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AN ALARM GAS LEAKAGE DETECTOR

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Abstract

Nowadays, home fires have been happening frequently and the threat to human lives and properties is growing in recent years. Liquid Petroleum Gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. Most fire accidents are caused because of a poor-quality rubber tube or the regulator is not turned off when not in use. Therefore, developing the gas leakage alert system is very essential. Hence, this paper presents a gas leakage alert system to detect the gas leakage and to alarm the people onboard. The design is recommended to protect human and properties from fire outbreak and related hazard. .

Keywords: Liquid petroleum gas, Gas sensor, Gas Leakage

1. INTRODUCTION

Gas leakage leads to various accidents resulting in both material loss and human injuries. The risk of explosion, firing, suffocation are based on their physical properties such toxicity, flammability, etc. The number of deaths due to explosion of gas cylinders has been increasing in recent years. The reason for such explosion is due to substandard cylinders, old valves, worn out regulators and lack of awareness in handling gas cylinders. The LPG or propane is a flammable mixture of hydrocarbon gases used as fuel in many applications like homes, hostels, industries, automobiles, vehicles because of its desirable properties which include high calorific value, less smoke, less soot, and meager harm to the environment. Natural gas is another widely used fuel in homes. Both gases burns to produce clean energy, however there is a serious problem of their leakage. Being heavier than air, these gases do not disperse easily. It may lead to suffocation when inhaled and may lead to explosion. Some people also have a low sense of smell in such way that they could not perceive any smell of diffusion talk less of Gas Leakage. Due to the explosion of LPG, the

number of deaths has been increased in recent years. To avoid this problem there is a need for a system to detect the leakage of LPG.
Mahalingam *et al*, (2012) presented gas leakage detection as the process of identifying potentially hazardous gas leaked by detecting through means of various sensors. Several designs of LPG detection and alert system have been proposed in the literature. Apeh *et al (2014)* designed kitchen gas leakage detection and automatic gas shut off system.
Soundarya *et al* (2014) presented the cylinder LPG gas leakage detection system
The paper presents a LPG leakage detection and alert system to avoid fire accidents and to provide house safety.

2. THEORECTICAL BACKGROUND

2.1 Gas Sensor

The MQ-6 sensor has a sensing range of LPG gas content is quick. Whenever there is to acetic acid, which is an organic acid the resulting chemical reaction will produce an electrical current. The difference of potential produced by this as an approximation of overall gas content in the atmosphere.
The internal heating system is a small tube made of this tube, there are heating coils which produce the heat. These coils can draw up to 150mA of current. The alumina tube is covered with tin dioxide, SnO tube is an aurum electrode movable electrons. These movable electrons allow molecules contact the electrode, the ethanol present in the LPG chemically changes into acetic acid and produces a flow of current within the tube. The more LPG gas present the more current is produced.

2.2. Capacitor

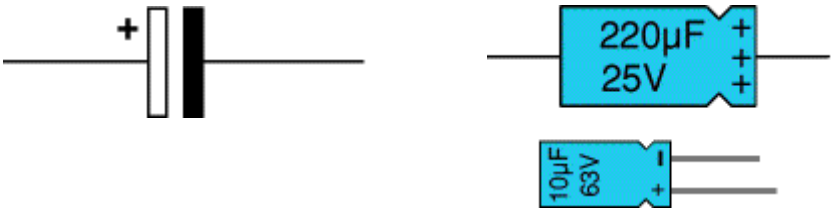

Figure 1: Capacitor

A capacitor (originally known as condenser) is a passive two terminal electrical component used to store energy in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction

consists of metal foils separated by a thin layer of insulating film. Capacitors are widely used as parts of electrical circuits in many common electrical devices. When there is a potential difference (voltage) across the conductors, a static electric field develops across the dielectric, causing positive charge to collect on one plate and negative charge on the other plate. Energy is stored in the electrostatic field.

The capacitance is greatest when there is a narrow separation between large areas of conductor, hence capacitor conductors are often called *plates*, referring to an early means of construction. In practice, the dielectric between the plates passes a small amount of leakage current and also has an electric field strength limit, resulting in a breakdown voltage. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies, in electric power transmission systems for stabilizing voltage and power flow.

