POWER AMPLIFIER.

The LM386 (IC) has an ample field of experimentation not only as an audio amplifier, but also a Wien bridge oscillator and a square wave oscillator.

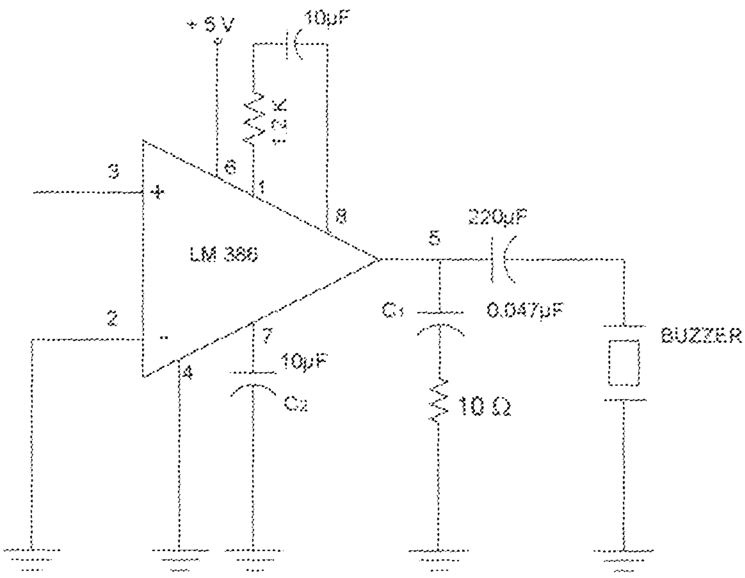


Fig 15: CIRCUIT DIAGRAM OF LM 386 POWER AMPLIFIER

3.6 OUTPUT TRANSDUCER (BUZZER)

This is a ceramic piezo buzzer element, it generates a range of audible tone and frequencies when energized by a 5V peak square wave. It can be driven directly from CMOS IC's with low power consumption. In addition to a wide range of application where audible warning or indications are preferred to visual, other uses include toys, clock and watches, calculators and electronic games, using the buzzer in the place of a speaker. Because there are no moving parts to wear out, these elements are reliable for use in professional commercial and industrial applications. It can withstand severe environment conditions and prove durable I n domestic appliances without causing r.f interference. It has a frequency range of 3 to 10 kHz and output of up to 90 dB [2].

3.7 PEUJEOT 504 BRAKE FLUID CONTAINER (MASTER CYLINDER)

Taking the brake fluid master cylinder of a Peugeot car as a case study. The volume of fluid that will fill the master cylinder is 200cm^3, it is calibrated as follows 1cm, 2cm, 3cm, 4cm, 5cm, and it is made up of plastic container.

The sensor probe is connected into the master cylinder through the top, it is 4cm long, while in the master cylinder it is at 2cm mark of the container. The circuit is design such that the LED will glow and the buzzer will sound when the volume of fluid in the master cylinder is below 2cm mark and also that the LED will stop glowing and the buzzer will not sound when the volume of fluid is at 2cm mark or above 2cm mark.

3.8 DISCUSION OF RESULTS

The result of this project was in line with the design and construction specification. During test running the circuit on bread board, the light emitting diode (LED) glowed and the Buzzer sounded, this indicated the absence or inadequacy of brake fluid in the master cylinder (that is the fluid was below the sensor probe) and also when the light emitting diode (LED) stopped glowing and the Buzzer did not sound, it indicates the presence of brake fluid in the master cylinder that is the sensor probe is fully immersed in the fluid.

CHAPTER 4

4.0 CONSTRUCTION AND TESTING

This project was initially constructed on bread board. The bread board is configured such that both ends are horizontally linked (continuity) while at the middle, it is vertically linked. Since this circuit requires a single 5V source, a 5V power source was constructed on the bread board using a 12V, 500mA transformer, the output of this transformer was rectified using a bridge rectifier and the ac ripples was filtered using a capacitor and a positive 5V dc source was achieved after filtration with the aid of a voltage regulator.

