EARLY-WARNING FIRE ALARMS

L. Dale Baker, Extension Safety Engineer, Cornell University, Ithaca, NY
Larry E. Stewart, Extension Agricultural Engineer, University of Maryland, College Park, MD

Fire in the home is a frightening thought. Many tragic stories constantly remind us of people who have died while asleep because they had no warning that a fire had started. Because of the great number of such incidents, smoke and heat detectors are becoming mandatory in many new and remodeled homes. All FHA and VA insured new homes, as well as FmHa financed homes, are required to have them. Some states now require these devices in multi-family housing. This trend is expected to accelerate. Detectors can reduce the thousands of deaths caused by smoke asphyxiation or toxic gases from home fires.

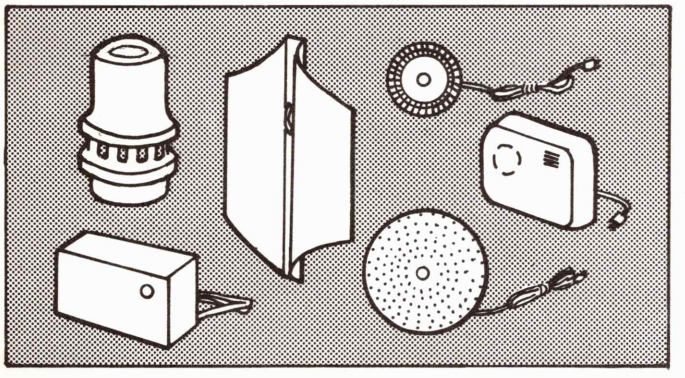

Figure 1. Typical fire detectors.

Fires have three stages of development.

- In the initial stage, invisible particles of combustion without significant amounts of smoke, flame, or heat are produced.
- In the second stage smoke can be seen but little heat or flame is present.
- The third stage begins when flame is visible.

An overloaded electrical circuit may take days to complete the initial stage. Grease spilled on a hot stove goes through all three stages in seconds. Most fire casualties result from inhaling smoke and toxic gases produced in the first two stages.

The National Fire Protection Association (NFPA) has observed that in nearly all fires detectable quantities of smoke precede detectable heat. In addition, slowly developing, smoldering fires seldom increase the room temperature, but they nearly always release toxic gases such as carbon monoxide. Many new synthetic materials found in homes produce deadly gases as they burn. For this reason the NFPA recommends that a home should include at least one smoke detector in any fire protection system.

Smoke Detectors

Three types of smoke detectors are currently available: ion chamber, photo-electric, and semiconductor crystal detectors.

Ion Chamber Detector

A source of alpha particles ionizes the air within the sensing chamber. When combustion particles enter the chamber the ions attach themselves to these particles and the current flow is reduced. The alarm circuit is activated when the current reduction reaches a predetermined value.

The radiation produced by these detectors is not a hazard. Alpha particles travel very short distances. When the detector is mounted on the ceiling, people are not in its radiation zone.

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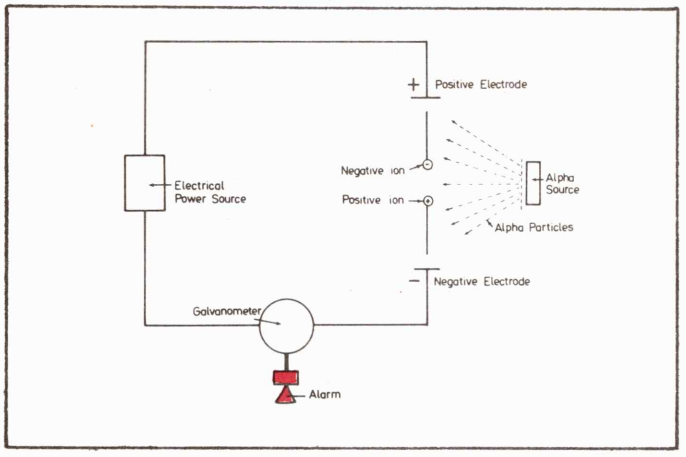

Figure 2. Circuit of an ion chamber detector. Combustion particles reduce electrical flow and trigger the alarm.

Photo-Electric Smoke Detector

A light beam shines across the sensing chamber of the photo-electric sensor and is received in the light trap on the far side. When smoke enters the chamber, light reflected by the smoke particles is picked up by a photocell on the side of the chamber. When the voltage output of the photocell reaches a set value the alarm circuit is activated.

