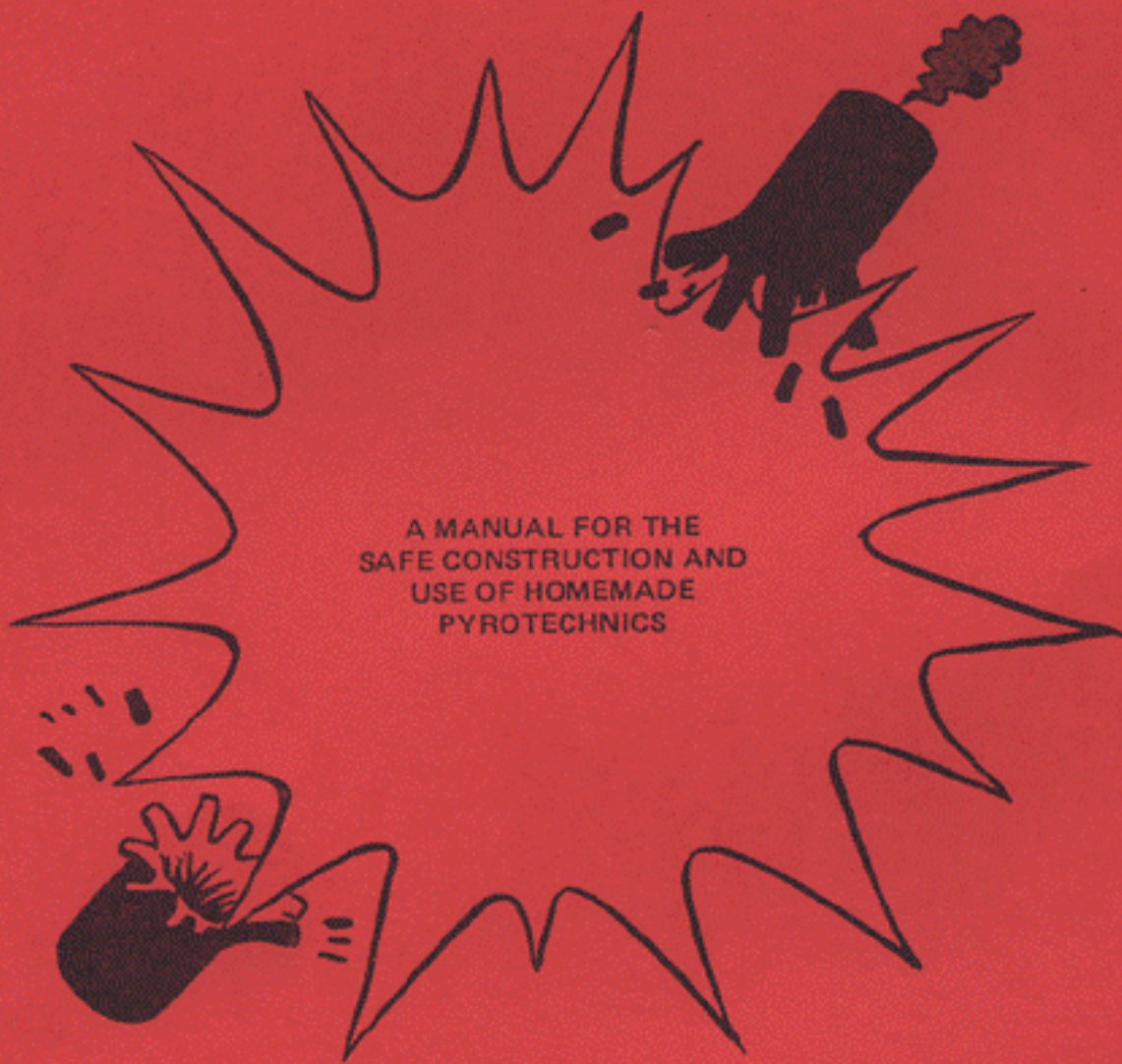


# **THE FIRECRACKER COOKBOOK**



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**THE FIRECRACKER  
COOKBOOK**

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— WARNING —

THE MAKING AND USING OF FIREWORKS, AS WITH ANY TYPE OF EXPLOSIVE, IS POTENTIALLY HAZARDOUS AND THE READER IS ADVISED TO USE EXTREME CAUTION WHEN MAKING AND USING ANY OF THE DEVICES DESCRIBED IN THIS BOOK. THE READER IS ALSO ADVISED TO FAMILIARIZE HIMSELF OR HERSELF WITH ALL FEDERAL AND STATE LAWS AND LOCAL ORDINANCES REGARDING THE MANUFACTURE, STORAGE, TRANSPORTATION AND USE OF FIREWORKS AND EXPLOSIVES.

— NOTICE —

ALTHOUGH WE HAVE MADE A SINCERE EFFORT TO VERIFY BY ACTUAL TESTS THAT THE FORMULAE & PYROTECHNIC DEVICES CONTAINED IN THIS BOOK ARE VALID AND WILL WORK, WE HAVE NO WAY OF CONTROLLING THE QUALITY OF THE CHEMICALS USED OR THE SAFETY HABITS OF INDIVIDUALS WHO MAY ATTEMPT TO MAKE ANY OF THE DEVICES CONTAINED HEREIN. **BUTOKUKAI INC.** ASSUMES NO RESPONSIBILITY FOR ANY ACCIDENTS WHICH MAY OCCUR AS A RESULT OF THE IMPROPER USE OF THE INFORMATION CONTAINED IN THIS BOOK. ANY ATTEMPTS TO MAKE THESE DEVICES ARE DONE SOLELY AT THE READER'S OWN RISK.



## Introduction

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The purpose of this manual is not to encourage people to get out and break the law by making and setting off potentially dangerous exploding fireworks. Enough people do that already, and no amount of legislation is going to make them stop.

Banning fireworks in an effort to eliminate injuries and fires is much like trying to ban the ownership of handguns to prevent crime and violence. It sounds good, it looks real nice on paper, but in the real world? No way!

As a general rule, most fire departments consider fireworks to be a colossal pain in the neck, and would like to see them ALL banned. However, they know that if their city did ban their sale and use, residents would simply go to areas in which they are legal and buy them there. Or they might order their stuff by mail from out of state, or even make the fireworks themselves. This is happening right now, and the practice will surely increase as the fireworks laws get more restrictive.

I agree that fireworks are dangerous if handled carelessly or misused. They are also a definite hazard if set off in dry, high fire risk areas. It is foolish to underestimate fireworks and not realize the potential for injury and damage that is possible if they are not used properly. This goes for the "safe and sane" variety as well as the real stuff.

Actually, the "safe and sane" fireworks can be even more dangerous than the more powerful types. Sparklers, smoke devices and similar stuff have decisive incendiary properties when handled carelessly (such as by throwing them).

Sparklers, for example, can be very dangerous. Some varieties can burn as hot as 5,000<sup>o</sup>, and a lot of fires and injuries have resulted from their use. Children will throw them at each other and in the air, try to touch the glowing hot wire, and even stand directly over a box bulging with the family assortment of fireworks while waving them around. I have seen this happen on many occasions.

The common pop bottle rocket, while not a "safe and sane" item, is very popular and easy to get. It, too, is dangerous if used carelessly. People tend to shoot these off from their yards, not realizing that they can land on a nearby roof and burn a house down in minutes. We had a small roof fire caused by careless neighbors who were shooting off these rockets, and our home could have been severely damaged had I not smelled the smoke and gone outside. These rockets can also land in dry brushy areas and destroy them, as any fire department can tell you.

By contrast, most people are aware of the damage that the larger exploding and flying fire-

## THE FIRECRACKER COOKBOOK

works can inflict, and so are usually more careful with them.

"Safe and sane" fireworks are designated as such by the State Fire Marshal. The Department Of Transportation (D.O.T.) labels these as Class C (common) fireworks. These "safe and sane" fireworks will have such a label on each device.

To be classified as "safe and sane", the fireworks must not be of the exploding variety, cannot discharge any type of projectile, and cannot fly or leave the ground. Common "safe and sane" fireworks include the various cone and box fountains, smoke devices, toy snake pellets (not containing mercury), sparklers, pinwheels, caps, whistling devices and carbide cannons. How "safe" these are depends on how "sane" you are.

Some of the illegal stuff is also labeled as Class C, but is not legally "safe and sane". These include firecrackers, lady fingers, Roman candles, pop bottle rockets, skyrockets, buzz bombs, etc. Under this classification, each device cannot contain more than 50 milligrams of exploding composition. This classification means that these can be shipped just like the "safe and sane" types, usually by freight or UPS, to the few remaining states where they are still legal.

Next comes the Class B stuff. These are illegal just about everywhere, and contain a large amount of exploding composition. This group includes M-80 salutes, cherry bombs, silver salutes, half sticks and various heavy tube salutes.

These goodies are sometimes brought back from foreign countries, and are made in incredible amounts in this country by bootleg factories. Now and then you will read of a major bust of such factories, and the police confiscate enormous quantities of chemicals, components and truckloads of finished stuff.

Even one person with enough chemicals, fuse and casings can become a factory and make and sell thousands of illegal fireworks. The initial cost is low, and there can be a lucrative profit margin. On the other hand, there are hundreds of people who just make enough goodies for the Fourth for themselves and a few friends, as well as to explore the field of creative chemistry without any profit motive.

