NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

BURGLAR ALARM USING DIFFERENT CIRCUITS

Graduation Project
EE- 400

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ABSTRACT

The need for security and the need to sound an alarm when the security has been threatened have always been with us. Early on, man devised methods of warning himself and others of danger. The industrial revolution that began in the early 1800's brought masses of people to cities and ushered in the age of technology. In the early 1800's sounding the fire alarm was crude.

Electronic security alarm systems can be an important contributor to the securing of life and property. When used properly, a security system can be an effective tool when used in conjunction with other crime prevention measures.

Many buildings and complexes being constructed today are equipped with some type of intrusion detection and fire alarm systems. You, as a Construction Electrician, will be challenged to install, troubleshoot, and maintain these systems. Numerous detection and fire alarm systems are in existence today.

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INTRODUCTION

Modem electronics has improved our quality of life in many ways. For example, electronic alarms have become very popular within the last decade. Their popularity is well earned, since they are both effective and affordable. Be careful, however, to not put all of your faith into them.

The aim of this project that shows the operation of different type of Alarm Systems.

The Thesis consists of the introduction, four chapters, and conclusion.

The Chapter-1 presents history of alarm systems and types of burglar alarm systems.

Chapter 2 presents general information about burglar and security alarm systems.

Chapter 3 presents informations about fire alarm systems, types of fire alarm systems, theory of operations, equipment descriptions, alarm initiating devices.

Chapter 4 presents the most important aim of my project here practical implementation of burglar alarm systems are examined.

1. AN OVERVIEW OF ALARM SYSTEMS

1.1. ALARM HISTORY

The need for security and the need to sound an alarm when the security has been threatened have always been with us. Early on, man devised methods of warning himself and others of danger. The threat may have come from natural causes such as fire and flood or from an attack by enemies. These warnings were sometimes as crude as drum beats, the sounding of gongs, or the trumpeting of horns. As civilization developed, alarm mechanisms became more sophisticated. Smoke signals, colored rockets, or heliographs that used mirrors to flash reflected sunlight messages from one mountaintop to another were often used. The industrial revolution that began in the early 1800's brought masses of people to cities and ushered in the age of technology. In the early 1800's sounding the fire alarm was crude. The more advanced cities provided bell ringers stationed in city buildings, towers and church spires to sound an alarm when a fire was spotted. In 1835, a fire in New York City leveled 700 buildings and caused between 20 and 40 million dollars in property damage. The major cause for this enormous loss was that almost all the warning bells sounded. The fire brigades became confused and many were ineffective in stopping the fire. To correct the problem, New York City officials devised a more reliable system. The city was divided into districts and sub-districts. Each district was served by a fire lookout in a tower. A lookout post in city hall supervised the entire city. By 1842 each sub-district was equipped with a distinct bell. This enabled each local fire brigade to recognize its own alarm. These steps improved the system but communications between towers was still difficult. In 1847 New York City's chief engineer Cornelius Anderson, added the newly developed telegraph to the system. The fire lookout towers were wired to the central lookout post. The telegraph was also wired from the central lookout post to each fire station. This was a tremendous improvement over past practices because a local lookout could immediately report the exact location of a fire to a central lookout post, which in turn could immediately wire that location to the nearest fire station. Those stations, upon receiving the alarm, could in a very short time, be dispatched to the fire.

Dr. W. F. Channing and Moses Farmer in Boston improved upon the central station concept. They developed a "call box" that when pulled sent (telegraphed) the message to the central location. The message included a location code that identified the call box. A rotating notched code wheel connected to a switch contact in the call box mechanism generated the code, a series of dots and dashes. When the call box handle was pulled, the wheel would rotate and telegraph a series of location codes to the central location. Boston approved the new technology in 1851. By 1854, Boston had 42 call boxes wired to a central station. The monitoring panel in the central station included a crude printout device that inscribed the received location on a piece of paper to produce a visual record of the alarm. The call box system was so successful that New York and many other cities soon adopted it. The call boxes found in most modern alarm systems are surprisingly similar to the early Boston boxes. Early burglar alarm systems used trip wire and mouse traps. In June 1853, Augustus Pope of Sommerville, Massachusetts, was granted a patent for an "Improvement in Electro-magnetic Alarms." Pope's burglar alarm was intended for home installation. He used magnetic switches or contacts to protect windows and doors. The switches were wired to a battery and a vibrating bell. The bell was mounted in the homeowner's bedroom. When any of the switches was closed, the bell would ring. In 1857 Pope sold his patent to Edwin Holmes, a New England businessman who owned a notions and sewing supplies store and was a manufacture of hoped skirts. Holmes invented and developed many of the devices and techniques still in use in the alarm industry today. When Holmes acquired the patent, he faced a myriad of problems. The first was supplies. At the time, there were no suppliers of electrical wire and equipment. There were, however a handful of shops that were beginning to manufacture electrical devices. Holmes was fortunate to be located within 1000 feet of one of the first electrical stores in the country, Hinds and Williams, in Boston. The early electrical pioneers such as Moses Farmer and Thomas Watson who were to help Alexander Graham Bell invent the telephone frequented the Hinds and Williams's store. Holmes befriended Williams, who began to manufacture bells and electro-magnetic contacts for him. Wire was also a problem. The available insulated wire was too thin to handle the current. Holmes used his skirt hoop experience to solve this problem. He had bare copper wire braided with cotton by the same plant that braided his skirt hoops. Holmes devised a mechanism to coat his braid with green paint to complete the insulation covering. Sales were slow in Boston so Holmes moved his new burglary alarm business to the more crime ridden New York City area. In New York, Holmes experienced sales resistance because nobody believed he could build an alarm system that would ring bells on the second floor when a basement window was opened. To break the sales barrier, Holmes constructed a model house, installed a working alarm system, and went door-to-door selling alarm systems to the wealthiest homeowners in New York. With money pouring in, Holmes was able to make improvements continually to the systems he installed. Annunciators were available with colored tags to indicate the status of each window and door. A clock was added to disable and enable the alarm system during certain time periods. Switches were added to control the house lights. These innovations are still found in many of the current burglar alarm systems. In the mid-1860's, although the "Central Station" concept was well developed in the fire alarm systems, it had yet to be utilized in the burglar alarm industry. The man who introduced the central station concept to the burglar alarm industry was E.A. Calahan. In 1871 Calahan conceived a "district messenger service" in which the city of New York would be divided into small areas. Each area would have a call box connected to a central station that would allow subscribers to call for a messenger. The American District Telegraph Company of New York was organized in 1871 to commercially develop Calahan's inventions. By 1874 American District Telegraph Company was operating 12 central stations in Manhattan. By 1887 there were as many as 20 companies in cities such as Philadelphia, Chicago, and Baltimore.

During this time, Holmes was developing his business and developing more elaborate alarm systems for both homeowners and business owners. In 1872, Holmes developed an electrically wired cabinet to store jewelry. The cabinet was lined with current carrying foil. The doors of the cabinet were equipped with detector switches. Holmes wired the cabinet to a central office allowing men, on duty 24 hours a day, to be dispatched in response to any alarm condition. The Holmes Company constructed a wiring frame on the roof of their building and ran their wires over the roof of their neighbors, often without their permission of knowledge. The central station was a natural for the newly invented telephone. Thomas Watson, who contributed to the invention of the telephone, worked for Holmes. Holmes' son Edwin T., an early electrical technologist, also added several refinements to the phone. Holmes Central

Station became the first telephone customer and the first telephone exchange. Holmes became the first President of the Bell Telephone Company of New York."

1.2 Burglar Alarm System Types

- Central station system description
- Mercantile system description
- Bank system description
- Proprietary system description

1.2.1 Central Station Burglar Alarm Systems (CPVX)

A central station system is one in which the operation of electrical protection circuits and devices are signaled automatically to, recorded in, maintained and supervised from a central station having trained operators and runners (alarm investigators) in attendance at all times. Runners are dispatched to make an investigation of unauthorized entry or opening of protected properties from which signals are received. The central station supervises system arming and disarming. A central station Certificate displays the following information about an alarm system.

System description

- **Type of system** - premise, stockroom, safe, vault, night depository, automatic teller machine or holdup.
- **Extent of protection** - numbers 1, 2, 3 and 4; complete or partial.(Definitions can be found in UL 681. For example, extent 1 is the highest level of protection and extent 4 the lowest).
- **Area covered/location** - text that clarifies exactly what is protected by system.
- **Alarm sounding device** - none, inside, outside, or inside and outside.

Remote monitoring

- **Monitoring location** - the address of the monitoring station.
- **Systems with no investigator response (for extent no. 4)** - the party notified in case of alarm - may be law enforcement, subscriber or subscriber's agent.

- **Primary signal transmission method**
- **Secondary transmission method (if used)**
- **UL Listed alarm transport company (if used)** - name of company and UL file number.
- **Line security employed** - no line security, standard line security (equivalent to the traditional Grade AA, BB, CC) or encryption (uses Listed equipment marked encryption).

Alarm investigator

Investigator response time

- **For "standard" or "encryption" line security systems** - five to 45 minutes, in five-minute increments (i.e.: 5, 10, 15, etc.)
- **For "no line security" systems** - five to 60 minutes, in five-minute increments (i.e.: 5, 10, 15, etc.)

Investigator team

- One runner, without keys, plus local law enforcement
- One runner, with keys, plus local law enforcement
- Two runners, with keys, no local law enforcement
- Two runners, with keys, plus local law enforcement
- None. Alarms retransmitted only. (Option available for Extent No.4 Systems Only)

Control and transmitter units

Manufacturer's name and model numbers

1.2.2 Mercantile Burglar Alarm Systems (CVSG)

A mercantile alarm system is one in which the operation of electrical protection circuits and devices activates an alarm sounding device inside and/or outside of the protected premises. A mercantile alarm system may or may not provide remote location transmitting equipment that will transmit a signal off premises. The operation of a mercantile alarm system is primarily under the control of the owner or others interested in the property to be protected. Any supervision of system arming and disarming is not audited by UL. Alarm investigators are not required or audited by UL. A mercantile Certificate displays the following information about an alarm system.

System description

- **Type of system** - premise, stockroom, safe, vault, night depository, automatic teller machine or holdup.
- **Extent of protection** - numbers 2, 3 or 4; complete or partial. (Definitions can be found in UL 681. For example, extent 2 is the highest level of protection and extent 4 the lowest.)
- **Area covered/location** - text that clarifies exactly what is protected by system.
- **Alarm sounding device** - inside, outside or inside and outside.

Remote monitoring

- **Monitoring entity (if monitoring is provided)** - the name and address of the party monitoring the system - may be law enforcement, subscriber or subscriber's agent.
- **Party notified in case of alarm** - may be law enforcement, subscriber or subscriber's agent.
- **Primary signal transmission method**
- **Secondary transmission method (if used)**
- **UL Listed alarm transport company (if used)** - name of company and UL file number.
- **Line security employed** - no line security, standard line security (equivalent to the traditional Grade AA, BB, CC), encryption (uses Listed equipment marked Encryption).

Control and transmitter units

Manufacturer's name and model numbers

1.2.3 Bank Burglar Alarm Systems (CUPZ)

A bank alarm system is one in which the operation of electrical protection circuits and devices of a bank safe, vault, ATM or night depository activates an alarm sounding device inside and/or outside of the protected premises. A bank alarm system may or may not provide supplementary remote location transmitting equipment that will transmit a signal off premises. The operation of a bank alarm system is primarily under the control of the owner or others interested in the property to be protected. Any supervision of system arming and disarming is not audited by UL. Alarm investigators are not required or audited by UL. The Bank Certificate displays the following information about an alarm system.

System description

- **Type of system** - safe, vault, night depository, automatic teller machine or holdup.
- **Extent of protection** - complete or partial. (Definitions can be found in UL 681.)
- **Area covered/location** - text that clarifies exactly what is protected by system.
- **Alarm sounding device** - inside, outside or inside and outside.

Remote Monitoring

- **Monitoring entity (if monitoring is provided)** - the name and address of the party monitoring the system - may be law enforcement, subscriber or subscriber's agent.
- **Party notified in case of alarm** - may be law enforcement, subscriber, or subscriber's agent.

- **Primary signal transmission method**
- **Secondary transmission method (if used)**
- **UL Listed alarm transport company (if used)** - name of company and UL file number.
- **Line Security Employed** - no line security, standard line security (equivalent to the traditional grade AA, BB, CC), encryption (uses Listed equipment marked encryption).

Control and transmitter units

Manufacturer's name and model numbers

1.2.4 Proprietary Burglar Alarm Systems (CVWX)

A proprietary burglar alarm system is one in which alarm initiating circuits and devices are installed at a property and are connected directly or indirectly to constantly monitored receiving equipment at a central supervising station. Personnel responsible to the owner of the protected property operate the central supervising station. The protected property may consist of a single property or of noncontiguous properties under a single ownership. The system is arranged so that a pre-determined change in the alarm initiating circuits or devices automatically causes transmission of an alarm signal over a supervised signaling channel to the central supervising station. A proprietary Certificate displays the following information about an alarm system.

System description

- **Type of system** - premise, stockroom, safe, vault, night depository, automatic teller machine or holdup.
- **Extent of protection** - numbers 2, 3 and 4; complete or partial. (Definitions can be found in UL 681.)
- **Area covered/location** - text that clarifies exactly what is protected by the system.
- **Alarm sounding device** - none, inside, outside or inside and outside.

Remote monitoring

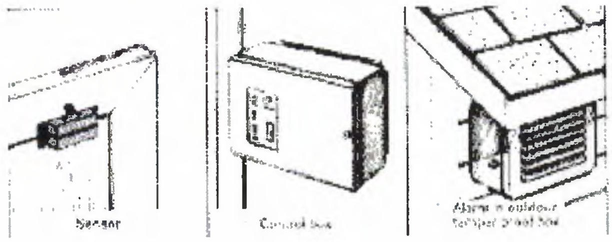
- **Monitoring entity** - the name and address of the party monitoring the system.
- **Primary signal transmission method**
- **Secondary transmission method (if used)**
- **UL Listed alarm transport company (if used)** - name of company and UL file number.
- **Line security employed** - no line security, standard line security (equivalent to the traditional grade AA, BB, CC), encryption (uses Listed equipment marked encryption).

Control and transmitter units

Manufacturer's name and model numbers.

1.3. Alarm Systems

Modem electronics has improved our quality of life in many ways. For example, electronic alarms have become very popular within the last decade. Their popularity is well earned, since they are both effective and affordable. Be careful, however, to not put all of your faith into them. When combined with other safety measures discussed in this chapter, they will make your house relatively secure. But if you rely totally on alarm systems, you will be vulnerable. Professional burglars know how to silence or incapacitate even the most complicated alarm systems. Most home burglars are not really professional. Remote alarms - alarms that ring only at the police station or at a private security office often allow burglars time to get away before help arrives. Also, false alarms are becoming so common that a lot of alarms are ignored. Local Bells or sirens, mounted both inside and outside the house, are preferable in conjunction with remote alarms.



(a) **(b)** **(c)**

Figure 1.1 (a) Door Sensor (b) Control Box (c) Alarm in outdoor tamper-proof box

There are several different types of alarm systems on the market. Some of these are well suited to the do-it-yourselfer, while others are best left to a professional alarm company. You need to consider seriously your family's lifestyle when you choose an alarm system. Motion sensor detectors will not work well if you have pets. If you have several children, or overnight guests or other visitors, alarm systems that demand you enter codes upon entering and leaving your home may not work. I remember visiting my brother and entering her house alone late one night The soft buzzer went off on the alarm system, indicating that I had ten seconds to enter the code before the alarm would blast. I had forgotten the code and stood there helplessly in the hallway as the alarm woke my brother's family as well as all the neighbors. If the police's or Security Company's response time is too slow you will need an alarm that rings at the house, thereby warning the neighbors. As you review the different types of alarm systems, determine which one will work best for you. Be sure to buy a high-quality system. Hopefully, you will never need it, but, when you do, you will want it to work properly. All systems have three basic components: the alarm itself, the sensor that senses the intrusion, and the control that causes the alarm to engage once the intrusion has occurred. These systems can be either battery operated or operated off the electrical currents in the house. The battery-operated units, though easy to install, often are not sophisticated enough to satisfy all your needs.

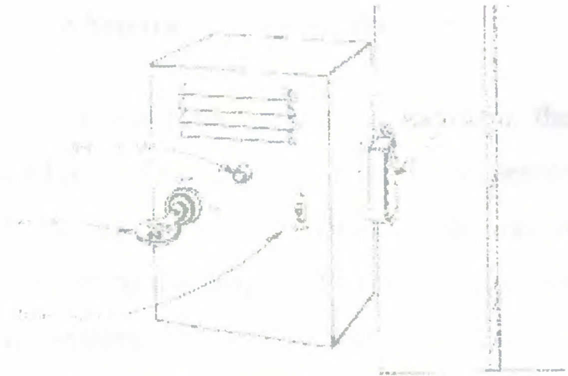


Figure 1.2. Self-Contained Alarm Systems

These have the alarm, control, and sensor all in one unit. They are mostly used in small houses offices, or apartments where there are a limited number of doors and windows. Sometimes these are as simple as a cigarette box- size alarm that hangs on the door or chain guard and that activates in the case of an intrusion. Others can be plugged into any wall outlet and are activated with a simple motion detector. The more sophisticated models may work off a change in air pressure (as when a door or window is opened) or off of high-frequency sound waves.

