MECHANICAL ACTION FUZES

1. General.

As you know, a certain amount of heat or shock is required to have explosives burn or detonate. Bombers use various mechanical devices to produce this heat or shock. During this class, we are going to analyze some devices requiring a mechanical action(s).

2. Definitions.

a. Mechanical fuze - any mechanical mechanism that is employed in a hazardous device and designed to function only when acted upon by an outside force.

b. Mechanical fuse types:

(1) Manual - Any mechanism that requires physical action; i.e., pressure, pull, or pressure release to actuate the device.

(2) Barometric - A bellows or balloon system which will expand or contract on altitude (air pressure) or pressure changes opening or closing electrical contacts.

(3) Hydrostatic - A bellows or balloon system which will expand or contract on depth (water pressure) or pressure changes opening or closing electrical contacts.

(4) Thermal - Any heat sensitive device that will open or close a switch when the proper amount of heat or cold is applied.

(5) Material fatigue - Any material, used as a delay, that will deteriorate, break, or weaken and cause a circuit to be completed.

3. Functional Analysis of Mechanical Mechanisms (fuzes):

a. Manual Fuzes -

(1) Mouse trap. (Pressure Release or Pull) One wire is connected to the bale of the mouse trap and the other to the wooden base of the trap.

(a) Method of employment.

(b) Mouse trap switch may also be used as a percussion type using the striker as a firing pin and a shotgun shell as detonator.

(2) Letter bomb.

This device is contained in an airmail envelope. The firing device assembly is comprised of a machined brass housing in which is placed a steel spring, firing pin, primer cap, and primer anvil. This assembly, which is actuated by a pressure release lever hinged at one end of the housing by means of a steel pin, is mounted in tandem with a blasing cap. The assembly is activated when the letter is opened, thereby allowing the lever to release the firing pin to hit the primer cap which is driven against the anvil causing a flash to enter the blasting cap and detonating the main explosive charge.

(3) Pressure.

(a) Penny match box fuze.

This fuze is constructed by weaving one bare wire laterally back and forth through the lower (sliding) section of a penny match box. The other contact wire is wrapped longitudinally around the top portion of the match box. A pressure (1 to 2 pounds) applied to the match box completes the electrical circuit and fires the explosive charge.

(b) Tin can strips.

This is a simple electrical pressure fuze constructed of bent strips of a tin can. Pressure on the upper pieces of tin causes it to bend and make contact with the lower piece thus completing the firing circuit.

(c) Tin can lids.

This fuze is made from two can lids. The lids have holes punched through them and a wire soldered to each lid forming a switch. When this fuze is used, a piece of paper is placed between the two lids to act as an insulator. When pressure is applied, the sharp edges of the holes cut through the paper insulator and metal to metal contact is made detonating the explosive charge.

(4) Clothespin switch (pull/tension release). This switch consists of a clothespin, two metal contacts, insulator, and a trip wire. A pull on the trip wire will dislodge the insulator from between the jaws of the clothespin and the spring action of the clothespin forces the two metal contacts together completing the electrical circuit.

____

____

____

(a) This type of switch is normally employed in an electrical circuit.

____

____

____

(b) Switch was used in a device found in Des Moines, Iowa, on 21 Jun 70. Device was a steel tool box with removable tray. The pull wire was attached to tray and designed to function when the police officer removed the tray to inspect components of box.

____

____

____

(5) Wire loop fuze.

This pull fuze consists of two pieces of insulated wire, whose ends have been stripped of the insulation and twisted into loops. The straight portion of each wire is then passed thru the looped portion of the other. In the slide, the white wire has been solidly fastened to the block. A rubber band prevents the bare loops from contacting one another. Anyone pulling on the string would overcome the resistance of the rubber band and cause the two bare wire loops to contact, completing the electrical circuit and detonating the bomb.

____

____

(6) Trembler/Vibratory Switches.

(a) Trembler and vibratory switches are actuated by movement or vibration. Used as a primary or auxiliary firing mechanism. Most hazardous to a bomb disposal person. Devices using these switches usually incorporate an arming delay to allow safe separation for the person emplacing the device.

(b) Clock leaf spring.

This vibratory fuse is constructed from a piece of leaf spring of an alarm clock. The right end of the spring has been glued to a board. The left end of the spring has a weight attached to increase sensitivity. Two nails have been driven into the board on either side of the weighted end, and electrical contact wires secured to the nails. Any movement of this fuse in a horizontal plane would function it.

(c) Metal ball switch. The metal ball switch is constructed to two "U" shaped pieces of copper wire, a metal ball, and a base. This switch will close an electric circuit when it is tipped in any direction.

(7) Tilt.

(a) Mercury switch (tilt). Consists of a glass envelope with leakproof ends, rigid, metal electrodes fuzed to its walls, and a pool of mercury. When the switch is tilted, the mercury flows over and around the electrodes and contact is made completing an electrical circuit. An arming delay (clock or timer) is usually employed in the circuit. Switches may be found in pairs, wired in parallel so that the device may function by either tilting or rolling.

(b) Pill bottle pendulum.

This fuze is constructed from a small pill bottle, a contact ring made of brass window screen, and a pendulum hanger which passes through the plastic cap of the bottle. Tilting this fuze causes the pendulum to swing and touch the contact ring completing an electrical circuit.

(c) Ball switch (door knob device). This device consists of a metal tube, a cork, a ball bearing, and two nails arranged as shown. The safety pin is withdrawn when the switch is installed. When the tube is rotated sufficiently, gravity rolls the bearing into contact with the nail and completes an electric circuit.

(d) Shallow dish (ball bearing).

In this fuze, two aluminum discs have been hammered into shallow dishes. Wires are attached to each dish. An insulating ring of cardboard, rubber, or plastic is cut and glued to one metal dish. A steel ball bearing is then placed in the disk and the two dishes are glued together. When the fuze is tilted, the ball bearing comes in contact with the two dishes and an electrical circuit is completed.

c. Hydrostatic fuze. This device is made from a can with an inner tube or any type of rubber. The tube is stretched across the top of the can. The contact is positioned under the tube. The spacing between the contacts determines the depth at which the charge will detonate. As the can descends in depth, the water pressure forces the rubber cover in, pushing the two contacts together in order to complete the circuit.

d. Thermal fuses - Functions by temperature change, either an increase or decrease.

(1) Bi-metal. Two contacts separated and attached to one terminal of the battery. A bi-metal strip is placed between the two contacts and attached to the other terminal of the battery. At a predetermined temperature, the bi-metal strip is not making contact with either of the other contacts. With a change in temperature, the bi-metal strip will move and will complete the firing circuit.

(2) Soluble Material.

(a) (Clothespin and wax). This device employs the clothespin technique and any soluble substance that will disolve with heat. The substance, wax, is placed between the open contacts of the clothespin. When enough heat is applied, the wax melts thereby completing the firing circuit. The time delay can be controlled by the type and thickness of the wax used.

(b) Clothespin and Ice Cube. This thermal delay switch consists of a clothespin which is set in an ice cube tray and placed in a freezer until the water freezes around the finger grips. As the ice melts, the jaws of the clothespin will snap together and complete the electrical circuit.

(c) Hacksaw blade and ice cube.

In this fuze, a hacksaw blade with a wire soldered to it has been fastened to a flat piece of wood. Pressed into the flat board directly under the end of the hacksaw blade is a thumbtack with a wire soldered to it. The hacksaw has been bent upwards and an ice cube placed between the blade and the board holding the contacts open. As the ice melts, the hacksaw blade moves downward until contact is made thereby completing the electrical circuit.

(d) Mousetrap with paraffin.

This fuze consists of a mousetrap wired into a spring loaded electrical switch. The snap bar is held in the cocked position by a block of paraffin. The paraffin is held in position by a wood screw passing upwards through the wooden base of the mousetrap and screwed into the paraffin. As the day warms up, the paraffin will soften and the snap bar will cut its way through until it is free to snap over and complete the electrical circuit.

(5) Thermal loss delay.

On September 21, 1972 a device consisting of twenty (20) sticks of Hercules 40% dynamite was placed inside a JP-4 jet fuel storage tank containing approximately 640,000 gallons of fuel. The storage tank was located at K. I. Sawyer AFB (SAC) Michigan.

The fuse for the device was a thermal loss delay using the thermostat element off a WRAP-ON automatic electric heat tape with a temperature setting of approximately 38 degrees.

The fuze functioned and detonated the blasting cap but fuel oil had entered the plastic bags in which the device was wrapped thereby desensitizing the dynamite and preventing a high order detonation.

The device was removed from the storage tank by Air Force EOD personnel and rendered safe by the Michigan State Police Officers.

(e) Material Fatique Fuzes - Works on deterioration of a material in order to close electrical contacts or release a cocked firing pin.

(1) Wire solder delay. A piece of wire solder is fitted into a previously notched area on the finger grip portion of a clothespin switch and twisted tight. When ready for use, the pressure of the clothespin spring begins to slowly stretch out the wire solder. Depending on the diameter and type of wire solder used, varying delays may be selected. (1/16 inch rosin core solder produced time delays from 55 minutes to 1 hour and 15 minutes.)

(2) Surgical tubing delay. A length of rubber tubing (surgical tubing is excellent) is slipped over the finger grip portion of a clothespin switch. A small nick is cut in the forward edge of the tubing. The spring pressure of the finger grip portion of the clothespin on the surgical tubing causes the rubber to slowly tear from the cut end toward the opposite end of the tubing.

INCENDIARY MATERIAL AND CHEMICAL INITIATING DEVICES

GENERAL

Fire has been used by military forces as a weapon of war for centuries. Today, it is used as a prime weapon by malcontents, subversives, revolutionaries, and others. In this class, we will study various means and types of devices used to start and accelerate fires.

DEFINITIONS.

Fire. The state at which ignited fuel or other materials combine with oxygen, giving off light, heat, and flame. There are three requirements: (1) the fuel or oxidizable material must reach (2) a certain temperature (heat) in the presence of (3) oxygen (usually air), unless the material being used has the ability to produce its own oxygen.

Ignition Temperature. The temperature at which an oxidizable material will ignite without having a flame or spark applied to it. Gasoline, for example, has an ignition temperature of 495 degrees Fahrenheit.

Flash Point. The lowest temperature at which a liquid will give off enough vapor to ignite if you apply a flame to it. Gasoline, for example, has a flash point of (−45 degrees Fahrenheit.) At the flash point, a liquid produces vapor that will burn only as long as an ignition source is present.

Fire Point. The temperature, usually a few degrees above flash point, when the vapors will continue to burn after removal of the ignition source.

Explosive Limits. Strict upper and lower limitations of flammable solids and liquids between which they will burn or explode. The explosive or flammable limits of a material refers to the ratio between the amount of potentially flammable vapor mixed with ambient air or oxygen. The lower limit is the minimum concentration of vapor in air or oxygen below which the propagation of flame does not occur on contact with a source of ignition. Likewise, there is a maximum concentration above which ignition does not occur. Example: Gasoline - upper limit 7.6%, lower limit 1.4%.

Spontaneous Combustion. The ignition of a substance from the rapid oxidation (combining with oxygen) of its own elements without heat from any outside source. For example, stacked green hay may burst into flame if not properly ventilated.

Igniter. A device or compound used to ignite an incendiary charge.

NOTES

SHINY BLACK RESIDUE INDICATES ACID.

Pyrotechnics. Chemical compounds that, when they burn, produce effects such as light, smoke, heat, and gas pressures. They can also be used for delay timing.

Corrosive Chemical Action. The eating away or decomposing of various materials by chemicals. These chemicals are used in firing devices for a delay and/or initiating action. Corrosive chemical action may complete firing circuits or release strikers.

Hypergolic Action. To ignite or burst into flame on contact. Hypergolic chemicals can be used to start incendiary fires or to initiate certain explosive devices when brought into contact with each other.

IMPROVISED INCENDIARY MIXTURES.

Chlorate and Sugar (50% potassium chlorate and 50% sugar).

Plaster of Paris (calcium carbonate and aluminum powder).

Thermite (60% ferric oxide (rust), and 40% aluminum).

PETROLEUM PRODUCTS.

Thickened Gasoline. Gasoline mixed with one of the following: (soap flakes, styrofoam, motor oil, rubber bands, or military thickener.)

Solvents. (Used in the same manner as gasoline, but tend to be more volatile than gas.)

Wax. (Sometimes is mixed with wood shavings or saw dust to form blocks.)

Burnol Backfire starter, Astro Lite, and charcoal lighter.

Military M-2 Fire Starter.

Self-Igniting Molotov Cocktail (2/3 gas, and 1/3 acid, potassium chlorate and sugar on outer label of container.)

Self-Igniting Molotov Antipersonnel Cocktail.

TYPES OF INITATING DEVICES.

Pyrotechnic.

- Matches.
- Firecracker fuze.
- Safety fuze.
- Cloth wick.
- Road flares.
- Sparkers.
- Light bulb tissue paper.

NOTES

Chemical.

- Copper pipe disk and sulfuric acid.
- Rubber diaphragm and sulfuric acid.
- Ping-pong ball and acid.
- Wax milk carton and acid.
- Brown paper and cardboard glycerin.
- Rubber bands soaked in gas. (Rubber bands contract when the gas evaporates.)
- Other chemicals that are sometimes used are:
  - Water.
  - Brake fluid.
  - Score hair cream.
  - Lestoil.

Hypergolic mixtures.

- Nitric acid and metal powders.
- Sulfuric acid, chlorates, and sugar.
- Potassium permangnate and glycerin.
- Sodium peroxide, sugar or powdered metals, and water.
- Iodine crystals, aluminum powder, and water.
- Calcium hypochlorate (HTH), brake fluid, Lestoil, glycerin, and Score hair cream.

SAFETY PRECAUTIONS.

Clothing. Public safety personnel who are responsible for handling and disposing of chemicals, or incendiary devices containing chemicals or their residues, should wear adequate protective clothing. Some important articles of clothing are as follows:

- Nomex coveralls, gloves, and hood.
- Safety goggles (acid proof).
- Rubber gloves and apron for handling acids.
- Scott pack (self-contained breathing apparatus).

Toxicity. Since chemicals are toxic when ingested or absorbed, take the following precautions:

- Avoid breathing chemical fumes.
- Chemicals have slower reaction time when temperature is below 50° Fahrenheit, or when it is damp.
- Observe wind velocity and direction.
- Use proper containers for chemicals and keep fueling agents such as brake fluid, Score hair cream and glycerine away from oxidizers, HTH, and potassium chlorate.

NOTES

- Avoid contact with chemicals. (Even chemical residues can cause a reaction if they contact your skin.)

Equipment. The following equipment should be on hand at all times:

- Common equipment for dealing with hazardous devices.
- First aid equipment for burns.
- Respirator, protective masks, and oxygen breathing apparatus.
- Fire extinguisher types.
  - Water. For petroleum, sawdust, and wax incendiaries.
  - CO_2. For sawdust, wax, and petroleum incendiaries.
  - Dry chemical. For sawdust, wax, and petroleum based products.
  - Dry sand. For most incendiary materials.

NOTES

MATERIALS COMMONLY USED FOR INCENDIARY DEVICES

MATERIAL	PHYSICAL APPEARANCE	NORMAL CONTAINER	HEALTH HAZARDS	REACTIVITY
Aluminum Powder	Silver or gray powder metal.	Cans, barrels, drums, boxes, and bottles.	Respiratory and eye irritant.	Forms explosive mixtures in air; reacts with some acids and caustic solutions to produce hydrogen.
Calcium Hypochlorate	White pills or powder with strong chlorine odor.	Air-tight cans, drums, and bags.	Irritating to skin, eyes, and respiratory tract.	Produces chlorine gas in contact with acids or moisture. Ignites when in contact with combustible and organic materials.
Ferric Oxide	Reddish-brown powdered metal (rust).	Bottles, barrels, drums, and boxes.	Respiratory and eye irritant.	Relatively nonreactive.
Gasoline	Liquid, color varies depending on dyes added.	Metal, glass, or plastic.	Toxic if ingested. Avoid breathing vapors. Liquid is explosive and flammable.	Sensitive to flame, sparks, and static electricity.
Glycerin	Clear, heavy, sticky liquid.	Glass or plastic containers.	No inherent hazard.	Reacts with calcium hypochlorate and potassium permangnate.
Iodine Crystals	Dark blue-red crystals with metallic sheen.	Bottles and boxes.	Poisonous if inhaled or swallowed. Skin contact also toxic. May cause burns to skin and eyes.	Reacts with water generating sufficient heat to cause combustion of certain materials.
Magnesium	Silvery metal (solid or powder), looks like aluminum.	Powder is shipped and stored in tightly closed bottles, boxes, and drums; solid is shipped as ingots, billets, castings, or forgings.	Dust is light irritant.	Combustible metal powders form explosive mixtures with air. In powder form, will react with water and acids to release hydrogen.

MATERIALS COMMONLY USED FOR INCENDIARY DEVICES

MATERIAL	PHYSICAL APPEARANCE	NORMAL CONTAINER	HEALTH HAZARDS	REACTIVITY
Nitric Acid ↑ VERY DANGEROUS.	Colorless, clear liquid, producing yellow or reddish fumes.	Glass containers.	Causes severe tissue burns. Fumes are toxic, highly caustic and corrosive liquid.	Dangerous reaction with many materials. Explosive reaction with metallic powders, carbides, hydrogen sulfides, turpentine, and cyanide.
Potassium.	Transparent colorless crystals or white powder.	Steel drums, barrels, fiber containers, and bottles.	Toxic if ingested. Produces toxic fumes in fire.	Powerful oxidizing material. Forms explosive mixture with combustible, organic or other easily ignited, easily oxidized materials.
Potassium Permangnate	Dark purple crystals with blue metallic sheen.	Bottles and cans.	No inherent hazard.	Powerful oxidizing material. Explosive when in contact with sulfuric acid or hydrogen peroxide.
Sodium ↑ TRANSPORT SUB-MERGED IN MINERAL OIL.	Silver, waxy-like metal, turns grayish-white when exposed to air.	Hermetically sealed cans, drums, and tank cars.	Solid material causes severe skin and eye burns. Fumes from burning sodium are highly irritating to skin, eyes, and mucous membranes.	Extremely dangerous in contact with moisture or water hot enough to cause ignition or explosion.
Sodium Peroxide	Yellowish-white powder, turns yellow-brown when heated.	Glass bottles, cans, boxes, and metal drums.	Toxic if ingested. Avoid breathing dust. Irritating to skin and eyes.	Reacts vigorously with water. Mixtures of sodium peroxide and combustible, organic, or readily oxidizable substances are explosive and ignite easily by friction or contact with water.

MATERIALS COMMONLY USED FOR INCENDIARY DEVICES

MATERIAL	PHYSICAL APPEARANCE	NORMAL CONTAINER	HEALTH HAZARDS	REACTIVITY
Sulfuric Acid	Colorless, clear, slightly oily liquid.	Glass or teflon containers.	Causes severe deep burns to tissue. Very corrosive.	Explosive when mixed with potassium permangnate. Incendiary when mixed with black powder, potassium chlorate, match heads, sodium peroxide, and calcium hypochlorate.
Thermite	Reddish-brown powder with a slight silver sheen.	Normally used as a filler in military ordnance.	Respiratory and eye irritant.	Extremely sensitive to spark, friction, and shock.