You should know that the Consumer Product Safety Commission (C.P.S.C.) has been trying for some time to ban the import of all exploding fireworks into the U.S. (Cherry bombs, silver salutes and M-80's have been banned since 1966.) So far, their efforts to ban the other stuff have failed, and these are still available. Even so, exploding fire-

works, and especially large firecrackers and heavy salutes, are illegal in most states. But since they are so popular, there is little trouble in finding them in many of these areas.

If the C.P.S.C.'s ban on the other fireworks ever went into effect, the rate of fireworks-related injuries and deaths would probably increase drastically due to more people experimenting around trying to make their own fireworks. It would also make the black market in bootleg boomers grow even bigger and more profitable than it is now. It seems that a large majority of these exploding fireworks from lady fingers to half sticks and God knows what else show up most often in areas where ALL fireworks are forbidden. This is proven quite audibly every year.

So, regardless of the laws, people who choose to use fireworks are going to continue to do so. They will either buy their stuff illegally or make it themselves. As for those who try to make their own, some will succeed, and some will fail -- and with disastrous results.

Hundreds of people are injured annually by homemade fireworks, and some are even killed. This is proven every year in the newspapers. It can safely be said that if you experiment around without knowing what you are doing, the chances are extremely good that you will blow your head off. Any police or fire department will be happy to show any would-be "Fyro-Expert" some pictures of the less fortunate who have blown themselves to pieces.

This will undoubtedly upset countless police and fire departments worldwide, but I believe it is useless to simply say, "Don't make fireworks." Such a statement would only fall on deaf (or deafened) ears, and will not accomplish anything except to literally encourage the practice.

I think it is far better to provide as much information on the subject as possible, as well as thoroughly researched and tested methods of construction, safe handling of the chemicals involved, and the safe and considerate use of the finished products without causing injuries and property damage.

I also think that the fireworks laws should be revised so as to allow people to enjoy fireworks on the Fourth Of July in specially designated areas such as beaches, large open parks, and fields that provide no fire risk, where they are presently illegal. This would be far safer than setting of fireworks in residential areas where the danger of fires is always present.

If people are taught the safe manufacture and

## THE FIRECRACKER COOKBOOK

use of fireworks, and if some of the presently illegal fireworks are legalized, I predict the risk of personal injury and property damage would decrease rapidly.

I have been making and handling just about every type of fireworks for about 9 years at this writing. I am not claiming to be an expert, but am simply showing what I have researched and what has worked well for me. I haven't suffered an injury worse than a fuse burn and ringing ears, and if this manual prevents even one injury the whole thing is worthwhile to me.

I consider pyrotechnics to be one of the highest forms of art where one can make ground displays and the sky can be your canvas. When one gains experience, the variations and possibilities are endless. This is the reason I wrote *The Firecracker Cookbook*.

I offer sources for some excellent literature at the end of the text. I feel that this is an important feature, as their offerings deal with making all types of fireworks used today as well as in the past. Since *The Firecracker Cookbook* deals primarily with exploding fireworks, it is not intended to be a complete course in fireworks making.

The more information you obtain, the safer fireworks become for you, as you are always learn-

ing new chemical manipulations and related safety procedures. It might even be interesting to take a few courses in chemistry if you really get into this. You may even want to become a licensed pyrotechnician, if this is legal in your state, and shoot off really impressive displays.

You need not be concerned with the legality of this manual. It is perfectly legal to buy and sell, as are any other books at this time. The same goes for the individual chemicals, fuse and related components. Unless you are caught with finished fireworks of the type that are illegal in your area, and showed the intent, ability and the means to make them, you are perfectly within the law. However, you should check your individual state laws and city ordinances before making or setting off any type of pyrotechnic device.

The only advice I can give you is to obey the law. For those of you who live in areas where fireworks are legal, make or buy your stuff cautiously and use it wisely and safely. Since this manual is written for reference and general information purposes only, *neither the author nor the publisher can be responsible for any injuries, property damage or legal action of any kind resulting from the use or misuse of the information contained herein.*

On the next and following pages are reproduced several newspaper accounts of the dangers of the misuse of fireworks and the attempts of police and fire officials to cope with the illegal use of fire-

works in many California communities. The legal picture on fireworks may well have changed by the time you read this, but the strong accident potential from their misuse will never change.



## Fireworks bill blasted

Fire department officials in Los Angeles County blasted a controversial state measure that was introduced into the state Assembly last week, after being blasted earlier by the state Senate, that would prohibit cities from banning the sale of "safe and sane" fireworks.

Safe and sane fireworks are non-explosive.

There are 81 cities in California that currently ban the sale or use of fireworks.

Under the proposed law, cities could regulate but not stop the sale but could prohibit the use of such safe and sane fireworks.

State Sen. William Campbell (R-Whittier), who has a reputation of championing firefighters' causes, hesitated for weeks before

introducing the controversial measure. During that period fire department officials urged him not to reconsider.

Campbell called the issue one of "free commerce" and also said the "tradition" in the United States dictates the use of fireworks in honor of the country's birth.

"If you ban the sale of safe and sane fireworks in the state of California, you dramatically increase the use of illegal fireworks," he said.

Fire department officials were quick to label the measure "ridiculous."

"Why would people buy them if they didn't intend to use them?" Hawthorne Fire Chief Ralph Hardin asked.

Although Hawthorne and many other cities in the surrounding area do allow the sale of "safe and sane" fireworks, Hardin and other officials believe the use of illegal fireworks will increase if there were statewide sales.

Richard Friend, spokesman for the Los Angeles County Fire Department, agreed with Hardin.

Friend also said it was ridiculous for a law to allow the sale of fireworks but also permit cities to ban their use.

Friend said, "I think you are opening a Pandora's Box to say you can sell them but not use them.

"It's like saying you can sell a car in the city of Lawndale, but you can't drive them here.

"If you have fireworks and you increase the use, you're going to have more injuries and fires," he concluded.

Los Angeles City Fire Chief John Gerard echoed what many other officials said: "The most sinister aspect of the bill is it smacks directly to the heart of local control."

Gerard was less concerned about the measure than his fellow fire fighters because he felt local laws could be passed to make the sale so difficult and expensive cities could all but ban them.

Campbell has stressed many times "safe and sane" fireworks don't cause the damage attributed to illegal fireworks and rockets. He said the illegal variety, such as bottle rockets, cause most of the fires and injuries.

Charles Masten, president of the Los Angeles County Fire Chiefs Association and fire chief of El Monte, said there is a study under way to determine what type of fireworks are responsible for fires and injuries.

"It's not just the fireworks (safe and sane or illegal) but how they are used," he said.

Masten explained that if safe and sane fireworks are tossed in the air and land on a wooden roof, a fire will start just the same.

"Fireworks are fireworks—and they are all fire," he said.

Culver City Fire Marshal Gary Goover said although his city sells safe and sane, he doesn't like it.

"We'd love to see all safe and sane fireworks discontinued," he said.

## Conflicting laws create enforcement problems

By JOHN NEEDHAM

**B**efore Fourth of July revelers proclaim their exuberance over the nation's birthday by firing a volley of ear-ringing pyrotechnics, they'd better make sure their display of patriotism is legal.

Fireworks without the "safe and sane" label, signifying they have been approved by the state fire marshal, are illegal to use or possess anywhere in California.

However, many cities, including Los Angeles, forbid the possession and detonation of any fireworks. Period. Similar bans are in effect in portions of the San Fernando and San Gabriel valleys. The ordinances even include a prohibition on sparklers, long-time favorites of young children.

According to Cecilia Anderson, spokeswoman for the L.A. Fire Department's Public Service Unit, the city's strictly enforced 40-year ban on fireworks is due to the large number of fires and injuries caused by the devices.

Anderson said last year, in a one-month period from June 13 to July 13, 500 fires were attributed to fireworks, causing about \$2 million in property damage in Los Angeles.

Countywide, 321 injuries were caused by the improper handling of illegal fireworks, she said, in some cases resulting in loss of sight and traumatic amputations.

Thomas Laski, a fire inspector in the department's Legal Division, said penalties vary according to the fireworks used.

Possession of devices containing 7,500 grains of explosive material or more are punishable by up to a

year in state prison and a \$5,000 fine.

Though all fireworks are forbidden in Los Angeles, fines and jail terms for implementers not deemed "safe and sane" legal in some communities by the state fire marshal carry stiffer penalties. Selling fireworks to minors is also punishable by a fine and jail term.

Laski added that the Los Angeles Fire Department is planning an aggressive enforcement campaign in an effort to prevent a multimillion-dollar loss of property, as well as personal injuries.

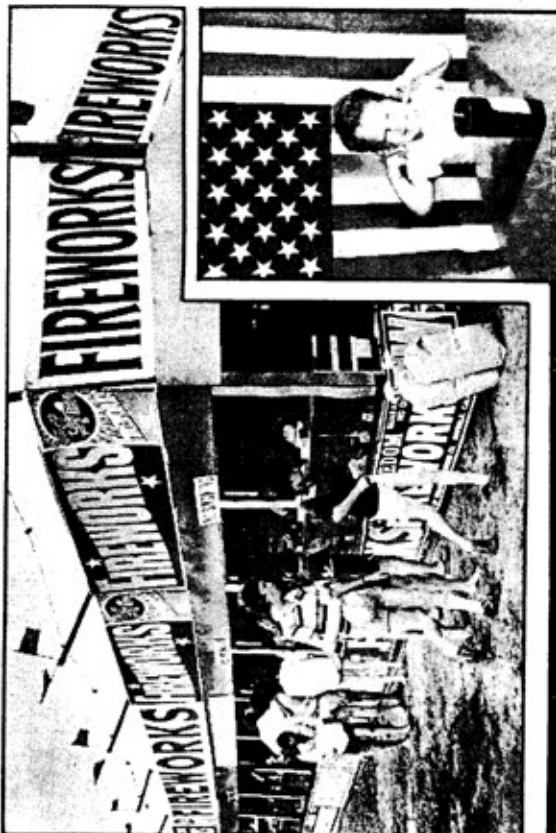
But the often-heard lament among fire officials is that codes governing the use of fireworks are a

variable crazy quilt, changing significantly from community to community and creating an enforcement nightmare.

