

## Fire Detection System

K. Govinda<sup>1</sup> L.Vamsi Krishna Reddy<sup>2</sup> R.V. Harsha S J Varma<sup>3</sup>

<sup>1</sup> SCSE, University, Vellore, India.

<sup>2,3</sup> SENSE, VIT University Vellore, India.

*Abstract*---this paper is based on creation of faster evacuation technologies and safer living conditions at affordable costs for everyone. This paper discusses the automatic fire detection system, the composition and working principle. The principle of the proposed circuit is derived from the physical principles of ionization. Fire detectors using two-wire method to reduce the wall alignment, improve reliability, and ease of construction and installation. This describes the overall structure of the fire detection system and control software in the design. This specific circuit generates an alarm on detecting ionizing radiation from radio isotopes like americium-241. What is interesting about it is that this technology is a low cost and easily deployable.

### I. INTRODUCTION

A smoke detector also called a smoke alarm is a device that detects smoke, typically as an indicator of fire. Commercial, industrial, and mass residential devices issue a signal to a fire detection system, while household detectors, known as smoke alarms, generally issue a local audible or visual alarm from the detector itself.

Smoke detectors are typically housed in a disk-shaped plastic enclosure about 150 millimeters (6 in) in diameter and 25 millimeters (1 in) thick, but the shape can vary by manufacturer or product line. Most smoke detectors work either by optical detection or by physical process, while others use both detection methods to increase sensitivity to smoke. Sensitive alarms can be used to detect, and thus deter, smoking in areas where it is banned such as toilets and schools. Smoke detectors in large commercial, industrial, and residential buildings are usually powered by a central fire alarm system, which is powered by the building power with a battery backup. However, in many single family detached and smaller multiple family housings, a smoke alarm is often powered only by a single disposable battery.

In the United States, the National Fire Protection Association estimates that nearly two-thirds of deaths from home fires occur in properties without working smoke alarms/detectors.

### II. LITERATURE REVIEW

Heat exposure to a tunnel construction is based on the use of standardized time-temperature curves. Indeed, standard fire temperature curve such as ISO 834 [1], the Hydrocarbon Curve (HC) [2] or the RWS curve [3] are widely used to test the tunnel linings. It is much purposed and very useful in our daily busy world. It is also failure in some cases. Earlier studies, like the one carried out by Kurioka et al. [4] proposed an empirical equation to predict the maximum gas temperature rise below the tunnel ceiling and its position relative to the center of the fire. Hu et al. [5] compared Kurioka's equation with their full-scale data and showed that there was a good agreement. However, the heat release rates of Hu's full-scale tests [6] were too small compared to the tunnel geometry. In the present paper, the theory of the

plume mass flow rate and maximum temperature beneath the ceiling for a small fire in a tunnel as given by Li et al. [7] is further developed.

### III. PROPOSED METHOD

**Ionization**-An ionization smoke detector uses a radioisotope such as americium-241 to produce ionization in air; a difference due to smoke is detected and an alarm is generated. Ionization detectors are more sensitive to the flaming stage of fires than optical detectors, while optical detectors are more sensitive to fires in the early smoldering stage.

The radioactive isotope americium-241 in the smoke detector emits ionizing radiation in the form of alpha particles into an ionization chamber (which is open to the air) and a sealed reference chamber. The air molecules in the chamber become ionized and these ions allow the passage of a small electric current between charged electrodes placed in the chamber. If any smoke particles pass into the chamber the ions will attach to the particles and so will be less able to carry the current. An electronic circuit detects the current drop, and sounds the alarm. The reference chamber cancels effects due to air pressure, temperature, or the aging of the source. Other parts of the circuitry monitor the battery (where used) and sound an intermittent warning when the battery nears exhaustion. A self-test circuit simulates an imbalance in the ionization chamber and verifies the function of power supply, electronics, and alarm device. The standby power draw of an ionization smoke detector is so low that a small battery can provide power for months or years, making the unit independent of AC power supply or external wiring; however, batteries require regular test and replacement.

An ionization type smoke detector is generally cheaper to manufacture than an optical smoke detector; however, it is sometimes rejected because it is more prone to false (nuisance) alarms than photoelectric smoke detectors. It can detect particles of smoke that are too small to be visible.