INTRODUCTION

This special text, used in the Civilian Confidence Competance Course (CCCC), contains information on various switches and circuits that either have been or may be encountered in hazardous devices. It is not intended to be an electronics guide, but rather a description of how various switches function and how they are used as electrical action fuzes in arming and firing improvised explosive devices.

As technology increases the likelihood of encountering hazardous devices using these and other sophisticated switches is increased.

To help you familiarize yourself with the electronic circuitry, we have inserted a page in the back of your text showing the most common electronic symbols. A symbol is a simplified design representing a part in a schematic circuit diagram.

REVIEW OF DIRECT CURRENT.

Figure 1 shows the relationship between current, voltage, and resistance.

Figure 1. Ohm's Law Equations.

Requirements for a Circuit. Figure 2 shows a basic DC circuit. The components needed to make the circuit work are:

- Source (power supply, usually a battery)
- Conductor (wire)
- Load (initiator)

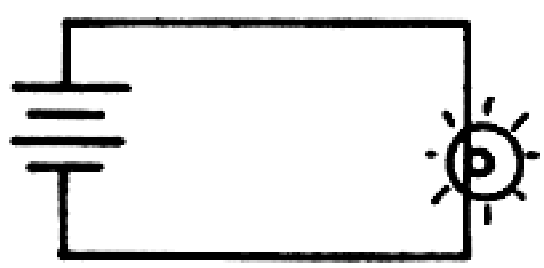


Figure 2. Basic DC Circuit.

Types of Circuits.

- Figure 3 shows a series circuit (current travels one path).

Figure 3. Series Circuit.

• Figure 4 shows parallel (shunt) circuits (current travels more than one path).

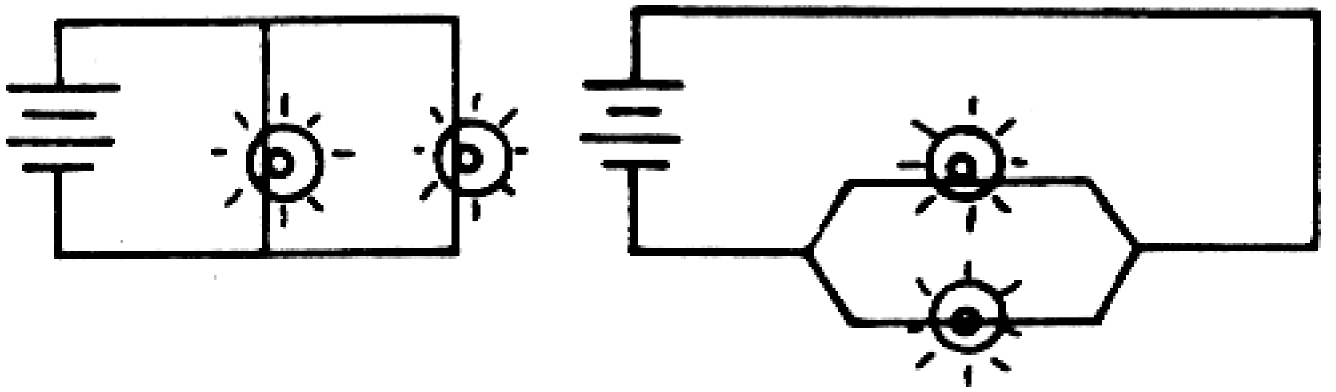


Figure 4. Parallel Circuit.

• Figure 5 shows series - parallel circuits.

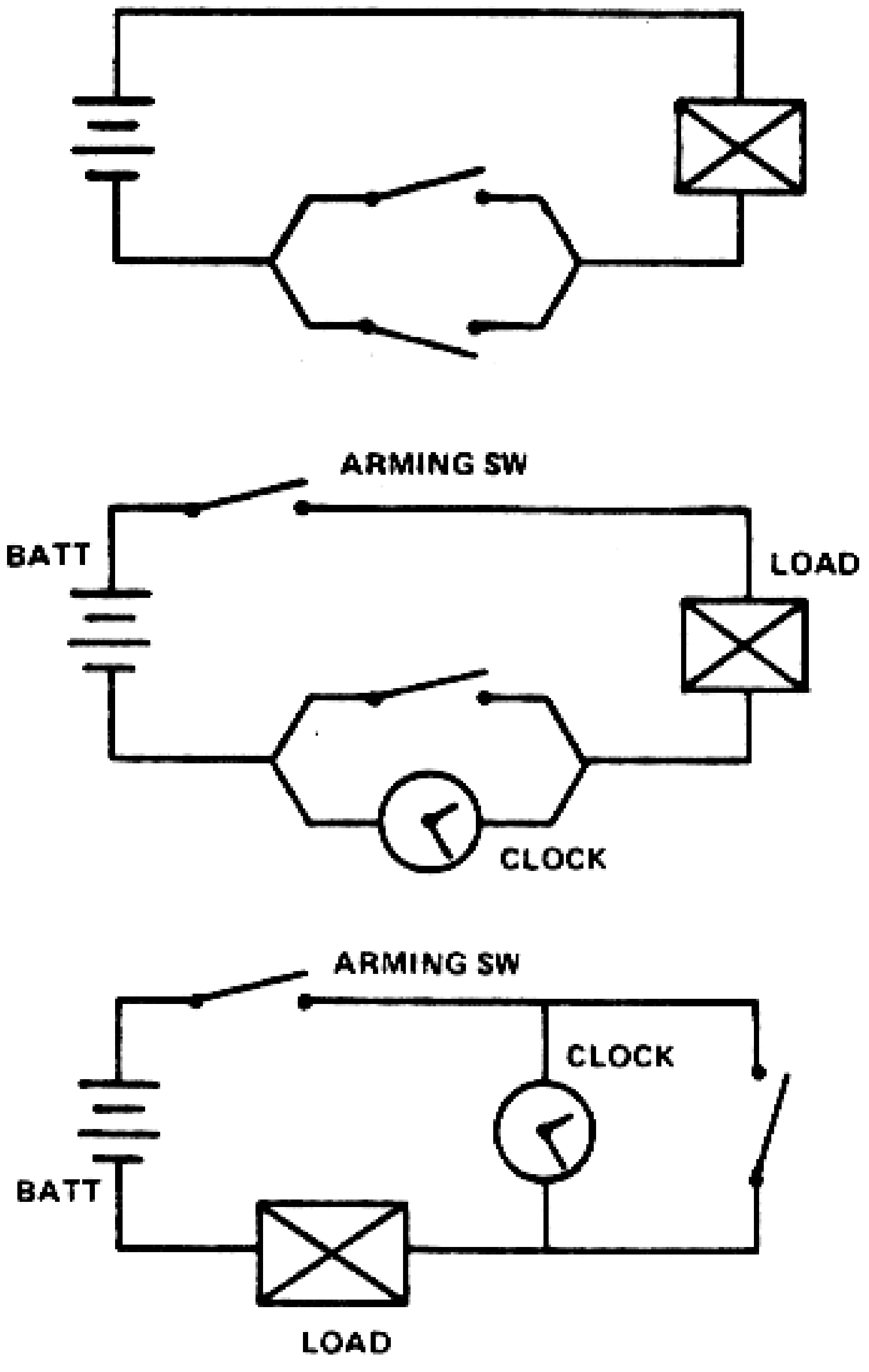


Figure 5. Series-Parallel Circuits.

STUDENT NOTES

CONTACTS IN SWITCHES.

There are three switch contacts discussed in this special text. They are common (C), normally closed (NC), and normally open (NO). Some switches have only two contacts while others have three.

The common contact on a switch is always used, hence the name COMMON. Regardless of what the switch is designed to do, the common contact is one leg of the circuit going to the switch and is the moveable contact.

A two contact switch. One contact is the common and the other contact is either normally closed or normally open. If the switch is at rest with no external force or energy being applied, it is in its NORMAL position. The contacts are either open or closed. If they are open, the contact is a NORMALLY OPEN contact. If they are closed, it is a NORMALLY CLOSED contact.

Switches with three contacts always use the common and either the normally closed or normally open contact depending on the action desired. When the switch is at rest (in its normal position) the common is in contact with the normally closed contact. The remaining contact is therefore open, hence the term normally open. This is how the terminology normally open and normally closed has been devised.

MAGNETIC REED SWITCHES.

Magentic reed switches (influence switches) are used to control circuits. They consist of two overlapping, flat steel spring contacts, in a dry inert gas and sealed in a glass or plastic envelope. A magnet, permanent or electro, causes the reeds to open or close as desired.

Figures 6, 7, 8, and 9 show circuits using normally open and normally closed magnetic reed switches.

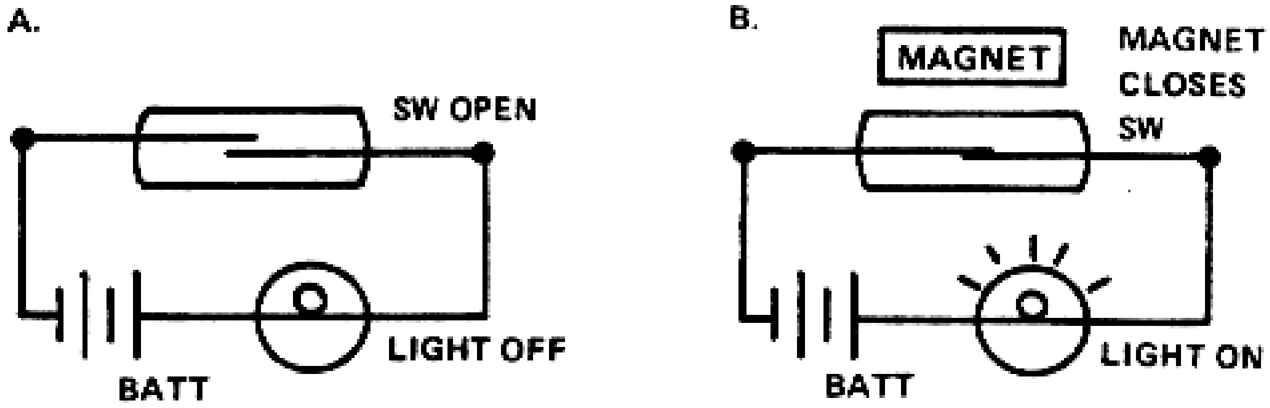


Figure 6. Magnetic Reed Switch-Normally Open.

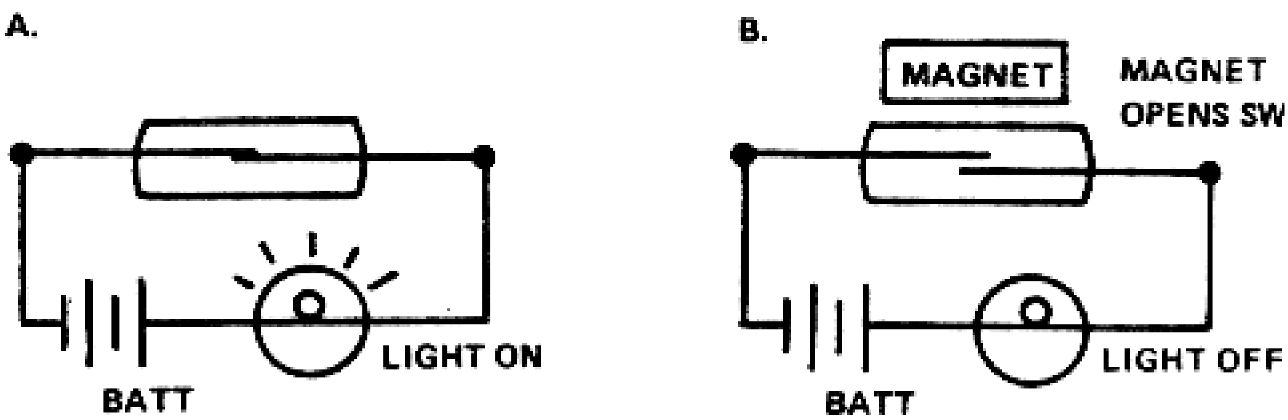


Figure 7. Magnetic Reed Switch-Normally Closed.

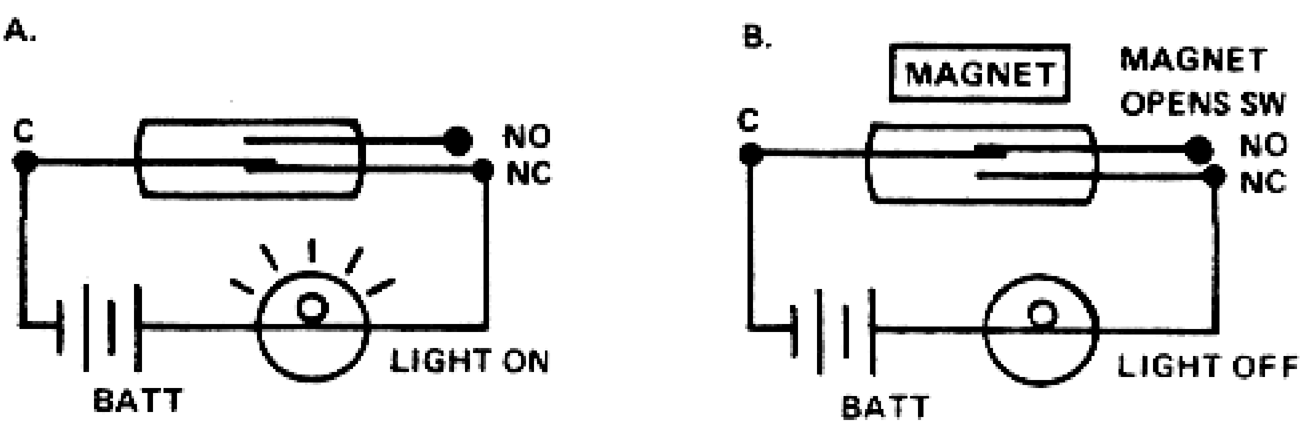


Figure 8. Magnetic Reed Switch, Common Contact and Normally Closed Contact Used.

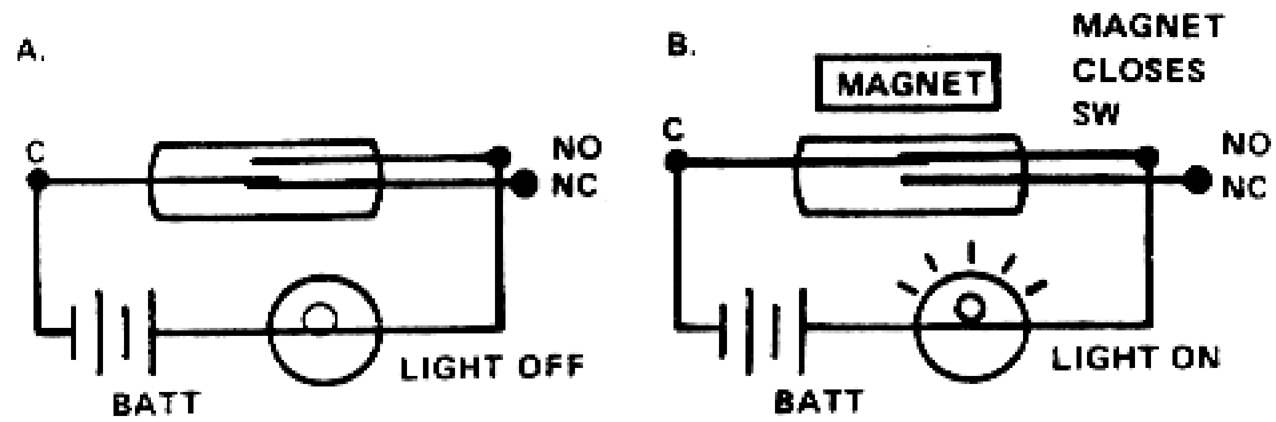


Figure 9. Magnetic Reed Switch, Common Contact and Normally Open Contact Used.

STUDENT NOTES

RELAY IS AN ELECTROMAGNETIC SWITCH.

STUDENT NOTES

NEED TWO SEPARATE POWER SOURCES TO PROPERLY OPERATE A RELAY.

RELAYS AS SWITCHES.

A relay is an electromechanical device used as an electronic switch to control a circuit. It uses a battery as a power source. Figure 10 shows a typical relay and its components.

A relay is made up of the following:

1. Coil of wire (electromagnet)
2. Moveable contacts
3. Spring.

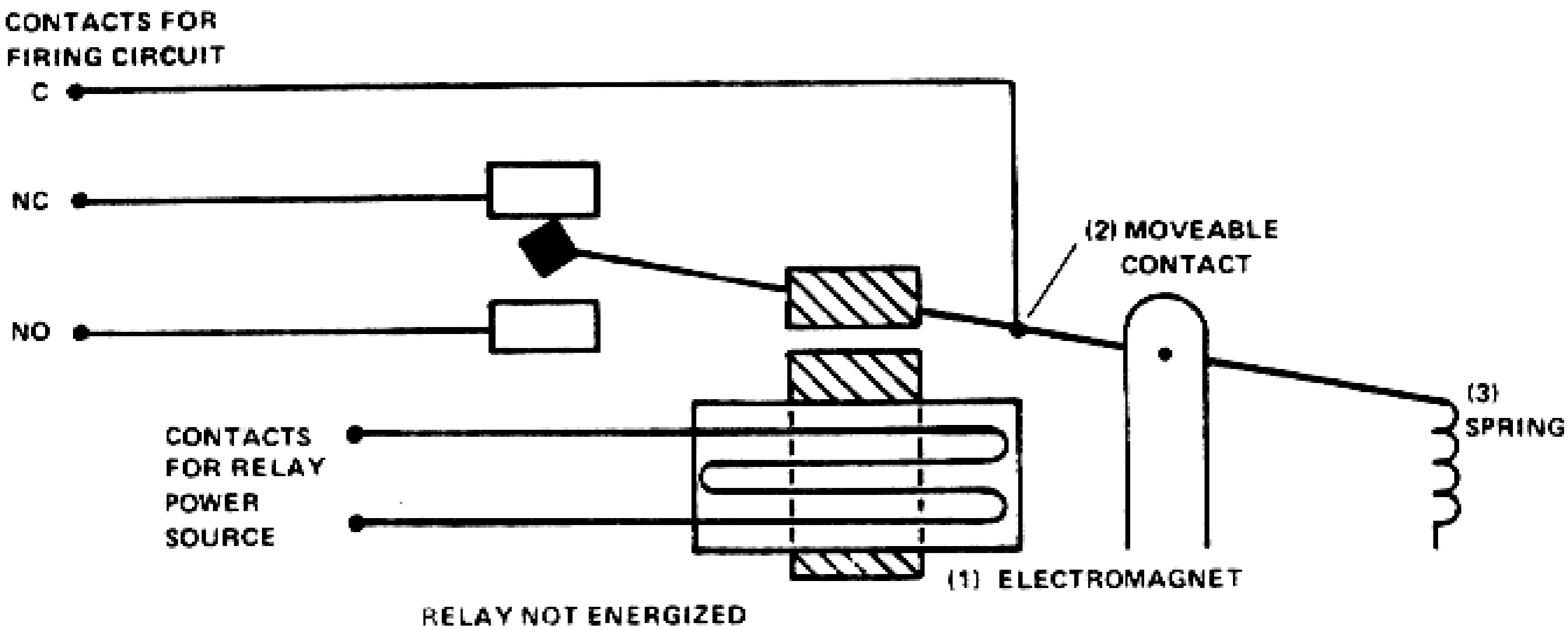


Figure 10. Relay Switch.