A spokesman for the Van Nuys Police Department said that despite the four-year prohibition on all fireworks in the San Fernando Valley, regulating the flow of fireworks into the area is nearly impossible.

"It's just a hop, skip and a jump to a fireworks stand outside the Valley," the spokesman said. Mike Aviani, battalion chief of L.A. County Fire Station 28

(Continued on page 6)



## Conflicting firework laws

(Continued from page 5)

in Whittier, said in the incorporated area of the city safe and sane fireworks aren't allowed, but in the adjacent unincorporated area they can be sold.

"All people have to do is drive a few miles away to the nearest fireworks stand and load up," Aviani said. "And there's not much we can do about it."

Carl Markmann, administrative chief for the Pasadena Fire Department, said his city's total ban on fireworks is difficult to enforce in light of rules which are more lax in surrounding areas.

Echoing Aviani's frustrations was Fire Capt. Ronald McIntyre of Station 92 in West Los Angeles. "Our enforcement problem is that we're surrounded by county areas, where fireworks can be legally bought and sold, he said.

Jim Auld, sales manager for the Red Devil Fireworks Co. in Anaheim, the West's largest supplier and manufacturer of safe and sane fireworks, said of the 435 California cities, 360 are open to the sale of his company's products.

In the past, the firm has lobbied against the inaction of ordinances banning fireworks within individual municipalities and county areas, maintaining such laws encourage the use of devices not approved by the state's fire marshal.

"The largest bootleg business is in the large metropolitan areas where fireworks are illegal," Auld said. "A Los Angeles Fire Department report says there is a \$2 million annual business in illegal fireworks in the city."

Auld said much illicit trade in fireworks would fall off if legal, safe and sane products were made available, adding that legitimate businesses are being made the "fall guy" by local lawmakers.

He said a major safety feature in fireworks sold by Red Devil, which also markets the Wild Cat line, is that their chemical composition makes it impossible for them to be altered to provide a greater explosive force.

In addition, Auld stressed that, unlike illegal fireworks, sales of Red Devil products benefit non-profit service and community groups.

Such organizations purchase the devices from the firm on consignment, then sell them in sidewalk stalls provided by the company.

To help convince San Gabriel Valley residents to forego purchases of fireworks on the Fourth, the City of Whittier and the Kiwanis Club are co-sponsoring a public fireworks display at the city's York Field.

Admission is \$2 for adults and children under 6 years of age get in free. Food will be available, as well as entertainment beginning at 6 p.m. Visitors are invited to bring along a picnic basket. York Field is located at 9110 Santa Fe Road.

Pasadena's Rose Bowl will be the site of a circus and fireworks display beginning at 6:30 p.m. on July 4. Admission is \$2 for adults and \$1 for children. The event is co-sponsored by the city's Chamber of Commerce and a group of private individuals who donated funds.

The Santa Monica Pier will have a fireworks display beginning just after dark. The fireworks were donated by a group of business owners in the pier area.

Local law enforcement agencies also reported that extra patrols would be called out on the Fourth of July weekend to crack down on drunk drivers. Department spokesmen wished to remind drivers of California's tough new drunk driving laws.

## Firemen give warning on illegal fireworks

"M80s" could blow your finger apart. Firecrackers, cherry bombs and sparklers all add to the potential of personal injury.

Fireworks that are launched — such as the bottle rocket or giant missile and Silver Star — constitute fire hazards.

Fireworks of any type are unlawful to be sold or used within the city limits of Los Angeles. In fact, they have been for the last 40 years. In an effort to reduce the number of fireworks-related injuries and fires this year, the Los Angeles City Fire Department has implemented a massive campaign involving the use of flyers, posters and banners.

The primary message on each is that "Fireworks are unlawful in the City of Los Angeles." Banners have been placed over intersections near neighboring communities where fireworks are legally sold. Every city fire station is also displaying the banner until the Fourth of July.

Posters have been placed in community businesses and at all public park entrances.

The purpose of the fire department's efforts are to raise the level of awareness of the public. Many Los Angeles residents are unfamiliar with the ordinance banning fireworks. The fire department

hopes, through this campaign, to educate the public regarding the hazards of fireworks.

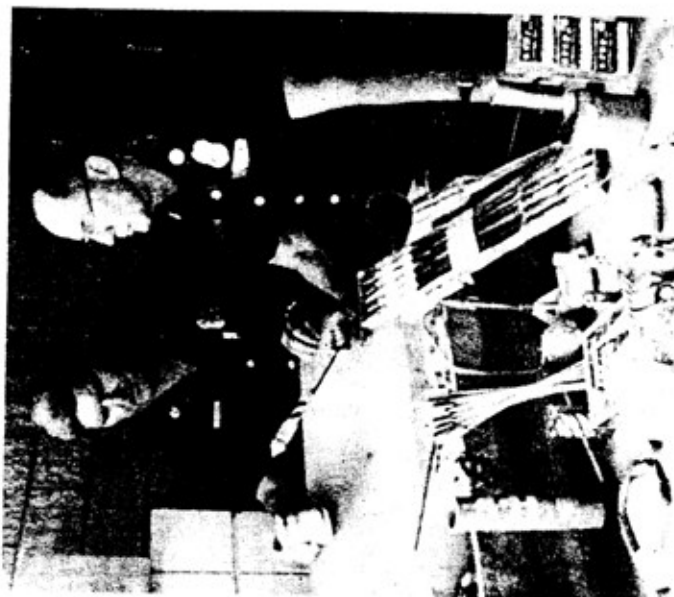
And those efforts are needed. In a comprehensive program to identify the fireworks problem and its devastating effect on the community, a comprehensive study was made covering the one-month period of June 13 through July 13, 1981.

The study was undertaken by the Los Angeles County Chapter of the California Fire Chiefs Association, in cooperation with the Los Angeles City Fire Department.

The study reveals that countywide there were 321 injuries requiring medical attention during the one-month period. Of those, 17 resulted in some degree of amputation or loss of sight.

There were a total of 500 fires caused by fireworks in the city of Los Angeles with property loss estimated at \$2,169,619. Countywide, the study reveals, there were a total of 1,266 fires with a property loss of \$3,772,901.

Although all fireworks are illegal in the city of Los Angeles, some nearby communities do permit the "sale and sane" fireworks. Among these is Culver City. "Sale and sane" fireworks can only be sold through properly licensed retail outlets from noon on June 28 through noon on July 6.



*DISPLAYING fireworks confiscated by Los Angeles Fire Department, Captains Philip McKay and William Hargett, from left, point out that all fireworks are banned in the City of Los Angeles.*



# July 4th fireworks kill two

United Press International

At least two people died in holiday weekend fireworks accidents, including a spectator hit in the forehead by a metal tube hurled 200 feet into a crowd at a July Fourth display.

Officials across the nation reported an explosion of fireworks-related injuries and doctors in Philadelphia operated Sunday to save the eyesight of a 4-year-old girl injured with nine others in an explosion triggered when a sparkler apparently ignited a bag of fireworks.

Fire officials said their phone lines were clogged with residents reporting a rash of fireworks-sparked blazes, which caused hundreds of thousands of dollars in damages. Three minor injuries to firefighters in California were reported.

An aerial fireworks display at a ballpark in Anderson, Mo., turned to tragedy late Saturday when a metal tube used in setting off fireworks was blown out of the ground by an explosion and flung into a crowd 200 feet away.

A spectator — Delores Bowzer, 58, of Neosho — was hit in the forehead by the tube and pronounced dead at the scene.

In Oak Park, Ill., a homemade firecracker bomb exploded, blowing out the stomach of a teenager and killing him. Two others suffered burns and a shrapnel injuries in the Saturday night explosion.

Officials said Kevin McTigue, 16, died after suffering a "blown-out belly" with injuries to his liver, spleen and intestines.

"They were playing with homemade fireworks," said Sgt. John Beerup. "They probably emptied some gunpowder from fireworks into a can."

Surgeons at Wills Eye Hospital in

Continued From Page 6

Philadelphia operated for two hours on Jennifer Kapper of Holland, Penn., who suffered tiny punctures to her eyes in an explosion touched off when an ember from a sparkler apparently ignited a bag containing cherry bombs and M-80s.

Police said the Saturday explosion "broke all the glass and damaged the porch" of a home in Fort Washington, a suburb of Philadelphia, and burned six adults and four other children — including Jennifer's sister and father.

"We saw and heard a great deal of screaming," said a neighbor.

The girl was reported in fair condition and doctors said they expected the girl to regain her sight, although particles from the exploded firecrackers also caused cataracts. Four of the others injured remained hospitalized in satisfactory condition.

In St. Paul, Minn., police said a youth was in danger of losing an eye from an explosion when a firecracker being hurled out of his car apparently flew back inside and ignited other fireworks.