(a) **(b)**

Figure 1.3. (a) Window Sensor (b) Window Alarm Switch

These units are less expensive and easier to install than some others. Their drawbacks are that burglars can quickly locate them (since the alarm is with the control). Also, the ones that work off of air pressure or sound waves can often give a false alarm resulting from noisy upstairs neighbors or high winds.

1.3.1 Alarm Systems with Separate Components

These units separate the sensor from the control and from the alarm and work well where you want to guard several rooms at once. Individual sensors (often a metallic tape with a current running through it) can be placed at the windows and doors, and the alarm and control hidden from the burglar. This makes it much more difficult for the burglar to dismantle the system. These units often have several control stations around the house so that you can activate or deactivate all or part of your sensors. Some units even tell you which doors and windows are open or closed. They also have panic buttons that can be used when you think you hear someone prowling around out- side. These systems are usually activated and deactivated by a code and can alarm at the house or the police station (or security office) or both. Also, some alarms can be wired to automatically dial a number and give a recorded message. You can change the number it dials and be reached wherever you are, in case the house is burning or you have been robbed. If you are installing an alarm, put decals on your doors that tell burglars your house is alarm equipped. They will probably go away.

2. TYPES OF ALARM SYSTEMS

2.1. Introduction to Alarm Systems

Electronic security alarm systems can be an important contributor to the securing of life and property. When used properly, a security system can be an effective tool when used in conjunction with other crime prevention measures.

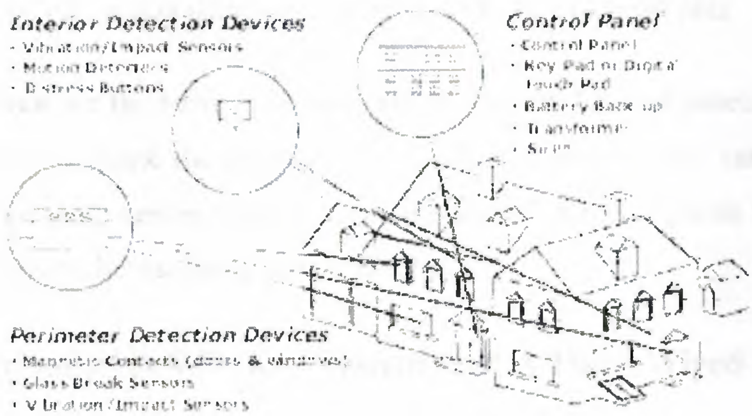


Figure 2.1. Sensors and Control Panels replaced inside to home

2.2 Security System Components

a) Keypads: display the status of the system using indicator lights or English-language displays. Entering your personal code turns the system on or off.

b) Sirens: installed inside and outside can discourage intruders and alert you and your neighbors.

c) Contacts: detect the opening of a door or window. Some contacts are flush-mounted, and are not visible when the door or window is closed. Sometimes, custom-made alarm screens can be used to protect windows, even when they are open.

d) Smoke Detectors are powered by the control panel's battery. If your system is monitored, these smoke detectors can send a signal, while you are home or away, to dispatch your local fire department for help.

e) Glass Break Detectors: can provide early detection of a burglary attempt. Some glass break detectors listen for the sounds of breaking glass, while others detect the impact of an attack on the glass.

f) Motion Detectors: sense an intruder's movement, regardless of how he got inside. Security systems often include a way to bypass the motion detectors while you're inside so you can arm the perimeter of your home, yet move freely about inside without setting off your alarm. Some motion detectors are designed to ignore small pets.

g) Control Panels are the heart of security alarm systems. Control panels monitor all of the various sensors, check the keypads, and sound the sirens. They can also transmit alarms to a monitoring center called a "central station." A rechargeable battery powers the system for several hours during power failures.

2.3. Comparison of A Wireless System And A Hard Wired System

While there are many types of products available on the market, the actual system you purchase can be either hard wired or wireless. The difference is that for hard-wired systems there is a wire connecting each device to the central control panel. A skilled installer uses special tools to conceal the wire inside walls, attics and crawl spaces. In a wireless system, small radio transmitters "connect" the sensors and keypads to the control panel. Higher quality wireless systems use frequent test signals to verify the operability of each transmitter. Hard-wired and wireless systems often cost about the same. Hard-wired systems look nicer, but take much longer to install. Wireless systems are a good solution when there's no way to get a wire from "here to there," however, each wireless transmitter will periodically need a new battery. Each type of system has its advantages and disadvantages. The choice between a wireless or hard-wired system is one you should make in consultation with your alarm company. They can help you choose the system that's best for you and your circumstances.

2.3.1. What Is A Central Monitoring Station?

An alarm system can be installed to emit a local alarm using a bell or siren, and/or it may be connected via a common carrier network (i.e. telephone lines) to a monitoring or "central" station where trained operators verify the alarm and dispatch the appropriate response authority (police, fire or medical) when the system transmits a signal. They may also notify you or your designee of the alarm signal. Alarm signals are usually transmitted over telephone lines, but some systems transmit signals by radio or cellular phone for added security. In addition to the police, fire or emergency medical dispatch, a monitored system may also emit a local siren when activated. A "local only" system does not, in itself, dispatch emergency response. In order to receive emergency police, fire or medical response, you must either call yourself, rely on a neighbor calling in the alarm (in the case of a local system) or you must have the system monitored by a monitoring station. For this service, a monthly fee is paid and is arranged through your alarm installation company. Alarm systems may not be connected directly to the Combined Communications Center. While there are a number of companies which install and monitor their own accounts, there are many more that install systems and contract with a third party monitoring facility. When you are deciding on which company to use, be sure to understand the service provided. The fact that the installing company subcontracts monitoring services is not a negative feature but, rather, is simply a standard practice in the industry. Because of advances in telecommunications, it is common practice to have your account monitored by an out-of-town or an out-of-state station.

2.3.2. What Should An Alarm System Do For Me?

An alarm system is installed to deter and detect intruders, to detect smoke, or to summon emergency medical assistance. A basic security system will consist of both perimeter and space protection to secure your premise. The first stage secures vulnerable perimeter access points such as doors and windows; the second stage consists of space detection such as interior motion detectors, which monitor movement inside the premise, and smoke detectors to detect a fire. The number of protective devices and the sophistication of the system you will have installed determine the level of security you purchase.

2.3.3. What Should A Qualified Company Do For Me?

A qualified company should perform a site inspection and discuss your individual security needs. Each person and premise is unique and the system should be tailored to fit your needs, lifestyle and price range. The company should provide you with an evaluation of your premise, highlighting the measures you can take to improve the security of your home over and above the addition of an electronic alarm system. They might suggest such simple measures as clearing brush around entranceways and installing proper locks. When comparing companies, be sure to make a true comparison by thoroughly reviewing numerous types of products to be installed. If there is a discrepancy, be sure you understand the impact it will have on the overall level of security you are purchasing

2.4. Examples Of Some Alarm Systems

There are many uses for alarm systems, a few of which are listed below.

1) Intruder Alarm
2) Holdup Alarm
3) Access Control alarm
4) Duress alarm
5) Fire alarm,
6) Medical alert,
7) Machinery failure alarm

2.4.1. Intruder Alarm Systems

This is the most common use for an alarm system. They are often employed in areas that are considered 'high risk' but not exclusively so. The sole purpose of this type of alarm system is to advise the owner either immediately or soon after of an unauthorized entry into their home or business has been made. This type of alarm works on the principle that once the occupier has left the premises, there should be no entry made except by authorized people through an authorized entry point. The alarm 'looks for' movement within the house and reports it by a predetermined means to the owner or occupier.

These devices are readily available from a growing number of licensed security companies in varying configurations at a cost, which is generally not prohibitive to the average person.

2.4.2. Duress Alarms

This type of alarm is of particular interest to seniors. A duress alarm can be installed into a home either separately or as part of an intruder alarm system. As the name suggests, it gives the occupier of the house a means of calling for help when under duress. The alarm can be designed to be activated from a wall-mounted switch or from a wireless pendant, which is worn on the person. The wireless pendant will activate the alarm from anywhere around the home. Duress alarms should always be silently monitored. It should be remembered that police respond to a duress alarm with much the same urgency as they would if attending an armed holdup. The alarm should only be used in cases of extreme urgency.

2.4.3. Medical Alarms

In the case of a person suffering from a serious illness with the likelihood of a sudden onset or attack, consideration should be given to the installation of one of the many medical alarms available today. These alarms work on the same principle as a duress alarm with the exception that when help is called, the security or monitoring company first summons an ambulance or doctor. These alarms can be made to operate from an automatic switch, which is in the form of a wireless pendant worn on the person. This is activated when the person's body becomes horizontal for more than a predetermined time. There is also often the facility to manually activate the device.

2.5. Alarm Parts

In dealing with alarm systems, it is very easy to become confused with the amount of information that is available for consumers. We will discuss the basic parts and their respective functions in order to give an understanding of the devices.

2.5.1.The Alarm Panel

This is the 'brain' of any alarm system. It can be compared with the head office of a large business in which information is received, processed, decisions made and then instructions given. The alarm panel is a network of electronic components and switches which combine to receive information from what are known as peripheral devices, analyses that information, makes a decision as to whether or not that information requires any action and if so, reports to a predetermined area. A good alarm panel must be manufactured in accordance with the Australian Standards and among other facilities, must have a built-in rechargeable battery-to run the system in the event of a mains power failure. Any one purchasing an alarm system should consider the security of their power supply.

2.5.2. Peripheral Devices

This is the term applied to any device, which is used to send information to the alarm panel this information is normally in the form of an electronic signal through wiring to the panel. It is this information that the alarm panel acts upon. There are many different types of peripheral devices, the most common of which are listed below.

a) Reed Switches

These are simply two fine leaves of metal contained within a glass tube, which are held apart by a small but strong magnet placed in the near proximity. While the magnet is in place, the switch stays open. When it is removed, the switch falls to the closed position sending a signal to the alarm panel. Reed switches are used on doors and windows to advise the alarm panel should they be opened, however, there are other applications.

b) Movement Sensors

There are many types of movement sensors, which operate on various principles. Some of the different types of movement are: Passive Infrared Sensors, (operate on Infrared energy and detect changes in temperature).

Microwave Sensor, (operate on Radio Signals at very high frequencies detecting movement). Ultrasonic Sensors (operate on sound waves that are inaudible to the human ear and detect movement associated with changes in reflected sound.

c) Breakglass Sensors

This type of sensor is, in actual fact, a microphone, which 'listens' for the sound or frequency of breaking glass. Through electronic means, when it 'hears' frequencies within its range, it tells the alarm panel which deals with it accordingly.

d) Shock Sensors

These devices are small switches encased in plastic, which respond to vibration and are normally located on window frames. When vibration is detected, a signal is sent to the panel.

e) External Siren

This is the part of the alarm system, which is erected outside the house, and its purpose is to attract the attention of passers-by or neighbors after the alarm panel activates it. The sirens are usually a waterproof horn type speaker encased in steel or polycarbonate box for security and mounted in a high position on an external wall. Most external sirens run on power supplied from the alarm panel, however, some have their own batteries, which are constantly charged from the panel. This allows the siren to sound, even if the wires to the panel are cut. They are known as Satellite sirens.

f) Internal Siren

This device is an important part of any alarm system. It's purpose is to sound a loud warning alarm within the building for two reasons. Firstly, to make the offender aware that there is an alarm summoning assistance and secondly, to make it uncomfortable for them The combination of these two points will reduce the time that the offender has to work.

2.5.3. Alarm monitoring

In many instances, it is more appropriate or desirable for an alarm system to not only create an audible alarm locally, but also to advise a person removed from that location that there is an alarm condition. Where a system is configured to advise a person removed from the premises, it is said to be monitored. The monitoring can be provided with or without the use of a local or audible siren.

There are basically three types of monitoring. They are:

1) Telephone dialer with voice announcement
2) Telephone dialer with digital announcement
3) Dedicated line monitoring

a) Dedicated Line

This type of monitoring uses a telephone line, which is placed, into the house exclusively for the alarm. This line is connected to a computer at a Security Company at all times and gives constant messages on the function of the system, even when the alarm is not armed. This information can tell the computer if a sensor malfunctions or if some other condition occurs. This is the most reliable and secure type of system as it also monitors the integrity of the line, however, it can cost upwards of $25.00 per week to maintain.

b) Telephone Dialler-Voice

This system allows the alarm panel to telephone a pre-programmed series of numbers and when answered, play a recorded message to the receiver advising of an alarm condition. To achieve this, the alarm panel seizes the existing telephone line into the home. If the numbers that are pre-programmed into the unit are not answered, it starts again at the first number and works through once again until the message is relayed. The cost involved is a once only charge for the cost of the dialer.

c) Telephone Dialler - Digital

This dialer is designed to dial usually only one telephone number, that being for a licensed security company who are paid to respond to an alarm. When an alarm condition occurs, the dialer seizes the existing telephone line into the home, dials to a security company and communicates with the company's computer in electronic or digital language. It tells the computer where it is calling from and what type of alarm condition exists. The security company then responds to the advice as instructed by the owner of the alarm. This type of monitoring is more reliable than the Voice system, however, it costs anything from $7.00 to $10.00 per week The average person contemplating the purchase of an alarm system for their home usually finds a wilderness awaiting them. Often the thought of an alarm system is off putting to people. The 'fear' of alarm systems is usually unwarranted. The operation of these devices is no more complicated than setting the timer on a domestic video recorder. When a decision is being made as to whether to install a system or not, careful consideration must be given to the following points:

1) How much value is placed on the property within the home?
2) How much importance is placed on keeping unauthorized persons out of the home?
3) What other security measures have been taken prior to considering the installation of the alarm?

The first two considerations are obvious. Most people place a great deal of value, either monetary or sentimental, on the property in their homes and there are very few people who would not be greatly disturbed by an intruder invading their privacy. The third point is well worth considering. It is good security sense to employ as many as possible of the proven, effective measures such as double cylinder deadlocks, window locks and security lighting prior to the installation of an alarm.

2.6. Home security

2.6.1. Burglary

You can fight back and take away the opportunity of crime. The two most effective methods of preventing burglary are:

1) Maximizing visual deterrents to offenders
2) Securing your premises

In many domestic burglaries reported to police, the offender gained entry through an unlocked door or window.

2.6.2.How you can protect your home?

Here are some suggestions to make your home safer and more secure. Remember most burglars are opportunists; so don't give them the opportunity. When leaving your home, ask yourself, "Does it look like the house is empty?" If it does, do something about it.

1) At night, leave on inside lights, which you would normally leave on if you, were at home. A house in darkness is a prime target for a burglar.
2) Consider using electronic timing devices that turn the TV, radio or lights on and off at selected times.
3) Ask your neighbors to keep an eye on your home, particularly if you're going on holidays, and to report any unusual activity to the police.
4) Become involved in Neighborhood Watch.
5) Lock all doors and windows when leaving.

6) Activate alarm systems.

7) Consider installing movement-activated external floodlights.

8) Don't leave blinds or curtains closed - it makes the house look empty.

9) Key operated locks for doors with glass panels are essential.

10) Make windows more secure by fitting locks, safety film, security screens or external roller shutters.

11) Identify your property with your motor driver's license number (e.g. WA1234567) by using engravers supplied free through Neighborhood Watch.

12) Photograph and record serial numbers of all valuable property and keep this information in a safe place.

2.6.3.What to do if your home has been broken into?

Coming home to find your front door has been forced open, or a window screen removed, is a moment all homeowners' dread. The temptation is to run in and see what's been damaged or stolen, but in reality, that's the last thing you should do.

1) Don't enter your house, as the offender may still be inside.
2) Call the police from you mobile, a neighbor's phone or the nearest phone box.
3) Don't touch any smooth surfaces, which may have the offender's fingerprints on them.
4) If it is obvious that no one is in the house, start making a list of all stolen property. Have the list available for the police when they attend.
5) Visit your neighbors, either side and opposite your home, while waiting for police when they attend.
6) Visit your neighbors, either side and opposite your home, while waiting for police to attend. They may have seen someone suspicious. Pass any information to the police.

2.6.4. Car security. Who steals cars?

As a general rule, the profile of a car thief can be divided into two distinct categories:

1) The opportunist and the professional. An opportunist car thief sees your car as a means of transport (a joy-rider), a chance to thrash someone else's car around in a reckless and often dangerous manner, or simply as an easy target. Cars stolen by an opportunist are often recovered badly damaged.