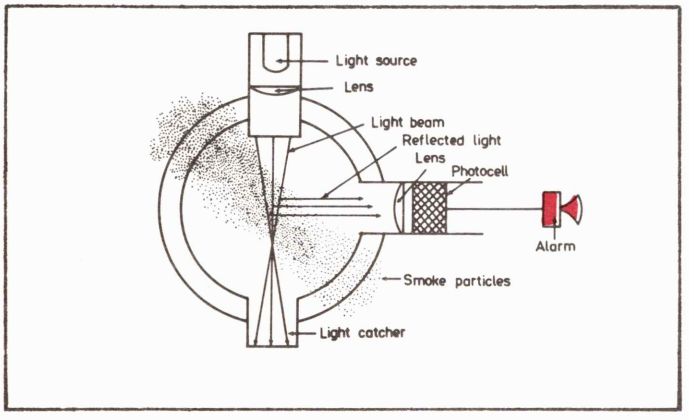

Figure 3. Sensing chamber in a photo-electric smoke detector. Smoke particles deflect the light beam and trigger the alarm.

Merits of Photo-Electric and Ion Chamber Detectors

In general, if the fire is a slow, smoldering fire, without flame, a good photo-electric detector will respond to the fire faster than an ion chamber detector. If flaming is present in the fire, an ion chamber detector will respond faster than a photo-electric detector. Either detector can be used for early warning fire detection because the type of fire that may occur is not predictable.

Any of these units can be connected to a 120v AC electric system. Fire detection units that operate on the home electrical system may be wired into an existing electrical circuit or plugged into an existing receptacle that is *not* controlled by a wall switch. It is best to have the fire detection unit wired into a separate circuit. Some units can be wired together to detect and sound an alarm at multiple locations. All AC powered fire detectors have a visible "power-on" indicator.

Ionization chamber detectors require very little electrical current and may be powered with batteries. NFPA regulations require that the battery powered units produce an audible trouble signal at least once a minute for seven days when the battery power drops below an effective level. Most of these units require expensive batteries that may be difficult to find. At least one manufacturer markets an ion chamber detector that operates on house current, with backup batteries for operation during power failures.

Battery powered units are easy to install, but batteries *must* be faithfully replaced about once a year. Unless the owner is the type of individual to do this, an AC powered unit should be used instead. House powered units are very convenient, once they are installed. In most home fires the house power almost never fails before a fire detector would sound an alarm. Almost no maintenance is required for any of the units, no matter how they are powered. The lamp in the photo-electric sensor lasts 3 to 5 years and then must be replaced. Some of the newest models use light emitting diodes that will last 15 to 20 years.

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Semiconductor Gas Sensor

Another type of combustion detector uses a semiconductor crystal with a metallic-oxide coating. Combustible gases near the device will reduce the sensor's electrical resistance, causing the alarm to trigger. Unfortunately, any flammable gas in the home—ammonia, alcohol, perfume, cooking smoke—can trigger the alarm. Also tests have shown that they do not respond to fires that are burning fairly completely and with little smoke.

Because the gas sensor has these characteristics it is not as good for home use as the ion chamber or photo-electric sensors.

Heat Detectors

Heat detectors detect abnormally high temperatures near them. In most rooms, heat detectors are preset to react at 135°F. In a furnace room or other areas that may occasionally exceed 100°F, heat detectors are preset to 200°F. Heat detectors will not sense the early stages of a fire and only detect heat in the area in which they are installed.

Several types of heat detectors are available: thermostats, spring wound alarms, gas operated alarms, and rate-of-temperature-rise detectors.

Thermostats

A fixed temperature thermostat is wired to supply electrical power to an alarm when the temperature at the thermostat exceeds 135°F.

Gas Operated Alarms

These alarms use a pressurized container of liquified fluorocarbon (Freon®) connected to a horn. A connecting pipe is blocked with a metal strip which melts releasing the gas through the horn to sound an alarm. A sight glass on the cylinder should be checked periodically to be sure fluid has not escaped.

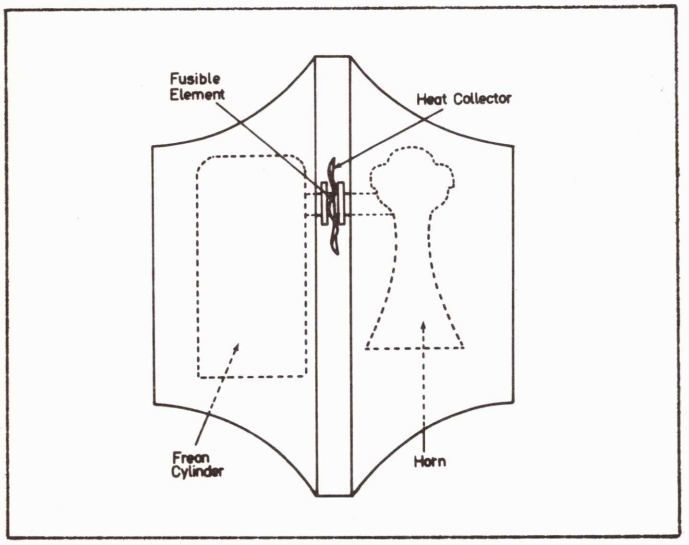

Figure 4. Gas-operated heat sensing fire alarm. Fusible element normally melts at 135°F to release the Freon that sounds the horn.