In suburban Buffalo, N.Y., a youth was injured in his face and hands when someone hurled a lighted firecracker at him.

Firefighters, using helicopters and planes, Sunday contained a 1,400-acre sagebrush fire near Boise, Idaho. Authorities suspect it was touched off Saturday by either fireworks or holiday picnickers.

Other fireworks-related blazes causing hundreds of thousands in damages were reported in Southern California and Los Angeles firefighters received more than 1,000 alarms Saturday — twice the number of a usual weekend. Three firemen suffered minor injuries in Vacaville, Calif.

In Akron, Ohio, two young children face possible charges for accidentally ignited some highly flammable roofing material with firecrackers in a blaze Friday night that caused an estimated \$50,000 in damage.

In Woodland, Calif., spectators to what was billed as an hour-long fireworks display at the Yolo County Fairground got a quicker and more explosive show. A stray spark — from a rocket or possibly unauthorized firecrackers — triggered an explosion of \$6,000 in fireworks in a display that lasted only five seconds and consumed nearly 400 rockets.

No one was hurt, but the blast catapulted a box of rockets over a 9-foot fence, set fire to a stack of old telephone poles and unseated a man sitting 350 yards away.

However, in the true tradition of the Fourth of July, the Woodland Jaycees, the sponsor of the display for 26 years, managed to proceed as scheduled with the event by using the fireworks from a canceled show in Stockton.

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**OPEN HOURS:**  
June 29-July 1 8 AM-10 PM  
July 2-4, 8 am-midnight

**SAVE IN  
CULVER CITY**

"Fireworks may be legally  
sold, possessed or discharged  
only within other where sale is  
authorized"

**BUY FIREWORKS IN CULVER CITY**

### State cracks down on fireworks sales

In an effort to combat a yearly increase in fireworks-related injuries throughout California, fire officials announced yesterday that a task force will be cracking down on all levels of illegal firework sales.

"It's big business, there's no question about it. It's a billion-dollar-a-year business in this state," said state Fire Marshal Philip C. Favro.

Due to lax enforcement of fireworks laws, injuries increased to 11,000 nationwide last year, according to the U.S. Consumer Product Safety Commission.

Of those injuries, 6,000 to 7,000 resulted in eye damage suffered in large part by young children. Thirty to 35 percent of those children lost their sight permanently, said ophthalmologist Kenneth Diddie.

Joining fire officials at a news conference at the Los Angeles Children's Museum, Diddie cited the example of a 2½-year-old boy whose eye was "ripped open" last year when a firecracker exploded near him.

Clamping down on out-of-state distributors of illegal fireworks is the key aim of the state task force, which includes fireworks' industry representatives as well as state and local fire officials, Favro said.

### Illegal fireworks

There has been much in the news lately regarding the confiscation of illegal fireworks by the Los Angeles City Fire Department. I am very glad to see the fire department taking action on this matter since it is all too obvious that the Los Angeles Police Department intends to do nothing about it.

This past Fourth of July, I left several messages for my area patrol officer to call me regarding the need for extra patrol on my street, where we have had serious problems with illegal fireworks causing fires in a nearby ravine. I never received a call.

I eventually paid a personal visit to the Hollenbeck police station (the LAPD station with no public parking) to speak to the station commander. I was told in so many words that he was too busy to see me. Finally I put in a formal request for extra patrol. A patrol car never came down my street, and when I called to report the problem, I was told that "fireworks calls are the lowest priority calls."

It was wonderful to see the billboards stating "All fireworks are illegal in the City of Los Angeles," but so sad to find that nothing else would be done.

Los Angeles

## Warning on mail-order fireworks

Customers buying fireworks from out-of-state mail-order distributors are likely to lose both their money and their purchases, the Los Angeles County Fire Department warned Wednesday.

"They're just throwing their money away," Battalion Chief Robert Curtis, said at a news conference, noting that the illegal items are confiscated immediately upon delivery.

Freight companies are required to notify the fire department upon their receipt.

Last year alone, Curtis continued, the county fire department destroyed \$1 million in firecrackers, Roman candles, sky rockets and other illegal fireworks.

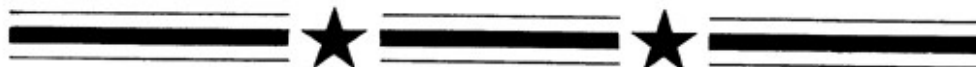
A total of 321 people were hospitalized for fireworks-related injuries and there was more than \$4 million in damages because of illegal pyrotechnics last year, he said.

In addition, because the customer is required to pre-pay for his purchases with a money order or certified check, he has no way to collect his money, the chief continued. Losses reportedly average \$100 per purchase.

Be advised that different state and local governments act differently in regards to fireworks. When

ordering fireworks through the mail, be forewarned that authorities in your area may confiscate them.

## Safety, Testing And Use Of Fireworks



This chapter deals with basic safety procedures, and the cautious testing and use of fireworks. I realize that some of you may be bored with safety reminders, but it is better to read and think about them before you do your thing than to risk blowing yourself up due to ignorance. If you think safety is boring, just remember that life in a hospital bed is a lot more boring!

When mixing composition, always wear some type of face and eye protection. A machine operator's face mask is ideal for this. It is superior to simple goggles or safety glasses since it protects the entire face instead of just the eyes. A dust filter mask is also advisable, as some of the chemicals you may use are irritating or toxic and should not be breathed in. These filters can be bought at paint and hardware stores and are cheap. They look somewhat like the masks that surgeons wear and fit over the nose and mouth.

Heavy cloth or leather gloves are important to protect the hands. Special asbestos gloves can also be used, and these are readily available. A small fire extinguisher or at least a can of water should always be kept handy. You may never need it, but it is a good idea to be prepared — just in case.

If possible, work at a table outside or in a clear area in the garage away from anything that is flammable. If you are forced to work inside your house or apartment, you will have to be that much more careful.

Your work table and the floor around the table should be covered with a few layers of newspaper. This can be wet down and thrown away after you are finished working. Only the chemicals and components which you need for a particular project should be out. All others should be stored in an area away from where you are working.

Chemicals should be stored in a sturdy, lockable box in a safe area. An Army foot locker is one example of a suitable storage container. A similar

box should be used to store your finished fireworks and it should be kept in a separate place from the components.

A laboratory gram scale is best for measuring amounts of chemicals, and need not be expensive. Mine cost around \$30.00, has seen several years of use and will undoubtedly still be in use several years from now. A mortar and pestle are great for pulverizing chemicals. It is *imperative* that these be non-metallic to avoid sparks. They can be bought at most hobby shops or any chemical supply house. Buy at least two sets. Use one for pulverizing your oxidizers such as potassium chlorate, perchlorate and nitrates. Use the other for chemicals such as sulfur, charcoal and the like. Mark these and do not get one confused with the other. If you should happen to grind an oxidizer like potassium chlorate in a mortar which had sulfur or sulfide residue in it, the chlorate could very well explode while you were grinding it. It *has* happened!

Follow all formulas exactly, and don't experiment around unless you are sure of what you are doing. That's how injuries occur. Too many people get hold of potentially lethal chemicals and think they're Joe Chemist. The next thing they know, the fire department is scraping them off the walls and ceiling with a spatula.

Do not mix up any more composition than you will need at one time, as some are relatively unstable and could be dangerous to store for long periods of time. Also, it is much better to mix up many small batches of composition rather than one or two large amounts. When mixing flashpowder, mix up only a gram or so at a time and be sure to use the Hand Savers that I describe in the chapter on powder.

Needless to say, when mixing or working with ANY pyrotechnic composition, the smoking lamp is out. The reason should be so obvious as to need no further commentary.



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Samples from all batches of fireworks should be tested. Test them in A REMOTE AREA AWAY FROM PEOPLE AND BUILDINGS. Do not test in residential areas. Neighbors do not appreciate a sudden BLLAAAMMM coming from next door, nor do they enjoy watching their house burned to the ground by a rocket that should have gone the OTHER way.

I can speak from personal experience here. As I said in the introduction, we had a small fire caused by a neighbor's rockets. We also had some fireworks buffs besides myself in the neighborhood, and some showed varying degrees of talent.

One such person set off a real thumper that even startled me. All the neighbors came running out of their houses just in time to see a huge cloud of resulting smoke billowing over the area. They stood in a large group, vigilante style, trying to determine who did it. I figured there was about to be a neighborhood hanging if they found out "who the inconsiderate dingbat was who threw that bomb!"

Since I was inside my house reading at the time the goody went off, no suspicion was directed towards me, even though the neighbors knew from acoustic experience that I was known to whip up a little something for the Fourth.

As I found out later, the culprit who lived nearby had simply rigged up his masterpiece with a burning cigarette taped to the fuse as a delayed ignition device. He, too, was inside his house — partying merrily when the thing went off.

The neighbors were understandably ticked off as this was not the first (or last) time such a thing had happened. I figured that the police would surely be called out for this one due to the extreme loudness of the device. It was a biggee! But as it happened, nobody called them at all. However, a couple of the neighbors made it very clear that their patience was wearing thin, and if this kind of thing continued, that the police *would* be involved.

The police got involved with me once as the result of a shell-shocked neighbor. I had made a small cannon, which I had charged with a blank load. I took it outside to the back yard to test it, and it turned out to be a very loud success. The resulting boom got one of my neighbors so horribly upset so as to call the police on me. About two hours later, a cop showed up at my door. Not just a regular cop, but a detective from the LAPD bomb squad! After I explained to him that I had simply fired a small homemade cannon with a blank charge, he was a bit upset (maybe disappointed). Apparently, the neighbor's description



was such that the police thought a real bomb had been set off. In a way, that's a compliment.