Figure 11 shows schematics of a relay with common-normally closed contacts being used.

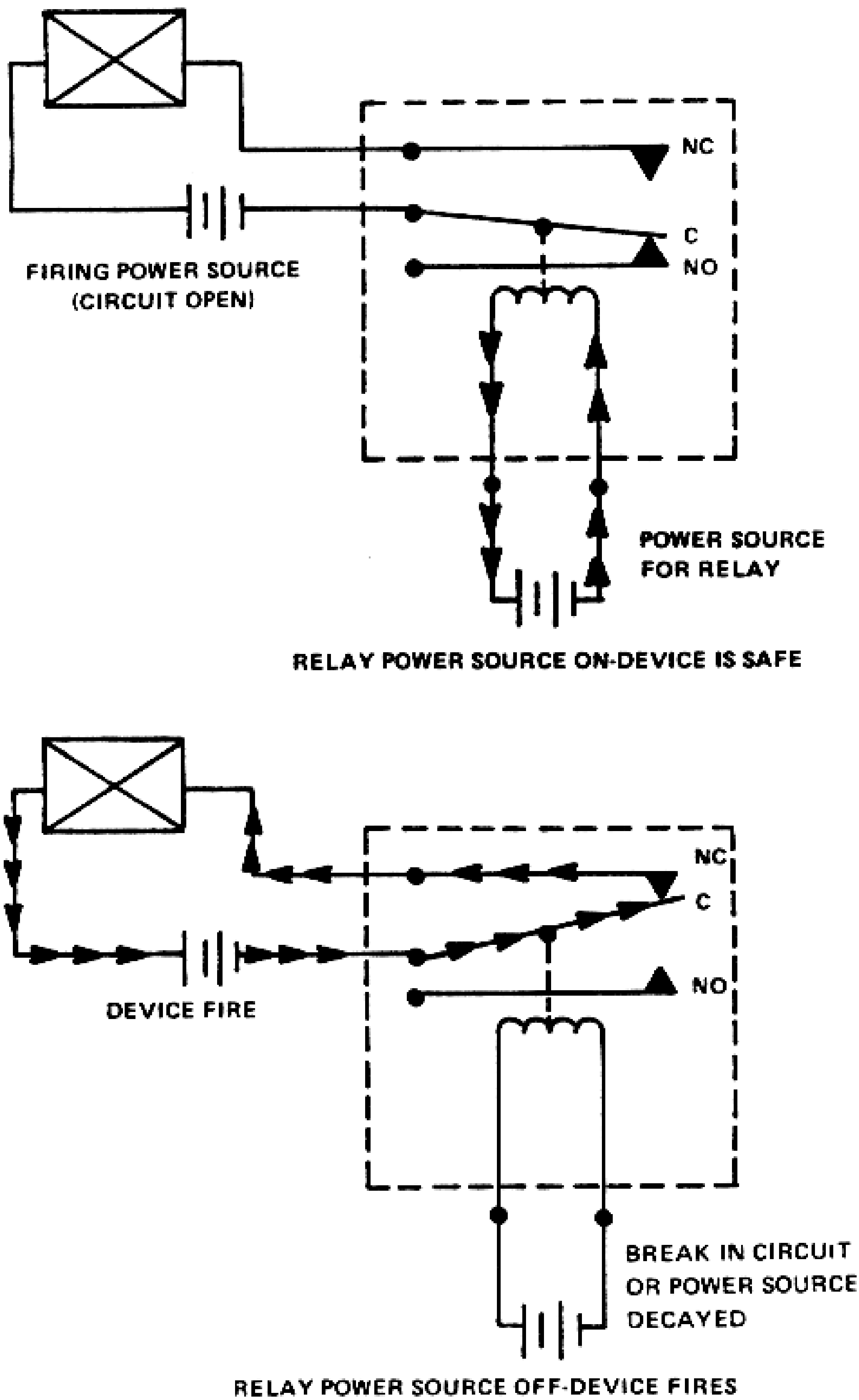


Figure 11. Relay with Common-Normally Closed Contact.

Figure 12 shows schematics of a relay with common-normally open contacts being used.

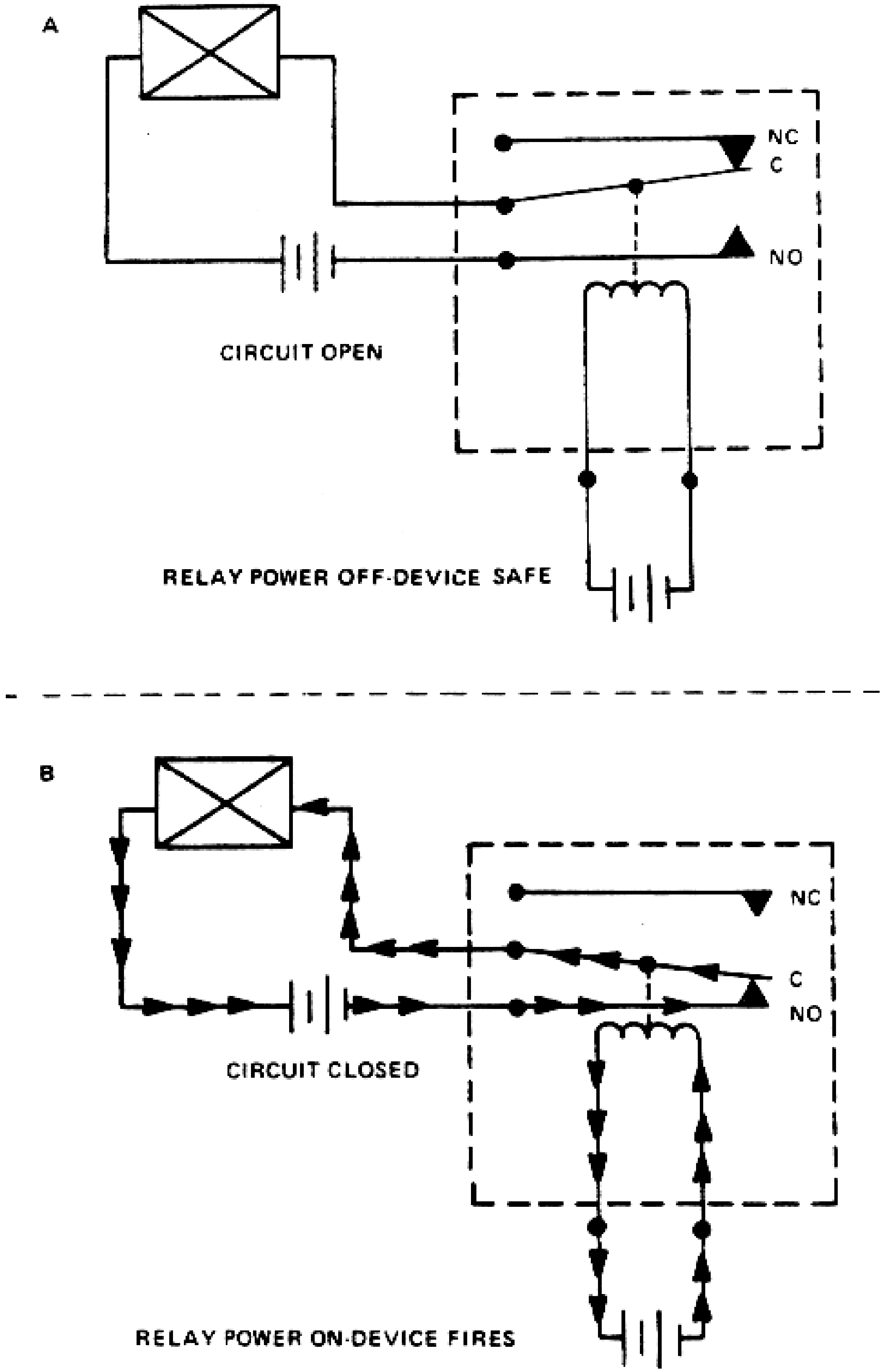


Figure 12. Relay with Common-Normally Open Contact.

CANADIAN DEVICE.

The Canadian device (fig. 13) was a self-contained battery decay fuzing system.

The Canadian device consisted of the following:

- Relay
- Three batteries
- Blasting Cap
- Jacks and jack plugs
- Light bulb

CURRENT RUNS NEGATIVE TO POSITIVE.

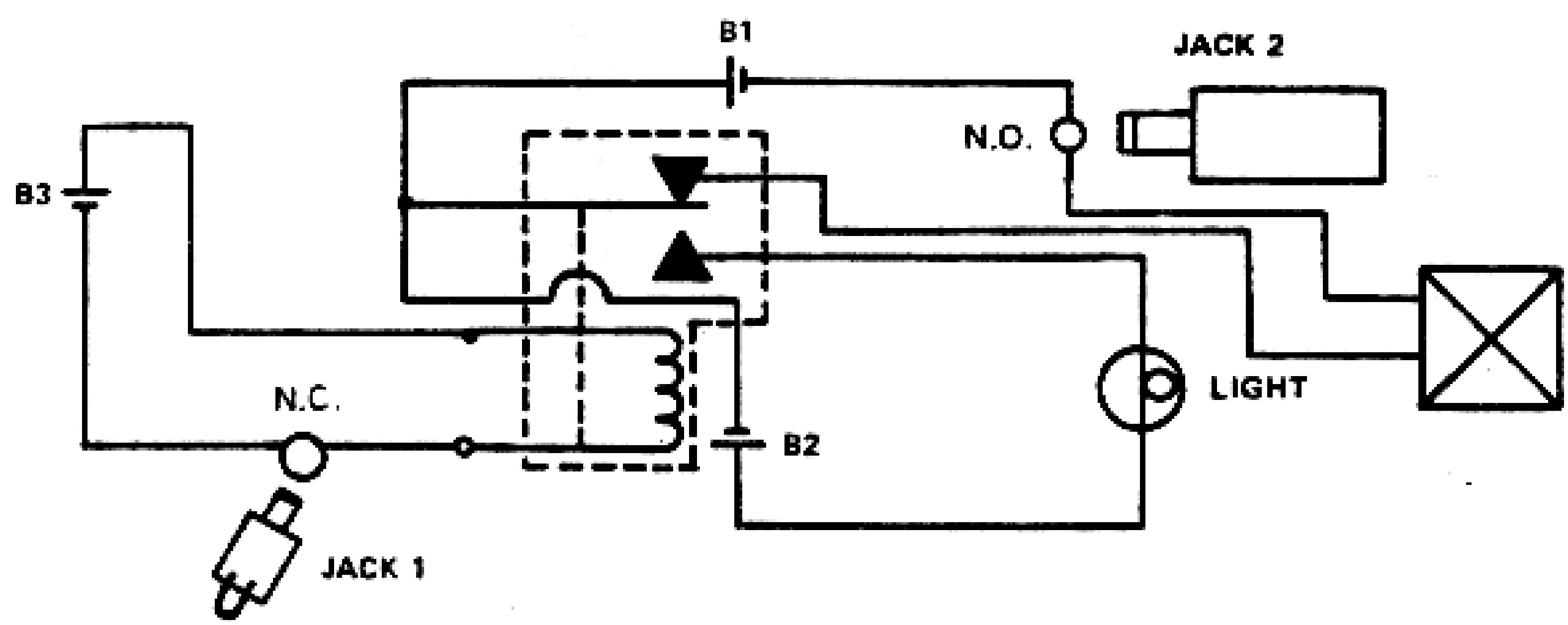


Figure 13. Canadian Device.

STUDENT NOTES

1. REMOVE PLUG FROM SOCKET "A".
2. CHECK SAFETY LIGHT.
   a. "ON" IS SAFE.
   b. "OFF" IS NOT SAFE.
3. CONNECT CAP TO RED AND BLACK WIRES.
4. INSERT PLUG INTO SOCKET "B" TO ARM.

MICROSWITCH.

A microswitch opens or closes a circuit by the use of either pressure or the release of pressure.

Figure 14 shows circuits connected to normally closed contacts (A) and normally open contacts (B).

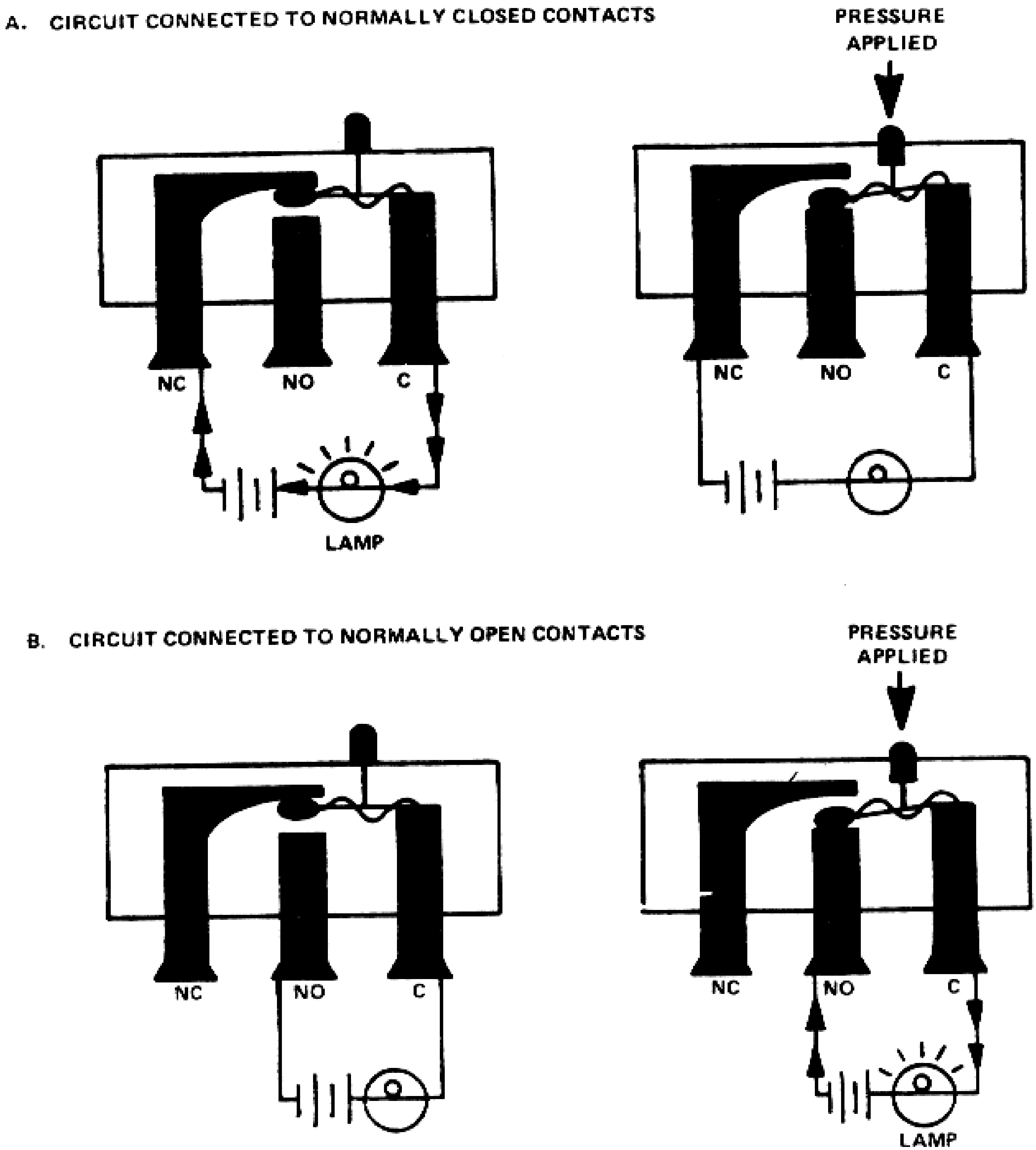
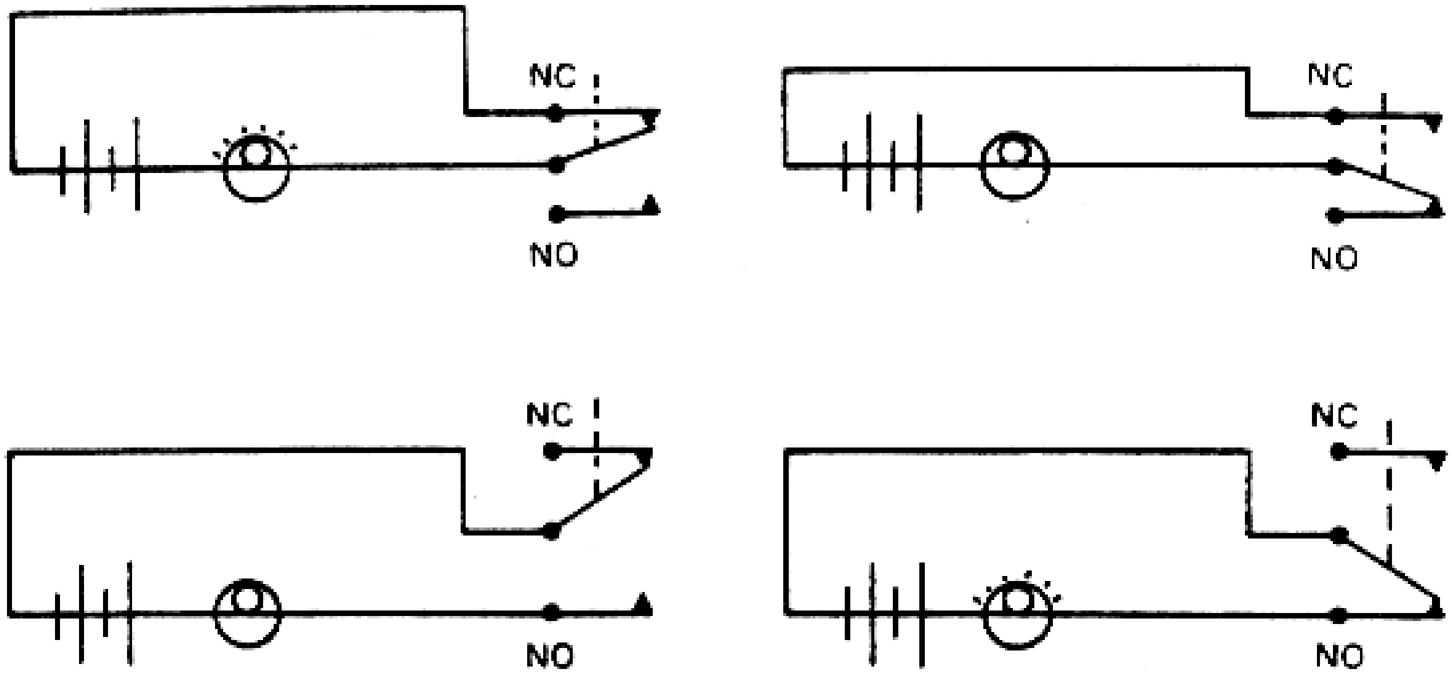


Figure 14. Circuits Connected to Normally Closed and Normally Open Contacts.