2) The professional car thief wants your car for profit. The car may be stripped and the parts taken, or its identity changed so it can be illegally sold.

3) Your stolen car may even be used in another crime, such as a ram-raid.

3. ALARM SYSTEMS

3.1 OVERVIEW

Many buildings and complexes being constructed today are equipped with some type of intrusion detection and fire alarm systems. You, as a Construction Electrician, will be challenged to install, troubleshoot, and maintain these systems. Numerous detection and fire alarm systems are in existence today. In this chapter, we will discuss the function and operation of a typical detection system and of various fire alarm systems. When you are in charge of the installation or maintenance of either detection or a fire alarm system, you should acquire reference material, such as manufacturer's literature. If such material is unattainable, look at NAVFAC MO-117, Maintenance of Fire Protection Systems, which provides an excellent description of several fire alarm systems. Design Manual 13.02, Commercial Intrusion Detection Systems (IDS), provides descriptions of various intrusion detection systems. The purpose of any alarm system is to either protect life or property or to detect an intrusion. Alarm systems are set up to (1) give early warning so occupants may evacuate the building and (2) notify the fire department and/or security soon enough that they have time to react.

3.2. Types Of Fire Alarm Systems

Building alarm systems may be local or local with base alarm system connections. They may be coded or noncoded and may operate either on line-voltage or low-voltage electric power. Their characteristics are described in the following paragraphs.

3.2.1. Noncoded Alarm Systems

A noncoded alarm system has one or more alarm-indicating appliances to alert the building occupants of a fire but does not tell the location or the type of device that has been activated (manual alarm or automatic protection equipment). The audible and/or visual alarm appliances operate continuously until they are turned off, until a predetermined time has passed, or until the system is restored to normal. The location or type of device originating the alarm condition can be determined by using an annunciator system.

3.2.2. Coded Alarm Systems

A coded alarm system has audible and/or visual alarm signals with distinctive pulsing or coding to alert occupants to a fire condition and to the location or type of device that originated the alarm. Coding the audible appliances may help personnel to distinguish the fire alarm signal from other audible signals. Clear and early recognition of the signal should encourage a more orderly and disciplined evacuation of the building. Common characteristics of coded alarm systems, especially of selective coded and multiplex coded systems, are that the coded alarm identification provided by the audible alarm signals is not repeated continuously. Normally, after four complete repetitions of the coded signal, the coding process ends.

3.3. Theory Of Operation

In the event of a fire, a certain sequence of events has to occur for any alarm system to be effective. First, the fire has to be detected. This can be done by any of the following means: visually and by operation of a manual pull box, heat detectors, water pressure/flow switches, flame-actuated detectors, or smoke detectors. Any of these devices will initiate a signal to the fire alarm control unit, which is powered by a reliable power supply. (See figure 3.1.) Second, the control unit accepts the signals from the initiating circuits and, through relays or other circuitry, provides the power to operate the indicated devices. These alarm devices may include, but are not limited to, horns, bells, chimes, flashing lights, or annunciators. Finally, operation of the alarm will alert personnel to evacuate and assist fire-fighting personnel in locating the fire, thus protecting life and property.

3.4. Equipment Description

Figure 3.1 shows how the basic parts of a local fire alarm system are interconnected. The devices in the diagram are grouped for convenience in labeling. Physical location and zoning of devices vary for different applications, and many systems do not have all the devices shown.

3.4.1. Power Supplies

Fire alarm systems are in two general categories, as determined by the voltage at which the systems operate: line voltage or low voltage. Regardless of the operating voltage, a system may be noncoded or coded. Many older local alarm systems are powered by alternating current (ac) power only with no provision for standby battery power. In these cases, two separate ac circuits (usually 120/240 Vac) are used: one to power the fire alarm system operating circuits and another to power the trouble-signaling circuits of the system. Low-voltage alarm systems, especially those provided with battery standby power, are most often found where some form of automatic fire detection or automatic fire extinguishing is connected to the alarm system. However, recent conversion by most alarm system manufacturers to solid-state electronic design, which is essentially a low-voltage direct-current (dc) technology, means that most recent installations are of the low-voltage type.

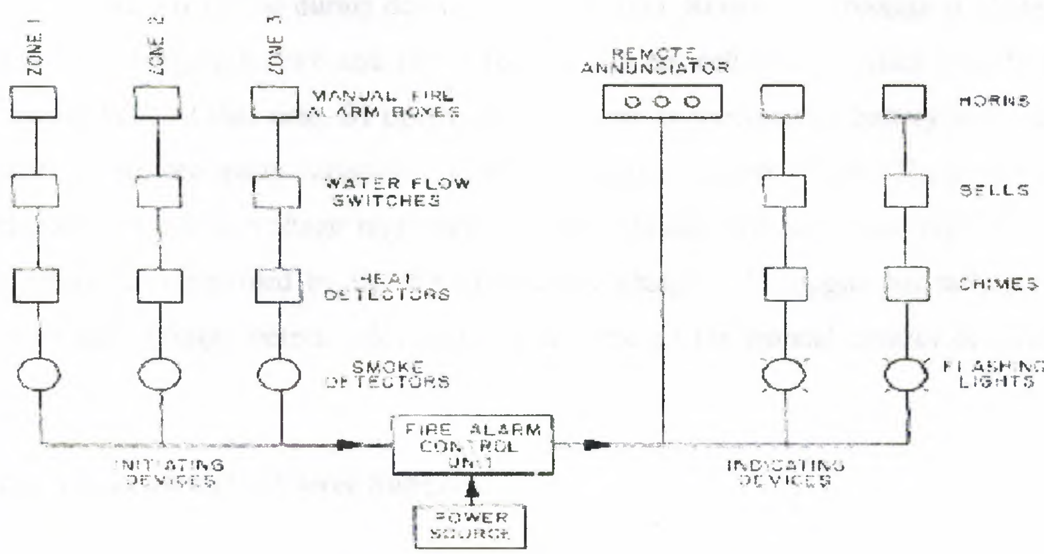


Figure 3.1. Local fire alarm system diagram.

3.4.2. System Power Supply

Power supply refers to the circuitry and components used to convert the ac line voltage to low-voltage ac or dc for operating the alarm system and for charging standby batteries. If the system is an older one with a dry cell, no rechargeable standby battery (no longer permitted by NFPA standards), the power supply probably contains a switching arrangement for connecting the battery to the system when ac power fails. Figure 3.2 is a simplified diagram of a typical dc power supply for powering a low-voltage dc alarm system and for charging a rechargeable standby battery. Transformer T drops the line voltage from 120 volts ac to a voltage in the range of 12 to 48 volts ac. The low ac voltage is rectified by diode bridge D, and the resulting dc voltage powers the alarm system through relay contacts S1 and charges battery B through the current limiting resistor R. When normal ac power is available, energizing relay coil S, contacts S1 are closed. If ac power fails, S1 opens and S2 closes, connecting the battery to the alarm system. Fuse F1 protects against a defect in the power supply or the alarm system during normal ac operation. Fuse F2 protects against alarm circuit defects that would cause a battery overload during dc-powered operation. Removal of resistor R eliminates the battery-charging feature and allows the use of a dry cell battery, which sits idle until ac power fails. At that time, S1 opens and S2 closes, connecting the battery to the alarm system. There are many variations of this basic power supply design. These variations add such features as voltage regulation, current limiting, and automatic high-rate/low-rate charging, controlled by the state of battery charge. All designs normally provide current and voltage meters, pilot lamps, and switches for manual control of charging rate.

3.4.3. Smoke Detector Power Supply

When smoke detectors are used in an alarm system, their internal electronic circuits are usually powered from the main fire alarm power supply.

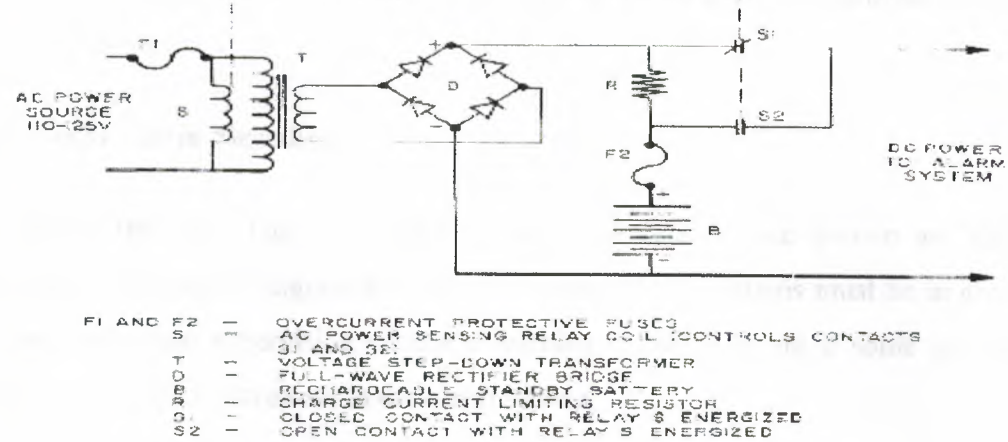


Figure 3-2 Typical dc power supply and battery charger.

Some types of smoke detectors have a more strict power supply requirement than other parts of the fire alarm system, especially with regard to purity of the dc voltage level. The power supply of those smoke detectors must have output voltage regulation and filtering not otherwise required by the fire alarm system. In those cases, the basic power supply may be upgraded to power the smoke detectors as well as the control unit, or a separate smoke detector power supply may be used in addition to the basic supply. In either case, if the system has battery standby, it is usually common to both power supplies.

3.4.4. Control Unit

The fire alarm control unit provides termination points for all initiating circuits, indicating circuits, remote annunciators, and other auxiliary devices. The control unit accepts low current signals from the alarm-initiating circuits and, through relays or other circuitry, provides the larger current required to operate the alarm indicating devices and/or auxiliary devices. The control unit also continuously monitors the condition of the alarm initiating and indicating circuit wiring and provides a trouble indication in the event of an abnormal condition in the system, such as an ac power failure or a wiring failure. The control unit is usually housed in a sheet metal cabinet (figure 3-3). The control unit usually provides annunciation of signals (telling where a signal originates). Because all circuits end at the control unit, it is a convenient test location. Test switches (if provided) are usually inside the locked door of the control unit. If the switches are key operated, they may be on the control unit cover rather than inside the cabinet.

3.4.5. Local Alarm Signaling

Because of the critical nature of fire alarm systems, a feature known as "electrical supervision" has been designed into these systems. Alarm systems must be in service at all times; electrical supervision causes a warning (trouble) signal if some potential or actual electrical problem exists in the alarm system.

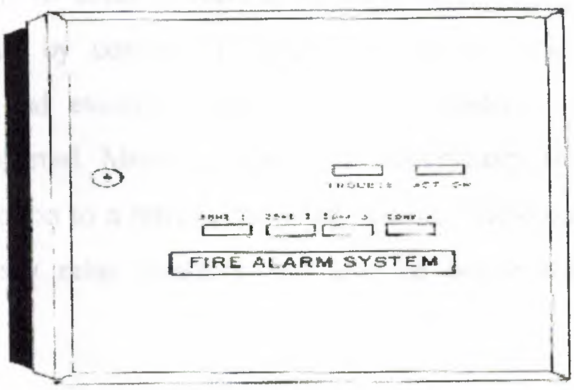


Figure 3.3 Control unit with annunciation.

This trouble signal is clearly distinguishable from a fire alarm signal. Figure 3.4 shows a typical local alarm signaling circuit using electrical supervision. A continuous small electrical current, supplied by the fire alarm control panel, flows through the series loop formed by one side of the initiating circuit, the end-of-line resistor, and the other side of the initiating circuit as indicated by the arrow. The fire alarm control panel reacts to this constant low current as a no-alarm or normal condition. Under normal conditions, the alarm and trouble relay coils have the same low value of supervisory current flow. This value is inadequate to close the normally open contacts of the alarm relay. The supervisory current energizes the trouble relay, being more sensitive, and the normally closed contacts (TR1) are held open. If the supervisory current drops to zero because of a broken wire anywhere in the initiating circuit, the trouble relay is de-energized, and the TR1 contacts close, causing an audible and visual trouble signal. Also, the portion of the circuit beyond the broken wire will not operate in the event of an alarm. If no wires are broken, closing the contacts of an initiating device provides a low-resistance current path, short-circuiting the end-of-line resistor and increasing the alarm relay coil current. The alarm relay is energized, causing its contacts (AR1) to close and the alarm bells to ring. Continued fire alarm operation with a broken wire depends upon the location of the break and which initiating device is actuated.

3.4.6. Remote Alarm Signaling

Because of excitement, a lack of knowledge, or a lack or responsible personnel on the premises, people frequently do not react properly to a local fire alarm signal. Therefore, it is usually desirable to connect building alarm systems to a remote receiving station manned at all times by competent personnel who can take the proper action-to extinguish the fire and evacuate the building if necessary or to see that necessary maintenance is completed. Most fire alarm and supervisory alarm control panels have provision for connection to a remote receiving station. These connections are usually in the form of auxiliary relay contacts that can be connected to operate an alarm transmitter.

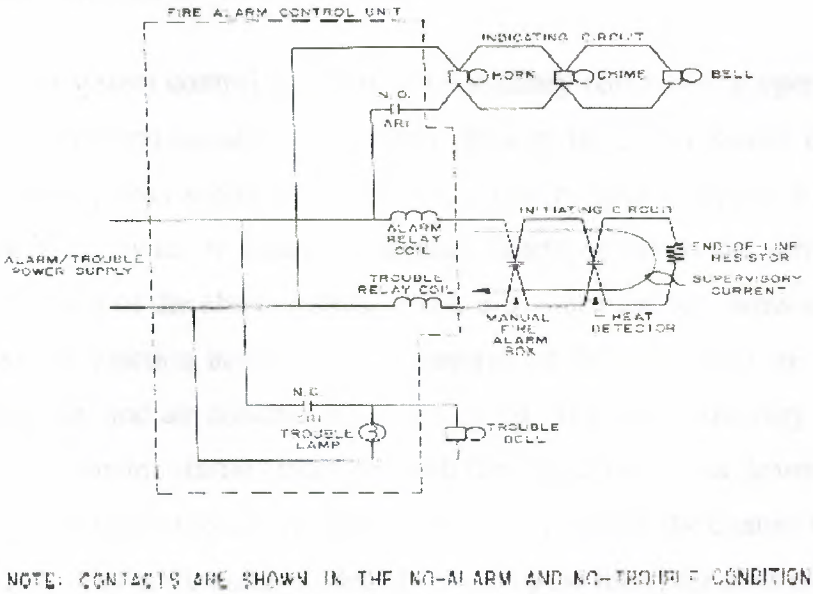


Figure 3.4. Typical local alarm signaling circuit.

Figure 3.5 shows a typical remote alarm signaling circuit, a commonly used arrangement for fire department connection to individual building alarm systems. The alarm transmitter can either be a part of the fire alarm control cabinet or be operated by it. If, instead of a fire condition occurring, one of the two telephone wires is broken, the supervising current supplied by the transmitter will drop to zero, closing the receiver module relay contacts, lighting the lamp, and sounding the buzzer. The meter indication will be zero, marked on the meter face as "T" (trouble). If a telephone wire is broken before an alarm condition occurs, the voltage will be reversed by the alarm transmitter, but the "no current" condition at the alarm receiver will not be changed, and no alarm will be caused. The trouble condition will continue until the broken wire is repaired. In the circuit shown in figure 3.5, if an alarm condition occurs, the transmitter contacts transfer, reversing voltage and current polarity of the telephone line pair. The meter in the receiver module changes indication from N (normal) to A (alarm). Current flow through the receiver module relay is blocked by diode D1, and the receiver module relay contacts close, lighting the lamp and sounding the buzzer. The current for meter alarm indication flows through the meter and diode D2.