The officer then wanted to see my room. I let him in and he noticed my bookshelf with a few Army manuals, my copy of *Chemistry Of Powder And Explosives*, and some other interesting titles. He thumbed through these and probably thought I was nuts. I explained that I had those books for reference use, and that they were legal to own, which he knew. After ascertaining that I was not a crazed militant, mad bomber, or an arsonist, and that my interests were academic, he let me off with a rather stern warning.

When testing and using fireworks, you may encounter some duds. If your goody fails to go off, leave it alone for at least 30 minutes and do not let anyone near it, especially if it is a large device. This goes for all fireworks — not just the home brew variety.

There are infinite reasons why a pyrotechnic device will dud out. Usually it is a problem with the fuse. Maybe it just quit burning, or it could be smoldering and sputtering and waiting to go off at any time — like when you stoop down to pick it up.

I have heard of firecrackers and salutes that just sat there and smoldered for as long as 10

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minutes before suddenly going off. This usually happens more with fireworks that are fused with a piece of string coated with a chemical mixture, such as some firecrackers from Mexico, rather than with those which are fused with the more reliable safety fuse.

After 30 minutes, soak the dud in water if possible and bury it deep in an area where there is little chance of someone else discovering it. NEVER cut open a dud, try to replace the fuse, attempt to use it again, or otherwise mess with it. Many serious injuries have resulted from such practices.

I once saw a foolish kid pick up a Black Cat firecracker that had duded out. He peeled some of the paper back to expose the flashpowder inside and tried to get it to ignite by holding a lit match to it — while holding it in his hand! I tried to tell him that he was really asking for it and warned him of what could happen. The fool ignored my advice and said that he had done this several times before without getting hurt. Sooner or later, he will most likely have plenty of time to reconsider his errors — from a hospital bed.

It is a good idea to obtain a blank lab manual and log your results with homemade fireworks, especially stuff that is new to you. This way, you will have a permanent record. If you make something that you are really pleased with, you can check the book and see how much of what compo-



Only one of these men follows standard safety procedures when handling and using fireworks. Guess which one.

sition you used, type and thickness of the casing, etc. On the other hand, if the results are unsatisfactory — or if something unexpected happens, you will be able to see what you did wrong later and so avoid repeating the same mistakes in the future. Consider record keeping one more safety step!

### 7 SAFETY STEPS

1. Enjoy fireworks from a safe distance.
2. Use fireworks outdoors only, in a clear area away from houses and buildings.
3. Never point or throw fireworks at another person.
4. Don't experiment or use homemade fireworks.
5. Don't use in mountains or other wooded areas, particularly vacant lots with dry weeds.
6. Share your celebration with others who keep "safety" first in mind.
7. Please supervise your children at fireworks time! You'll have fun, too!

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## Fuse

There are some excellent commercially made fuses presently available through mail order. First, there is the standard 3/32" safety fuse. This is much used in M-80 salutes, cherry bombs and many other types of fireworks. It gives good results, is still readily available and is cheap.

There is also a 1/4" blasting (time) fuse. This is the same stuff that is used with non-electric blasting caps and is quite durable. It is used mainly for aerial fireworks such as aerial bombs, single and multiple break shells, etc. It is also used in some mortar tubes. This type of fuse sells for about a dollar a foot at this writing, and it is well worth it. Wonderful stuff!

Next is 3/8" fuse. This is also used for aerial fireworks, and it is good and thick. It does not cost that much more than the 1/4" fuse, and it can be useful.

There are also black match (plain black powder fuse) and quick match, which is plain black match covered with paper "piping" to make it burn instantly from end to end. This is used for setting off many fireworks at once, such as lances, gerbes and other display fireworks. Even the Chinese tissue paper fuse shows up from time to time.

With all this super stuff so easily available, I don't see why people would make their own. The fuse is one of the most important components of fireworks, and is often the difference between a successful masterpiece and a sputtering dud. However, this manual would not be complete without a formula for black match. This one has worked well for me:

### MATERIALS

1. Black powder FFFG grade.
2. Parcel Post wrapping twine (the thick white cotton type).
3. Powdered dextrin.
4. Wood alcohol (methanol).

Black powder is obtained from gun stores, and sells for about \$7.00 per pound at this writing. It is used in muzzleloading arms. There is a black powder substitute called Pyrodex on the market, but I don't think it would give the best results for what we want. Homemade powder usually doesn't work very well, either, so you should stick to the commercially made product.

To make this fuse, you will need what is called "meal powder". This is black powder ground to the consistency of flour. To make it, first put on all the protective equipment mentioned in the previous chapter. Once safely "armored", grind the black powder *one teaspoonful at a time* in a mortar and pestle (*NOT* the one used for oxidizers). Grind it as fine as flour, take your time, and GO EASY. Keep the rest of the powder, both ground and unground, away from that which you are grinding.

After the powder has been ground, measure 1 pint of water and 8 ounces of alcohol into a large bowl. While stirring this mixture, add about two tablespoons of dextrin. Stir until no lumps remain.

Continue stirring while slowly adding the meal powder a little at a time until the mixture assumes the consistency of thin honey or molasses.

Cut a 20 foot length of parcel post twine and boil it in clean water for about 5 minutes to remove any preservatives or other impurities that it might contain.

After washing, stir the string into the black powder slurry, leaving one end out of the bowl so that an end can be found easily. Stir until the string is well saturated. Let soak for approximately three hours.

After it has soaked, hang the fuse up like a clothesline and remove any globs of powder mixture from it. When finished, the fuse cord should be round and uniform in thickness. While it is still wet, dust it well and evenly with some of the pulverized meal powder. Hold a container such as a



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pie pan under the fuse as you do this so you can collect the excess powder that falls away. It can then be saved and used for your next batch of fuse.

Leave the fuse hanging until it is thoroughly dry, then store it in a cool, dry place, well away from any source of heat or fire. A metal can such as a cookie tin is ideal to store fuse in.

Black match fuse is not waterproof like the various types of safety fuse, and it cannot be reliably made that way. NEVER try to waterproof it with tape or anything else. This will make it burn instantly from end to end just like quick match. I once roasted a bunch of fingers while trying to do this. If black match so modified were used in a large salute, you would never have time to get away before it went off.

All fuse should be tested for its burning rate. Measure off a foot and see how long it takes for it to burn from ignition to final burn out. A watch with a second hand is useful here. This test is simple, and should be done every time you make or purchase a new roll of fuse. Different batches of fuse will vary in burning rates. When cutting fuse to use in your fireworks, remember the old saying: "Better a foot too long than an inch too short."

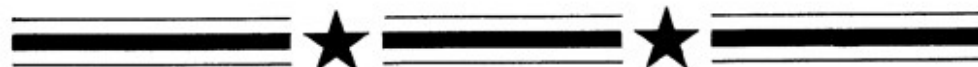
Next comes the water test for safety fuse. Fill a large glass with water. Cut off a foot of safety fuse and attach a piece of modeling clay, shot sinker, etc., to one end. Drop the weighted end of the fuse into the glass and let it sink to the bottom. Ignite and time as before. This is best done outside, as wet, burning fuse gives off an odor that no one would want to have in their home.

A word is in order concerning Jetex fuse which is sold in many toy and hobby shops. This is a thin wire coated with some kind of chemical mixture. It is used in small model jet engines. It is very fragile and quite expensive and totally unsuitable for pyrotechnic purposes. It is best to leave it for its intended purpose.

Sources for many types of fuse as well as additional information for other types of homemade fuse will be given later.

While on the subject of fuse, let me explain why you sometimes see it spelled with an "s" and sometimes with a "z". Some people may feel that the spellings are interchangeable, but they aren't really. Fuse with an "s" applies to the burning type with which we are concerned here. Fuze with a "z" refers to an electrical or mechanical type.

## Flashpowder & Chemite



### Flashpowder

Properly made flashpowder is the only stuff that will work well in firecrackers and salutes. Black powder and the various types of smokeless gunpowders simply don't produce good, loud results. Also, these powders almost always blow the end plugs out of salutes while leaving the casings intact. This is frustrating and no fun at all.

There are two basic types of flashpowders. One type simply burns super fast when lit. This type *deflagrates*. The other type literally explodes by itself when confined and ignited. This *detonates*.

The detonating variety is the loudest and the most powerful. It is used for M-80 salutes and cherry bombs as well as the more powerful tube salutes. A deflagrating mixture would not give the best results in these types of salutes.

The deflagrating compositions are used in less critical fireworks such as old fashioned firecrackers and some novelty fireworks. They are also safer to mix and handle and the materials are often available locally without restrictions. This saves you the wait of ordering the chemicals through the mail.

There are several formulas for flashpowder that give good results. A few are listed below. There are also additional formulas which can be ordered from the Source section of this manual. We will start with some of the deflagrating mixtures which are as follows:

1. One part potassium nitrate (saltpeter), one part magnesium dust.
2. One part strontium nitrate, one part magnesium dust.
3. Two parts potassium permanganate, 1/4 part sulfur, 1/4 part aluminum powder.
4. 2½ parts potassium nitrate, one part aluminum powder, 1½ parts sulfur.