FUSIBLE ELEMENT SWITCHES.

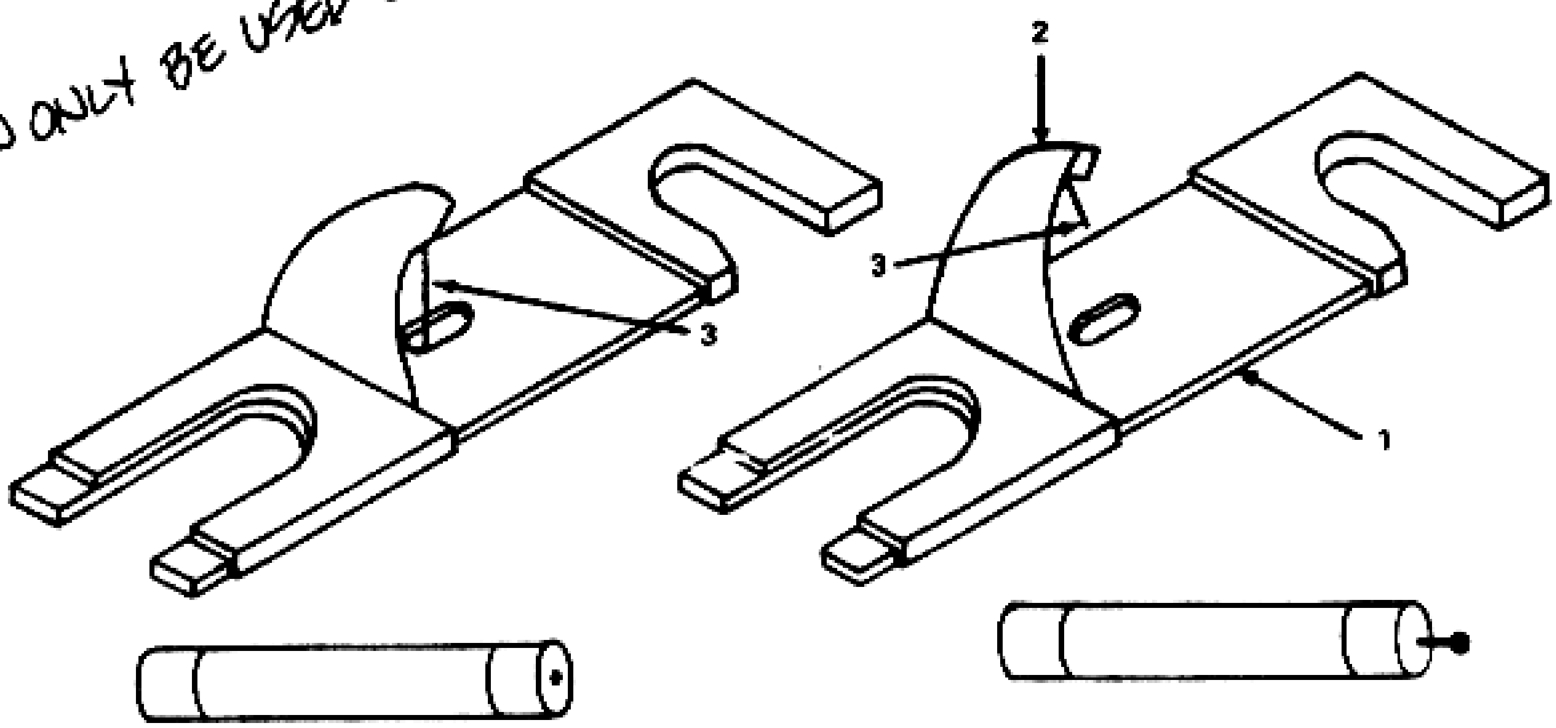
A fusible element switch (fig. 15), used to arm devices, changes the path of current flow from one circuit to another. The fusible element switch is made up of the following:

1 Nonconductive base

2 Spring contacts

3 Fusible, breakable wire

CAN ONLY BE USED ONCE.



1– NONCONDUCTIVE BASE
2– SPRING CONTACTS
3– FUSIBLE, BREAKABLE WIRE

Figure 15. Fusible Element Switch.

Figure 16 shows a circuit using a fusible element switch for arming devices. The switch is in the UNARMED position.

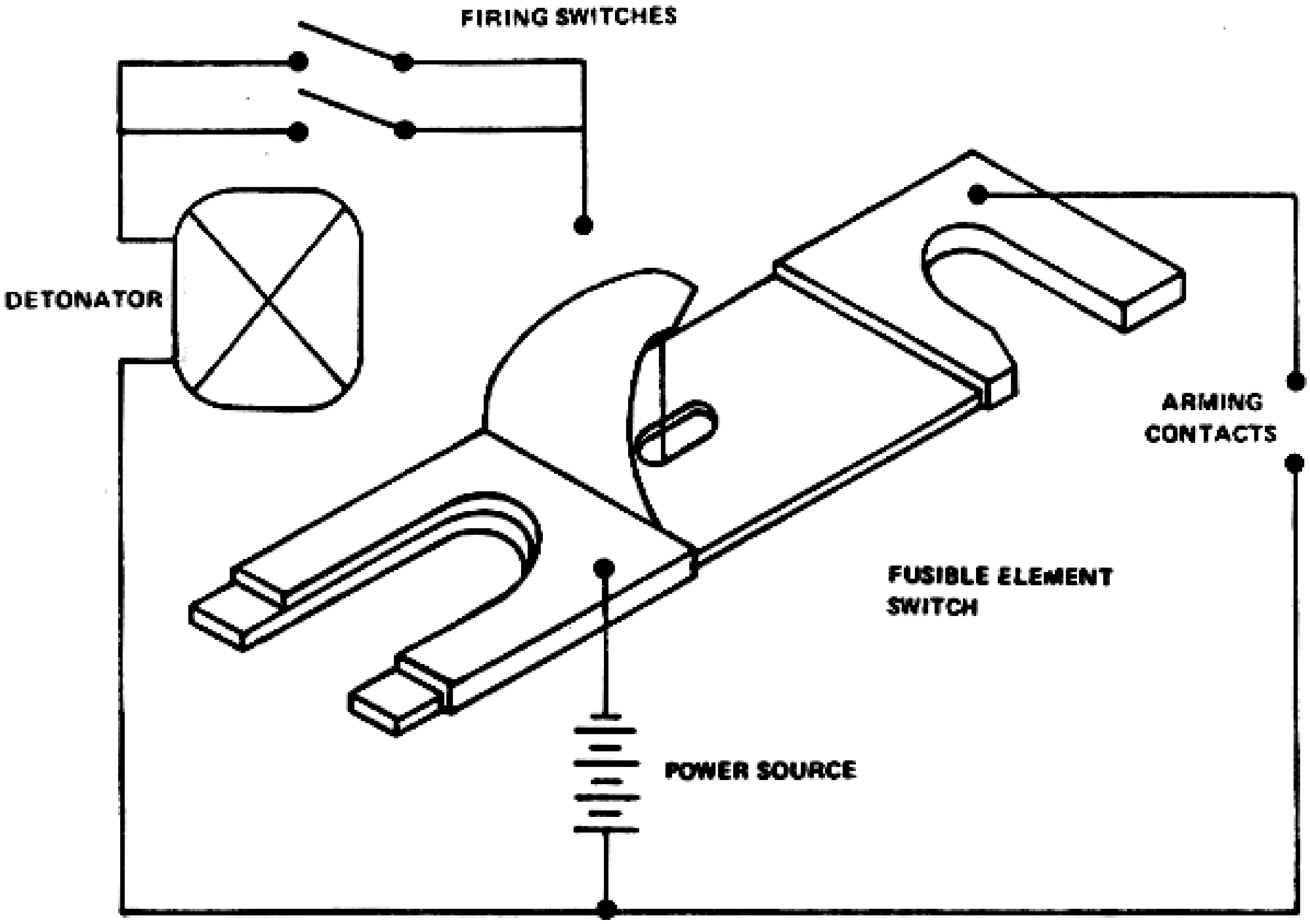


Figure 16. Switch in Unarmed Condition.

STUDENT NOTES

Figure 17 shows a circuit using a fusible element switch for arming a device. The switch is in the armed position.

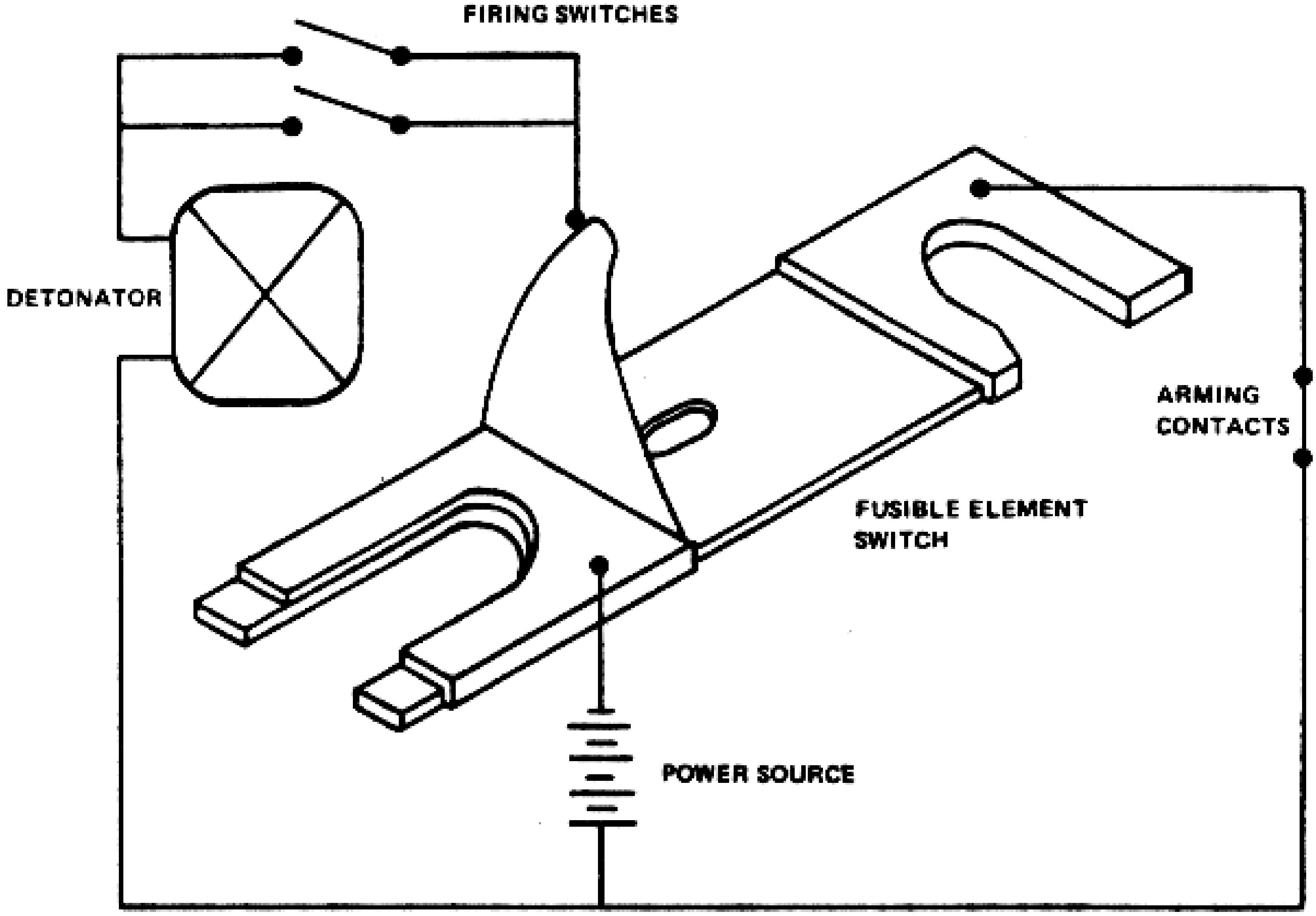


Figure 17. Switch in Armed Condition.

STUDENT NOTES

CASTLE ROBINS DEVICE.

The first fusible element switch used in a device was in a simple series-parallel circuit. The circuit contained a fusible element arming switch and two microswitches. The microswitches were used as firing mechanisms. The device was built in a plywood box that contained a hole for the arming rod. The device would fire if it was lifted or if the top of the box was removed.

Figure 18 shows a series-parallel circuit with a fusible element switch used in the Castle Robins device.

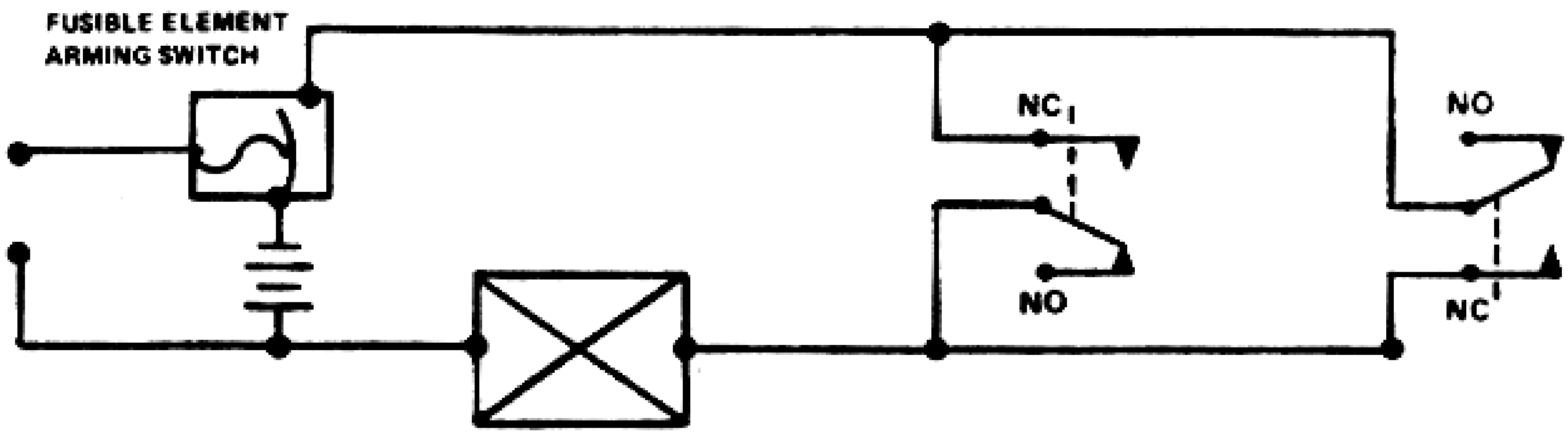


Figure 18. Castle Robin Device

TRANSISTORS/THYRISTORS

When these components are used in a circuit, current will NOT flow in Leg E-C (transistor), Leg A-K (SCR) until a change in current flow is felt at B (transistor), G (SCR) or the Gate (Arrow) of the thyristor.

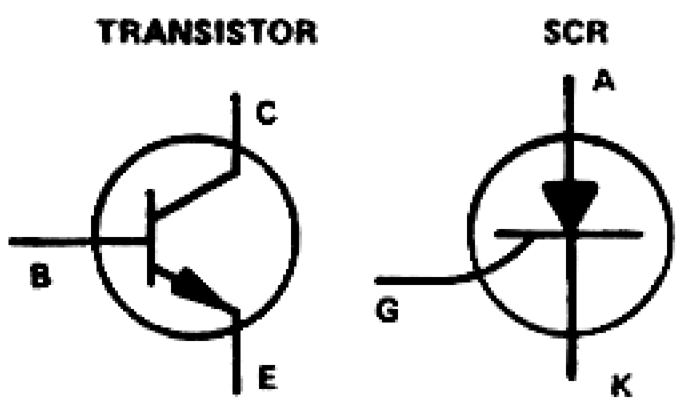


Figure 19. Transistor, SCR, and Thyristor Symbols.

Due to the advent of semiconductors (transistors, etc.) and the accelerated advances in electronic components, bombers have been using some rather sophisticated electronic fuzing systems. In this section we will take a basic layman's approach to understanding how some of these semiconductors work.

First of all, it is important to realize that transistors and thyristors all have something in common: they all have three leads. For simplification, we will discuss only the transistor, although thyristors are similiar.

There are various types of transistors. They may be designed for filtering, amplification, or switching. It is the latter that we are primarily concerned with. Specifically, how do these electronic switches work, and what will cause them to function a device?

Transistors are constructed of three separate layers of Silicon or Germanium, each layer having a separate lead. They are called the base (B), emitter (E), and collector (C). The arrow in the transistor schematic denotes the emitter. Two types of transistors (NPN, PNP) are identified by the direction the arrow points. In the NPN the arrow points *out*, and in the PNP, the arrow points *in*. (See figure 20 **A**).