3.4.7. Auxiliary Devices

A building alarm system control unit may have auxiliary contacts that operate auxiliary functions when an alarm occurs. For auxiliary devices, the power source can be either the main fire alarm power supply or line power, if battery standby power is not required for the auxiliary functions. A failure of auxiliary functions should not adversely affect the primary function of the alarm system, which is to warn the occupants of a threat of fire. One auxiliary function included in the majority of fire alarm systems today is the heating, ventilation, and air conditioning (HVAC) fan shutdown. Auxiliary contacts are connected into the motor starter circuit for each fan that is to be shut down upon alarm. It may be more convenient to use an alarm voltage output from the control unit to cause fan shutdown. A relay with multiple contacts (a multipole relay) for controlling multiple fans is located near the motor control center or the temperature control panel. The relay coil is energized by alarm voltage from the alarm control unit, causing contacts to open in the individual

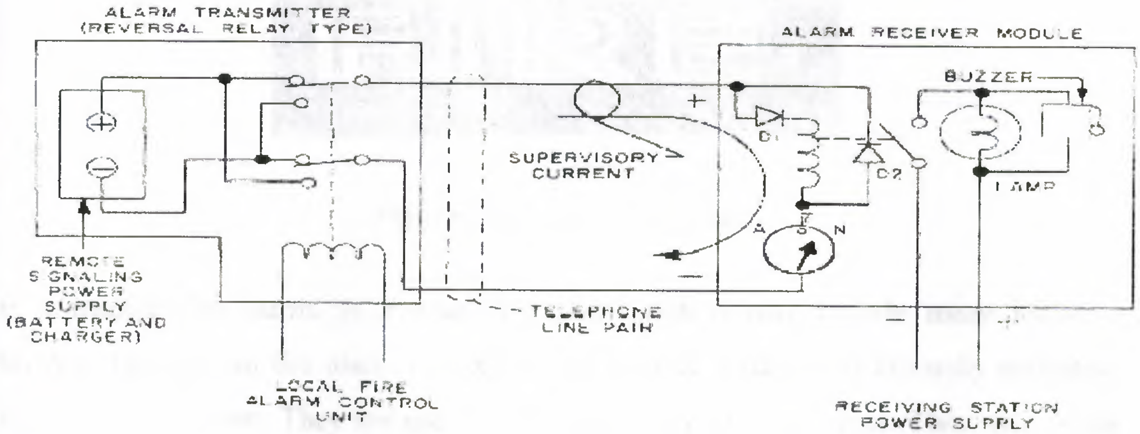


Figure 3.5. Typical remote alarm signaling circuit.

fan control circuits, thereby stopping all the fans. Other auxiliary devices controlled by the alarm system can perform the following functions: fire door closure, ventilation louver closure, and/or release of extinguishing agent. Consult the manufacturer's literature and/or base blueprints to determine the options included in your fire alarm system.

3.5. Alarm-Initiating Devices

An alarm device initiates a fire alarm signal either as a result of manual operation, such as a manual fire alarm station, or automatically, as in the case of heat, smoke, flame, or water-flow detectors. Initiating devices, with rare exceptions, have normally open contacts that close on an alarm condition. Normally closed devices are intended only for such applications as operating the shutdown control for fans or other auxiliary devices.

3.5.1. Manual Fire Station

Figure 3.6 shows a manual fire station, which is also called a manual pull box, a manual firebox,

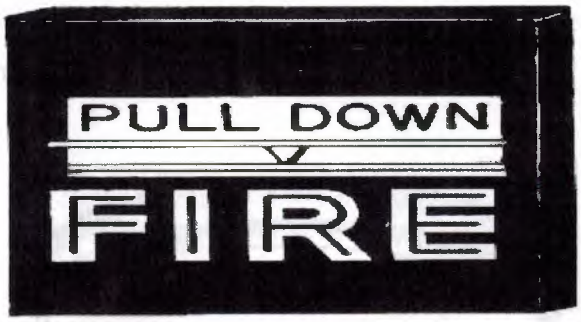


Figure 3.6. Manual pull box.

or a manual fire alarm. A manual fire alarm system may include many initiating devices. The manual fire alarm devices are to provide a means of manually activating the fire alarm system. They are used in all types of fire alarm systems. They may be the only type of initiating devices provided or they may be used with automatic initiating devices, such as heat or smoke detectors. Manual fire stations are generally located near main exits from a building or from a floor of a multistory building and in certain work areas containing unusual fire hazards, valuable equipment, or records subject to fire damage. Paint shops, aircraft repair areas, computer rooms, and telephone equipment rooms are examples of such work areas. Single-action and double-action devices are both used. The single-action device requires one action to cause an alarm, and a replaceable glass rod is broken with each operation. The double action device requires two actions to cause an alarm: first, the glass window is broken; second, the alarm lever is pulled. The glass elements in these two examples are necessary parts to retain all the design features. Both devices can be tested without breaking the glass parts by opening the device. To open a manual fire alarm box, you may have to loosen a setscrew or operate a latch with a hexagonal (allen) wrench, screwdriver, or key. Manual initiating devices should be visually inspected monthly for physical damage, such as that caused by vandalism or painting. At this time, count the devices to be sure that none have been concealed or removed. Correct deficiencies promptly. Test repaired units by mechanical operation and transmission of local and remote signals without glass breakage. Be sure to inform building and fire department personnel that the test is to be performed. Test all manual devices on a rotation schedule so that all devices are tested semiannually. Some devices should be tested each month, at least one from each initiating circuit (zone) or remote signaling circuit, in the case of coded fire alarm boxes. Keep accurate records of devices tested, their locations, and the rotation scheme. Store a copy of building system diagrams and test records in the control unit.

Figure 3.7. Low-profile heat protector.

3.5.2. Heat Detectors

Heat detectors are probably the most widely used initiating device for general-purpose automatic fire alarm systems. Some common types of heat detectors are discussed below.

a) Spot Type Of Fixed-Temperature Detectors: Fixed-temperature heat detectors that are categorized as spot type have a detecting element or elements that respond to temperature conditions at a single point or in a small area.

These detectors are shown in figure 3.7 and figure3.8. Other fixed-temperature detectors are manufactured in the style shown in figure 3.9.

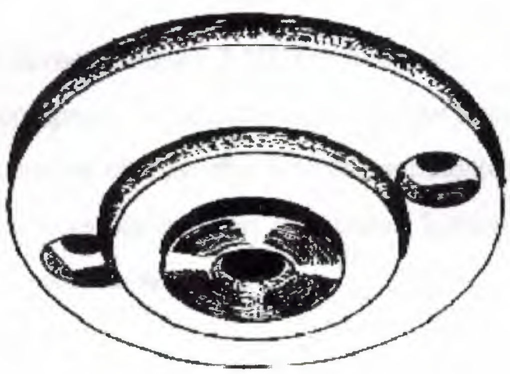


Figure 3.8. Replaceable-element fixed-temperature heat detector.

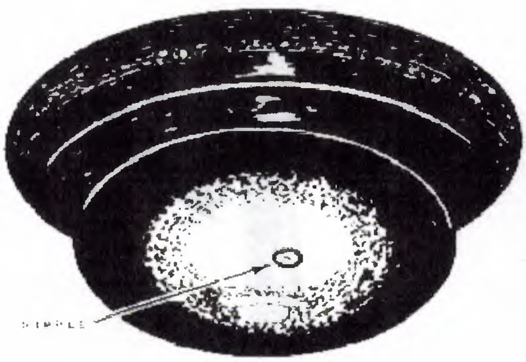


Figure 3.9. Combination fixed-temperature/rate-of-rise heat detector.

The spot type of fixed-temperature detectors is used mainly in unattended spaces to detect smoldering fires that increase the temperature of a detector above its design value, usually 135°F to 145°F or 185° to 200°F. The higher temperature devices are used in spaces that may reach higher temperatures under ordinary conditions, such as boiler rooms, attics, or cooking areas. The melting usually actuates the device or fusing of an element made of a fusible metal alloy. Actuated devices usually can be detected by visual examination. In the devices shown in figures 3.7 and 3.8, the smaller diameter part in the center drops away. In figure 3.9, the dimple becomes a hole when the detector operates. Fixed-temperature devices are often designed for one-time operation, and the whole device (figures. 3.7 and 3.9) or the element (figure. 3.8) needs to be replaced.

3.5.3.Rate-Compensated Detectors

This type of detector is shown in figure 3.10. For low rates of temperature change (up to 5°F per minute), rate-compensated detectors operate like fixed-temperature detectors. For higher rates of temperature change, the detector anticipates the rise in temperature to its set point and operates faster than the usual fixed-temperature detector. It automatically resets and is reusable when the

Figure 3.10. Rate-compensated heat detector.

temperature drops below its design value. There is no difference in external appearance between an actuated device and an unactuated device; therefore, its status must be checked electrically.

3.5.4. Rate-Of-Rise Detectors

These detectors are found in the styles shown in figures 3.7 and 3.9. Rate-of-rise detectors cause an alarm whenever the rate of temperature rise exceeds about 15°F per minute. Heating causes an increase in air pressure inside the detector. A slow increase in pressure bleeds off through a breather valve, while a fast increase operates a bellows type of diaphragm, which operates the alarm contact, causing a signal. The detectors automatically reset after actuation and are reusable. Actuation is not visually indicated.

3.5.5. Combination Detectors

These detectors are found in the styles of figures 3.7 and 3.9. The combination detectors contain both fixed-temperature and rate-of-rise elements. If either element actuates, an alarm results. The fixed-temperature element is visible and actuates only once. If the fixed-temperature element actuates, the whole device must be replaced. The rate-of-rise element automatically resets and is reusable.

3.5.6.Testing Heat Detectors

Test heat detectors semiannually on a rotation schedule to ensure that all devices will be tested over a 5-year period. During the semiannual tests, select at least one detector from each initiating circuit (zone) for testing. Removing and reinstalling the element can test no reusable detectors with replaceable elements. Test and replace all nonreusable detectors in a 5-year period. The testing provides training opportunities and improves the alarm system reliability. Keep accurate records of devices tested, their locations, and the rotation scheme so no devices are overlooked and so that other personnel can do the testing. The spot type of heat-actuated detectors can be tested using various sources of heat. If the detector is located in a hazardous area that may contain explosive fumes or other highly flammable materials, use an explosionproof lamp. For no hazardous areas, the heat source may be an infrared lamp, a hair dryer, or a hot air gun. Be careful to avoid heat or smoke damage to reusable detectors and to the surroundings. To test combination detectors that have a nonreuseable fixed-temperature element, test both the rate-of-rise and fixed-temperature features. First, use a higher heat level for a short period and direct it away from the fusible fixed-temperature element, if possible, to actuate only the rate-of-rise element. When an alarm occurs, allow cooling; reset; and then apply more gradual heat to actuate the fixed-temperature element.

3.5.7. Smoke Detectors

Smoke detectors are faster acting than heat detectors. They are frequently used in fast acting automatic fire detection systems that incorporate an extinguishing agent release function to protect high value or highly combustible storage and work areas. Computer rooms, aircraft storage and repair areas, explosive processing areas, and telephone equipment rooms are frequently protected in this way. Smoke-actuated detectors may be of the photoelectric type used in spot, beam, or duct designs or the ionization type, which is applied in the spot or duct design. The principle of operation is the same, regardless of design.

3.5.8. Photoelectric Smoke Detectors

Most modern photoelectric detectors of the spot type use the light-reflection principle to detect

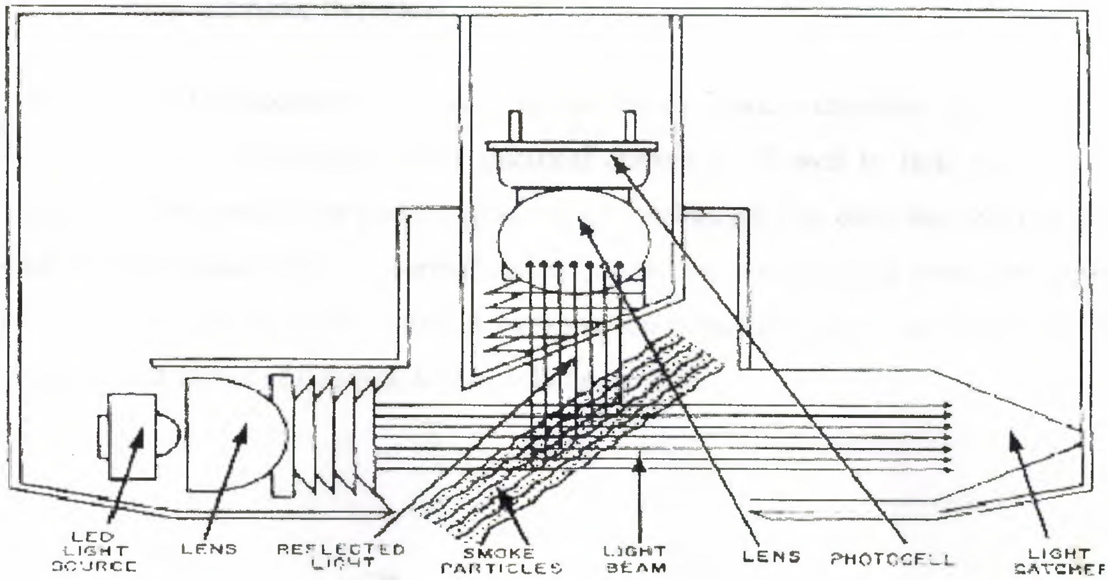


Figure 3.11 Typical arrangement of photoelectric smoke detector components.

smoke. The diagram in figure 3.11 shows a typical arrangement of functional parts. A pulsed light beam from a light-emitting diode (LED) with its associated optics is projected across the interior of a blackened chamber that may contain smoke to be detected. A photocell, with its optics, looks toward the projected beam along a line perpendicular to the beam. When smoke enters the chamber, the smoke particles reflect a small portion of the light beam toward the photocell, which provides a voltage to be amplified and causes an alarm. The light source may be monitored ahead of the smoke chamber and regulated to prevent variation of the light intensity from causing erratic detector behavior. In detectors of the beam type, the light source and photocell are mounted near the ceiling on opposite sides of the protected room. When smoke obscures the light below a predetermined value at the photocell, an alarm results. Detectors of the duct type are intended for detecting smoke in an air-handling system. A detector of this type is mounted directly on the outside of an air duct or nearby with a sampling tube extending about three quarters of the way across the inside of the duct. The airflows into the smoke detection chamber mounted on the outside of the duct, and back into the duct through a return tube, having a hole or holes directed downstream. As long as there is airflow in the duct, a portion of that air continuously flows through the detection chamber.

3.5.9. Ionization Smoke Detectors

A small amount of radioactive material ionizes the air inside a chamber that is open to the ambient air. A measured, small electrical current is allowed to flow through the ionized air. The small, solid particle products of combustion that enter the chamber as a result of fire interfere with the normal movement of ions (current), and when the current drops low enough, an alarm results. A two-position switch to control sensitivity may be provided. A detector of this type is shown in figure 3.12.

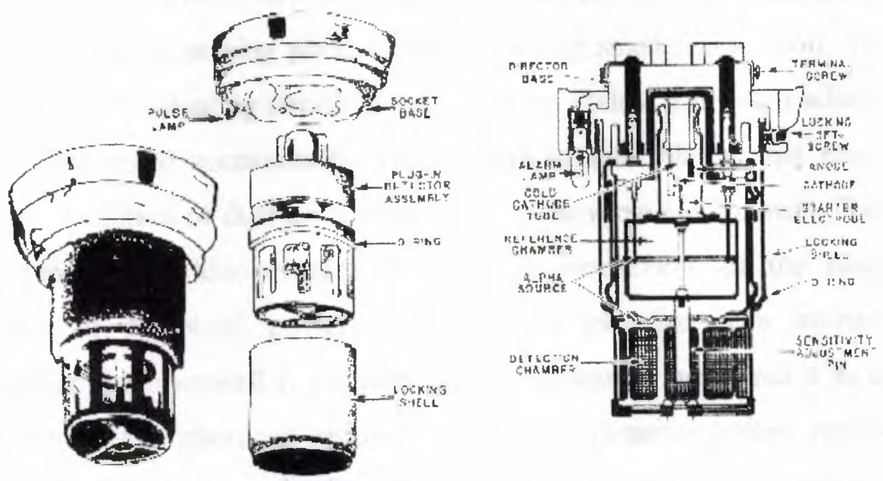


Figure 3.12 Ionization Smoke detector.

Modern ionization detectors have additional means to improve stability and immunity to atmospheric effects. A reference chamber is vented to the outside through a small orifice, which does not readily admit smoke particles. Both the reference chamber and the smoke chamber sense electronic balancing eliminates temperature, humidity, and pressure changes, and their effects on alarm sensitivity. The major difference between detectors of the spot and duct types is the method of moving the smoke into the detection chamber. The spot type detects or relies on convection of air in a room. The duct type is intended. for detecting smoke in an air-handling system and is mounted directly on the outside of an air duct or nearby with sampling and return tubes extending completely across the duct.