Some of the better detonating compositions would include:

1. Two parts potassium chlorate, one part aluminum powder and one part sulfur FLOUR.
2. Two parts potassium perchlorate, one part aluminum and one part sulfur FLOUR.
3. 3½ parts potassium perchlorate, 2½ parts aluminum powder.
4. Two parts potassium perchlorate, one part aluminum powder.
5. Seven parts potassium perchlorate, three parts aluminum powder.

The parts are measured in fractions of a gram for safety. You can use 1/4, 1/2, etc., just be sure to keep the quantities small. As I said before, it is better to mix several small batches of composition rather than a few large ones.

Be sure to wear the protective equipment mentioned earlier when working with any of these compositions. There is also a device called the Hand Saver which I designed that allows you to mix compositions at a safer distance from your face and body, thus lessening the risk of personal injury. The Hand Saver is shown and described on page 18. Although the one shown was made from a coffee can, it would be an even better idea to make a non-metallic one, such as from a plastic one quart ice cream container. It should be thoroughly washed and dried before use, of course. Non-metallic containers should be used for all grinding, pulverizing and mixing since they won't spark. Plastic or wooden spoons are also in order.

Sulfur flour is a special type of sulfur that contains almost no sulfuric acid. It is the safest type to use with chlorates and perchlorates. Westech Corporation sells it. Like the rest of their chemicals, it is of top quality.

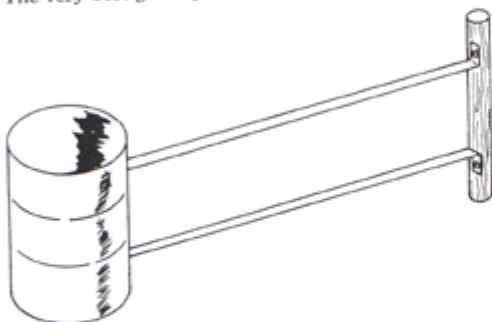
When you mix these compositions, add the oxidizing chemical(s) last. For example, if you mixed a flash composition consisting of potassium

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perchlorate, sulfur flour and aluminum, you would first mix the sulfur and the aluminum, then add the potassium slowly and gradually to the mixture while gently swirling the mixing container.

Be sure all chemicals are pulverized to the consistency of flour SEPARATELY before mixing. NEVER grind any chemicals after they have been mixed. For any pyrotechnic mixtures that combine potassium chlorate or perchlorate with sulfur or any sulfides, add a tiny pinch of common baking soda. This helps to neutralize the minute quantities of sulfuric acid that are present in sulfur or sulfides. This will result in a safer and more stable mixture.

A word is in order about aluminum powder. The very best grade you can get is the German black



The Hand Saver consists of a 1 lb. coffee can attached to a handle made from a piece of wooden dowel. It is attached with two strips of sheet metal about 18 inches long. The device can be assembled with small screws through the metal strips. It is a good idea to have a separate mixer for each different composition you plan to mix. Mark them and don't get them confused with one another.

pyrotechnic grade aluminum dust. It is a grayish-black substance that doesn't even resemble common aluminum powder. It sells for around \$12.00 per pound at this writing and is worth every cent. It gives excellent results and is neat and easy to work with. It is available from some chemistry and pyrotechnic supply outlets.

If for some reason you can't find the German stuff, you can always use common paint store aluminum. This is called aluminum bronzing powder, and it's used for making metallic paints. It's cheap and gives fair results. Be sure that the package contains the phrase "chemically pure" or C.P. somewhere on the label.

The paint store aluminum is very difficult to work with. A dust filter mask is definitely in order when working with it. It seems the particles get all over everything, no matter how carefully you work. The German aluminum is a real pleasure to work with in comparison.

To test these flashpowders (fun), put about half a teaspoon full on a brick or other fireproof object, lay a fuse across it, and ignite. Do this outside, as all flashpowder mixtures give off a lot of smoke. Store the finished powder in a covered coffee can in a cool, dry place away from any sources of heat or sparks.

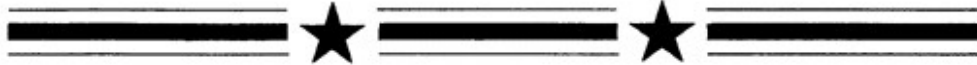
### Chemite

There is a report intensifier called Chemite which is sold by Westech and it dramatically improves the performance of flashpowder. It increases the surface area of the flashpowder and literally gets between the individual particles of the mixture and sort of fluffs it up so that more surface area of the powder is ignited at one time. This results in a much louder report. Simply add 1/10 of 1% of Chemite by weight to your composition. I have used Chemite in some of my mixtures and have found the results to be spectacular. At the present time, Chemite sells for \$1.00 per ounce, and an ounce is a lot when you consider the small amount used.

### White Smoke

Westech also has an additive for flashpowder which produces white smoke reports in salutes. Adding a pinch to the flashpowder produces additional smoke. While I have not tried this, it sounds interesting and worthwhile for special effects such as daytime aerial salutes. The price is around \$8.00 per pound.

## Salutes



A salute firecracker consists of a strong, hard cardboard tube which is filled half to three quarters full with a detonating flashpowder mixture. The casing is sealed on both ends with plugs and a length of fuse seated well into the powder for sure ignition. The fuse can be inserted into the side or the end of the casing.

Salutes are simple to make and can be made in any size you want from baby to bionic. The accompanying illustrations will give you the general idea.

Basically, there are three ways to obtain salute casings. The first and best is to simply order them from a pyrotechnic supply house since commercial casings can be bought about as cheaply as home-made ones can be constructed. Commercially made casings are top quality and let you avoid the mess of making them yourself. Sources for casings of all sizes will be given later.

The second way to get casings is to scrounge scrap cardboard tubes, or have someone save them for you. Stores use them for displays and such and are always throwing them away. Most stores will be glad to give you the old tubes just for the asking. You can also check the trash bins in alleys behind stores. You should have no trouble finding more tubes than you can conveniently store. Most of these tubes are either parallel or spiral rolled on machines, just like commercially made salute casings. In most cases, they give equal results.

There are two things to consider when selecting scrap tubes for casings. First, be sure the tubes are clean, strong, dry and hard. Then be sure that you can find a wooden dowel with a diameter that will fit the tubes snugly for the end plugs. If the fit is almost right, but still a bit loose, cut some paper from a shopping bag the length of the dowel (about 12") and wide enough to be rolled around the dowel for two or three turns. Smear the paper with glue and roll it tightly and evenly around the

dowel. Set aside to dry for a few days before using. This will increase the diameter of the dowel slightly to ensure a good, snug fit in the casing. If the fit is just a bit too tight, a little sanding will remedy the situation.

The third way to get salute casings is to make them yourself. This is easy once you get the hang of it. Personally, I consider case making to be messy and boring. However, it's good to know how to make your own rock hard casings that will produce a super report.

To make a strong salute casing similar to those used for the quarter stick (also known as the M-250, whatever that means), you will need a wooden dowel 3/4" in diameter and about three feet long. These can be found at lumber yards and many hobby shops.

Cut the dowel into three one foot lengths. One piece will be used as a case roller and the other two will become stock for end plugs. Treat the case roller by rubbing it with a cake of paraffin wax until the entire surface of the roller has a light coating of wax on it. This will prevent the paper and glue from sticking to the roller when making casings. It's very frustrating to have them stick together and have to throw the whole mess out.

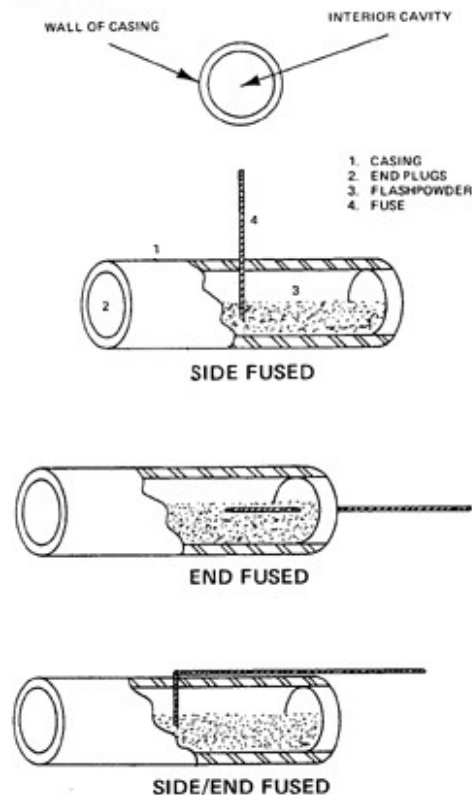
For paper, use double strength grocery bags. These are constructed of a high quality Kraft paper and make excellent casings of all sizes. It is best to use new bags, which most supermarkets will sell you for pennies.

The best way to prevent wasting any of the paper is to cut the bottom out with a pair of scissors and discard it, then gently tear the bag apart along the seam. If the seam won't tear easily, then simply cut it. Cut strips of the desired width lengthwise from the paper. A ruler and a razor blade or X-acto knife can be helpful here.

To make a quarter stick casing, you need two and a half strips 5 1/2" wide. Roll the first strip one

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and a half turns around the dowel *without gluing it*, then smear the strip with glue and roll it tightly and evenly around the dowel until there is only about an inch of paper remaining. Line the second strip up with the first and insert the edge under the remaining inch of paper. Smear the second strip with glue and roll it around the dowel until there is again only about an inch of paper remaining. Take the last half strip and do likewise. You will find it easier to apply the glue with a sponge, brush or a clean, dry cloth.