Spring Wound Alarms

In abnormal heat conditions a fusible element melts releasing a spring driven alarm gong. The unit can be reused by replacing the element and rewinding the spring.

Rate-of-Temperature-Rise Detectors

This detector uses a bellows with a permeable membrane at one end. During normal air pressure changes, air passes through the permeable membrane. However, if the unit is heated rapidly, air in the bellows expands faster than it can escape through the permeable membrane. The bellows then expands and activates an alarm.

Levels of Protection

The National Fire Protection Association Standard No. 74 describes the location and type of detection units needed to achieve four levels of protection.

Level 4 is the basic level of protection recognized by the NFPA standard. A smoke detector is required in the vicinity of each sleeping area and at the top of each stairway leading to an occupied area. Only one smoke detector would be needed for small single story homes with clustered bedrooms and no basement.

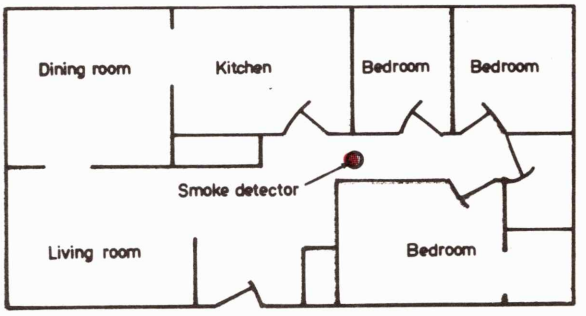

Figure 5. Level 4, the basic protection level. Smoke detectors are required in the vicinity of each sleeping area and at the top of each stairway leading to an occupied area.

In Level 3 protection a smoke detector is required in the vicinity of each sleeping area. In addition, the basement, kitchen, living room, and furnace (utility) room must also have smoke or heat detection devices. Heat or smoke detectors are *not* required in each bedroom in Level 3 protection.

Level 2 protection requirements are the same as Level 3 with the addition of smoke or heat detectors in each bedroom.

Level 1 protection requires smoke detectors in or near each sleeping area, and at the top of the basement stairs. In addition, every room must be covered by a smoke or heat detector.

Full scale experiments using typical fires in living units indicate that detectable quantities of smoke precede detectable heat levels and lethal atmospheres. For these reasons, each of the four levels of protection described above includes at least one smoke detector.

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Each homeowner must decide for himself how much fire protection to provide in his home. Costs for single detection and warning units vary from $20 to $150. Fire detection and warning systems, equipment and supplies are usually listed in the yellow pages of the telephone directory under "Fire Alarm Systems". Some department stores or electrical supply firms carry fire detection equipment. The local fire department may have additional information to assist in selecting and installing a fire alarm system for protecting your home. Look for Underwriter Laboratory (UL) or Factory Mutual labeled units. Installation and maintenance instructions and testing procedures should be provided when any of these units or systems are purchased.

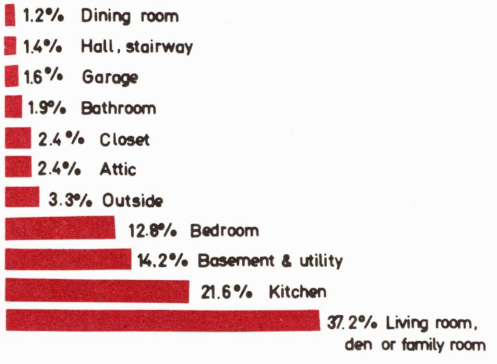

Figure 6. Where fatal fires start.

A Plan for Fire Safety

The National Fire Protection Association suggests that "reasonable fire safety" can be achieved in your home by a three point program.

(1) *Minimize fire hazards.* Keep stoves and furnace rooms clean. Do not allow trash to accumulate. Keep heating and electrical equipment operating properly. Use proper sized wiring and fuses. Avoid smoking in bed. Do not leave children at home alone. Exercise caution when using flammable liquids. Never store or use gasoline inside the house.

(2) *Provide a fire warning system.* The systems described can mean valuable extra minutes, that hopefully will never be needed, to escape from a fire in your home.

(3) *Have and practice an escape plan.* There often is little time between detection of a fire and the time it becomes deadly. This interval may be as little as one or two minutes. Planning and practicing for fire conditions with accent on rapid exit from the home is important. Drills should be held so that all family members will know exactly what to do. Everyone should have at least two escape routes. Everyone should know not to open bedroom doors if the door is hot. Establish a meeting place outside and away from the house so all family members can be quickly located.

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The October 1976 issue of *Consumer Reports* has further information on smoke detectors.

References

Detecting Fires. National Fire Protection Association Pub. No. SPP-28.

Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment. NFPA Standard No. 74.

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