Americium-241, an alpha emitter, has a half-life of 432 years. Alpha radiation, as opposed to beta and gamma, is used for two additional reasons: Alpha particles have high ionization, so sufficient air particles will be ionized for the current to exist, and they have low penetrative power, meaning they will be stopped by the plastic of the smoke detector or the air. About one percent of the emitted radioactive energy of  $^{241}\text{Am}$  is gamma radiation. The amount of elemental americium-241 is small enough to be exempt from the regulations applied to larger sources. It includes about 37kBq or 1 $\mu\text{Ci}$  of radioactive element americium-241 ( $^{241}\text{Am}$ ), corresponding to about 0.3  $\mu\text{g}$  of the isotope. This provides sufficient ion current to detect smoke, while producing a very low level of radiation outside the device.

The americium-241 in ionizing smoke detectors poses a potential environmental hazard. Disposal regulations

and recommendations for smoke detectors vary from region to region. Some European countries have banned the use of domestic ionic smoke alarms

#### A. Design and Implementation

Here is a simple fire alarm circuit based on a Light Dependent Resistor (LDR) and lamp pair for sensing the fire. The alarm works by sensing the smoke produced during fire. The circuit produces an audible alarm when the fire breaks out with smoke.

When there is no smoke the light from the bulb will be directly falling on the LDR. The LDR resistance will be low and so the voltage across it (below 0.6V). The transistor will be OFF and nothing happens. When there is sufficient smoke to mask the light from falling on LDR, the LDR resistance increases and so do the voltage across it. Now the transistor will switch to ON. This gives power to the IC1 and it outputs 5V. This powers the tone generator IC UM66 (IC2) to play music. This music will be amplified by IC3 (TDA 2002) to drive the speaker. Resistor R6 is meant for protecting the transistor when R4 is turned towards low resistance values. Resistor R2 and R1 forms a feedback network for the TDA2002 and C1 couples the feedback signal from the junction of R1 & R2 to the inverting input of the same IC.

The diode D1 and D2 in combination drops 1.4 V to give the rated voltage (3.5V) to UM66. UM66 cannot withstand more than 4V

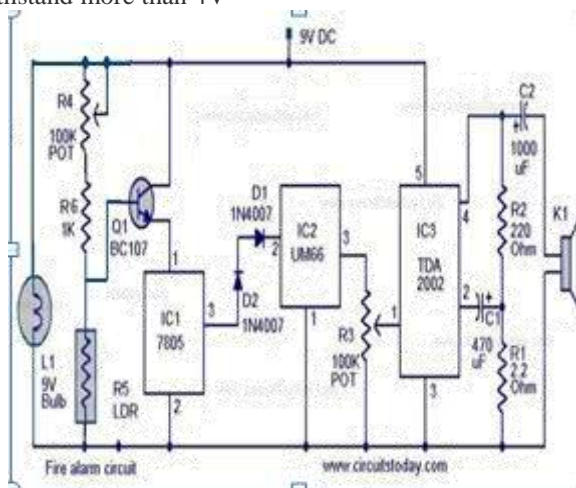


Fig. 1: Circuit of the system



Fig. 2: Overall view of the system

#### B. Carbon monoxide and carbon dioxide detection

Some smoke alarms use a carbon dioxide sensor or Carbon monoxide sensor to detect characteristic products of combustion. However, some gas sensors react on levels that are dangerous for humans but not typical for a fire; these are therefore not generally sensitive or fast enough to be used as fire detectors. Other gas sensors are even able to warn about particulate-free fires (e. g. certain alcohol fires).

#### C. Air-sampling

An air-sampling smoke detector is capable of detecting microscopic particles of smoke. Most air-sampling detectors are which work by actively drawing air through a network of small-bore pipes laid out above or below a ceiling in parallel runs covering a protected area. Small holes drilled into each pipe form a matrix of holes (sampling points), providing an even distribution across the pipe network. Air samples are drawn past a sensitive optical device, often a solid-state laser, tuned to detect the extremely small particles of combustion. Air-sampling detectors may be used to trigger an automatic fire response, such as a gaseous fire suppression system, in high-value or mission-critical areas, such as archives or computer server rooms.

Most air-sampling smoke detection systems are capable of a higher sensitivity than spot type smoke detectors and provide multiple levels of alarm threshold, such as Alert, Action, Fire 1 and Fire 2. Thresholds may be set at levels across a wide range of smoke levels. This provides earlier notification of a developing fire than spot type smoke detection, allowing manual intervention or activation of automatic suppression systems before a fire has developed beyond the smoldering stage, thereby increasing the time available for evacuation and minimizing fire damage.