After rolling the casing, leave it on the dowel. With your fingers and palms, roll the casing back and forth on a smooth, hard surface such as a clean bread board. This will eliminate any air pockets in the casing and help the paper to stick together properly.

With the casing still on the dowel, measure and cut 1" from each end. Use a thin, sharp knife for this purpose, such as an X-acto or a kitchen paring knife honed razor sharp. Cutting the ends off will result in a casing that is universally strong and even. If you don't cut the ends off, the casing will be weaker there. Don't ask me why, it just is!

Slip the casing off the dowel and allow it to dry for about three weeks before using it. You now have a casing 3 1/4" long, with an inside diameter of 3/4" and a wall approximately 1/8" thick.

For a long time I thought it was very dangerous to roll casings with white glue lest the case break into a few large chunks that could cause damage or injuries at a long distance. However, recent tests revealed that casings rolled with white glue instead of mucilage still burst into many small pieces just like commercially made casings do. If the thought of flying projectiles from the casing really bothers you, you could always roll them without any adhesive, but the report is considerably reduced this way.

After the casing is completely dry, it can be painted with watercolors or model airplane dope. Either paint can be purchased at hobby shops. As an alternative, you could wrap a few turns of colored tissue paper around the casing, glueing the first and last half inch of it before punching the hole for the fuse.

Salute casings can be waterproofed easily by simply rubbing them with a cake of paraffin wax until a light coat is deposited. This works quite well and is very inexpensive. Spray-on plastic or acrylic coatings can also be used, but they are far more expensive and don't really work any better than wax, if as well.

Just about any size casing can be made using the above technique. For larger salutes, use more bag strips and cut them wider. For smaller salutes, use less. You can experiment with different casing lengths and wall thicknesses as well as different inside (and corresponding outside) diameters. Keep track of the results in your log book for future reference. Enjoy.

Salutes can be plugged on the ends in a variety of ways such as with clay, paper end discs and plugs, crimping, special pyrotechnic adhesive, plaster of Paris, cork and slices of wooden dowel cut to size.

The wooden dowel method is my favorite. The other methods offer varying degrees of success, and I have used some of them in the past. However, I believe that the wooden dowel plugs offer a somewhat stronger seal since they fit in tightly. A plug

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1/4" to 1/2" thick will suffice for most of the salutes that you might want to make. I recommend using a good grade of wood glue to cement the plugs into place. An aliphatic resin glue such as Titebond or any of the carpenter's or woodworking glues are best. These are extra-strong white glues which are available at hardware stores and some hobby shops. In a pinch, though, a common white glue like Elmer's will work well.

Some may feel that the use of wooden plugs is dangerous and fear that it may cause shrapnel when the salute goes off. I say that if you are close enough to a salute when it goes off to be hit by ANY of it, you were too close anyway.

In our field tests, we noticed that the wooden end plugs are blown into many small bits that are relatively harmless. I have been hit by these and they didn't hurt much. I doubt that they would have enough velocity to cause any injuries unless one hits an eye. On the other hand, the plaster and clay plugs ARE dangerous as they don't break up in the explosion. You can always use paper end plugs and discs if you fear injury from the wooden plugs.

Following are some of the more popular salutes. We will start with the construction of the M-80 and go into the method of assembling salutes. With the exception of the cherry bomb, they are all assembled the same way. The only difference is size, and possibly the manner of fusing.

To make the M-80, you use a casing of 1/2" ID, 3/4" OD and 1 1/2" in length. The casing can be commercially made, found as scrap, or homemade.

The end plug stock is 1/2" wooden dowel, which may or may not need a couple of turns of paper glued to it to make it fit snugly. The end plugs are 1/4" thick, so measure off 1/4" sections along the dowel's length and mark them with a pen.

Begin assembly by taking a casing and installing one end plug as follows: Smear the plug dowel lightly with glue all around for the length of one measured section. Insert the dowel into the casing up to the 1/4" mark. Cut the rest of the dowel off flush with the casing using a small coping saw. Turn the dowel as you cut it so the cut will be even. Wipe off the plug stock dowel well after each installation to prevent any sawdust from sticking to it. Repeat for as many casings as desired. If you see any glue on the inside of the casing after installing the first plug, remove it with a Q-tip.

Next, slip the semi-plugged casing onto a scrap piece of 1/2" dowel without paper and punch a hole for the fuse in the center of the side of the

casing. Start the hole with an ice pick, then remove the casing from the dowel, then finish the hole with a small nail or an awl so the fuse will fit firmly but not too tightly. Secure the fuse with a drop of glue, making sure the hole is sealed to prevent a spark from igniting the powder prematurely when the fuse is lit.

Fill each casing about three quarters full with a detonating flashpowder mixture. Seven parts potassium perchlorate and three parts of German black pyrotechnic aluminum powder, along with Chemite (one tenth of one per cent by weight) will give the best and loudest results. Try to maintain even loads in each salute.

Next, remove any powder that may be in the open end with a Q-tip. Take the plug dowel and smear another 1/4" section lightly with glue. Install and saw off evenly as before. Allow the salutes to dry on their sides to prevent any glue from touching the powder. Repeat for as many as you want.

When dry, the finished salutes can be painted with red or orange model airplane dope and waterproofed with a light coating of paraffin wax. The ends can be waterproofed with black tree grafting compound or tar. When this is done, the M-80 is ready to go. Be advised that these are the real thing, so use them cautiously. As I said before, all other tube salutes are assembled the same way. Here are some others:

### Silver Salutes

These are made from the white tubes found on certain types of clothes hangers and are painted silver with model airplane dope. Cut the casing to 1 1/2" long and assemble as before. The end plugs should be 1/4" long.

### Mini Salutes

These use the same coat hanger tubes as the silver salutes, but the casings are only 1" long. They can be painted any color desired. Like the silver salutes and the M-80, the end plugs are 1/4" long.

### Finger Long Salutes

The same casing material as above, only 3" long. These may be end fused if you wish. The casings can be beefed up a bit by rolling a few turns of glued newspaper around them.

### Quarter Sticks

These use a casing about 3 1/2" long, with a wall thickness of about 1/8" and an ID of 3/4". End plugs should be approximately 3/8" thick. Quarter sticks can be fused on the side or the end.



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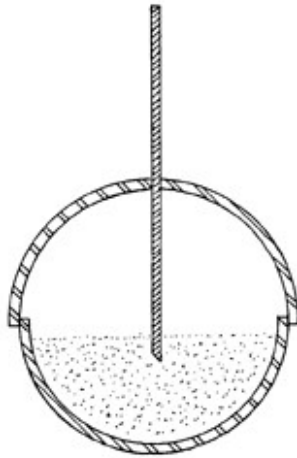
### Atom Bombs

The casings are 6" long, have a wall thickness of about 1/4", an ID of 1" and end plugs 1/2" thick. Atom bombs are usually end fused due to their length. The 1/4" blasting fuse is recommended for these.

All of the above tube salutes can be constructed from commercially made, scrap or homemade casings. Of course, salutes of sizes in between those listed above can be constructed as well.

### Cherry Bombs

Cherry bombs are made differently than the above salutes. These use round casings which are loaded, fused and fit together like a capsule. Cherry bombs are extremely loud and powerful when properly made. I have seen some homemade ones blow bricks to pieces. Quite impressive.



CHERRY BOMB

Commercially made round casing sets can be ordered from pyrotechnic supply outlets. The smaller half is loaded about three quarters full with a detonating flashpowder composition. The mixture previously described for M-80 salutes is also best for these.

A 1/8" hole is punched in the top half of the casing for the fuse and a 2" length of fuse is inserted into the hole and secured with a drop of glue. Make certain the fuse protrudes about 1/4" into the inside of the casing to insure reliable igni-

tion of the powder. When the casing has been loaded and fused, fit the two halves together like a capsule, using a light coating of glue on the outside edge of the smaller half. This is repeated for as many as you wish to make. Allow to dry overnight.

Next, take a compass and draw several circles about 2" in diameter on brown paper lunch sacks. These are made of a thinner grade of Kraft paper than the double strength bags. These circles are used to beef up the cherry bombs to create a louder report. Three such circles are needed for each casing.

Cut out the circles and punch a hole in the center of each with an ice pick so they can be slid down over the fuse. Take one circle, smear it lightly on one side with white glue, and slide it down over the fuse to the casing with the glued side down and carefully wrap it around the casing. You may have to moisten your fingers slightly with glue as you do this. The idea is to form the glued paper around the casing as evenly as possible, so that it becomes a part of the casing. After mating the paper to the casing as tightly as possible, cut away any excess paper. Allow this first application to dry overnight, then repeat the process with the other two, allowing each to dry overnight.

Once the final circle has dried, the cherry bomb can be painted with model airplane dope. The traditional color, as you may have guessed from the name, is red. After being waterproofed with wax, it's ready to use.

Don't underestimate the power of cherry bombs, for they can be very potent.

It's rumored that some salutes are as powerful as one eighth or one quarter stick of dynamite. The M-80 is said to equal one eighth stick. I don't know if this is true, as I haven't had any experience with dynamite (nor do I care to). There are several types of dynamite with different velocities. I would imagine that the people who made these comparisons had the lower velocity explosives in mind. At any rate, it would be a fun topic to bring up at a party. But know your audience first. There are some people out there who would be convinced that you were a real looney, or subversive, or both, if they found out you were interested in pyrotechnics of any kind. Others could care less or might show a genuine curiosity about the subject, even though they knew nothing about it.