2.3. Transistor

Transistors are active component which are often found in many different electronic circuit. They play their roles in circuit as amplifier or switch component, they have their lead which must be connected the correct way round.

The triode, however, was a fragile device that consumed a lot of power. Physicist Julius Edgar Lilienfeld filed a patent for a field effect transistor (FET) in Canada in 1925, which was intended to be a solid state replacement for the triode. Lilienfeld also filed identical patents in the United States in 1926 and 1928.

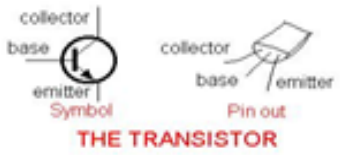

Figure 2: the transistor

2.4. Transformer

A transformer is a power converter that transfers energy between two electrical circuits by inductive coupling between two or more windings. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (EMF), or "voltage", in the

secondary winding. This effect is called inductive coupling. If a load is connected to the secondary winding, current will flow in this winding, and electrical energy will be transferred from the primary circuit through the transformer to the load. Transformers may be used for AC-to-AC conversion of a single power frequency or for conversion of signal power over a wide range of frequencies, such as audio or radio frequencies.

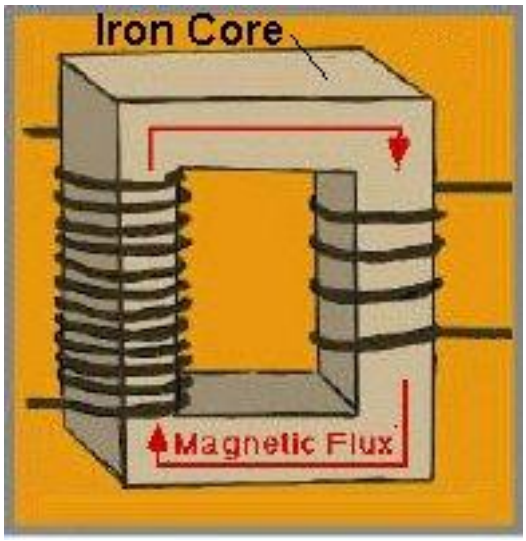

Figure 3: Iron Core

If the secondary has more turn than the primary the transformer is known as a ''step up ''type .however the power output can never be more than the power input.

2.5. Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$I = V/R$

where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms. The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

2.6. Integrated Circuit CM324 & ULN2003: This is also called microelectronic circuit, microchip or chip, an assembly of electronic components, fabricated as a single unit, in which miniaturized active device (e.g transistors and diodes) and passive devices (e.g, capacitors and resistor) and their interconnections are built up on a thin substrate of semiconductor material (typically silicon). The resulting circuit is thus a small as a few square millimeters. The individual circuit components are generally microscopic in size.

2.7. Voltage Regulator

The voltage regulator is one of the most common components to be added to a project. It's the heart of what we call a "built-in" power supply. It allows the project to operate from almost any type of voltage. It can be AC or DC and any voltage (within prescribed limits). The voltage can come from batteries, a plug pack or a transformer. The only other components that need to be added are diodes, a few capacitors and electrolytics and the power-supply section of a project is complete. The voltage regulator has made the designing of a power supply a relatively simple task. However, before we take the designing too simply, there are a number of features and facts that must be taken into consideration.

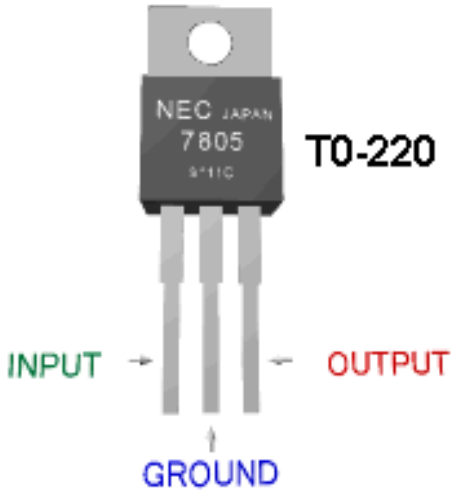

Figure 4: Voltage Regulator

3. METHODOLOGY

3.1 LPG LEAKAGE DETECTION AND ALERT SYSTEM

The LPG leakage detection and alert system presented in this section is a simple as shown in Figure 1, yet reliable. It is battery operated and hence portable. It is designed in such a way that it can also be operated with ac power supply. To support the latter case, it has a bridge rectifier with a capacitor filter. This is followed by a regulator designed with IC7805 which provides +5V regulated power supply.