3.6. Testing Smoke Detectors

Before testing detectors that are connected to auxiliary functions, such as release of a fire-extinguishing agent, release of fire doors, or fan shutdown, disconnect or bypass the auxiliary functions (unless the test is specifically intended to test these features). Before the test, notify the fire department and persons where the audible signals can be heard. Most PHOTOELECTRIC detectors have a built-in test feature. In some models, a test light source actuated by a key-operated test switch or by a magnet held near a built-in reed switch causes light to reach the normally dark, smoke-sensing photocell in a quantity approximately the light of an average smoke test. In other detector models, inserting a reflective surface into the smoke chamber so that the actual source light is reflected to the smoke sensing photocell performs the smoke simulation. Test at least one detector in each initiating circuit (zone) monthly. Follow a rotation schedule so that all detectors are tested semiannually. Test failures or false alarms may result from an excessive accumulation of dust or dirt caused by an adverse environment. Blow out the smoke chambers with low-pressure air. (Partial disassembly of the detectors and disconnection of detectors' power, following the manufacturer's instructions, are required.) Since the photocell is normally dark, disassemble and clean it in a darkened area to minimize the photocell recovery time after cleaning before repowering the detectors. Allow approximately 30 minutes for recovery after reassembly of the detectors before reconnecting power. Disconnecting power by unplugging one detector may also disconnect power from the other detectors further from the power source. Inform the fire department before or during any extended testing period. Special equipment that may be required for cleaning consists of a low-pressure air source for blowing out dust and a suction cup for chamber cover removal. If the cleaning does not correct the false alarms or failure to alarm, return the detectors to the manufacturer for repair. Test at least one IONIZATION detector in each initiating circuit (zone) monthly. Follow a rotation schedule so that all ionization detectors are tested semiannually, following the manufacturer's instructions. Any detectors that produce false alarms between semiannual tests or do not test satisfactorily should be checked for sensitivity, following the manufacturer's instructions and using test equipment available from the manufacturer or other sources. An aerosol synthetic smoke is available from some manufacturers for testing their detectors. Unsatisfactory tests or erratic operation may indicate a need to remove accumulated dust or dirt. The frequency of cleaning should be based on results of regular tests and local conditions. Clean, check, and test operation and sensitivity, following the manufacturer's instructions. For loose dust deposits, blow the area with lowpressure air after removing a protective cover. For more stubborn deposits, disassemble and clean, using a liquid recommended by the manufacturer. Recheck sensitivity and adjust if necessary after cleaning and drying thoroughly.

3.7. WARNING

Some smoke detectors of this type produce an electrical shock that may not be severe enough to cause injury directly but could cause a fall from a ladder. Some manufacturers, because of such possible injury to personnel or damage to the detectors, do not recommend servicing by anyone other than factory-trained personnel. Personnel in the customer service departments of most manufacturers can give advice on the telephone for specific problems. Be prepared to give the equipment model number and other pertinent information.

3.7.1. Flame-Actuated Detectors

Flame-actuated detectors are optical devices that "look at" the protected area. They generally react faster to a fire than no optical devices do.

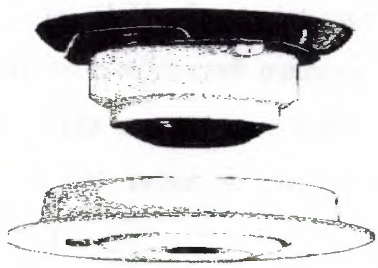


Figure 3.13. Infrared flame detectors.

3.7.2.Infrared Flame Detectors

Figure 3.13 shows two typical infrared (IR) flame detectors. IR flame detectors respond directly to the IR, modulated (flickering at 5 to 30 cycles per second) radiation from flames. The sensor design usually incorporates a delayed response, selectable in the range of 3 to 30 seconds, to minimize responses to nonfire sources of radiation. Thus, alarms are caused only by sustained, flickering source of IR radiation. The IR flame detector is ineffective for smoldering or beginning fires. It is used where possible fires would develop quickly (fuels, such as combustible gases and liquids, or loose cotton fiber), and it is capable of protecting a large area if it is mounted high on a ceiling or wall (30 to 50 feet). The distance of the device from the fire affects the sensitivity of IR detectors to a fire. For example, if the distance is doubled, the fire has to be four times as large to be detected. To maintain immunity to possible nonfire sources of alarms, you should usually select longer response delays (10 to 30 seconds) for low (8-foot) ceiling mounting. Shorter delays, in the range of 3 to 10 seconds, are used when detectors are mounted on higher ceilings. For high-hazard areas, the detector can be mounted on a low ceiling and a low delay setting used to obtain sensitivity and fast response. Shields to eliminate possible false alarm sources from the field of view of the detector are sometimes used, especially in a high-sensitivity application of the device. Some detector models designed for fast response do not have the "flicker" discrimination feature, but instead have two sensors with different spectral responses. These sensors are used to distinguish between an actual fire and other sources of IR radiation. Glowing ember detectors are nondiscrimination and fast acting. Ambient light levels must be maintained below 20 foot-candles. Location and shielding are important for this type to avoid false alarms caused by incandescent lamps and sunlight.

3.7.3. Ultraviolet Flame Detectors

The ultraviolet (UV) flame detector is extremely fast and is used in high-hazard applications, such as aircraft maintenance areas, munitions production, and other areas where flammable or explosive liquids or solids are handled or stored. The detector responds to UV radiation not visible to humans. Figure 3.14 shows a typical UVdetector.

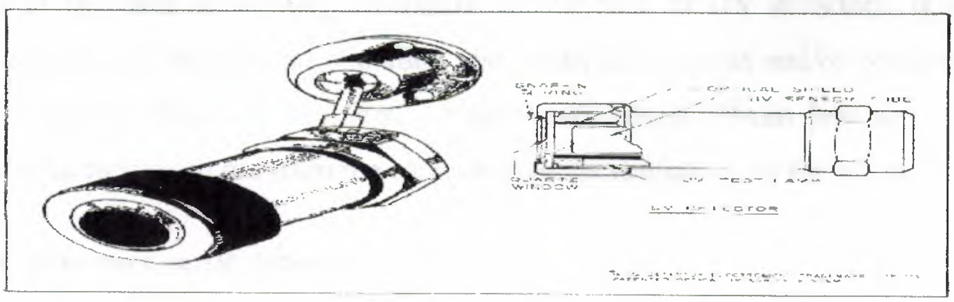


Figure 3-14 Ultraviolet flame detector.

The detector and circuitry may be in a single housing or in separate housings. They act together as a normally open switch that becomes momentarily closed, causing an alarm, when UV radiation enters the detector-viewing window. Response time is typically less than 25 milliseconds for an intense UV source. Some models have a built-in short time delay (3 seconds, nominal) to reduce responses to lightning and other momentary events. Frequently, separate relay contacts are provided for immediate and delayed alarm outputs, adjustable up to 30 seconds. A visual indicator, visible through the viewing window, usually indicates detector actuation. The UV detector is capable of use in explosive atmospheres, and some models have swivel mounts for directing them at specific hazards. Various models have angular fields of view ranging from 90 to 180 degrees. Sensitivity is usually factory set for the application.

3.7.4. Testing Flame-Actuated Detectors

Flame-actuated detectors should be inspected monthly for physical damage, accumulation of lens deposits, and paint. A spot of paint on a lens can prevent the detector from "seeing" a critical area in the protected space. Remove or protect the detectors when painting is being done. Be sure that auxiliary functions of the flame detection system are deactivated before testing is done unless these features are intentionally being tested. Before the test, inform the fire department and persons who would hear the alarm. Environmental factors or the aiming of the detector may cause false alarms or failure to detect during a test. During the monthly inspection, check that detectors are not blocked and that lenses are shielded from direct rays of the sun and other sources of IR, such as welding equipment, in the case of UV detectors. If a detector has a clean lens but fails an operating test, make adjustments and/or perform other field maintenance, following the manufacturer's instructions. Obtain field service by a factory-trained technician or return the equipment to the manufacturer for repair.

3.7.5.Infrared Detectors on IR detectors

The dark spot or dome at the bottom center of each IR device (figure 3.13) is the lens. Detector lenses must be kept clean to ensure the earliest possible detection of a fire. Test at least one detector in each initiating circuit (zone) monthly. Follow a rotation schedule so that all detectors are tested semiannually. A small soldering iron held 6 inches in front of a glowing ember detector can serve as a heat source for testing. A 250-watt IR heat lamp several feet from the detector can serve as a flame substitute in testing an IR flame detector.

3.7.6. Ultraviolet Detectors

Keep UV detector lenses totally clean. A gradual buildup of contaminants frequently found in high-hazard spaces (oil, gasoline, petrochemicals, salt, and dust) block UV radiation. A layer thin enough to be undetectable to the human eye can cause a UV detector to be completely blind. Clean lenses according to the manufacturer's instructions. A test feature designed into some detectors allows for checking the optical integrity of the device. A small UV source inside the detector housing is shielded from directly illuminating the sensor. Local or remote operation of a test switch deactivates alarm circuits and illuminates the test lamp. The test lamp rays then pass through the front window to the sensor. Detector response to the test indicates that the window is clean and that the sensor and electronic circuits are operational.

3.7.7. Water-Flow-Actuated Detectors

Sprinkler water-flow alarm-initiating devices are switches, just as fire alarm initiating devices are. Normally open switches that close upon alarm are frequently used in end-of-line resistor circuits, though some normally closed switches are used in normally closed loop circuits. However, the alarm-initiating devices for sprinkler water-flow mount differently and sense different conditions from fire-alarm-initiating devices. Sprinkler water-flow detectors are generally pressure actuated or vane actuated. Pressure switches are used on both wet- and dry-pipe sprinkler systems. Vane switches are widely used on wet-pipe sprinkler systems.

3.7.8. Pressure Type Of Water-Flow Detectors

Numerous styles of water-flow pressure switches of the pressure-increase type are found in wet- and dry-pipe systems. (Figure 3.15 shows one style.) The usual arrangement for switch actuation includes a sealed accordion like bellows that is assembled to a spring and linkage. The spring compression or tension controls the pressure setting of the switch and may be adjustable and/or factory set to the desired pressure. As water or air pressure in the bellows increases, it expands, providing motion against a spring. The linkage converts the motion of the

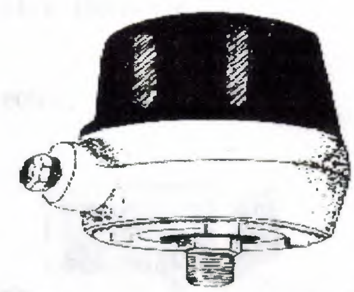


Figure 3.15. Pressure-increase type of water-flow detector.

bellows into the desired motion to actuate the electrical switch. If the pressure switch is used on a wet-pipe system, it is usually mounted at the top of a retarding chamber, which reduces the speed of pressure buildup at the switch. There are also water-flow pressure-increase detectors that incorporate a pneumatic retarding mechanism within the detector housing. The retard time is adjustable to a maximum of 90 seconds with usual settings in the 20- to 70-second range. The retarded switch would be connected to the alarm port of a wet sprinkler system alarm check valve. The usual pressure settings for these switches are in the range of 8 to 15 psi. Pressure-drop detectors can be used in wet pipe sprinkler systems equipped with a check valve that holds excessive pressure on the system side of the check valve. These detectors are most frequently used where a water surge or hammer causes false alarms with other types of water-flow detectors. The construction of pressure-drop detectors is similar to that for pressure-increase detectors. The switch for a pressure-drop detector is arranged to actuate on a drop in pressure, and there is no retarding mechanism or chamber. A typical switch of this type would be adjusted for some normal operating pressure in the 50- to 130-psi range. The alarm pressure would be adjustable to 10 to 20 psi below the normal pressure.

3.7.9. Vane Type Of Water-Flow Detector

A vane type of water-flow detector,

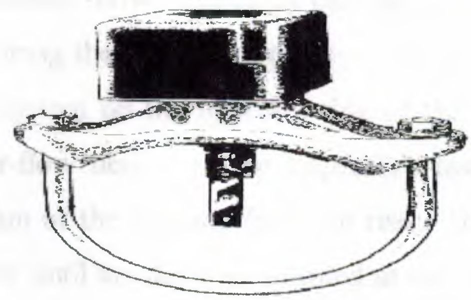


Figure 3.16. Vane type of water-flow detector.

used only in wet-pipe sprinkler systems, is shown in figure 3.16. The vane (a flexible, almost flat, disk) is made of corrosion-resistant material. The detector is assembled to the pipe by drilling a hole in the wall of the sprinkler pipe. The vane is rolled up to form a tube and inserted into the pipe through the hole. Once inside the pipe, the vane springs open, almost covering the inside cross-section of the pipe. The whole detector assembly is clamped to the pipe with one or two U-bolts. Gaskets and other sealing devices prevent leakage of water out of the riser pipe and into the detector housing. Operation of a sprinkler causes water to flow in the system, moving the vane. A mechanical linkage connects the vane to an adjustable retarding device in the detector. The retarding device, which is usually a pneumatic dashpot, actuates the alarm switch or switches and/or signal transmitter if the vane is still deflected at the end of the adjustable delay period. The retarding device prevents spurious alarms by delaying the mechanical actuation of the alarm switch(es) and/or transmitter to allow the vane and retarding mechanism to return to their normal positions after momentary water surges. The retarding-device setting is usually in the range of 30 to 45 seconds, though the maximum setting may be as high as 90 seconds.

3.7.10.Testing Water-Flow-Actuated Detectors

Water-flow-actuated detectors should be inspected monthly for physical damage and for paint on information plates and labels. Replace or repair damaged devices immediately. Clean or replace painted plates and labels. Correct other deficiencies promptly. Test wet-pipe-sprinkler-system-water-flow devices by causing a flow of water equal to that from one sprinkler by opening the inspector's test valve fully. This valve is usually near the end of the sprinkler system on the opposite side of the building from the system riser. For sectional water-flow detectors, the inspector's test valve is usually on the opposite side of the section of the building from the riser. The inspector's test valve is left open to allow full flow until an alarm is indicated at the local control unit or, if the control unit is connected to the base alarm system, until a clear alarm is received at the alarm headquarters. One person with radio or telephone communications at the test valve and one person at each alarm-receiving location are usually needed for testing. The delay between the start of full flow and receipt of the alarm signal should be between 15 to 90 seconds for retarded signals. Detectors that sense a pressure drop should respond in less than 15 seconds. If the alarm has not been received after water has been flowing for 3 minutes, stop the test and determine the cause of the problem. Dry-pipe sprinkler systems have an alarm test valve at the sprinkler riser in the trim piping that allows water from the supply side of the dry-pipe valve to exert supply pressure on a water-flow detector of the pressure-increase type. The alarm test valve is frequently a small lever valve but may be a globe valve. It should be permanently tagged Alarm Test Valve to expedite future testing. The regular trip test of a dry-pipe sprinkler system to check the operating condition of the sprinkler system can also be used to test the water flow detector and alarm system if the tests are coordinated. However, it is not practical to trip-test the dry-pipe valve for every alarm system test. Do not open the inspector's valve at the end of a dry-pipe sprinkler system for an alarm system test unless a trip test is desired. The purpose of these initiating devices is to detect a fire condition and provide that information to the control unit. The control unit energizes the indicating circuit to warn building personnel for evacuation and to inform fire personnel of a fire.

3.8. Alarm-Indicating Devices

Alarm-indicating devices are the lights or sounding devices that indicate a fire alarm or abnormal condition. These lights and sounds may also provide information about where the signal originates. Indicating devices are divided into two major categories: visual (annunciators) and audible (bells, horns, chimes, and so forth).

3.8.1. Annunciators

Annunciators give a visual indication of the "zone" or general area where an alarm originated. In some cases, such as a sprinkler water-flow alarm, the annunciator can be arranged to identify the individual initiating device. In other cases, such as heat detectors, many initiating devices can activate the same indicator on the annunciator. The annunciator indicator can be operated directly by auxiliary contacts in the initiating device or from a connection to the fire alarm control unit. A trouble or maintenance condition in the system wiring is also frequently annunciated by zone. Usually, a yellow or amber light indicates trouble and a red light indicates an alarm signal. An annunciator may be incorporated into the fire alarm control unit, in which case it is generally actuated by connection to the control unit. It may also be located at a remote point, in which case it may be actuated either by the control unit or by auxiliary contacts in the initiating devices. Some installations may have a fire alarm control unit with an integral zone annunciator and a remote annunciator provided elsewhere. Frequently, the control unit standby battery is used to provide power for annunciator operation during power failure. Annunciator visual indicators may be of the drop type or the lamp type. Those of the drop type (which are essentially obsolete) use electromagnetic devices to move a flag into or away from a window to indicate a change in zone condition. Annunciators of the lamp type use pilot light assemblies to indicate an alarm or trouble condition (usually red for alarm, amber for trouble). The more common type of annunciator in use today is the lamp type. Figure 3.17 shows a frequently used incandescent lamp annunciator. More recent annunciator designs use matrices or arrays of light-emitting diodes (LEDs). The advantages of LEDs are low current, long life, and small size, allowing annunciation of many zones in a small space.