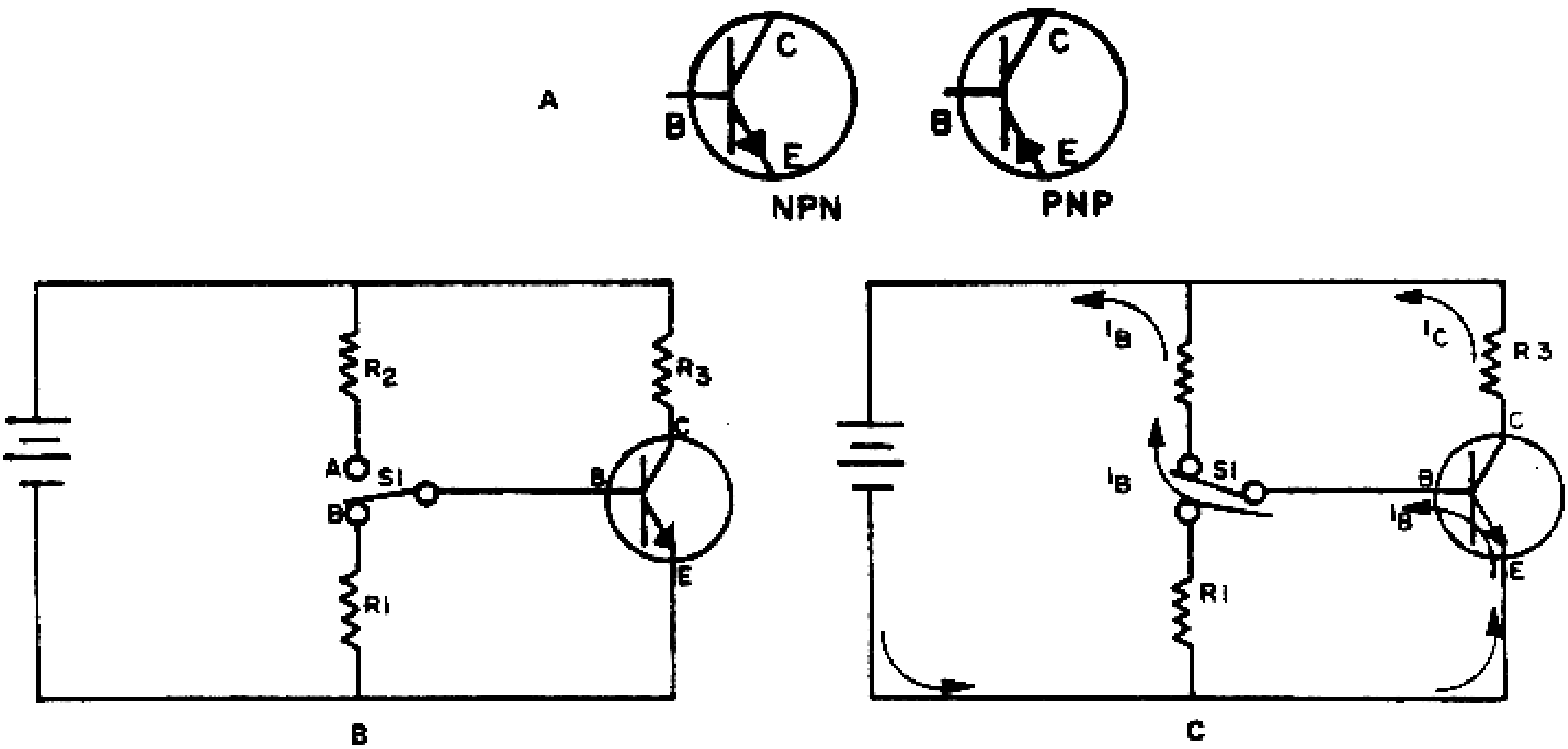


Figure 20

Each layer of silicon within the transistor is doped with impurities to give it negative or positive characteristics. NPN and PNP describe the arrangement of the material: neg-pos-neg and pos-neg-pos, respectively.

The basic principal governing the switching action of the transistor is that a small current flow controls a much greater one.

In figure **B** and **C**, a mechanical switch (S1) is being used to turn the transistor on and off. It is not necessary to use a mechanical switch, but it will help us to understand how the current is flowing.

In figure **B**, switch S1 is insuring the base of the transistor is at the same polarity as the emitter. This way, no current can possibly flow through the base.

Moving S1 to position A (Figure **C**) allows base current to flow (I_B). The base current causes collector current (I_C) to flow, thereby turning the transistor on. Collector current is often referred to as the load current. R3 is the load, and in a device, it would be replaced by some form of an electrical initiator for the explosive charge.

If we remove S1 and replace R1 with an E cell or capacitor, base current will not flow until resistance increases at the E cell or capacitor. In the following sections, we will look at how these circuits work.

ELECTROCHEMICAL CELL (E-CELL)

(From National Bomb Data Center Special Technical Bulletin 73-9, 74-3, and 74-9).

E-cell is a trade name for an electrochemical cell known also as a microcollometer or a couliode. (fig. 21) shows a simple E-cell timing circuit.

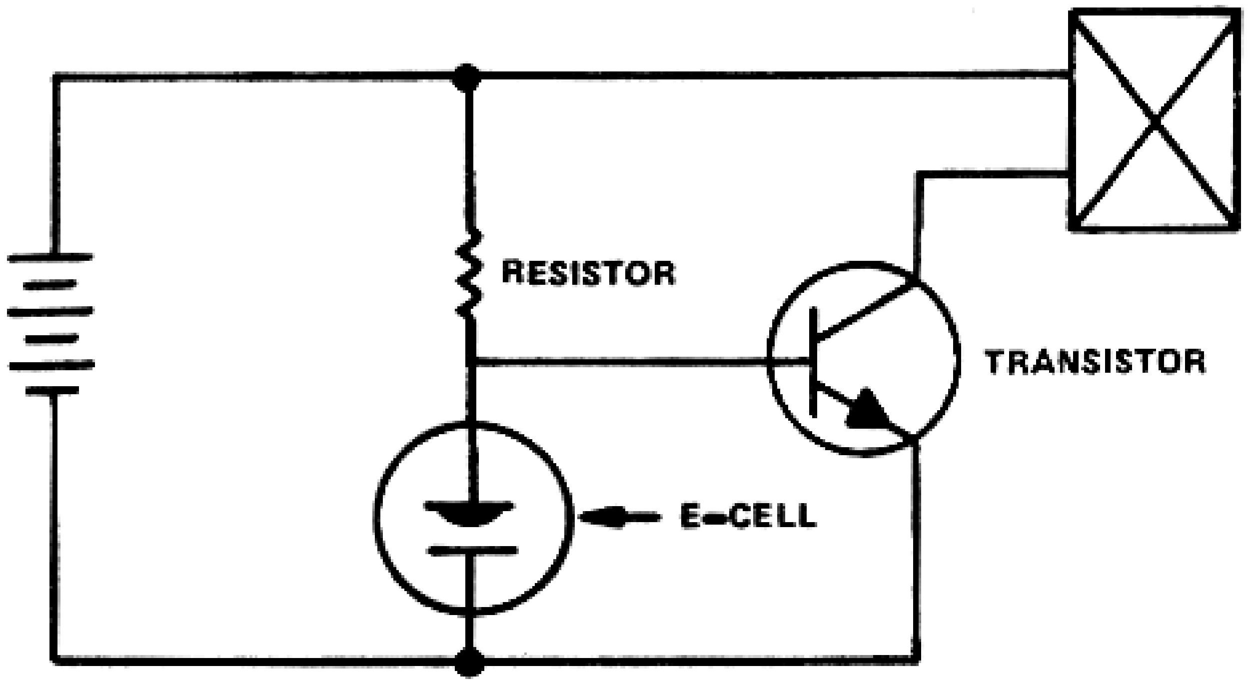


Figure 21. E-Cell Timing Circuit.

An E-cell consists of two electrodes and one electrolyte. One electrode is usually silver and the other is gold. The cell has a silver electrode in the form of a case, and a center gold electrode. The silver case performs a triple function; it is the silver electrode, a reservoir of active metal (silver), and a container for the electrolyte. The case is called the reservoir electrode. The center gold electrode is called the working electrode. The electrolyte serves as the medium through which silver is plated onto or removed from the gold electrode. The amount of silver transferred between electrodes is a function of current and time. At a constant current flow through the cell, a specific length of time is required to transfer a known amount of silver.

If the same amount of current is used to plate a given amount of silver as is used to deplate the silver, the time for both actions will be the same. To change from plating to deplating you reverse the direction of current flow.

While deplating is under way, the voltage measured across the cell is low; usually less than 100 millivolts (0.1 V dc). As soon as the silver has been transferred the voltage increases sharply (resistance increases sharply). This increase in voltage may be used to operate switching devices such as a silicon controlled rectifier (SCR) or a transistor, to complete a firing circuit to a detonator.

WARNING

1. **Removing the battery from an E-cell firing device may cause the device to fire.**
2. **Freezing an E-cell may cause it to act as if it has completed deplating and can fire the device.**
3. **Dropping an E-cell timer may cause the device to fire.**
4. **Removing an E-cell from a circuit will cause the device to fire.**

Figure 22 shows a possible wiring diagram of a recovered E-cell timing device. (see STB 82-10)

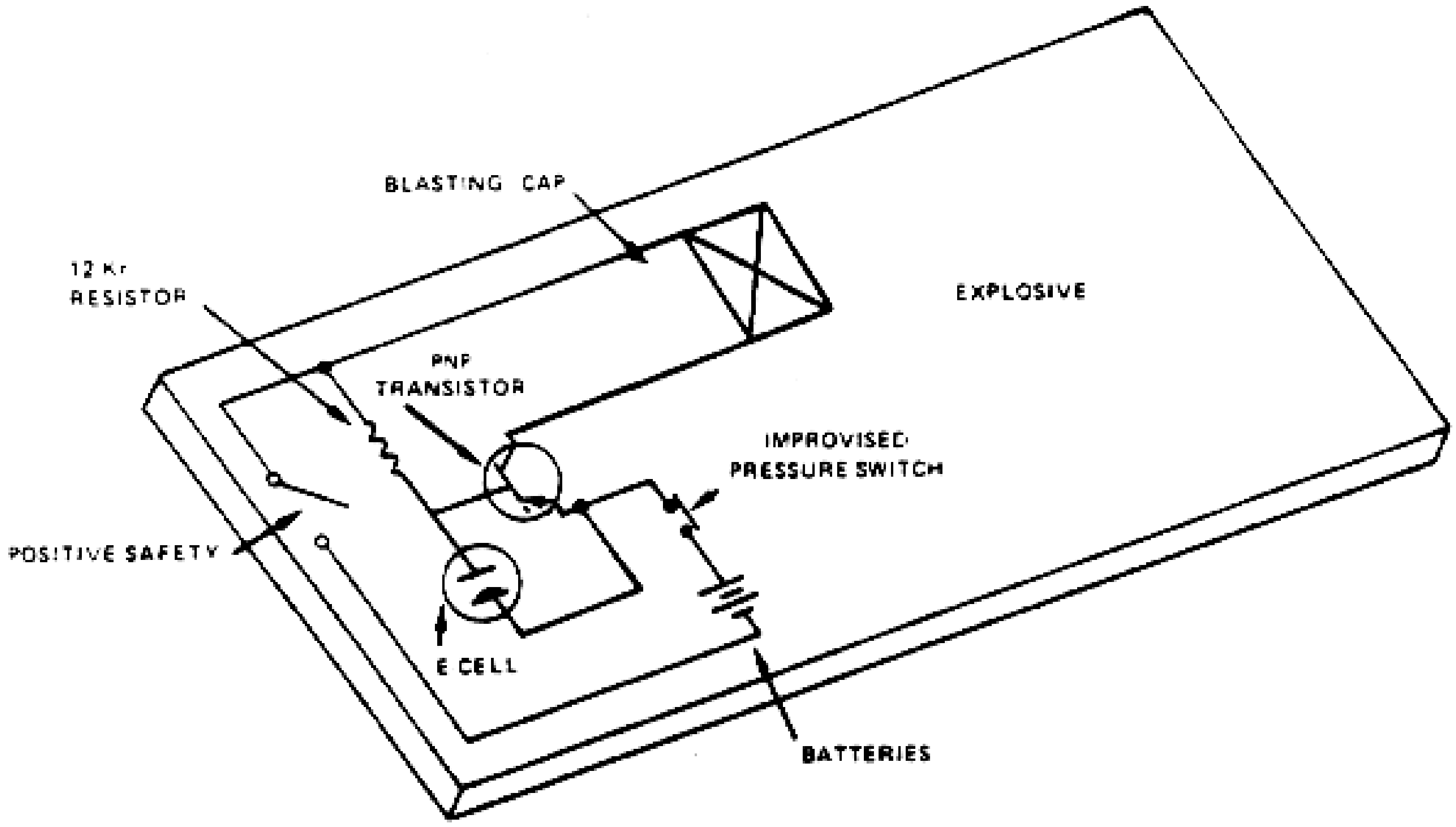


Figure 22. Possible Wiring Diagram of a Recovered E-Cell Timing Device.

An E-cell IED was positioned in an airplane seat between the cushion and the webbing, susceptible to the pressure of a seated passenger. Prior to its placement, the battery pack was attached and the jack used to arm the IED. Application of pressure, therefore, activated the E-cell cicruit. (This theory is contingent upon the power source being wired as indicated in Figure 22.) Following the elapse of the predetermined interval of the E-cell, the circuit through the transistor was closed, detonating the cap and explosive. In this case, the time delay period has not been determined.

NOTE: By changing the resistance in the E-cell circuit you can delay the timing device for over a year.

STUDENT NOTES

YOU SHOULD NOT ATTACK AN E-CELL WHEN YOU RENDER A DEVICE INERT.

RESISTOR CAPACITOR TIMER (RC TIMER)

IACP TB 2-72.

A resistor capacitor timer (fig 23) works on the same principle as the E-cell. While the capacitor is charging, the transistor is turned OFF. When the capacitor is fully charged, current flows through the transistor and detonates the device.

This type of circuit has a possible time delay of from seconds to hours. It was used to make homemade hand grenades.

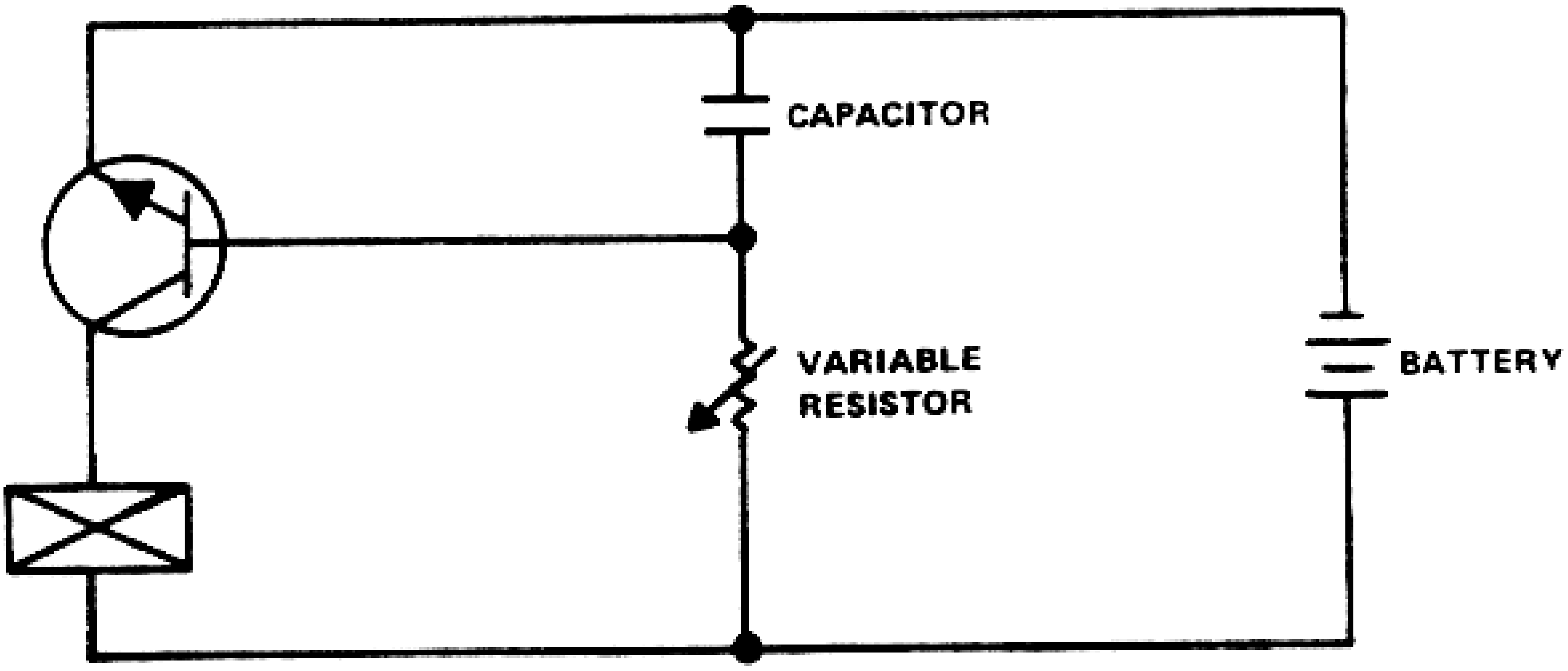


Figure 23. Basic Resistor/Capacitor Timer.

VIENNA LETTER BOMB.

This device used a capacitor, batteries, and a slide switch as the timer. The batteries also fired the explosive.

The capacitor charges to the batteries voltage (16.8 V). When the slide switch is moved on opening the package, the circuit is completed through the blasting cap and fires the device.

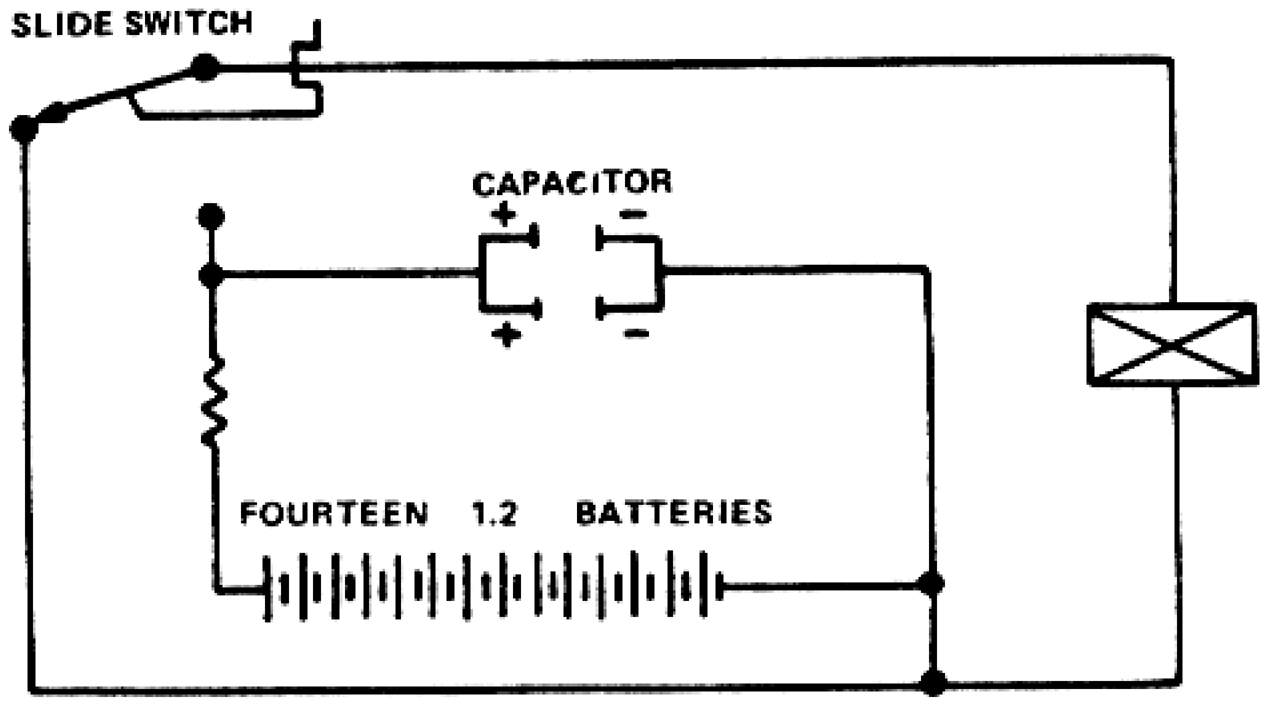


Figure 24. Vienna Letter Bomb.