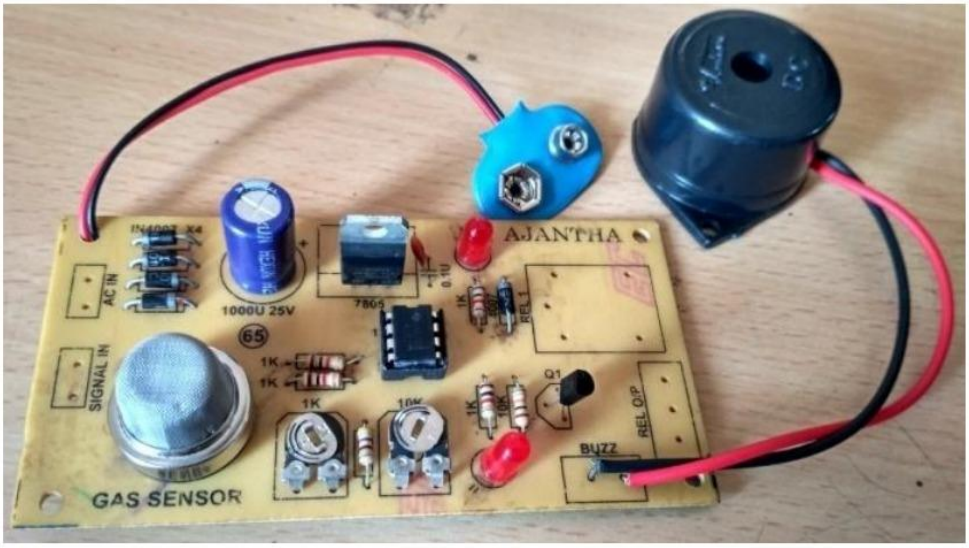

Figure 5: LPG leakage detection and alert system

To detect the LPG, MQ-6 gas sensor is employed. This sensor can be operated at +5V. The sensitivity of this sensor is very high and it has quick response time. It can detect the LPG concentration in the range of 200-10000ppm. The gas sensing layer of this sensor is made of Tin Dioxide (SnO) and gold (Au) electrodes. The output of the gas sensor is given to LM358dual operational amplifier where it is compared with the threshold value for gas density which is set using preset potentiometers and amplified.

If the sensed voltage is greater than the preset threshold voltage, the operational amplifier output fires the driver circuit for LED and Buzzer. As a result, the LED will glow and the buzzer starts to produce alarm sound.

3.2 Design Method

The Alarm Gas leakage detector system design is achieved by using top-down approach. The hardware module is designed first as indicated in the block diagram. The software module is developed using C-language. The design focuses mainly on module integration and interface of the system. The system

architecture has four different functional units and each unit requires input to generates desired output.

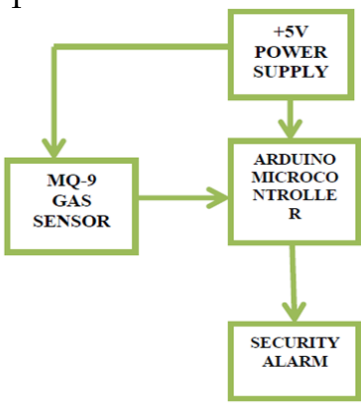

Figure 6: Alarm Gas leakage detector block diagram

+5 VOLT POWER SUPPLY: The power supply was designed considering the available resources while meeting the design specifications. Most of the components operates on 5 V DC, while relays operating at 12 V were used, hence the need to step down the normal power supply voltage from mains (Approx. 240 V AC), to a reasonably voltage that will have to be rectified (convert to DC) and further filter to remove unwanted pulsation. The 240 V AC power was stepped down to 12 V AC (12 V RMS value wherein the peak value is around 17 V) as can be seen from the calculation that follows, the 17 V was further regulated using a voltage regulator (LM7805) to 5 V and (LM7812) to 12 V. A transformer of turn ratio of 20:1 was used after calculation for the purpose of stepping down the voltage and rectifier diodes (IN4001) were also used for rectification. A preferred value of 3300 µF was however employed for the filtering of the assumed ripples as the value is higher than the calculated value, hence will filter much more than expected. Fig. 3.2 shows the designed power supply circuit and the results gotten from simulation.