This positive 5V dc source was connected to one horizontal line of the bread board and the ground was connected to the other horizontal line of the bread board. A CMOS 4011 (IC) was mounted on the bread board. Pins 1 and 2 of the IC where connected together, a resistor 27 kΩ was connected to 5V source and other terminal of the resistor was connected to one terminal of variable resistor 1 MΩ, the middle terminal of the variable resistor was connected to pins 1 and 2 of the CMOS (IC) and also to the sensor probe that was immersed in the fluid. Pins 3, 5, 6, 12 and 13 of the same IC where connected together. Pin 7 of the IC was connected to ground, pins 4 and 11 of the same IC where connected together and one terminal of resistors 18 kΩ was connected to it, the other terminals of the resistor was connected to another resistor 27 kΩ and the other terminals of this resistor was connected to ground. The base terminal of a transistor 2N2222 (NPN) was connected between resistors 18 kΩ and 27 kΩ, the collector of this transistor was connected to the cathode of a light emitting diode (LED) and the anode of this diode was connected to one terminal of a current limiting resistor 330 Ω and the other terminal of this resistor was connected to 5V dc source; the emitter terminal of this transistor was connected to ground. Pin 14 of this CMOS (IC) was connected to 5V dc source. Pins 8 and 9 of the same IC where connected together and then connected to the collector terminal of transistor 2N2222. Pin 10 of the same IC was connected to the base terminal of transistor BC 547 (NPN), the collector terminal of this transistor was connected to pin 1 of NE555 (IC) that is acting as an astable multivibrator and the emitter terminal of this transistor was connected to ground. Pins 4 and 8 of NE555 (IC) where connected to together and than connected to 5V's source, one terminal of a series resistor 10kΩ each was connected to 5V's source and other terminal of this series resistor was connected to one terminal of a 4nF capacitor and other terminal of this capacitor was connected to ground. Pins 7 of NE555 (IC) was connected between the series resistor, pins 2 and 6 of this IC where connected together and then connected between the 4nF capacitor and the series resistor. Pin 5 of NE555 (IC) was connected to pin 10 of CMOS 4011 (IC), pin 3 of NE555 (IC) was connected to one terminal of resistor 1kΩ and the other terminal of this resistor was connected to pin 3 of LM386 (IC), pin 6 of this IC was connected to 5V's source. Resistor 1.2 kΩ connected with series capacitor 10μF, one terminal of this resistor was connected to pin 1 of LM386 and other terminal of the capacitor was connected pin 8 of LM386 (IC), pins 2 and 4 of LM386 (IC) where connected to ground. Pin 7of this IC was connected to one terminal of capacitor 10μF and the other terminal of this capacitor was connected to ground, one terminal of capacitor 0.1μF was connected to pin 5 of LM386 (IC) and the other terminal of this capacitor was connected to one terminal of resistor 10 Ω and the other terminal of this resistor was connected to ground. One terminal of capacitor 220μF was connected to pin 5 of LM386 (IC) and the other terminal of this capacitor was connected to one terminal of buzzer and the other terminal of the buzzer was connected to ground.

After all these connections on bread board, the circuit was tested and expected results were achieved.

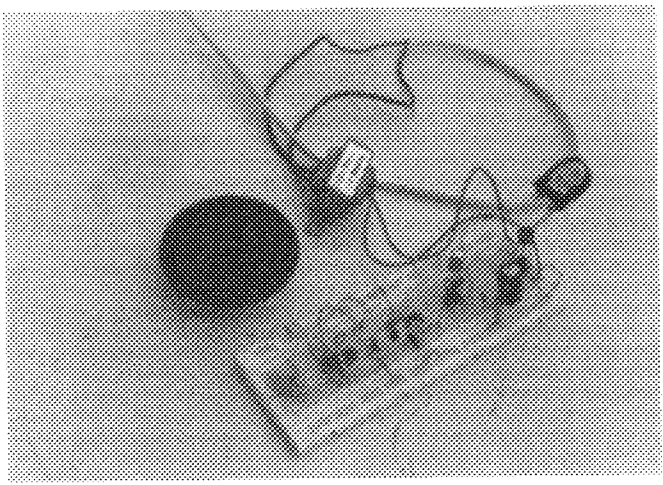


Fig 16: CIRCUIT DIAGRAM OF BRAKE FLUID LEVEL MONITOR ON BREAD BOARD

The bread board being a temporary layout, the design was then transferred permanently into vero board.