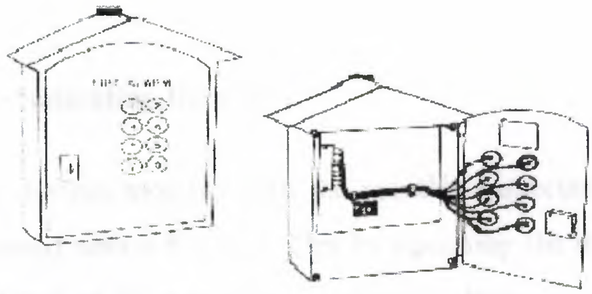


Figure 3.17. Remote annunciator (weatherproof)

3.8.2. Audible Signal Devices

Any device that sounds an audible signal is classified as an audible signal appliance. The audible signal appliances most frequently used in building alarm systems are bells and horns. In addition, there are chimes, cowbells, buzzers, sirens, speakers, air horns, and steam whistles. Audible signals can be used to indicate either a fire alarm or a system-malfunction (trouble) condition. The audible signal appliances are connected to audible signal circuits for alarm or trouble indication (depending on their function) at the control unit. Figure 3.18 shows some of the commonly used audible signal appliances. Audible signal appliances have varying levels of sound output. Louder devices are for areas with high ambient sound levels or where the devices cannot be located near the area to be warned. Hospitals might use softer devices, such as chimes, to avoid frightening patients. Coded building alarm systems normally use single-stroke versions of bells or chimes so the coded signal can be clearly produced. Vibratory bells, chimes, or horns are used for noncoded systems but can also be used in coded systems if the mechanism used can respond rapidly enough to provide an accurate rendition of the code being transmitted. In a building that uses audible signals routinely, such as bells for announcing class periods in school, the fire alarm audible appliances must have a distinct, easily identified sound. If the fire alarm signal is coded, the coding provides the distinctive sound, and it is feasible (though not normal) to use the same bells for both functions. For a noncoded fire alarm system, necessary distinction of sound can be obtained by using a completely different type of audible signal appliance, such as a horn or siren, for sounding fire alarm signals.

3.8.3. Testing Alarm-Indicating Devices

Test alarm-indicating devices monthly with the monthly inspection. When convenient, the test may be combined with a fire drill. Test by operating the drill switch or the test switch at the control unit or by actuating an initiating device. If the test switch or an initiating device is used, notify the remote alarm headquarters because remote signal transmitters

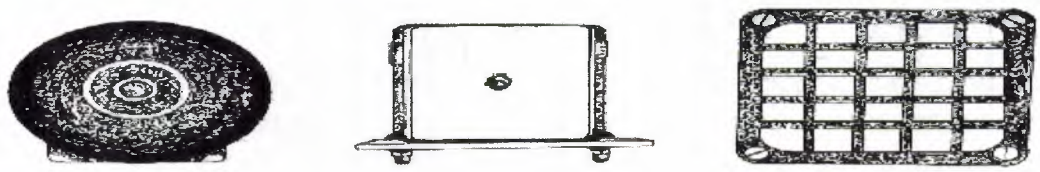


Figure 3.18. Audible signal appliances.

and other auxiliary features will be actuated by such a test. While there is an alarm condition, check all the indicating devices and note any that fail to operate properly. Audible devices should produce loud, clear, consistent tones, and coded system codes should be clearly recognizable. Visual devices should be bright and steady or pulsating, as intended. Test annunciator lamps by operating a "lamp test" switch if it is provided; otherwise, cause an alarm and a trouble condition on each zone. It is usually convenient to cause these conditions at the control unit initiating circuit terminals. When a single indicating' device fails to operate, it is usually defective. If a group of devices fails to operate, the fault is usually a defective circuit.

3.9. Troubleshooting Circuit Faults

Because of the variations in equipment from manufacturer to manufacturer and the numerous types of circuits and devices in use, it is important to have the following reference materials available to personnel responsible for servicing:

3.9.1.Wiring and Equipment Schematic Diagrams.

Complete, accurate wiring diagrams of each type of device in use, of each circuit as installed, and equipment schematic diagrams.

a) Manufacturers' Data Sheets.

The descriptive information in manufacturers' data sheets on all equipment in use and

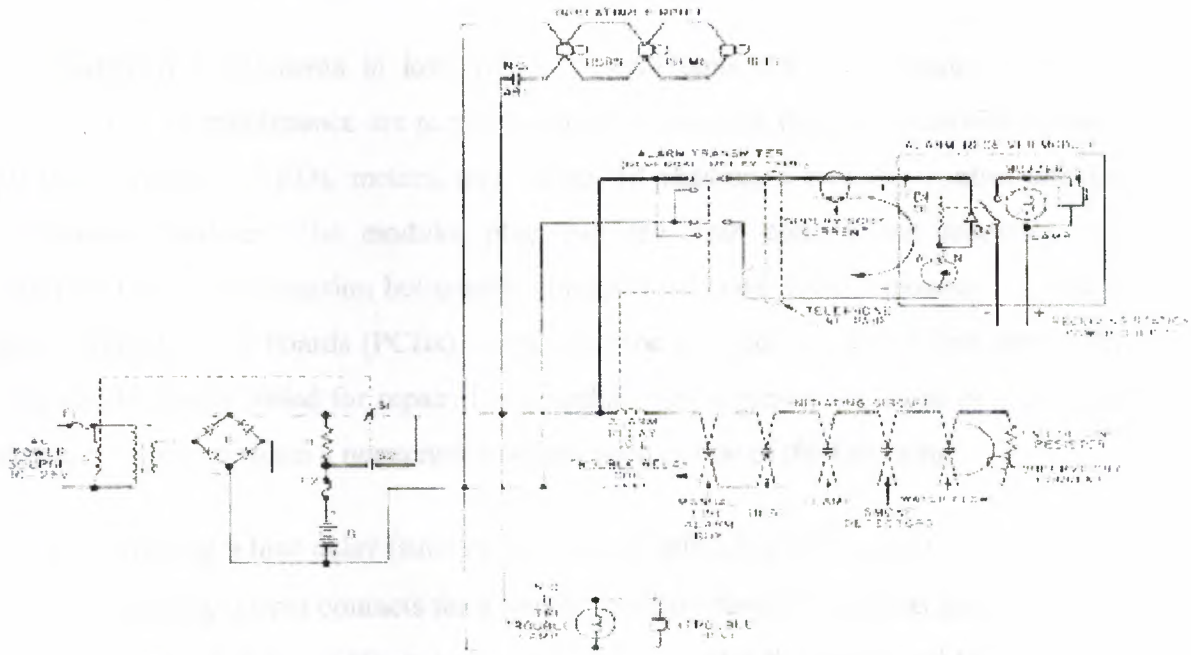


Figure 3.19. Typical fire alarm system schematic diagram.

manufacturers' instructions for any special testing and maintenance.

b) System Revision Information.

Information on all extensions or modifications to existing fire alarm systems.

c) Tags

Identification of wires removed from terminals during repair or testing is essential to ensure accurate reconnection. Improperly connected wires may make a fire alarm device or circuit ineffective or may actually damage equipment. In general, detectors are returned to the manufacturer as a complete package for repair. However, control units and annunciators are large and interconnected with a number of other system components, and there should be some attempt at local repair before you ship the total unit to the manufacturer. Circuit faults may occur in the connection to the power source, in the alarm-initiating circuits, and in the alarm-indicating circuits. Procedures for locating the fault depend on which one of these is involved. Figure 3.19 represents a typical building fire alarm system.

3.10. Power Supply Circuit Faults

The common components in low-voltage control units that may require occasional replacement or maintenance are relays, resistors, capacitors, diodes, transformers, fuses, switches, lamps or LEDs, meters, and wiring. In addition, a modular control unit has replaceable modules. The modules plug into the main control unit assembly. The modules vary in construction but usually contain solid-state devices mounted on one or more printed circuit boards (PCBs). Sometimes the modules are sealed, but more often they can be disassembled for repair. Each module may represent one zone or a group of zones, or it may perform a nonzoned function, such as one of the following:

- Providing a time delay (such as shutting off bells after 15 minutes)
- Providing output contacts for a remote auxiliary function (such as fan shutdown)
- Transferring power (from commercial power to standby power and back)
- Sounding a local trouble buzzer
- Controlling audible signal devices
- Providing a reverse polarity alarm output (for remote station connection)

Use the manufacturer's diagrams and servicing information to narrow down any problems to a small area. If a problem can be isolated to one of these modules or if a problem appears to be related to a zone module, the most immediate repair is to replace the module. If the module is not sealed, inspect it for a condition such as an overheated resistor or transistor, a poorly soldered connection, a bent connector pin, or a malfunctioning relay. Repair or replace the parts, resolder the connection, or straighten the connector pin. For other conditions more difficult to analyze, replace the module. (Keep spares on hand.)

3.11.Caution

Any soldering that is performed, especially in replacement of solid-state devices on printed circuit boards, must be performed with care, following good commercial soldering practice.

3.11.1. Grounded and Short Circuits

A ground fault in the power source wiring will typically cause the building circuit breaker for the fire alarm system to trip. The equipment will continue to operate on standby battery, if one is provided. If the battery is discharged or if no battery is provided, the equipment affected will be out of service, and fire alarm protection will be nonexistent. Because battery capacity is limited and complete discharge should be avoided to prevent permanent damage to the battery, repair the fault immediately.

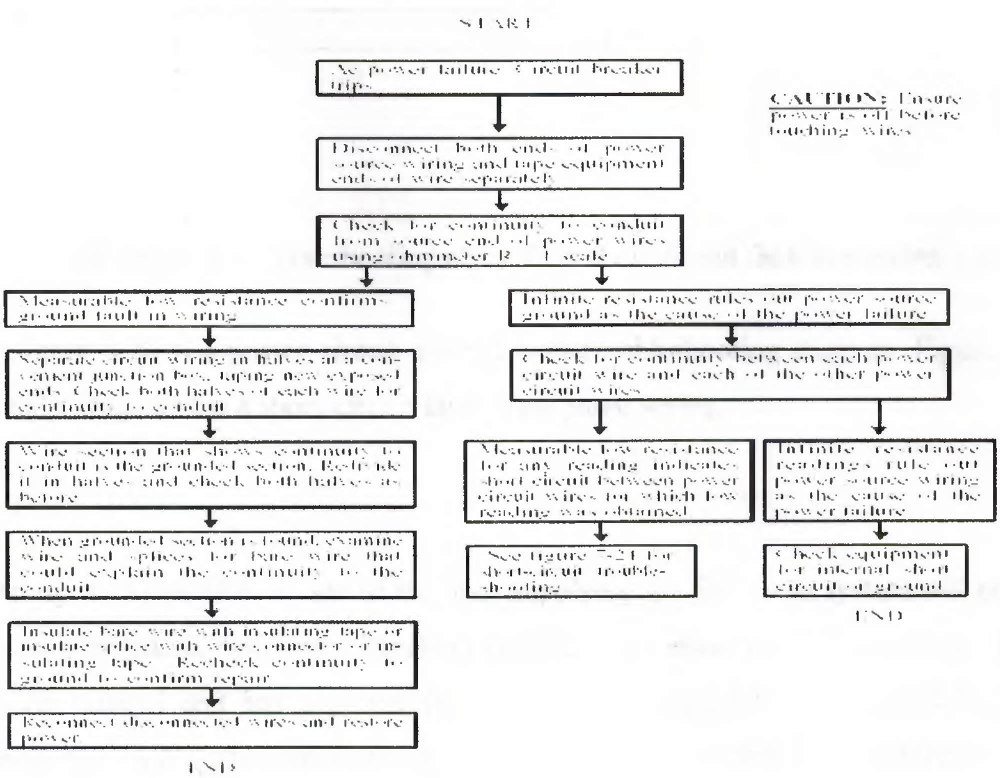


Figure 3.20. Troubleshooting chart for a power circuit ground fault.

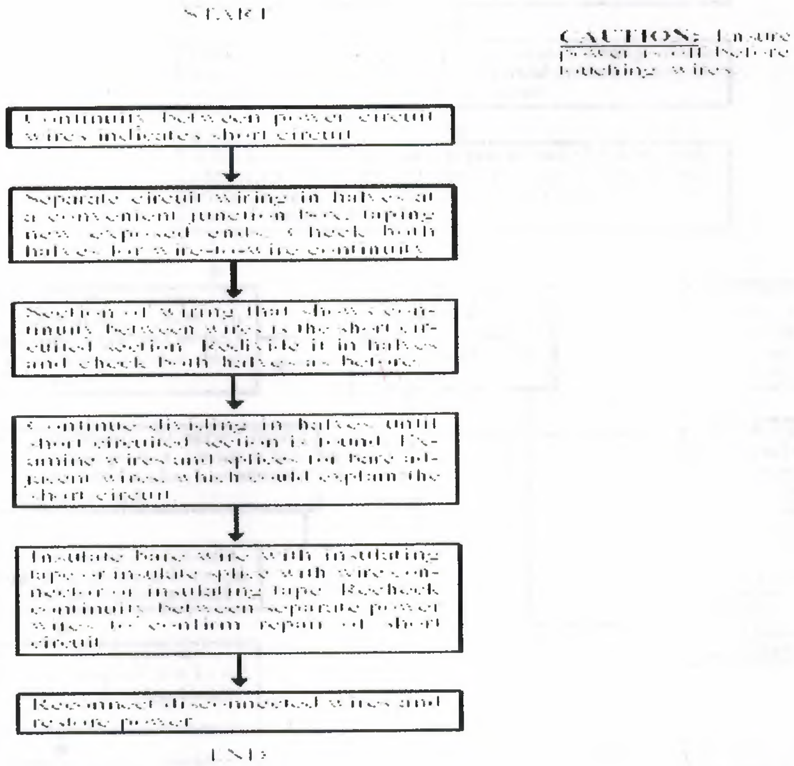


Figure 3.21.Troubleshooting chart for a short circuit fault in a power circuit.

Figure 3.20 is a power circuit ground fault-troubleshooting diagram. Figure 3.21 is a similar diagram for a short-circuit fault in the same wiring.

Open Circuits

An open-circuit fault in one of the lines supplying the fire alarm system will cause signs of power failure, but circuit breakers or fuses may show normal conditions. If the fire alarm control unit has a power failure or trouble signal feature, it will be activated, indicating that a problem exists. Refer to figure 7-22, which is a troubleshooting chart for this condition.

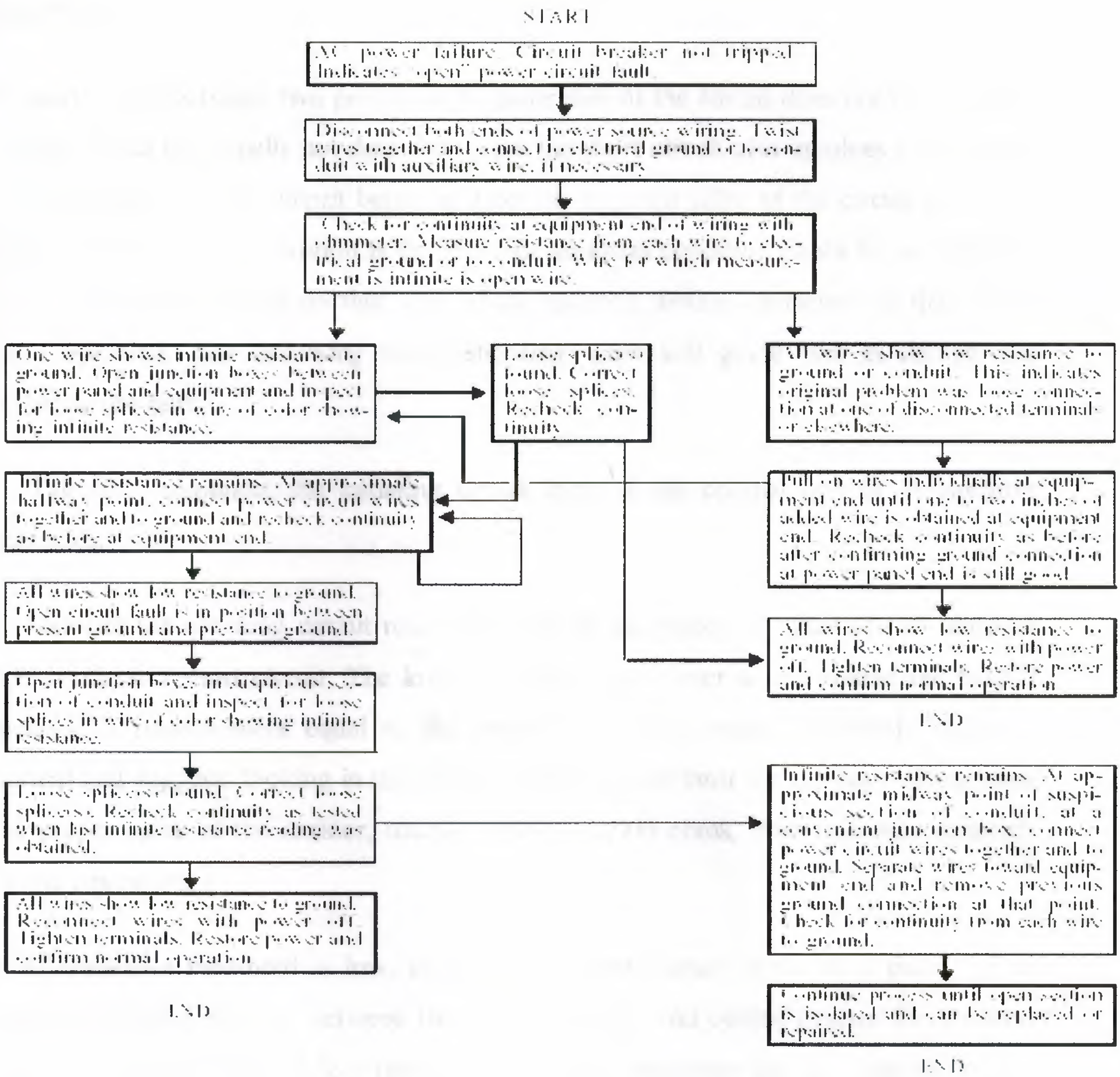


Figure 3.22. Troubleshooting chart for an open fault in power circuit.