ELECTRONIC DELAY CIRCUIT.

(See National Bomb Data Center Special Technical Bulletin 75-1 and 75-1/1).

Two devices using the same electronic delay circuit design have been found. One circuit was connected to a pipe filled with explosives. The other was connected to a plastic box with explosives. The circuit designs were primarily the same, the difference being the value of various components thus allowing two different delay times.

The circuitry shown in figure 25 has 11 electrical components mounted on a 2 inch by 3 inch piece of fiberglass, copper clad, printed circuit board. The electronic timer supplies power to a blasting cap after a predetermined time period has elapsed. The device is totally electronic and has no moving or mechanical parts. There is no visible or audible indication that a timing process is taking place.

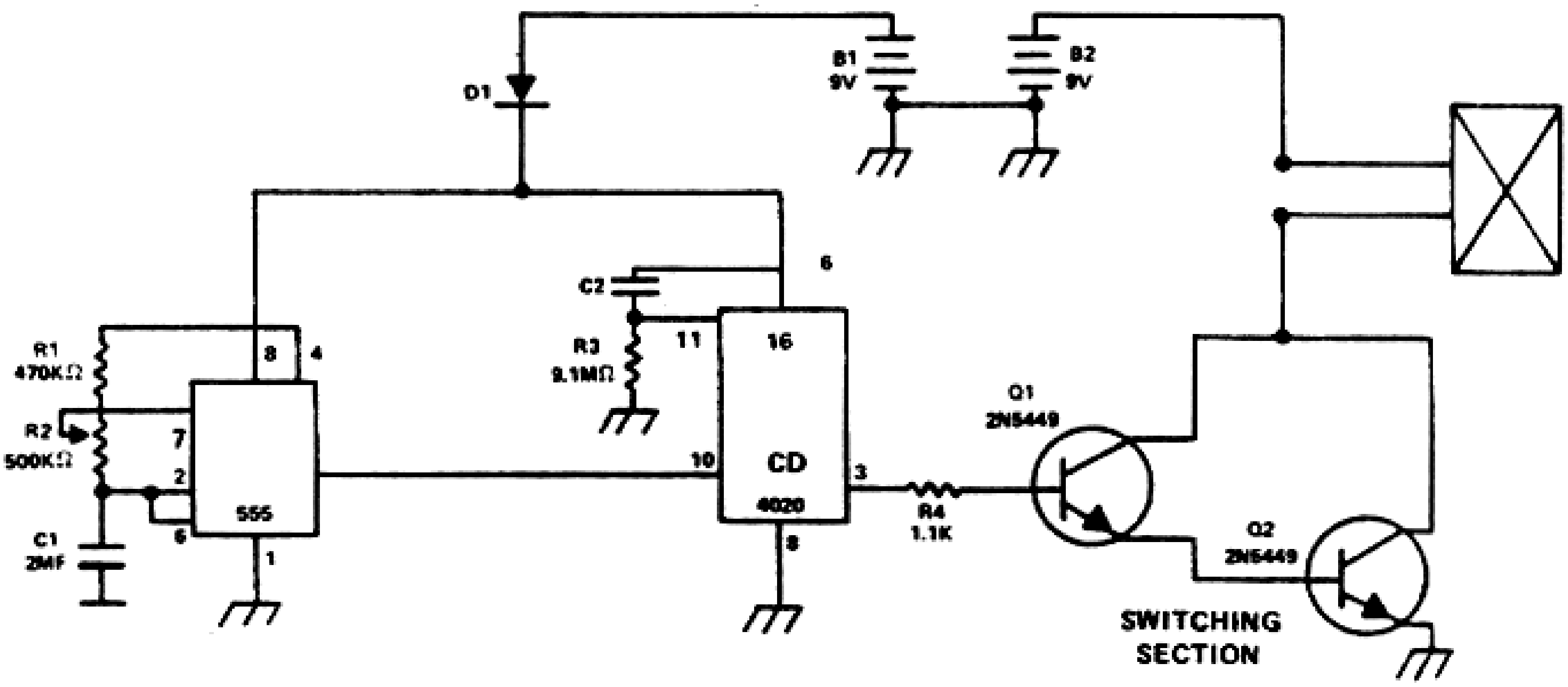


Figure 25. Electronic Delay Circuit (555 Timer).

To power this timing circuit, 9 volt battery clips were soldered onto the board. Two machine bolts and nuts were mounted through one end of the board to connect the blasting cap to the timer. The batteries and blasting cap may be attached in any sequence as the design of the circuit precludes any power being supplied to the cap before the elapse of the designed time period. In addition, the timing process does not begin until the battery, B1, farthest from the cap post is attached to the circuit.

The circuit design has four parts: a timing oscillator, a time accumulator, a switching section, and a dual battery power supply. All components used in the circuit can be purchased at most electronic supply stores.

The timing oscillator is similar to the balance wheel in a clock. It consists of Signetics integrated circuit (IC) 555, and R1, R2, and C1. The IC serves the same purpose as the ticks of a time piece. R2 is variable within limits and can be used to adjust the pulse rate of the oscillator. This adjustment corresponds to the speed adjusting mechanism of a clock.

The time accumulator is similar to the mechanism which gears down a clock. It consists of an RCA IC, CD4020, C2, and R3. The RCA IC is a 14 stage binary counter. It accumulates a predetermined number of impulses at pin 10, and provides an output pulse on pin 3. When power is applied, C2 and R3 provide an automatic reset pulse to pin 11 insuring the accumulator always starts at zero. In this design, the accumulator is counting the pulses from the oscillator. After a predetermined number of pulses have been counted, the IC responds by providing a voltage at pin 3.

The switching section provides power to the blasting cap on command from the time accumulator (pin 3). This is similar to an alarm clock sounding when the hour hand and the alarm set hand overlap. This section consists of two 2N5449 transistors and R4. The transistors are arranged in a power gain design, and act as a switch which in this circuit is normally off. When the time accumulator counts to the designated number, the signal voltage on pin 3 of IC CD4020 causes this switch to turn on. This completes the circuit through the blasting cap.

The dual battery power supply is similar to a clock with two main springs, one which runs the time mechanism, the other which causes the alarm to ring. In this design, one battery (B1) runs the timing circuitry, and the other battery (B2) remains unused until the switch is turned on and fires the blasting cap.

Various components of this circuit could be changed in value and cause the delay time to be anything from less than 30 seconds to that equal to or greater than the shelf life of a battery.

Figure 25 shows an electronic delay circuit (555 timer).

Specifications on a 555 timing circuit are shown below:

Delays	Printed No. By Builder	Calculated Delay	Timed Delay
Device 75-1	6	6 hours, 4 minutes 5 1/3 seconds	6 hours, 3 minutes 57 seconds
Device 75-1/1	24	23 hours, 36 minutes 32 seconds	

STUDENT NOTES

PHOTOELECTRIC COMPONENTS (see National Bomb Data Center Bulletin 74-6).

Improvised explosive devices (IEDs) vary in detail: however, the basic design of any light actuated IED includes an explosive charge, one or more electric initiators (blasting caps, squibs, and so on), a power source, and a photoelectric circuit.

The photoelectric circuit, which constitutes the fuzing system, contains a photoelectric component, an amplifier, and one or more switches mounted on fiberboard or a similar rigid material.

The following are definitions of photoelectric components:

- Photocell - A resistor whose resistance decreases when exposed to light.
- Photodiode - Light activates the diode. IF there is no light, it acts as an open circuit.
- Phototransistor - Compares in size and weight to the photodiode. It differs primarily in its sensitivity to light. It is ten times more sensitive than the photocell or the photodiode.
- LASCR (Light Activated Silicon Controlled Rectifier) - Light entering the LASCR generates a small current which triggers the SCR.
- Solar Cell - Generates an electric circuit when exposed to light.

Figure 26 is a schematic of a possible device using an LASCR.

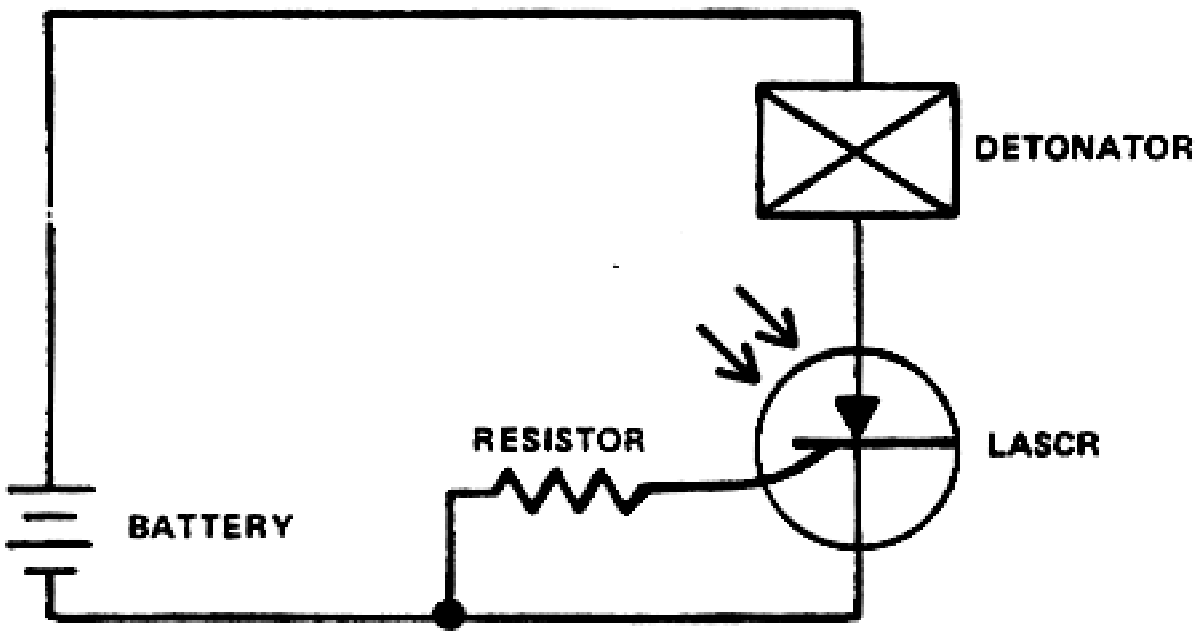
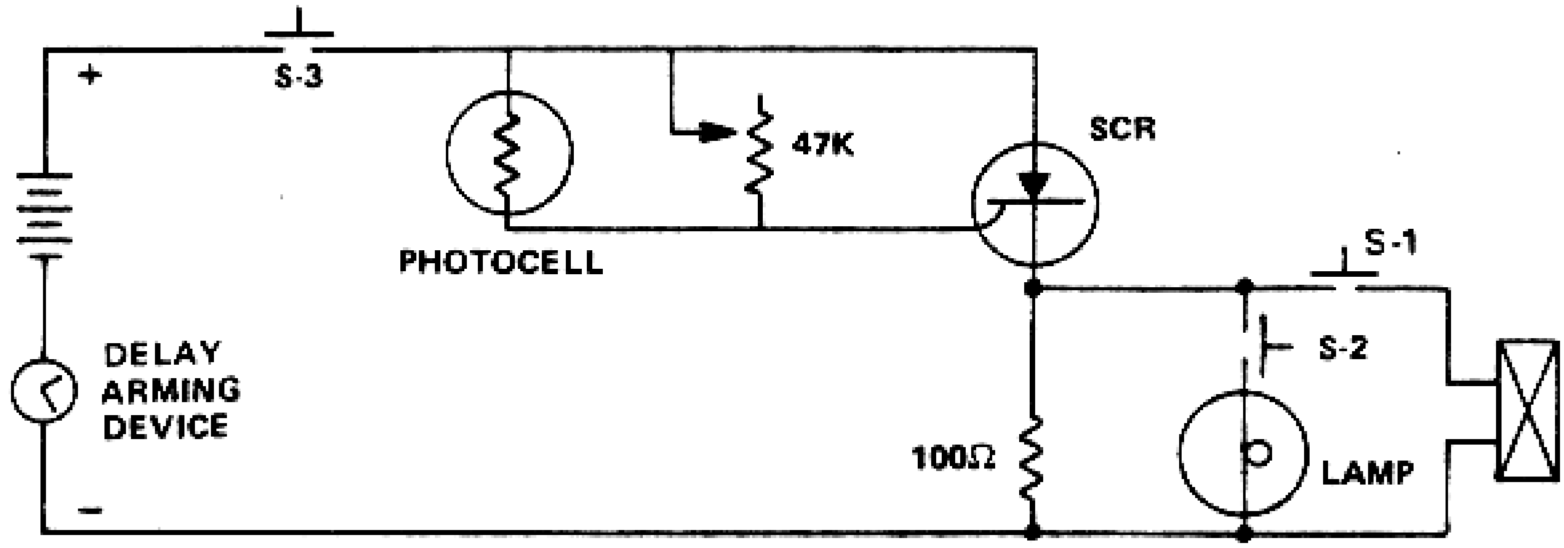


Figure 26. Schematic of a Possible Device Using an LASCR.

STUDENT NOTES

PHOTOCELLS REACT TO CHANGES IN LIGHT. YOU CAN ADD OR SUBTRACT LIGHT TO MAKE IT DETONATE.

Figure 27 is a schematic of a light sensitive device.



Legend:

SCR - Silicon controlled rectifier
K - Kilohms
Ω - Ohms
S - Switch

Figure 27. Schematic of a Light Sensitive Device.

This IED consisted of an 11 pound explosive charge, two 2-second delay electric blasting caps, and a photoelectric fuzing system with a delayed arming timer. Two 9 volt batteries served as the power supply.

The fuzing system was contained in a wooden box 6 inches long by 3 inches wide by 1 1/4 inches deep. The box was covered with a crudely cut white plastic lid. Three switches (two black and one red), a test bulb, and a variable resistor were all visible through holes in the lid. At least one of the screws securing the switches was marked with red paint. The device was designed to accommodate a photocell. To use, the bomber would set the desired sensitivity of the photocell by adjusting the variable resistor while observing the test bulb. The fuzing system would be tested and then the power source disconnected before connecting the explosive charge. After assembly, it would not be safe to arm the firing circuit unless the bomber was working in the dark or a delayed arming device was used. Testing and assembly of the delayed arming of an IED by the bomber would be done as follows:

WARNING

Main charge and detonator are not connected.

- Close switches 2 and 3. Bulb snould light.
- Open switches 2 and 3. Disconnect power source.
- Connect power source to delayed arming device which, in turn, is connected to light sensitive device.
- Connect detonator to light sensitive device and insert into main charge.
- Set delayed arming device, thereby breaking the circuit.
- Close switches 1 and 3; switch 2 is optional.

When the timer completes its cycle, it connects the batteries with the fuzing system and the IED is armed. Subsequently, when the photocell is exposed to light, its resistance decreases and the positive voltage on the gate of the silicon controlled rectifier (SCR) increases. The SCR then switches from OFF to ON, supplying electric power to the blasting cap.

The rheostat adjusts the sensitivity of the fuzing system. If the sensitivity (or resistance) is decreased too much, the SCR will switch and the detonator will fire even if the photocell is not exposed to light.

The components needed to construct a photoelectric fuzing system can be purchased at most electronic supply stores. Bomb technicians should be alert to the possibility of encountering IEDs with this type of fuzing.

Photoelectric circuits can be made even more hazardous by combining the photoelectric circuit with a collapsing relay or timer circuit and adding trembler switches or other antidisturbance devices. A photoelectric circuit can also be arranged to operate when the light is cut off.

STUDENT NOTES

VOLTMETER WILL NOT COMPLETE A CIRCUIT.

There has been a significant increase in the employment of radio controlled explosive devices (RCEDs) in the last few years. The low cost, availability, and flexibility of employment of RCEDs has contributed to this increase.

An RCED has the following components: a transmitter unit and a reciever unit. The transmitter consists of a power supply, RF generator, controls, and an antenna in one unit. The receiver portion consists of a receiver module, an antenna (concealed or exposed), servo motors (could be as few as one, or as many as six), on-off switch for receiver, electrical initiator, a power supply for receiver, and possibly another for the initiator. The initiator portion usually consists of an electrical initiator in series with a power source, and an open contact point which is closed by the movement of a servo. Microswitches are frequently used. It is possible to use electronic switching, eliminating the need for servo movement to complete the circuit. (To date this latter method has not been used.)

The major component of an RCED is the receiver unit. This unit receives radio frequency (RF) energy, interprets the signal and directs movement of the servo unit(s). The movement of the servo(s) is then used to close a circuit to fire the device. The antenna of the receiver module may be in the form of loose wire in the box with the receiver unit.

In hobby remote control units, the transmitter emits a carrier signal when on. The signal broadcasted is determined by the position of the controls on the transmitter. Moving the controls directs the change in frequency that is being sent. The change in signal is received by the receiver module, which in turn interprets it, and directs servo movement. Using a mini-relay it would be possible to have a device function upon loss or interruption of the signal, although this type of arrangement has not been encountered.

There are various methods of RCED employment. If used in the "line of sight" command mode, the bomber will be in visual contact with the device, and have complete control. By using a spring-loaded control on the transmitter that returns to a certain position, the bomber may hold this switch, which could be directing the transmitter to send a signal that is keeping the firing circuit open. If released, the transmitter would emit a signal directing the receiver to move the servo, closing the firing circuit. This type of command control is referred to as a "deadman." If the RCED is used in the unmanned mode, the receiver with the explosive is planted in a vehicle, and when it comes into the range of the transmitter which has been hidden, the device functions. The transmitter could also be unmanned, but transmitting a signal that could be keeping the firing circuit open. Upon battery decay of the transmitter, it could fire the device.

The radio control devices used to date have included pagers, remote-operated controls, radio controlled airplanes and toys.

There are a number of hazards presented by remote control, one of which is identification. A remote control device may be concealed, making identification a problem. Stray EMR is also a hazard, as any radio remote control receiver is susceptible to stray RF energy. The uncertainty as to the location and status of the transmitter and bomber is also a hazard. Not knowing how a suspected remote control device is being employed creates some problems in response and approach to said items.

As for recommended procedures, there are no concrete answers. The hazards described in the preceding paragraph aggravate the problem. Shielding has seemed to be a popular solution, but it is not really part of the solution but rather compounds the problem.

Shielding an RCED may very well cause the device to function, as the transmission signal is altered while applying the shield. Elimination of the signal by shielding could cause a device to function if it has been designed to operate on loss of the transmission.

The radio frequencies designated for public use are found in CFR, part 95, Subpart C. The approximate ranges are: 26 - 28 MHZ and 72 - 76 MHZ.
Listings of BDC bulletins dealing with Remote Control can be found in the appendix of this handout.

RADIO CONTROLLED PIPE BOMB.

Radio controlled IEDs can use any number of different types of electronic sending and receiving systems such as TV tuners, garage door openers, model airplane guidance systems, and the like. These systems may have moveable parts or may be completely electronic. The principles of operation are basically the same.