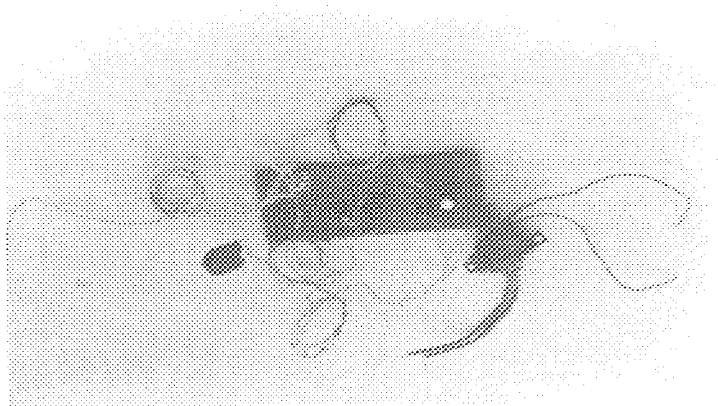


Fig 17: CIRCUIT DIAGRAM OF BRAKE FLUID LEVEL MONITOR ON VERO BOARD

4.1 MATRIX BOARD LAYOUT

This is a rectangular casing that is used to house the circuit design. The outlet for ac supply, ac supply switch, light emitting diode (LED), buzzer and buzzer switch are marked out on casing.

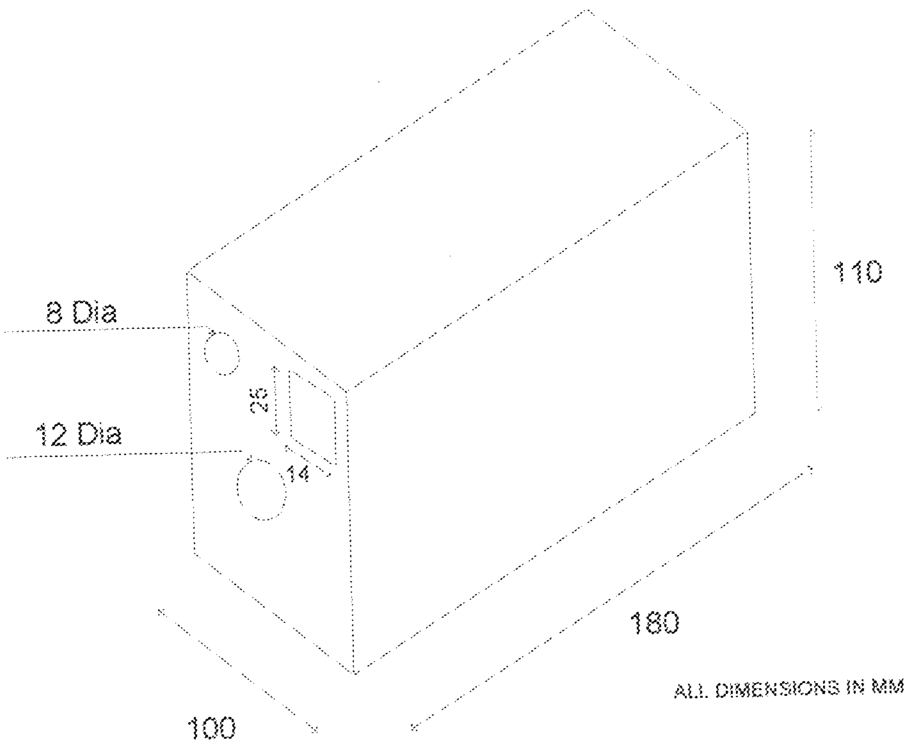


Fig: 18 DIAGRAM OF CASING.