3.11.2 Initiating Circuit Faults

Initiating circuits, like power supply circuits, may experience shorts, opens, or ground faults. Operating tests of initiating circuits to locate and repair faults are best performed after normal working hours to avoid disruption of normal activities.

Short Circuit

A short circuit between two points on the same side of the circuit does not harm system operation and is normally not detected unless the short circuit also involves one or more ground faults. A short circuit between wires on opposite sides of the circuit causes an alarm. A clue to this condition is the fact that an alarm condition exists for an initiating circuit, but inspection shows that none of the initiating devices connected to that circuit have operated. The following troubleshooting steps will guide you in finding and repairing the fault:

1. Tag and disconnect the initiating circuit loop at the control unit or annunciator terminals.

2. Measure the initiating circuit resistance with an ohmmeter. A value of 100 ohms or less confirms a short circuit. The lower the value, the closer to the source the fault is located. A measurement equal to the end-of-line resistor value or slightly higher is normal and suggests looking in the control unit or annunciator for the fault. (Determine the proper value of the resistor, usually 1,000 to 2,000 ohms, from reference materials on the equipment.)

3. If resistance measured is low, confirming a short circuit, move to a point that is electrically about halfway between the source and the end of-line resistor for the next resistance measurement. A low resistance, near zero, indicates the short circuit is quite near the test point. A resistance of 50 to 100 ohms indicates that the circuit is a long one of smaller gauge wire and that the short-circuit fault is near the end of the circuit. At each new test location, break both sides of the circuit by disconnecting wires at a convenient initiating device or junction box. Measure circuit resistance in the direction toward the end of the circuit.

4. Low resistance measured from the second location, less than 100 ohms, indicates the short circuit is still farther toward the end of the circuit. High resistance, approximating the end-of-line resistor value, indicates that the short circuit is closer to the control unit.

5. Continue moving toward the short circuit, dividing the circuit approximately in halves each time, and repeat the measurement of resistance toward the end of the circuit using the guidelines in Step 4 as the rule for interpreting each succeeding measurement.

6. When the fault is located, repair it, reconnect the disconnected wires, and restore the circuit to normal service.

Open Circuit

An open-circuit fault in an initiating circuit stops the supervising current. The trouble relay at the control unit or annunciator reenergizes, and trouble indicators are activated for the circuit. Initiating devices closer to the control unit or annunciator than the open *fault may continue to function. Devices beyond the fault cannot operate. If an open-*circuit fault occurs, turn off any audible trouble signals by operating the trouble silence switch. Continue troubleshooting by using the following steps:

1. Tag and disconnect the initiating circuit loop at the control unit or annunciator terminals.

2. Measure the initiating circuit resistance with an ohmmeter. An infinite reading (no change in meter reading from the reading with the meter disconnected from the circuit) confirms an open circuit fault. A measurement equal to the end-of line resistor value, or slightly higher, is normal and suggests looking in the control unit or annunciator for the fault.

3. If the open-circuit fault is confirmed, leave the two circuit wires off their terminals, taped separately. Move to a point that is electrically about halfway between the source and the end of-line resistor for the next resistance measurement. Choose a convenient initiating device or junction box and measure resistance across the two sides of the initiating circuit. If the measurement is still infinite, the open-circuit fault is still farther along the circuit toward the end-of-line resistor. If the measurement is now about equal to the end-of-line resistor value, the open-circuit fault is between the present measurement point and the source.

4. Move toward the fault to a point electrically about halfway between the present measurement point and the end-of-line resistor or the source, and measure resistance across the circuit.

5. Infinite readings indicate the open-circuit fault is toward the end-of-line resistor from the new test point. Readings approximating the end of-line resistor value indicate the open-circuit fault is toward the source.

6. Continue taking new readings, advancing toward the fault. Look especially for loose connections at splices and at initiating-device screw terminals.

7. When the fault is located, repair it, reconnect wires at the control unit or annunciator, and restore alarm service.

Grounded Circuit

A single ground fault on an initiating circuit should not cause any malfunction, but a circuit trouble indication may be caused at the control unit or annunciator if ground-fault detection is a feature of the equipment. Even a single fault should be corrected so that a possible additional fault will not cause a serious deficiency in the alarm system. Two ground faults on opposite sides of the initiating circuit cause a short circuit between the two faults. Follow troubleshooting directions described earlier for a short-circuit fault.

Troubleshoot for a single ground fault using the following steps:

1. Tag and disconnect the initiating circuit at the control unit or annunciator terminals.

2. With an ohmmeter check for continuity between each end of the circuit and an unpainted spot on the electrical conduit or another ground connection, such as a cold-water pipe.

3. Continuity confirms that at least one circuit ground fault exists. An infinite reading suggests looking in the control unit or annunciator for the ground fault.

4. At a point that is electrically about halfway between the source and the end-of-line resistor, break both sides of the circuit by disconnecting wires at a convenient initiating device or junction box. Check for continuity between each wire and ground separately.

5. Each time continuity to ground is found, move toward the ground fault at a new test point about halfway between the present test point and the last previous test point or the end of the circuit in that direction (source or end-of-line resistor). Look especially for wet, pinched, and damaged wire.

6. When the fault is located, repair it, reconnect wires at the control unit or annunciator, and restore alarm service.

3.11.3. Indicating Circuit Faults

An open- or short-circuit fault in an indicating circuit causes a trouble indication at the control unit. A ground fault may also cause a trouble indication if ground-fault detection is a feature of the control unit.

Short Circuit

A short-circuit fault in an indicating circuit is difficult to detect by the usual test methods because the normal circuit resistance is quite low. A short circuit is just a low resistance in parallel with the low-resistance indicating devices. The symptoms would be a blown fuse at the control unit or power supply during a routine system test or fire drill and audible devices that do not operate as loudly as usual. If you suspect a short-circuit fault, the following troubleshooting steps may help locate the fault:

1. There may be several indicating circuits powered from one power supply or fuse in the control unit. Separate the several circuits from each other by tagging the wires and disconnecting them from the control. unit terminals. It may be necessary to make continuity measurements to confirm that the wires from each circuit are tagged separately. Compare the resistance readings for the indicating circuits using the × 1 resistance range of the ohmmeter. If there is a short-circuit fault, that circuit should have a lower resistance reading than the others. Insulate with tape the individual bare wires of the circuit being checked.

2. Determine how the circuit wires are routed, using the best available information you may have to trace the wire or conduit route. Move to a point electrically about halfway between the control unit and the most distant indicating device for the next check. At a convenient initiating device or junction box, separate the wires leading back to the control unit from those leading to the more distant indicating devices by disconnecting them at device terminals or at splices. Measure circuit resistance in both directions. The short-circuit fault should be in the direction of the lower resistance.

3. Move toward the fault to a new test point about halfway between the present test point and the last test point or the end of the circuit in that direction (power source or last indicating device). Separate the wires toward the control unit from those leading away from the control unit and again measure the circuit resistance on the × 1 scale of the ohmmeter in both directions. The fault will be in the low-resistance direction.

4. Continue to move toward the fault, looking for pinched and damaged wires and for improper connections at indicating devices. Make careful measurements at each new test point since the difference between normal and abnormal resistance may be only slight.

5. When the fault is located, repair it, reconnect all wires, test the indicating devices, and restore the alarm system to service.

Open Circuit

In a two-wire parallel circuit, one open-circuit fault near the control unit would deactivate all the indicating devices. The only sign of an opencircuit fault is the failure of one or more indicating devices during an alarm system test or fire drill. The following troubleshooting steps will help locate the fault:

1. Operate the system test or drill switch at the control unit and check the operation of each indicating device on the suspected faulty circuit.

2. Check the circuit connections at any device with intermittent or weak signals. If a group does not work, check circuit connections at the working and nonworking devices

at each end of the group. Make sure that terminal screws are clean and snug and that there are no broken wires at the devices checked.

3. If the fault was not located in Step 2, check the wiring between working and nonworking devices, looking especially for poor splice connections at junction boxes.

4. If all the indicating devices on a circuit fail to work, check for a blown fuse or poor connections at the control unit or at the first indicating device on the circuit.

5. When the open-circuit fault is found, repair the fault and retest the indicating circuit to confirm that all indicating devices work properly.

Grounded Circuit

A single ground fault in an indicating circuit may not cause any symptoms unless the indicating circuit is ac-line powered. If the ground fault is on the "hot" side of the ac circuit and the indicating circuit is tested, a fuse or circuit breaker at the control unit or at the power panel supplying the alarm system will blow. A ground fault on the neutral side of the indicating circuit causes no symptoms. Two ground faults on opposite sides of the indicating circuit are also a short circuit. Troubleshooting for the short circuit may be accomplished as described earlier.

Troubleshoot for a ground fault using the following steps:

1. Tag and disconnect the indicating circuit wires at the control unit.

2. With an ohmmeter check for continuity between each circuit wire and an unpainted spot on the electrical conduit or another ground connection, such as a cold-water pipe.

3. Continuity confirms that there is at least one circuit ground fault. An infinite reading suggests looking in the control unit for the ground fault.

4. If a ground fault in the indicating circuit is confirmed, insulate the bare ends of the circuit wires with tape. Move to a point electrically about halfway between the control unit and the most distant indicating device on the circuit. At a convenient indicating device or junction box, separate the wires leading back to the control unit from those

leading to the more distance devices by disconnecting them at device terminals or at splices. Check again for continuity between each wire and ground separately.

5. Each time continuity to ground is found, move toward the ground fault at a new test point about halfway between the present test point and the last test point or end of the circuit in that direction. Look especially for wet, pinched, and damaged wires.

6. When the fault is located, repair it, reconnect all wires, and test the indicating circuit by operating the drill or test switch. If all devices operate properly, restore the alarm system to service.

3.12. Intrusion Alarms

So many types of intrusion alarm systems or combination systems are available today that a detailed discussion here would not be practical. Each alarm system is of a special nature, and no two systems will ever be identical. For more information on intrusion detection systems, refer to Design Manual 13.02. In this section, we will cover one intrusion system developed to be used by all branches of the service. This system is called joint service interior intrusion detection system (JSIIDS). The system has been designed to protect small arms, ammunition, and sensitive materials in storage.

Purpose

JSIIDS was designed to DETECT, not prevent, an attempted intrusion. The main purpose of JSIIDS or any other alarm is to give the earliest possible notice of an attempted intrusion. The more notice the reaction force (security police) has before the intruder gets past the outer boundaries, the better the chance that the intruder will be caught.

Components

The various components of JSIIDS are of two general classes: (1) the control unit and its sensor components and (2) the monitor and display equipment.

3.12.1. Control Unit

The control unit is the central control element of the JSIIDS. It is located within the protected area. It receives and processes the intrusion tamper and duress alarm signals generated at the sensors. The control unit contains an emergency standby power supply (battery) with an automatic switchover when primary ac power is lost. It operates in much the same manner as emergency lights do. A key switch mounted on the control unit door controls the JSIIDS mode of operation. Three modes of operation are provided as follows:

1. Secure: When the protected area is not open to authorized personnel. In this mode, all alarms are processed.

2. Access: When the area is open to authorized personnel. In this mode, only tamper and duress alarms are processed.

3. Test/Reset: When electricians perform tests and maintenance. All alarms are processed, and a sounding device operates for 10 seconds at the control unit to aid in testing.

3.12.2. Sensor

There are four classes of sensor components associated with the control unit. They are classified as follows:

1. Penetration sensors-those designed to detect penetration into the protected area through doors, windows, walls, floors, ceilings, and other openings in the room.

2. Motion sensors-those designed to detect movement of a person within the protected area.

3. Point sensor-those designed to detect the attempted removal of an item from its normal position in the protected area, such as removal of a rifle from a weapons rack.

4. Duress sensor-those designed to be activated by guard personnel to call for help under a duress situation.

3.12.3.Monitor Cabinet

The monitoring and display equipment is the primary notification equipment of the JSIIDS. The monitor cabinet has a self-contained signal module and primary and emergency power supply. The signal module displays the status of the monitor cabinet power supply; that is, operation on the primary or emergency power source.

3.12.4.Display Equipment

The display equipment is located in an area where monitoring personnel are on duty 24 hours a day. The monitoring equipment consists of a status module or an alarm module, one for each control unit.

3.12.5.Status Monitor Module

The status monitor module displays the status and mode of operation of one control unit. By looking at the lights on the status monitor module, the monitoring personnel can tell what is taking place in the protected structure.

3.12.6.Alarm Monitor Module

The alarm monitor module is used in the monitor cabinets when only an alarm indication is required

3.13.Theory Of Operation

JSIIDS operates on the basic theory of a 20-volt dc circuit that has less than 2,000 ohms of resistance being supplied to the detector or detector processors. This voltage is provided from the control unit. A rise in ohmic value of the circuit to 100,000 ohms will trigger an alarm or tamper condition in the control unit. If you think about that for just a minute, isn't that the way our supervised fire alarm circuit operates? Sure it is! One main point to remember in any alarm system is that a small change in current flow (less than one-tenth of an ampere) can be used to activate an alarm. Our basic Ohm's law provides that a rise in resistance causes a drop in amperage in the same circuit.

When the control cabinet receives an alarm or tamper signal, it then transmits the signal over telephone lines to the monitor cabinet.

3.13.1.Installation

The installation of components of the JSIIDS must comply with the current edition of the National Electrical Coder (NFPA No. 70) and with the following requirements for component mounting, conduit, and conductors.

a) Component Mounting

Wall-mounted components are designed to be held by fasteners that are accessible only through the open door or cover of the component. Before components are mounted, conduit holes should be cut in the enclosure if they are not already provided. All holes should be made with a half-inch chassis punch.

b) Caution

NEVER use a hole saw, since it produces metal shavings that can harm the performance of the equipment.

c) Conduit

All conductors except phone lines outside the protected area are to be installed in rigid galvanized steel conduit or intermediate metal conduit in accordance with article 345 of the *NECR*. Conduit outlet boxes pull boxes, junction boxes, conduit fittings, and similar enclosures are to be cast metal or malleable metal with threaded hubs or bodies. Conduit for JSIIDS circuits is NOT to contain any building wiring. Conduit is required to be at least one-half inch in size. All requirements for tapered threads, supports, bends, locknuts, and bushings are the same as discussed under hazardous wiring. Covers on pull and junction boxes used in the installation of the system have to have a tamper switch installed, or be tack-welded, brazed, filled with epoxy, or provided with twist-off screws.

d) Interior Conductors

Power conductors for 120-volt ac power to control units and monitor cabinets are to be solid copper, no smaller than No. 14 AWG, type RW or RH-RW or THW insulation. Low-voltage conductors are to be no smaller than No. 22 AWG. They are to be installed using crimp-on spade terminal lugs at all wire connections to threaded screws on component terminal boards. All neutral conductors and noncurrentc arraying metal parts of equipment have to be grounded. A wiring diagram of the installed system will be drawn up for each protected area. The diagram should indicate which sensors are installed and show color-coded interconnections between each sensor and the control unit. The diagram will aid in maintenance and troubleshooting. The diagram should be classified confidential and placed in an appropriate security container.

e) Connections

All requirements for installation and component connections for the JSIIDS will be found in the manufacturers' literature. Foldouts are provided, showing block diagrams that include each component used by the JSIIDS. One point you should remember is that several manufacturers using government specifications manufacture JSIIDS components. Always check the terminal boards before connecting your conductors. Although one system may have terminals numbered from left to right, the terminals on the next system you install may be numbered from right to left. Always check before you connect.

f) Maintenance

The JSIIDS should be inspected on a monthly basis as part of your shop's recurring maintenance program. Always inform the reaction force or law enforcement desk before you begin. The system is vulnerable to compromise during maintenance, and for this reason, personnel of the alarm crew should request a security person to accompany them for their own protection. You should alter the schedule of your inspections with a different routine each month. General maintenance of the JSIIDS includes a visual inspection of all equipment, conduits, and boxes. Look for signs of tampering and loose straps or screws, and observe the general condition of flexible cords or conduits. Perform an operation test on all installed sensors, check the power supply for proper voltages, and check the condition of the battery. Return all functions of the system to normal operation, and call the law enforcement desk before leaving. Maintenance procedures for the control unit and each sensor component are listed in the manufacturers' literature.

g) Troubleshooting

The JSIIDS was designed for fast, easy troubleshooting. Inside the control unit is a component called the status processor. Mounted inside the processor are printed circuit boards (PCBs). There is one PCB for the duress switches and one for each group of additional sensors. This means that the group of motion sensors terminates to one PCB, the door contacts to another PCB, and so on. LEDs are installed in the last PCB. An LED looks like a small red lamp that illuminates when the processor receives the initial alarm input. The LED will remain illuminated until the system is reset. When you open the control unit door, you can see immediately what sensor group triggered an alarm by checking for an illuminated LED. Each PCB has test points for a voltmeter. The status of each sensor group can be checked at these test points for a tamper or alarm condition. An alarm condition will give a 20-volt dc reading. When the problem is cleared and the system is reset, the voltage should drop off to zero. Most system malfunctions and troubles will come from a faulty power supply. The JSIIDS requires a constant 20 volts + or - 1 volt to operate. When the power supply starts breaking down, the voltage will start creeping up or down. A voltage reading of less than 19 volts dc or more than 21 volts dc requires the replacement of the power supply.

h) Repair

The major JSIIDS components are designed in modules. Replacing the defective module normally makes repairs to the system. An example is the power supply. It can be replaced after disconnecting and tagging all conductors and removing four screws. The status processor can also be replaced by removing four screws, or a single PCB in the processor can be replaced by a snap-and-pull action. The new PCB is then inserted into the processor. Minor repairs on some components can be completed with the aid of a soldering gun. These components are toggle switches; fuse holders, the mode switch, and so on. Your main concern is to repair the system as soon as possible and bring it back on line. The defective components can then be shipped back to the manufacturer for replacement. The main point to remember when replacing JSIIDS components is to TAG YOUR CONDUC-TORS. One conductor out of place can cause you hours of downtime troubleshooting.