#### D. Commercial Smoke Detectors

Commercial smoke detectors are either conventional or analog addressable, and are wired up to security monitoring systems or fire detection control panels (FACP). These are the most common type of detector, and usually cost a lot more than a household smoke alarms. They exist in most commercial and industrial facilities, such as high rises, ships and trains. These detectors don't need to have built in alarms, as alarm systems can be controlled by the connected FACP, which will set off relevant alarms, and can also implement complex functions such as a staged evacuation.

#### E. Single Station Smoke Detection

The main function of a single station or "standalone" smoke alarm is to alert persons at risk. Several methods are used and documented in industry specifications published by Underwriters Laboratories Alerting methods include:

- Audible tones
- Usually around 3200 Hz due to component constraints (Audio advancements for persons with hearing impairments have been made; see External links)
- 85 dB at 10 feet
- Spoken voice alert
- Visual strobe lights
- 177 candela output
- Tactile stimulation, e.g., bed or pillow shaker (No standards exist as of 2008 for tactile stimulation alarm devices.)

Some models have a hush or temporary silence feature that allows silencing without removing the battery. This is especially useful in locations where false alarms can be relatively common (e.g. due to "toast burning") or users could remove the battery permanently to avoid the annoyance of false alarms, but removing the battery permanently is strongly discouraged.

While current technology is very effective at detecting smoke and fire conditions, the deaf and hard of hearing community has raised concerns about the effectiveness of the alerting function in awakening sleeping individuals in certain high-risk groups such as the elderly, those with hearing loss and those who are intoxicated. Between 2005 and 2007, research sponsored by the United States' National Fire Protection Association (NFPA) has focused on understanding the cause of a higher number of deaths seen in such high-risk groups. Initial research into the effectiveness of the various alerting methods is sparse. Research findings suggest that a low frequency (520 Hz) square wave output is significantly more effective at awakening high risk individuals. Wireless smoke and carbon monoxide detectors linked to alert mechanisms such as vibrating pillow pads for the hearing impaired, strobes, and remote warning handsets are more effective at waking people with serious hearing loss than other alarms.

#### F. Reliability

In 2004, NIST issued a comprehensive report that concludes, among other things, that "smoke alarms of either the ionization type or the photoelectric type consistently provided time for occupants to escape from most residential fires", and "consistent with prior findings, ionization type alarms provided somewhat better response to flaming fires than photoelectric alarms (57 to 62 seconds faster response), and photoelectric alarms provided (often) considerably faster response to smoldering fires than ionization type alarms (47 to 53 minutes faster response)".

The NFPA strongly recommends the replacement of home smoke alarms every 10 years. Smoke alarms become less reliable with time, primarily due to aging of their electronic components, making them susceptible to nuisance false alarms. In ionization type alarms, decay of the <sup>241</sup>Am radioactive source is a negligible factor, as its half-life is far greater than the expected useful life of the alarm unit.

Regular cleaning can prevent false alarms caused by the buildup of dust or other objects such as flies, particularly on optical type alarms as they are more susceptible to these factors. A vacuum cleaner can be used to clean ionization and optical detectors externally and internally. However, on commercial ionization detectors it is not recommended for a lay person to clean internally. To reduce false alarms caused by cooking fumes, use an optical or 'toast proof' alarm near the kitchen.

A jury in the United States District Court for the Northern District of New York decided in 2006 that First Alert and its parent company, BRK Brands, was liable for millions of dollars in damages because the ionization smoke alarm in the Hackett's house was a defective design by its nature, typically failing to detect the slow-burning fire and choking smoke that filled the home as the family slept.

#### IV. CONCLUSION

The making a simple fire alarm has been successfully implemented. As shown above it can be used for various other things like ionization detection, heat alarms, CO and CO2 detection. The project is highly cost effective and requires very less or no maintenance. The circuit can be modified to many other simple applications. A battery can last for about a month in this circuit. Considering that we can say that spending one meals cost on it can get your house protection from fire or burglary for a whole year. Yearly thousands of people die from uncontrollable fires and arson. Taking simple and small measures like these can save a huge amount of money, property as well as countless no. of lives. The govt. must incentivize homes to be fire protected. At such cheap costs, that is the least we could do. After all, the human race is all about moving forward, isn't it???

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