The control system for the IED (TB 73-40) was designed to use the remote control of a model aircraft, automobile, and boat. It consisted of two major components, a transmitter and a receiver, and a battery pack and other accessories. The transmitter was carried by the operator. It had an effective range of about 1 mile. The two pipe bomb was packed in an attache case. The attache case also contained a receiver, a battery pack (four 1-1/2 volt AA batteries wired in series), an ON/OFF switch, a servomechanism, and connecting wires.

A microswitch was added to the servomechanism. The switch was connected to flashbulbs in one of the bombs and was glued to the servomechanism so the servo arm would close the switch.

Each pipe consisted of a 6 inch length of 2 inch diameter pipe, filled with about three-fourths of a pound of smokeless powder and capped at both ends. Heat generated by the flashbulbs detonated and one pipe bomb and knocked the end cap off the second bomb (which did not detonate).

Figure 28 shows a block diagram of a radio receiver and firing circuit.

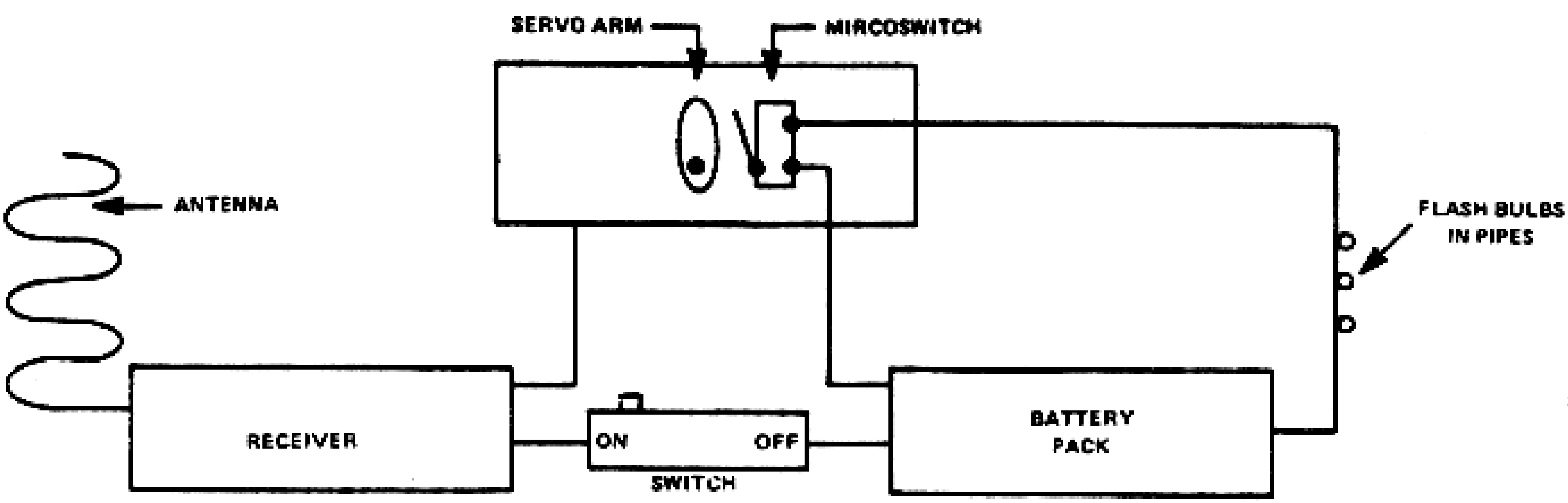


Figure 28. Radio Receiver and Firing Circuit.

MIDLANDER DEVICE (TIME DELAY BY BATTERY DECAY).

The Midlander device (fig. 29) was another device containing fusible element switches. By using two fusible element arming switches, the bomber was able to construct this device and carry or store it indefinitely. It was basically a battery decay firing circuit with two antidisturbance features consisting of an antiintrusion circuit and an antilift microswitch.

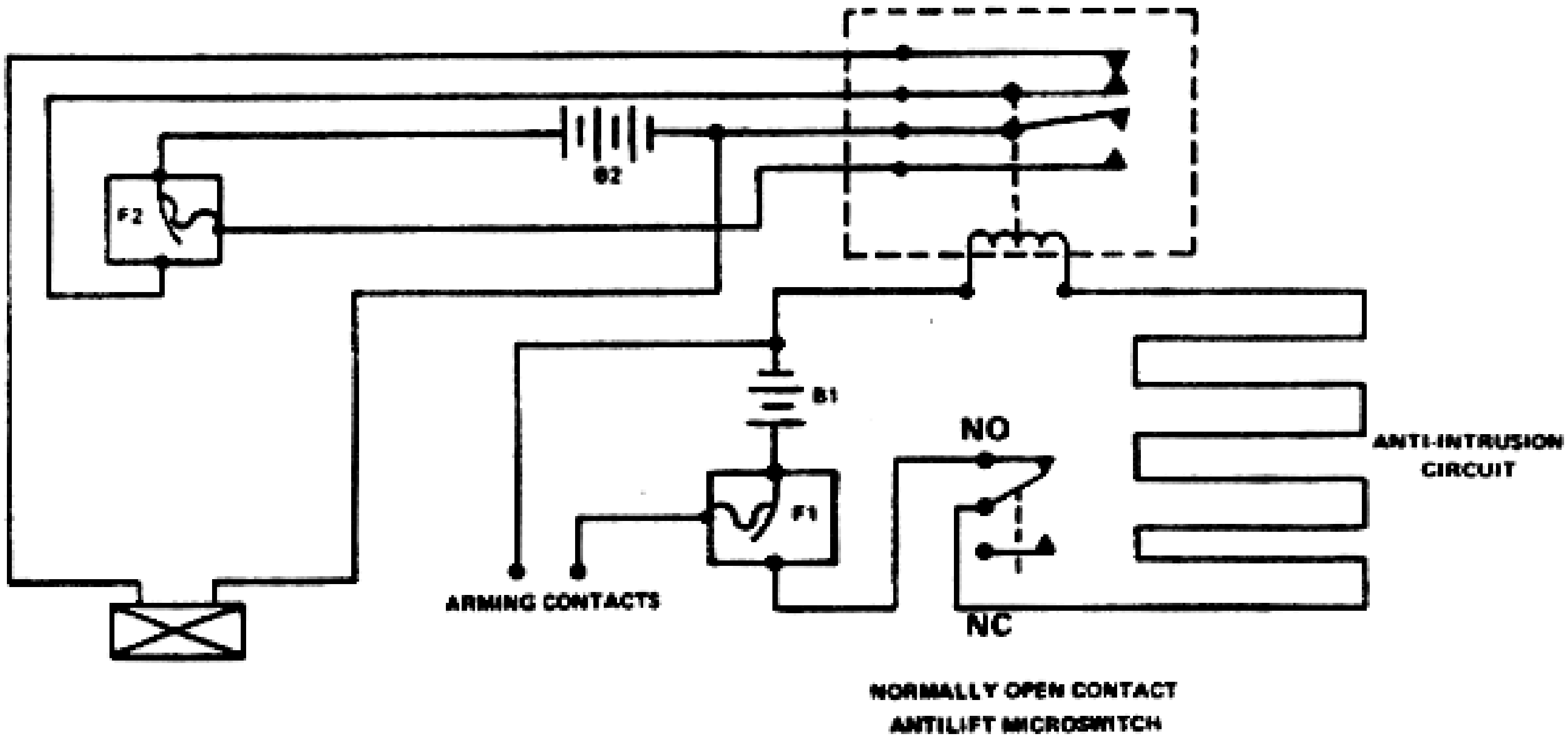


Figure 29. Midlander Device.

STUDENT NOTES

BOOBYTRAPPED FLIGHT BAG. (SEE NBDC STB 74-5)

An incident was reported recently involving an IED found in a boobytrapped flight bag. The IED was a sophisticated device similar in design to those used by terrorist groups. Recovered unarmed, the device had a complex electrical circuit Figure 30 which included antilift and antiopening features in combination with collapsing (time-delay) circuits.

The fuzing contained two alternative circuits connected to a common detonator; both circuits were to have been armed by a single action of the perpetrator after the device had been placed in the target area. Once armed, the device was designed to detonate as follows:

- Instantaneously, if the flight bag was unzipped.
- Within 3 1/2 minutes, if the flight bag was lifted.
- Within about 30 minutes, if the device was not otherwise disturbed.

The Initial Arming Procedures. The metal studs which secured the handles of the flight bag made up the arming contacts for the fuze. This permitted the bomber to safely carry the device to the target area where it was to have been armed in place by the simple insertion of a metal rod through the studs. The metal to metal contact between the rod and the studs would have shorted the arming contacts and completed the two circuits containing batteries A and B and fuses F_1 and F_4, respectively. As illustrated when current from battery A flows through fuse F_1, the fuse changes from its normal position to the energized position and allows battery A to energize relay R. Similarly, when current from battery B flows through fuse, F_4, it changes to the energized position and battery B is placed in the circuit with relay NF. However, relay NF is not energized at this point because its circuit is held open by the microswitch (which only closes when the flight bag is picked up).

Time Delay and Antiopening Circuit. Once battery A has been placed in the circuit with relay R through the functioning of fuse F_1, relay R which is a double pole relay closes contacts R_2 and R_1. Contacts R_2 and R_1 are in series with two additional batteries (C and D) which are used to provide power to the detonator. When relay R is energized, it causes contact R2 to close placing fuse F_2 in circuit with batteries C and D. The functioning of fuse F_2 places batteries C and D in circuit with the detonator and contact R_1. Contact R_1 is open while relay R is energized and thus the detonator will NOT function until relay R de-energizes and contact R_1 closes. Relay R is de-energized through either of two ways:

- When battery A, holding relay R in the energized position runs down (within 30 minutes or so) it is no longer able to power relay R. Relay R then becomes de-energized, contact R_1 closes, and the firing circuit to the detonator is complete.
- An antiopening feature built into the zipper of the flight bag is also incorporated in the circuit containing battery A and relay R. Consisting of pieces of wire laced through the zipper, the antiopening device conducts the current from battery A to Relay R. As long as the zipper remains undisturbed, the circuit remains unbroken; however, if the zipper is opened, the circuit collapses instantaneously, de-energizing relay R and causing the device to detonate as described above.

Antilift Circuit. An alternate boobytrap triggered by a microswitch was built into the circuitry. This antilift circuit was designed to detonate the IED within 3 1/2 minutes if the flight bag was lifted with the arming rod in place. Lifting the bag would permit the microswitch to close allowing battery B to energize relay NF, a triple pole relay which operates contacts NF_1, NF_2, and NF_3. When NF_3 is closed, it closes an alternate circuit from battery B which keeps relay NF energized. (The IED will detonate within 3 1/2 minutes even if the flight bag is set down again and the microswitch opened. Once the microswitch is closed, there is an irreversible action.) When contact NF_2 is closed, it allows current from batteries C and D to flow through fuse F_3, causing it to assume the energized position. In this position, fuse F_3 places batteries C and D in circuit with the detonator and contact NF_1. Contact NF_1 remains open with respect to the circuit containing batteries C and D and the detonator. Relay NF rapidly consumes the energy of battery B and de-energizes, causing contact NF_1 to close. This allows current from batteries C and D to flow to the detonator, completing the firing circuit.

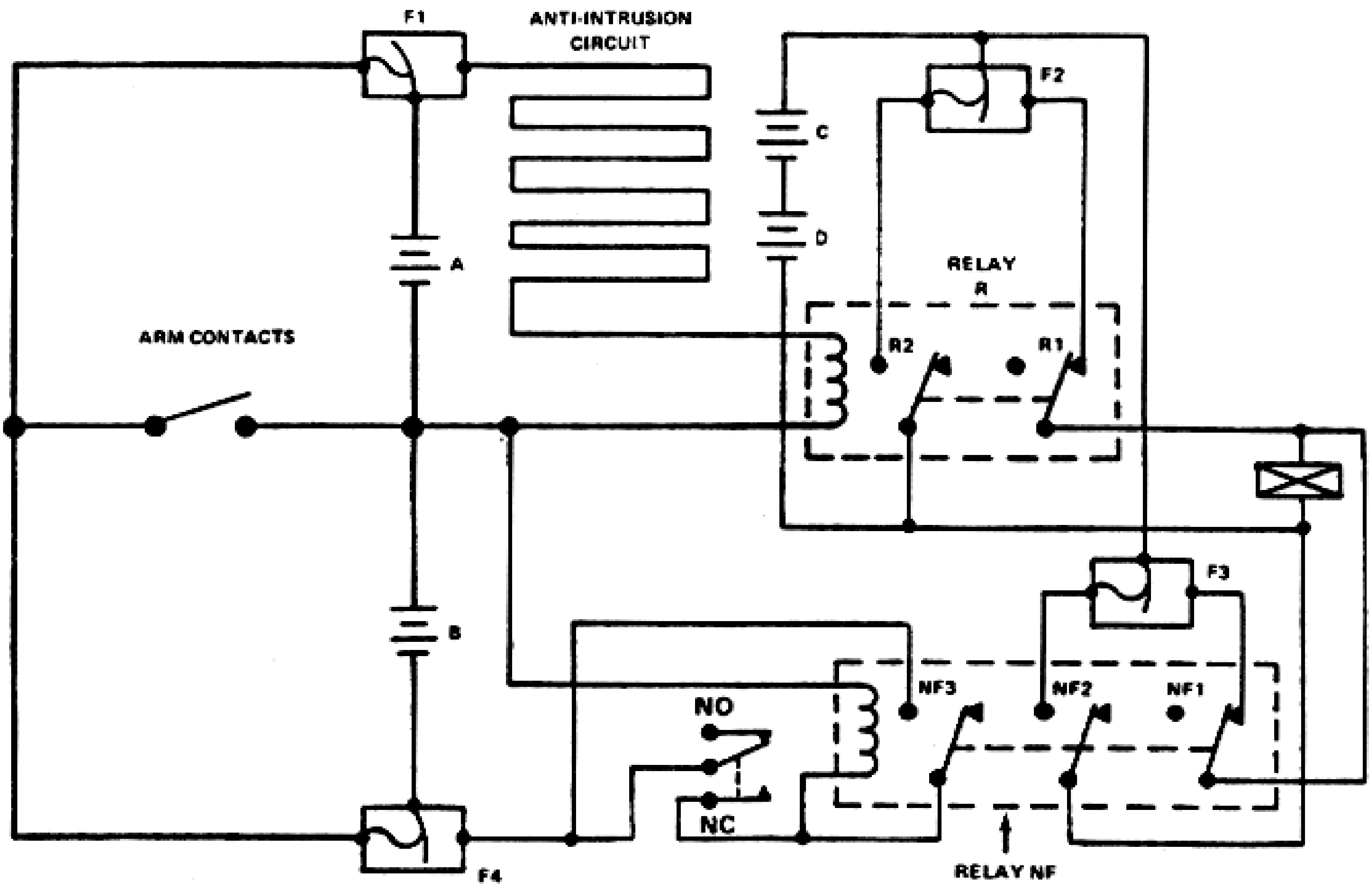


Figure 30. Boobytrapped Flight Bag.

STUDENT NOTES

SOUND ACTIVATED DEVICE.

This training aid is shown just to let you see another method of actuating a device that is available to a bomber. To our knowledge this type of firing system has never been used.

The item being shown is a voice actuated relay kit sold by Radio Shack for about $6.00.

PROXIMITY DEVICES.

Body Capacitive Circuit. This is another circuit found in most hobby shops. It works on the principle that the human body acts like half of a capacitor, the other half is contained in the circuit. When someone touches or gets near the unit it trips the circuit and fires the device.

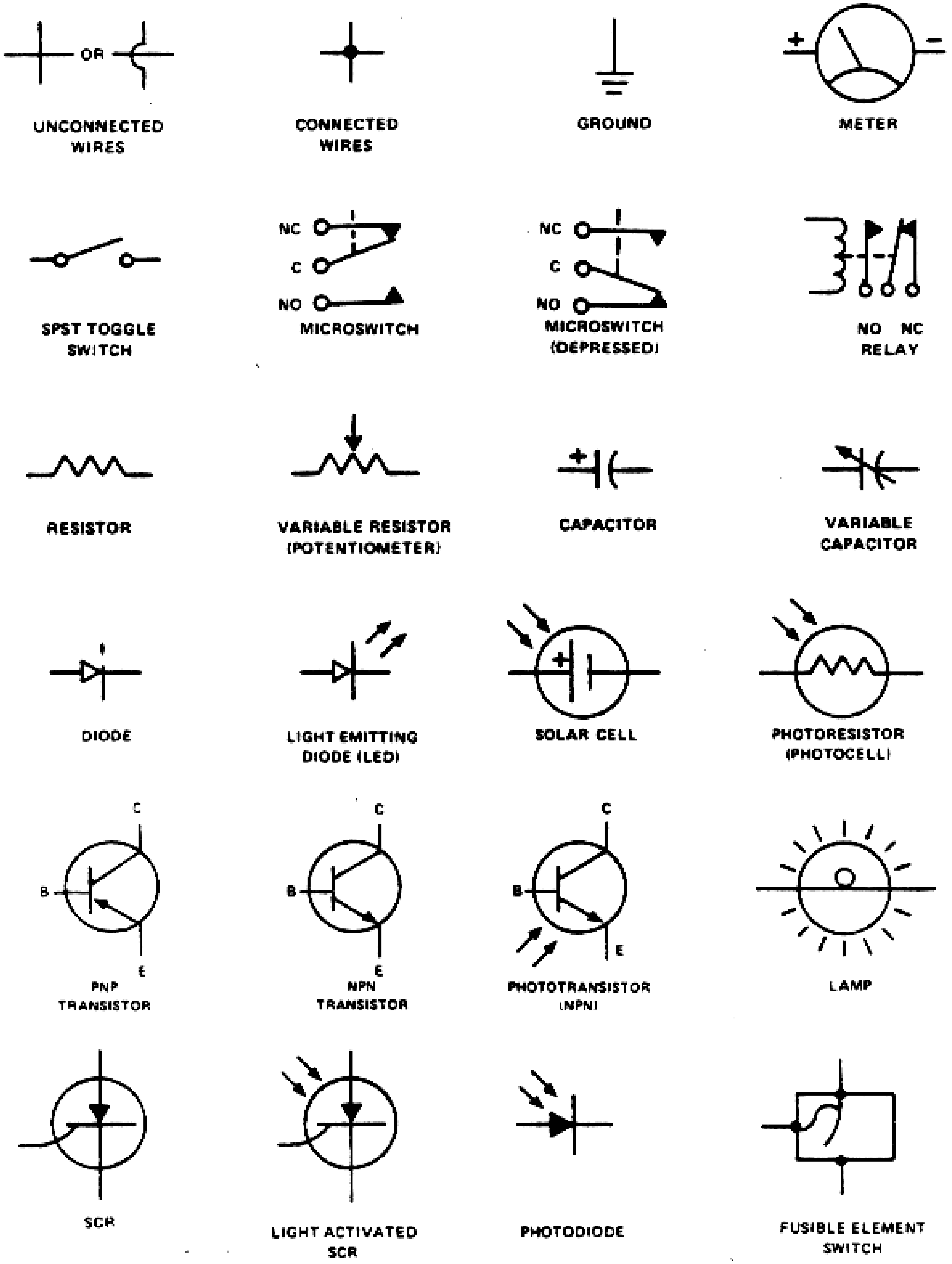
Passive Infrared. Similar to the door opening sensor units at supermarkets, this type of sensing device detects heat from the body and activates the circuit. The range is variable up to hundreds of feet depending on the unit. Although they are widely used as intrusion detection alarm systems, they could just as well be used to fire a device.