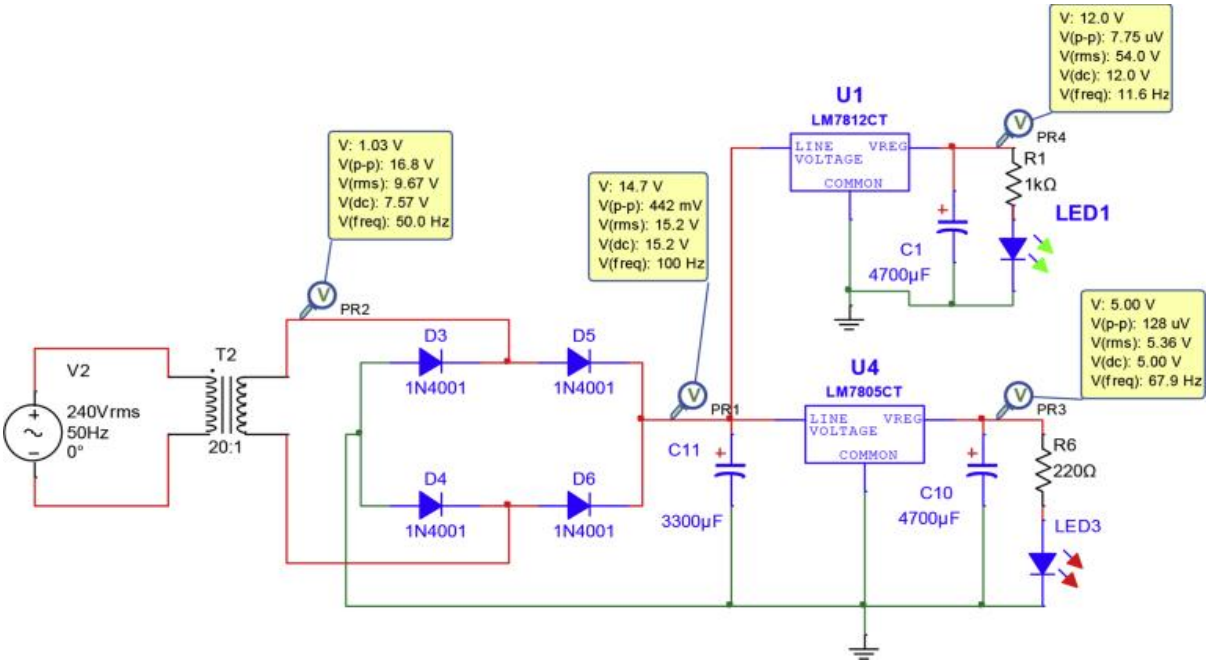

Figure 7: Power supply circuit.

MQ-6 Sensor unit: The most common gas leakage at homes/industries are carbon monoxide and liquefied petroleum gas (flammable gases), MQ-6 gas sensor as shown in fig.3.3. is deployed to detect any gas leakages and report to the control unit of the system.

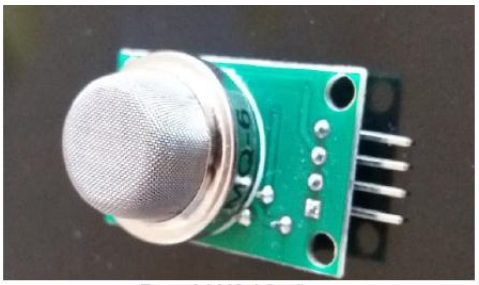

Figure 8: MQ-6 Gas Sensor

MQ-6 is a Semiconductor Sensor designed to detect carbon monoxide/Combustible gas and it does detection by the method of cycle high and low temperature. It detects carbon monoxide when low temperature heated by 1.5V is supplied. The sensor's conductivity is higher along with the gas concentration rising at high temperature (heated by5.0V). It detects Methane, Propane combustible gas and cleans other gases adsorbed under low temperature. The sensor could be used to detect different gases containing

carbon monoxide and combustible gases, at low cost and suitable for different applications.