CHAPTER 5

5.0 CONCLUSION

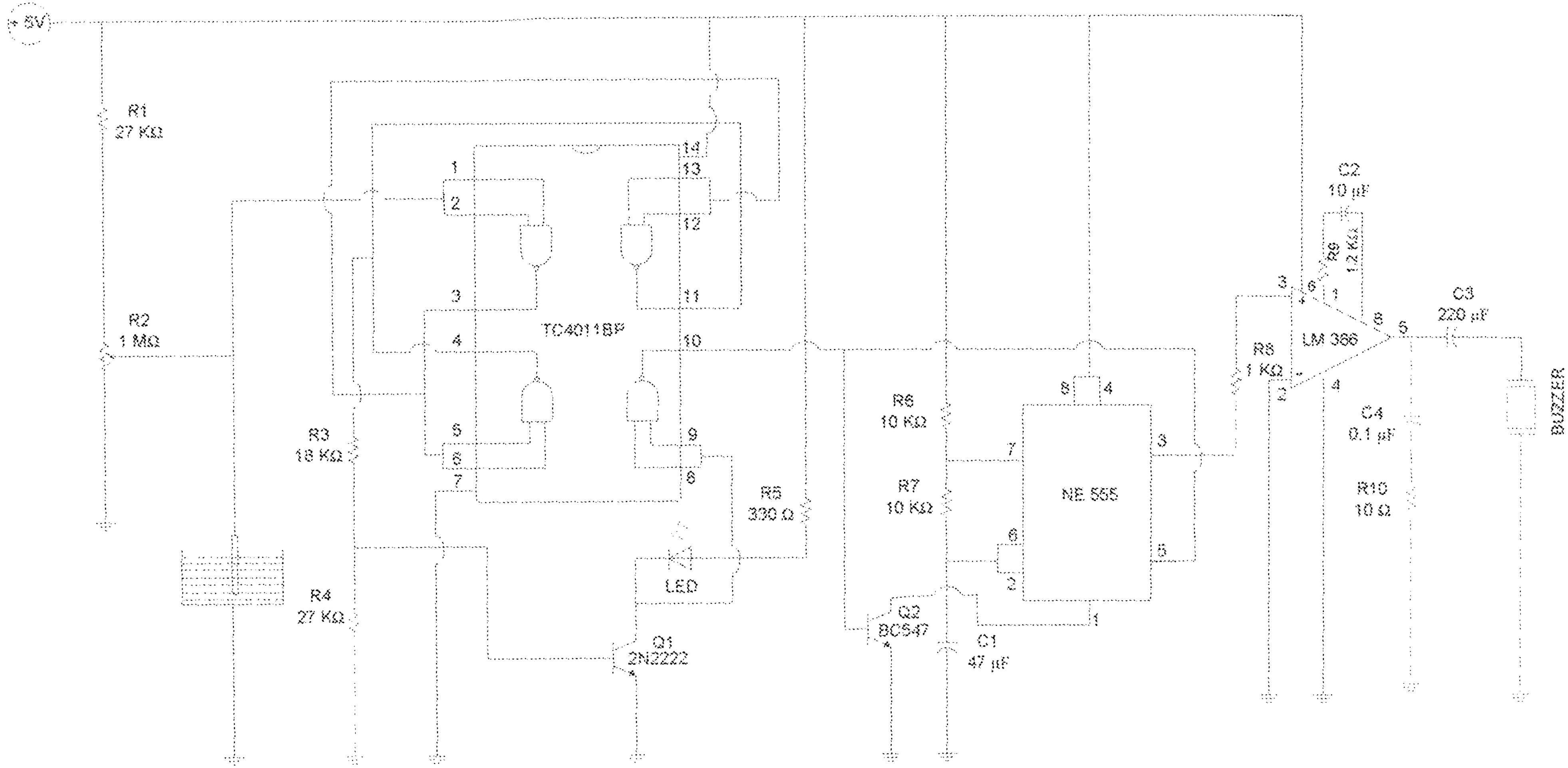
This project was design to minimize the rate of brake failure in vehicles and thereby reducing accident rate. A sensitive adjust variable resistor increases the sensitivity of the sensor probe which constantly senses the inadequate of fluid in the master cylinder and then warns the driver with a glowing LED and a sounder.

The astable multivibrator was employed to generate a requency to drive the audio-amplifier, which amplifies this frequency for the sounder switch S1 was also employed to silence the sounder while the glowing LED is constaon as a reminder to the driver.

5.1 RECOMMENDATION

The circuit is designed for all type of vehicletrailers, heavy- duty trucks caterpillar's cranes, aircrafts and any form of brakeat users fluid to monitor the inadequacy of fluid in the braking system.

Hence this project is recommended for use in the dustries to be incorporated in all brake systems.



CIRCUIT DIAGRAM OF BRAKE FLUID LEVEL MONITOR

LIST OF FIGURES

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