MAGNETIC INDUCTION DEVICE.

This type of sensing circuit radiates an electromagnetic field. Any metallic object entering this field distorts it, causing the circuit to activate an alarm (or firing device).

STUDENT NOTES

COMMON SCHEMATIC SYMBOLS



CLOCK AND TIMER DEVICES

1. General - Timing mechanisms used to determine homemade devices include clocks, electrical timers and numerous mechanically operated timers. These mechanisms may be used to arm or fire an explosive or incendiary device.

2. Definition - Any escapement mechanism such as a mechanical or electrical, clock or timer, that is employed in a hazardous device and is designed to arm and detonate the device at a predetermined time, independent of further action, is a clock or timer device.

NOTE: Basically all clock and timer devices are simple and easy to understand.

NOTE: Consider pocket and wrist watches as clocks.

3. Functional Analysis:

a. Clocks alarm actuated - Mechanical clocks and watches that operate by spring tension or weights to provide energy to the escapement mechanism.

EXAMPLES: Ordinary household clocks (spring powered), grandfather or grandmother clocks (weight powered).

(1) Operation - When time set on alarm is reached, whether spring or weight powered, the alarm wind handle on the spring powered clock will turn, causing an electrical wire attached to it to turn, making contact with a lead from the battery, completing a circuit causing the item to function. On the weight powered clock, the weight descends until electrical contact is made which completes the circuit causing the item to function.

(2) Materials required.

(a) Clock.

(b) Battery.

(c) Wire.

(d) Cap - electric.

(e) Explosives.

NOTE: INTERNAL ALARM MAY ALSO BE USED AS A FIRING SWITCH.

b. Clocks using the hands to arm or fire a device - May use either minute or hour hand dependent on delay time desired.

(1) Operation - When the hands contact the screw in the crystal of the clock, it completes an electrical circuit causing the item to function.

(2) Materials required.

(a) Clock. ____________________

(b) Power source to operate clock. ____________________

(c) Wire. ____________________

(d) Battery to fire the item. ____________________

(e) Electric cap. ____________________

(f) Explosives. ____________________

c. Combination hand and alarm wind handle - By using the combination of the screw in the crystal, hands, and modified alarm wind handle switch, increases the bomber(s) personal safety when handling or transporting the device. This also provides a delay and could add an arming circuit. ____________________

____

____

(1) Operation - By using the combination of hands in series with the alarm wind handle switch an arming and firing circuit is constructed. The modified type operates by having the hands or the alarm wind handle arm the circuit and then having either the hands or alarm wind handle cause the item to function. Notice that the modified type uses an alarm wind handle with non-conductive material attached to the handle. An insulated wire extends from the handle and is inserted between a set of spring contacts. When the alarm goes off it pulls the insulated material from between the spring contacts causing the item to arm or function, depending on how it was setup. ____________________

____

____

(2) Materials. ____________________

(a) Clock. ____________________

(b) Battery. ____________________

(c) Wire. ____________________

(d) Insulating material. ______________________

(e) Cap - electric. ______________________

(f) Explosives. ______________________

(g) Clothes pin. ______________________

d. Clock to Arm a Device - This type of switch is used to provide a delay in arming for the bomber(s) safety and may be intended to cause the target to function the item. The delay can be accomplished in several ways; with mercury switches the hands can be set for a delay of several minutes to hours. When the hands contact the screw in the crystal the circuit is complete except for activation of the mercury switches by tilt or movement. When the item is moved the mercury switch closes and the item functions. Another way is to have the alarm wind handle pull the insulating material from between the clothes pin contacts and then have the hands fire the item when they come in contact with the screw in the crystal, or vice versa.

____

____

e. Clock using main spring as firing switch or arming switch.

NOTE: ANY SPRING POWERED CLOCK MAY BE USED.

(1) Operation - When clock is set, it is wound to operate for the maximum amount of time. The spring unwinds as the clock runs and when it has unwound to the extent that the spring contacts the bolt used as part of the electrical circuit the device is armed or fired.

____

NOTE: THE BOMBER(S) USUALLY TAKES THE CLOCK WORKS OUT OF THE CASE TO ACCOMPLISH THIS SETUP.

(2) Materials required.

(a) Clock. ______________________

(b) Battery. ______________________

(c) Wire. ______________________

(d) Cap - electric. ______________________

(e) Explosives. ______________________

(f) Bolt or screw to use as contacts. ______________________

____

f. Timer device (commercial) - Timers come in assorted sizes and delays and are found in one shape or another in most homes. They may be mechanical or electrical. ______________________________

____

____

(1) Operation - One wire is attached to each side of a timer switch or plug receptacle. When set time has elapsed, contacts are closed causing the item to function. ______________________________

____

____

(2) Materials.

(a) Timer. ______________________________

(b) Battery. ______________________________

(c) Wire. ______________________________

(d) Electric cap. ______________________________

(e) Explosives. ______________________________

____

____

____

____

IMPROVISED EXPLOSIVES

1. General

The information in this handout is intended to provide you, the bomb technician, with the composition of some improvised explosives that have been manufactured by various individuals or groups in the past.

Warning

The mixing of any improvised explosive by any method is considered to be dangerous; therefore, it is recommended that any mixing be done taking extreme precautions.

2. Types of Improvised Explosives

a. Black Powder & Smokeless Powder

(1) Black Powder Mixtures

Component	Mixture	
Potassium Nitrate	75%	15 PARTS
Charcoal	15%	7 PARTS
BINDER { Sulphur	10%	3 PARTS
Dextrine (optional) CORNFLOWER	—	1 PART

(2) Smokeless Mixtures

(a)

Component	Mixture
Potassium Nitrate	40%
Ammonium Nitrate	37%
Charcoal	23%

(b)

Component	Mixture
BAT SHIT ← Guandine Nitrate	50%
Potassium Nitrate	40%
Charcoal	10%

Mixing Method for Black Powder

1. Dry mix appropriate amounts of ingredients listed.

2. Add water until ingredients are dissolved.

3. Heat mixture until small bubbles form.

   CAUTION: Do not boil mixture. Be sure all mixture stays wet.

4. Pour mixture into alcohol and let stand for about 5 minutes.

5. Pour mixture into cloth and strain liquid out.

6. Pour damp mixture onto a suitable screen & gradulate by rubbing through screen.

   NOTE: If granulated particles appear to stick together and change shape, recombine & repeat steps 5 & 6.

7. Spread granulated powder out in a layer about 1/2" thick and let dry.

8. Drying should be accomplished in about one hour. The longer the drying time, the less effective the mixture.

EXTREMELY SENSITIVE.

b. Ammonia Tri-iodide

MOST SENSITIVE IMPROVISED EXPLOSIVE →

Component	Mixture	
Aqueous Ammonia	1/2 CUP	HOUSEHOLD AMMONIA & IODINE CRYSTALS
Iodine Crystals	2 TEASPNS	

Mixing Method for Ammonia Tri-iodide

1. Pour 1/2 cup of aqueous ammonia into a glass or styrofoam cup.

2. Measure 2 teaspoons of iodine crystals into ammonia.

3. Pour mixture into second glass or styrofoam container with gauze bandages over it. The gauze will filter liquid and leave the activated iodine crystals behind.

4. Carefully transfer activated crystals to surface or container. When dry the crystals are extremely sensitive and may explode spontaneously.

c. Perchlorate Mixtures

(1)

Component	Mixture
(a) Potassium perchlorate	80%
(b) Aluminum dust	20%

(2)

Component	
(a) Potassium perchlorate	60%
(b) Iron dust	40%

(3)

Component	
(a) Potassium perchlorate	1/2 PART
(b) Potassium nitrate	2 PART
(c) Sulfur	1/2 PART
(d) Charcoal dust	1/2 PART
(e) Red Gum	1/4 PART

CHLORATES = WHITE CRYSTALS
NITRATES = WHITE POWDERS

RED PHOSPHORUS — DOES NOT IGNITE WITH AIR. DO NOT CONFUSE WITH YELLOW OR WHITE PHOSPHORUS (WHICH BOTH IGNITE WITH AIR). DO NOT PUT RED PHOSPHORUS UNDER WATER; IT WILL BUILD HEAT AND PRESSURE.

Mixing Method for Potassium Perchlorate Mixtures

A dry explosive mixture can be made from potassium perchlorate combined with ingredients shown in handout.

1. Pulverize potassium perchlorate into a fine powder.

2. Measure appropriate amounts of ingredients and pour into a mixing container.

3. Mix ingredients well with a wooden rod.

d. Chlorate Mixtures

(1) Component — Mixture

(a) Potassium Chlorate — 50%

(b) Sugar; Sulfur or Charcoal — 50%

(2) Component

POOR MAN'S C-4 {

(a) Potassium Chlorate — 9 PARTS

(b) Petroleum Jelly — 1 PART

}

(3) Component

(a) Potassium Chlorate — 7 PARTS

(b) Antimony Sulfide — 2 PARTS

(c) Sulfur — 1 PART

(d) Red Phosphorus — 1 PART

NOTE: This is an extremely sensitive mixture due to the use of red phosphorus, therefore, it is not recommended that it be used.

(4) Component

(a) Sodium Chlorate — 3 PARTS

(b) Shellac — 1 PART

(5) Component

(a) Sodium Chlorate — 3 PARTS

(b) Aluminum Powder — 1 PART

Mixing Method for Chlorate Mixtures

1. Pulverize the chlorate into a fine powder.

2. Measure appropriate ingredients into a container and mix thoroughly.

   e. Nitrate Mixtures

Component	Mixture		
Sodium Nitrate	50%	50%	POTASSIUM CHLORATE
Red Phosphorus	50%	50%	

NOTE 1: This is an extremely hazardous substance to mix.

NOTE 2: Substituting Potassium chlorate for Sodium Nitrate will increase sensitivity; therefore, potassium chlorate must be wet when mixed. POTASSIUM IS ALMOST AS POWERFUL AS TNT.

NOTE 3: It is not recommended that the above be mixed unless it can be accomplished remotely.

Component	Mixture
Ammonium Nitrate	88%
Aluminum Powder	12%

Component	Mixture
Ammonium Nitrate	28 PARTS
Charcoal dust	4 PARTS
Dextrine	1 PART

Component	Mixture
Ammonium Nitrate	30 PARTS
Potassium Nitrate	15 PARTS
Charcoal	2 PARTS
Sulfur	2 PARTS
Dextrine	2 PARTS

* NOTE: DO NOT USE TEFLON-COATED ALUMINUM. AFTER MELTDOWN, IT IS STILL SUBJECT TO DETONATION.

Mixing Method for Dry Nitrate Mixtures

1. Pulverize the nitrate into a fine powder form.

2. Mix ingredients into appropriate mixture.

3. These mixtures should be used as soon as possible as the nitrate will absorb moisture and weaken the mixture.

Component	Mixture
Ammonium Nitrate	8½ LBS.
Fuel Oil	1 PINT

FERTILIZER EXPLOSIVE

An explosive munition can be made from fertilizer grade ammonium nitrate and either fuel oil or a mixture of equal parts of motor oil and gasoline. When properly prepared, this explosive munition can be detonated with a blasting cap.

f. Special Compositions

(1) Component — Mixture

Component	Mixture
(a) Potassium Permanganate	2 LBS
(b) Aluminum powder	½ LB.
(c) Glycerin	½ LB.

(2) Component

(a) Benzoyl Peroxide $C_{14}H_{10}O_4$

NOTE: Used alone, when heated will form toxic fumes and explosive gases.

(3) Component

USED TO MANUFACTURE RDX. ← (a) Hexamethylenetetramine $(CH_2)_6N_4$

(b) Nitric Acid

(c) Acetone

2. Weigh or measure out 70 grams by weight, 18 teaspoons by volume, of the hexamine and start adding the salt-like hexamine slowly, 1/2 teaspoon at a time, during a 15 minute time period. Maintain the temperature between 20° and 30° C. while stirring gently with the thermometer. Control the temperature by dipping the canning jar in and out of the basin filled with cold water.

3. When all of the hexamine is dissolved in the acid, heat the solution to 55° C. (131° F.) by placing the canning jar in a basin of hot water. Maintain this temperature for about 10 minutes.

4. After heating the solution for 10 minutes, remove the canning jar from the basin of hot water and place it in the basin of cold water. Cool the canning jar to 20° C. (68° F.)

5. When the temperature has reached 20° C., add 3 cups (750 ml) of cold water to the solution and a white salt will appear.

   CAUTION: The white precipitated salt is RDX explosive and should be handled with care from this point on.

6. Filter the acid/water/RDX solution through a paper towel covering the mouth of another jar.

7. Wash the RDX crystals off of the paper towel and into a canning jar, using an additional 3 cups of fresh, cold water. Add a teaspoon of sodium carbonate to neutralize the acid and stir rapidly for 2 to 3 minutes, then filter again.

8. The crude product can be dried out on the paper towel filter. It is suitable for fairly immediate use, or it can be purified.

9. To purify RDX, fill a quart canning jar 2/3 full of acetone. Heat the acetone by placing the jar in a basic of hot simmering water, than add RDX, a tablespoon at a time, until it completely dissolves in the acetone.

10. After the maximum amount of RDX has been dissolved into the hot acetone, allow the solution to cool to room temperature, then let stand for one more hour.

11. The RDX will form a salt once again. Filter the RDX and spread it out to dry on a paper towel as before.

12. The purified RDX should be stored in a clean canning jar with a tight fitting lid. It can be stored for months without loss of effectiveness.

NOTE: RDX is not too sensitive to heat and shock, but is fairly sensitive to friction. Care should therefore be exercised when the explosive is to be packed or when the dry explosive is handled. Using the amounts of chemicals listed in this article, the yield of RDX should be about 1 1/2 ounces.

g. Metallic compositions

(1) Sodium - soft white metal

NOTE: Reacts violently with water. Has been used with calcium carbide in a gelatin capsule. Used by dropping in gas tanks. The capsule melts releasing the calcium carbide into water in tank which produces acetylene gas. The sodium explodes upon contact with water.

(2) Pulverized Metals -

Used as fuels with oxidizers and tends to increase the temperature of explosive substance making it more brisant.

h. Gas Mixtures -

(1) Liquid

(a) Component	Mixture
Nitromethane	1 GAL.
Aqueous Ammonia	½ PINT

* 60% GRADE OR BETTER HYDROGEN PEROXIDE CAN BE DETONATED BY A BLASTING CAP.

NITROMETHANE LIQUID EXPLOSIVE

A liquid explosive, that resembles water in appearance, can be made from nitromethane and aqueous ammonia (household glass cleaner). This liquid explosive is 22 to 24 percent more powerful than military T.N.T., and can be detonated with a standard blasting cap. However, to achieve maximum velocity, a compound detonator should be used.

MATERIAL REQUIRED:	SOURCES:
Nitromethane	Chemical supply house or hobby stores (racing fuel)
Aqueous ammonia (non-detergent)	Grocery stores
Measuring container (cup, pint, gallon, etc.)	
Blasting cap or compound detonator	

PROCEDURE:

NOTE: Nitromethane is a common chemical reagent, and under normal conditions cannot be made to detonate even if a strong detonator is used. However, if certain ammonia-containing compounds (called sensitizers) are added in small percentages, then the sensitized nitromethane can be detonated with a standard No. 8 blasting cap. The most readily available sensitizer is common household glass cleaner (aqueous ammonia).

To produce the explosive, simply pour the sensitizer into the nitromethane and mix thoroughly. One-half pint sensitizer will sensitize one gallon of nitromethane.

(b) Dust Explosives.

A mechanical explosion may be produced by suspending particles of flammable dust in the air of a confined and igniting it. The best and most readily available materials for this purpose are flour, starch, and coal.

3. AVAILABILITY.

a. Chemical Supply Companies.

b. Drug Store.

c. Grocery Store.

d. Hardware Store.

e. Paint Store.

f. Fuel Oil Supplier.

g. Mining Operations.

4. USES OF IMPROVISED MATERIALS.

a. Substitute explosives by legitimate, federally licensed organizations.

b. Commercial, school, and private laboratories. Possession of most of the materials are legal, unless illegal interest is proven. Gun enthusiasts use nitrate mixes to make their own black powder.

c. Clandestine operations - The availability of these materials make them popular with subversive groups. Generally, the mixing of the materials to make explosives, are simple, requiring very little knowledge of chemistry, and easy to follow formulas are readily available.

5. SAFETY HAZARDS.

a. Sensitivity - Improvised explosives are very unpredictable.

b. Toxicity - Smoke, vapor, and residue are always considered toxic.

c. Safety precautions are covered in the Blaster's Handbook, SOP, and safety in handling and use of explosives, Pam #17.

NAME	FORMULA	DESCRIPTION
Potassium chlorate	$KClO_3$	White crystals. Used to produce oxygen in laboratory. Powerful oxidizer that will generate flame with sulfuric acid and organic material (sugar, paper).
Potassium perchlorate	$KClO_3$	White crystals. Also powerful oxidizer but more stable than the chlorate. Will produce explosive mixture with red phosphorous and a propellant with organic material (asphalt, plastic, vaseline).
Nitric acid	HNO_3	Yellow colorless liquid. Strong oxidizer. Can be used to make guncotton, nitroglycerine.
Phosphorous	P	Comes in two forms, yellow (or white) and red. Yellow phorous is poisonous and self-igniting in air -- can be used as igniter. Red phosphorous forms explosive mixtures with oxidizers.
Potassium permanganate	$KMnO_3$	Very dark purple (almost black) crystals. Another strong oxidizer forming explosive mixtures with red phosphorous or organic materials.
Carbon disulfide	CS_2	Colorless liquid with characteristic "rotten radish" smell. Poisonous and very inflammable. Used as solvent for yellow phosphorous in self-igniting systems.
Magnesium	Mg	Grayish metal, comes in strips (1/8 inch wide) and powder. Strips used as igniters for thermite for other bombs. Powder ("flash powder") used in cherry bombs.
Aluminum	A_1	Only as a powder is it dangerous. Used as main component (with iron oxide) of thermite bombs.
Chlorine	Cl_2	Gas. Comes in cylinders. Original World War I poison gas.

Ammonium nitrate	$NH4NO_3$	White crystals. Can be combined with fuel oil to make a high explosive similar to TNT.
Sulfuric acid	$H2SO_4$	Colorless oil liquid. By itself ("vitriol") will cause severe burns and lesions. Also used with potassium chlorate as igniter.
Sodium Potassium	Na K	Reactive metals. Usually kept under oil and covered with gray layer. Can be cut with knife, showing metallic luster. Both react strongly with water, setting off explosion.