Security Alarm Unit: The audio sound system is a transducer that coverts a electrical signal into acoustic energy. The buzzer produces sound based on application of an electrical signal. The buzzer as shown in fig.6 can be used to alert a user of an event corresponding to a switching action, countersignal or sensor input. They are also used in alarm circuit. The buzzer produces a same noisy sound irrespective of the voltage variation applied to it. It consists of crystals between two conductors. When a potential is applied across these crystals, they push on one conductor and pull on the other. This, push and pull action, results in a sound wave. Most buzzers produce sound at the range of 2 to 4 kHz. When a gas leakage is sensed, the Integrated Circuit sends signal to the buzzer and it sounds an alarm.

Figure 9: Buzzer Alarm

Integrated Circuit CM324 & ULN2003: This is also called microelectronic circuit, microchip or chip, an assembly of electronic components, fabricated as a single unit, in which miniaturized active device (e.g transistors and diodes) and passive devices (e.g, capacitors and resistor) and their interconnections are built up on a thin substrate of semiconductor material (typically silicon). The resulting circuit is thus as small as a few square millimeters. The individual circuit components are generally microscopic in size.

3.3 Principles of operation

A cost-effective gas leakage detection and alarming monitoring system was proposed, designed and successfully implemented in this research work. The system has four units namely power supply, gas detector, controller and security alarm. Test was conducted on each of the unit to verify its working capability. From the test, gas detector senses the presence of gas leakage and sends the signal to the controller through its analog input port. The Integrated Circuit CM324 & ULN2003 picks the signal, processes it and security alarm is activated which would attract attention of nearby to take action in order to protect property from dangerous inferno.

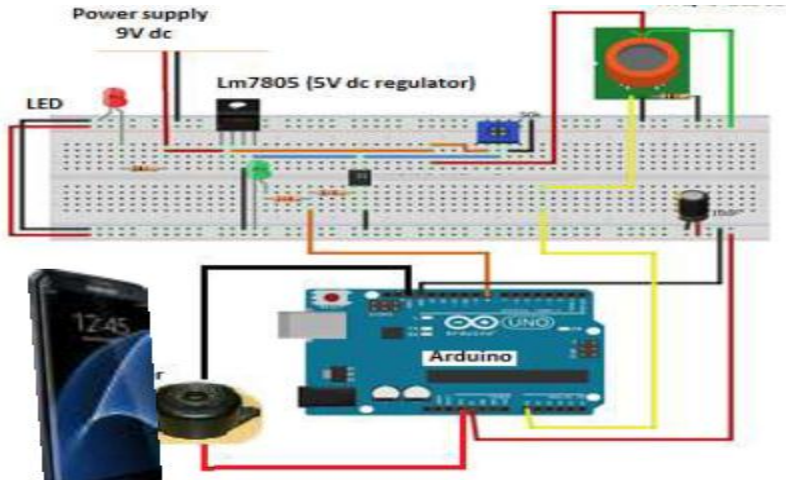

Figure 10: Principles of operation

4. RESULT AND DISCUSSION

The design and construction of the Alarm Gas leakage detector takes two major parts which are hardware and software as earlier explained. In hardware section, power supply unit of 9v but regulated to 5v DC was designed, built and tested with Multimeter to ensure constant supply of +5V DC to the system. The MQ-6 sensor was tested by connecting the output pin to the analog input port of the Integrated circuit. The cigarette lighter gas was used to test the performance of the gas sensor and security alarm triggered by the integrated circuit when the gas is detected.

The designed, which is meant to detect gas leakage and alert users through alarm action (by buzzer), was tested as shown in fig.3.5. Physical testing was done to ensure that Gas leakage detection alarming triggers the integrated circuit to alert

the Gas owner's for preventive action to be taken in order to avoid any further hazardous effect in the home/industry.

5. CONCLUSION

Gas leakage leads to severe accidents resulting in material losses and human injuries. Gas leakage occurs mainly due to poor maintenance of equipment and inadequate awareness of the people. Hence, LPG leakage detection is essential to prevent accidents and to save human lives. This paper presented LPG leakage detection and alert system.

This system triggers LED and buzzer to alert people when LPG leakage is detected. This system is very simple and reliable.

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