4. PRACTICAL IMPLEMENTATION OF ALARM CIRCUIT

4.1. Equipments that used in this project

Time Circuit Equipments

- 1 x NE 555 IC
- 1 x 470 μF 16 Volt Capacitor
- 1 x 1000 μ F 16 Volt Capacitor
- 1 x 1N 4148 Diode
- 1 x 100 Ω Resistance
- 1 x 1 MΩ Variable Resistance
- 1 x BD 575 Transistor
- 1 x 12 Volt Lamb
- 2 x Micro Switch
- Project Board

Light Circuit Equipments

- 1 x LDR (Light Depending Resistance)
- 3 x 1N4148 Diode
- 1 x 100 kΩ Resistance
- 1 x 100 Ω Resistance
- 1 x 1 MΩ Variable Resistance
- 1 x BD 242 Transistor
- 1 x BC 640 Transistor
- 1 x BD 140 Transistor

Audio Circuit Equipments

- 1 x Dynamic microphone
- 1 x 1 μF 10 V Capacitor
- 1 x 5 μF 10 V Capacitor
- 2 x 50 μF 10 V Capacitor

- 1 x 10 nF Capacitor
- 2 x 470 Ω Resistance
- 3 x 180 kΩ Resistance
- 1 x 150 kΩ Resistance
- 1 x 8.2 kΩ Resistance
- 1 x 10 kΩ Resistance
- 1 x 27 k Ω Resistance
- 1 x 47 kΩ Resistance
- 1 x 3.3 kΩ Resistance
- 1 x 4.7 k Ω Variable Resistance
- 3 x BC 113 Transistor
- 1 x BD 242 Transistor
- 3 x 1N 4148 Diode
- 1 x Relay
- 1 x Switch

4.2.OPERATION OF TIMING CIRCUIT

The +12Volts DC power supply connects in series to D_1 "1N 4007" diode. The operation of D_1 Diode is balancing the +12 Volts power supply , If power supply was connected wrongly to the circuit D_1 cuts the voltage and protects the circuit.

C_1 "16 Volts 470 μ F" Capacitor filters the +12 Volts voltage that comes from power supply and balances the voltage.

R_1 "1M Ω" Variable resistance charges the C_2" 16 Volts 1000 μ F" Capacitor, Product of R_1 and C_2 give to us the time ($T= R_1 * C_2$).

IC_1 "Ne 555" time integrating circuit gives to us time according to charge and discharge positions of C_2 , second legs of IC_1 makes the set operation. 100 k Ω R_1 resistor connects to second leg of IC_1 with +12 volts voltage because R_1 gives very low voltage (0.05 V) to second leg of IC_1 with this low voltage prevents the operation of IC_1.

S_1 switch was connected between the ground and second leg of IC, when S_1 switch closed IC is starting to operate. The third leg of IC gives +5 Volts this voltage that connected with R_2 (100 k Ω) R_2 gets this voltage and gives to Base of Transistor that also connected To Tr_1 "BD 140" Tr starts to operate so the lamp will be ON that connected to transistor. Fourth leg of IC is "reset" between the fourth leg of IC and ground there is S_2 switch when pressed to S_2 IC will stop and turns to initial condition.

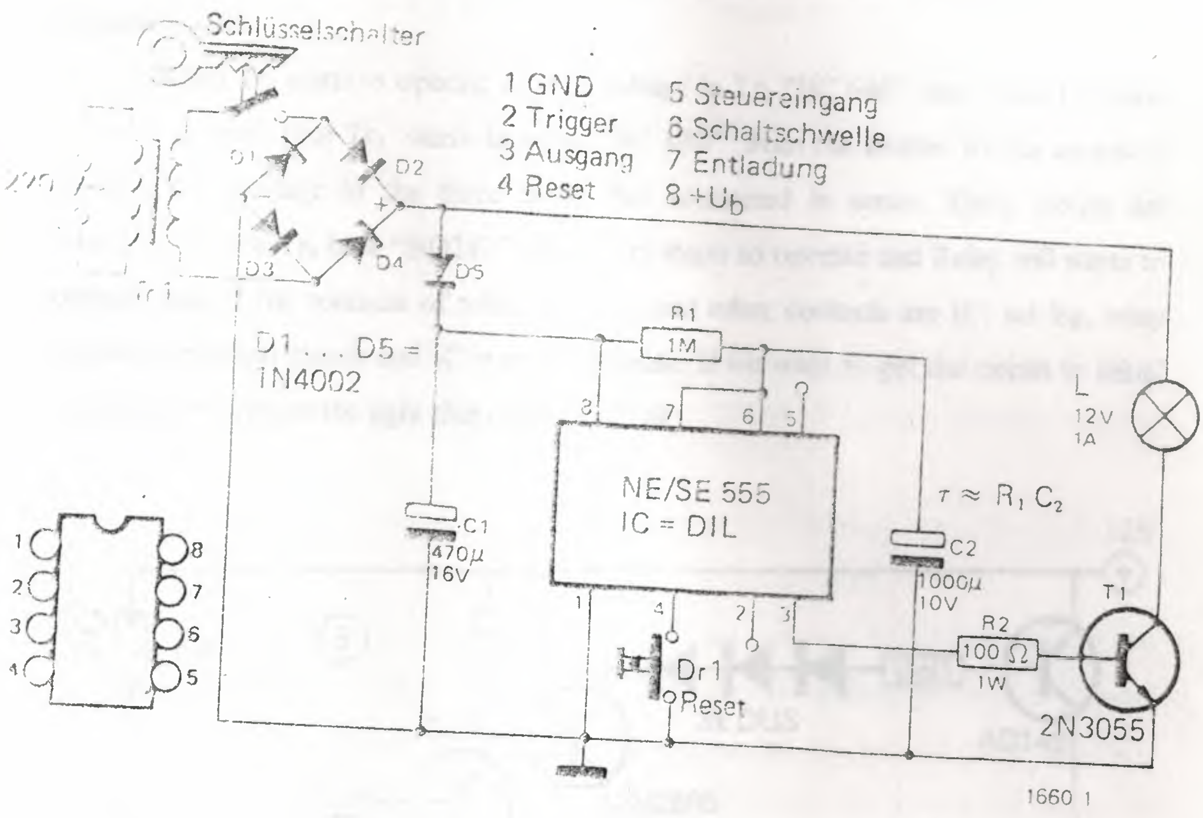


Figure 4.1. Timing Circuit

4.3. Operation of Light Circuit

+12 Volts that comes from power supply connected to LDR "Light Depending Resistance"LDR is working when light comes because the empedance of LDR drops and starts to transmit voltage. If light does not come the empedance of LDR increases and it does not transmit voltage.

When light comes to LDR starts to transmit +12 V than R_1 "1MΩ" takes this voltage and transmits to ground in this way the sensitivity of circuit is adjusted. R_2 "100k Ω" resistance connects between LDR and R_1 in parallel and R_2 starts to work, with the voltage that its sensitivity adjusted and it gives this voltage to the Tr_1 "BC 640" transistor base.

When Tr_1 starts to operate it gives voltage to Tr_2 "BC 640" base. Also Tr_2 starts to work at same time Tr_3 starts to work "BC 140" from the emitter of this transistor gives 0.5 V voltage to the three diode that connected in series. These diodes are connected to the Tr_4 base "BD242". When Tr_4 starts to operate and Relay will starts to operate one of the contacts of relay is the ground other contacts are IC_1 set leg, relay contacts are short circuit and IC starts to operate. If we want to get the circuit to initial condition we will cut the light that comes to LDR.

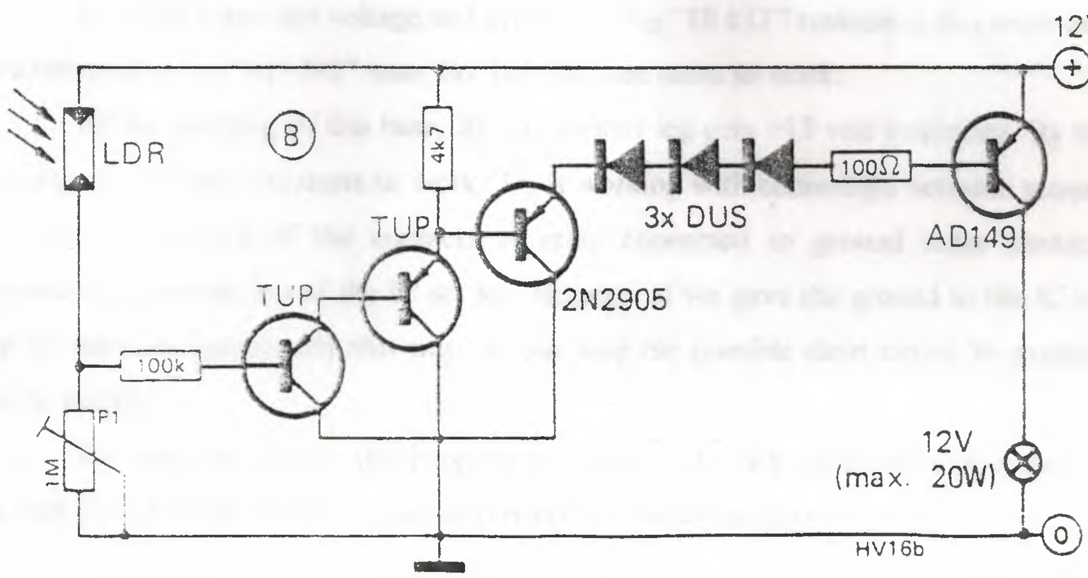


Figure 4.2. Light Circuit

4.4. Operation of Audio Circuit

Dynamic microphone is taking the sounds from the outside and turns it to electric signal. C_1 "10 V 1 μF" cuplaj condansator gives the electric signal to Tr_1 "BC 327" transistor and works the Tr_1 transistor R_1 "150 k Ω" resistance gives +9 Volt to Tr_1 transistor. The coming voltage is passing through the collector to the emitter and works the Tr_2 "BC 327" transistor by the help of R_2, R_3 "180 kΩ" resistance the Tr_1 and Tr_2 transistors works a while after their starts. R_4 and R_5 (470 Ω) resistance are connected between around and emitters of transistors.

By that a difference is obtained in voltage. The obtained difference is used to contains the base of C_2 "25 V 5 μF" R_6 "180 k Ω" resistance makes the Tr_3 to work a little while after the sound stops. R_7 "47 kΩ" resistance balances the voltage that comes to the Tr_3 base. R_8 resistance is connected to Tr_3 collector. Tr_3 collector is giving us the voltage that we need for the following steps. C_3 "10 V 50 μF" R_4 "3.3 kΩ" and R_{10} "147 kΩ" resistances balances the working of the circuit according to the voice of the sound.

C_4 "10 V 50 μF" capacitor cuplajes the voltage to the next circuit which is coming from the Tr_1 collector. The voltage to D_1 "1N 4148" diode. Which is coming from C_4 cuplaj.

D_1 diode takes this voltage and gives it to R_{12} "18 kΩ" resistance. R_{12} resistance is connected to Tr_4 "BD 242" base. So that this base starts to work.

By the working of this base, the Tr_4 emitter leg gets +12 volt electricity. By the coming of +12 volt, Tr_4 starts to work. Tr_4 is working with connection between ground leg and Relay. One of the contacts of relay connected to ground other contacts connected to second leg of the IC set leg. Because of we gave the ground to the IC set leg IC starts to operate. By this way we can stop the possible short circuit by pushing the S_1 switch.

We reset the circuit, this happens because of +12 volt electricity that comes to 12 volt D_3 "1N4148" diode and circuit turns of the initial condition.

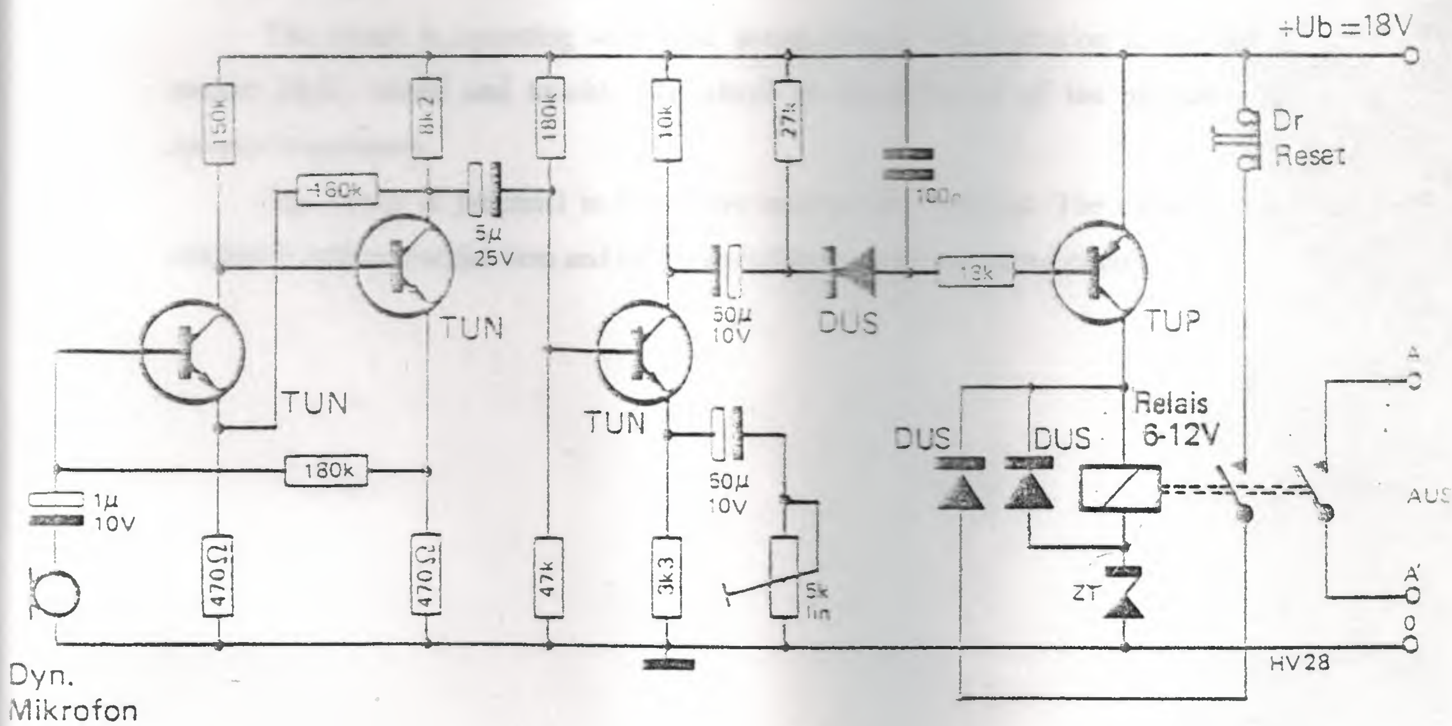


Figure 4.3. Audio Circuit

CONCLUSION

The circuit realized in this project is an alarm circuit composed of integrating three different circuits.

The circuit is operating with light, sound, touch. The activation is realized by sensors (light, sound and touch). The circuit is applicable to all the mediums that security is necessary.

The circuit is prepared in laboratory mediumand operated. The circuit cost is 11000000 million Turkish liras and this is an optimum value for such a circuit.

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