Some people say to never hold a salute or any other firecracker in the hand when lighting it, but rather place it on the ground. I disagree. I would much rather hold it in my hand while lighting it so

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I could throw it to a safe area to explode. And if the fuse were a bit faster than normal, I could get rid of it quickly before it went off (You develop fast hands in this business!).

By contrast, if I were standing over it when it went off, an injury could easily occur. Holding firecrackers in your hand to light them is perfectly safe if you use safety fuse. 2" *outside* the cracker is

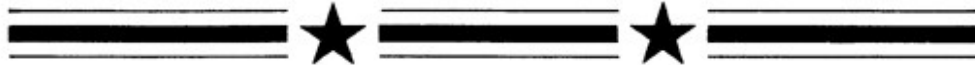
sufficient as it burns slowly and evenly. If you use homemade black match, make it long.

Salutes are very powerful even in the smaller sizes and are not to be misused. They are for adult use and should be stored in a locked box. Don't let children play with them, and keep them out of the hands of adults who have been consuming alcoholic beverages.

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## Triangle Firecrackers



Triangle firecrackers are a novelty item which are simple and fun to make. They are very loud when carefully made and are lots of fun when shot off in long strings. A nice feature of triangle firecrackers is that duds are virtually non-existent.

There are a few different ways to make them, but the following method is about the simplest and it produces good, loud firecrackers.

To make one, you will need four strips of paper from a glossy magazine page. Cut the strips  $\frac{1}{4}$ " wide lengthwise from the page. This will make a strip approximately 11" long. If you want to give the triangle firecracker a finished appearance, cut a piece of colored tissue paper the same size as the other strips and wrap it around them last.

To begin, take one of the magazine strips and measure off  $2\frac{1}{8}$ " on the top and  $1\frac{3}{8}$ " on the bottom. Using your ruler as a straight edge, draw a diagonal line between the two.

Lay this marked strip over a second one, making sure the edges are even, and fold both strips down and to the right along the diagonal line. Crease the fold firmly.

Next, turn the strips over so that the tab created by the fold is projecting up. Fold this tab over the top of the strips toward you. If its edge doesn't line up with the edge created by the first crease, adjust it until it does. This is important. Once the fold is completed, attach it to the back of the paper strips with a piece of masking tape as shown. This is all much easier than it sounds and is illustrated in Steps 1-4.

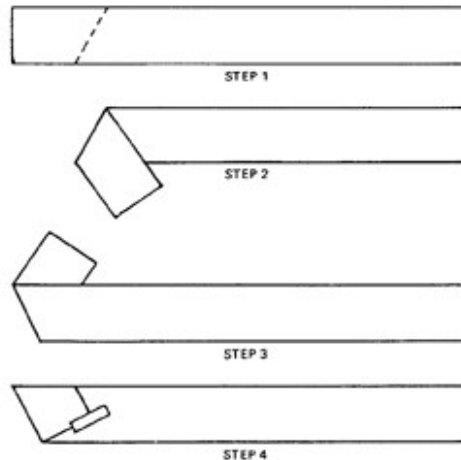
Turn the strips over once more and pick them up so the point of the triangle is facing down. Spread the pocket formed by the last step out a little and add roughly a half teaspoon of the flash-powder of your choice. Insert a 3" piece of fuse into the pocket alongside the powder so it is resting along the left side of the pocket as shown in the illustration on page 26.

Be sure that the powder pocket bulges out a little bit, but not too much. After making a few of these, you will be able to judge the proper amount strictly by eye.

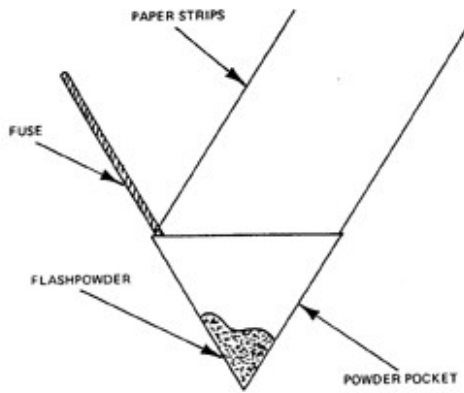
Next, fold the paper strips down and to the right. This will effectively close the powder pocket and secure the fuse. Fold the strips firmly and keep them in an even line with the edges of the triangle.

Next fold the strips up and to the left around the triangle. Now fold them to the right around the front of the triangle, and down and to the left around the triangle. Continue wrapping in this manner until you come to the end of the strips, then tape them down neatly. As you fold, be sure that the turns are pulled firmly and evenly, as this is important. Don't squeeze or pinch the firecracker too tightly as you wrap the strips.

Take another strip and line one end up evenly with the taped ends of the first two strips. Fold



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and wrap around the triangle as before. Again, wrap firmly and evenly. Take the fourth paper strip and repeat, finally adding the colored tissue in the same manner.

The triangle firecracker is now finished and ready to use. Don't be discouraged if your first few turn out looking a little tacky. Practice makes perfect. The results will speak loudly for themselves.

Long strings of these firecrackers can easily be made by simply using a length of fuse with the

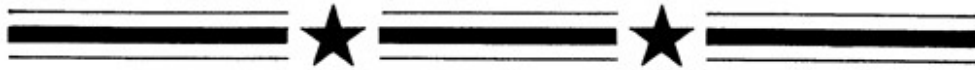
fuses of the firecrackers stapled to it in a staggered line, about 2" to 3" apart. For best results, use black match for the the long fuse as well as for the fuses in the individual firecrackers.

The string can be topped off by a salute by stapling its fuse to the end of the long fuse. These strings are rather fragile, so it's recommended that you assemble them where you wish to set them off.



COMPLETED TRIANGLE FIRECRACKER

## Delayed Ignition Devices



I used to use delayed ignition devices for testing salutes and other fireworks so that I could observe them from a distance. I would rig one up, back off maybe 300 feet, and watch for the show. You may wish to repeat my tests on your own, so a brief description of these devices is included for that purpose.

Most of the time, I used a cigarette attached to the fuse as a delay. This is about the oldest and simplest technique, and is workable. Take a cigarette and remove the filter, then punch a hole near the end so the fuse to the goody of your choice can be inserted into the tobacco. Cigarettes can also be cut to different lengths for varied delay times.

During one such test, we found that a whole cigarette (a Marlboro) provided roughly ten minutes of delay time. With cigarettes coming in all different lengths, the size you pick should be tested by attaching a small piece of fuse to it and timing how long it takes to ignite with a watch with a second hand.

However, the cigarette method does have its drawbacks. Quite often cigarettes will just burn out if they weren't lit right. Also, if they get damp, they are sure to go out. I found this out when I was trying some aerial fireworks attached to kites and flying them at the beach. The damp sea air ruined my delay almost every time. The cigarettes simply wouldn't stay lit.

The following delays will give good results. However, the delay times may vary due to temperature, humidity and the like, so testing under various conditions would be in order if you plan to experiment with these.

One device uses match head powder and concentrated sulfuric acid. Match heads contain potassium chlorate, which will ignite on contact with

the acid. Match head powder is made by taking several books of matches, placing them on a concrete surface, then pulverizing them with a hammer. The resultant powder is then sifted through a fine tea strainer and is stored in a pill bottle until needed.

To make a match head powder delay, simply fill a small match box about three fourths full with match head powder. Then use a glass eye dropper to fill a gelatin capsule almost full with sulfuric acid. *Make certain there is no sulfuric acid on the outside of the capsule.* If there is, all the match head powder will ignite immediately upon contact with the botched capsule.

Place the capsule in the box of match powder, insert the end of the fuse of the goody into the box, slide the box shut and depart.

A similar device is made almost the same way. Instead of match head powder, a mixture of one part silver nitrate and one part magnesium powder is used. Keep the mixture dry, as water will ignite it and is, in fact, used in the capsule in this delay instead of acid, which will also ignite it. The silver nitrate/magnesium powder mixture goes into the match box and a water-filled capsule is inserted into it. Again, make certain there is no water on the outside of the capsule.

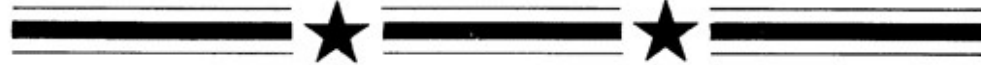
Yet another delayed ignition device consists of strips of newspaper that have been soaked for 12 hours in a concentrated water solution of potassium nitrate (saltpeter). These strips are then allowed to dry. Once dry, they should be tested for their burning time, just like black match fuse. One end of the newspaper is simply attached to the fuse of your pyrotechnic device and the other end is lit. This is a slow burning fuse, making it ideal for setting off fireworks carried high into the sky by balloons, which brings us to our next chapter.



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## U.F.O.'s & Rocket Aerial Bombs



### U.F.O.'s

**WARNING:** These devices carry flammable and burning material thousands of feet into the air. They are probably illegal everywhere. Don't launch these near any fire risk areas, and especially near any airport or known flight patterns. This same warning also applies to any other aerial pyrotechnic devices.

These U.F.O.'s are simple and quick to make, being based on medium and large helium filled weather balloons. The balloons are available from some science supply companies like Edmund Scientific, as well as novelty and surplus stores. Check the classified ads in science magazines, *Popular Mechanics*, etc., for additional sources.

Helium can be bought or ordered through dealers listed in the Yellow Pages under "gasses", by mail order, or from local welding and toy shops. You will need a large refillable tank with the valve and hose connections for balloons. The gas dealer should be able to get you refills at a reasonable cost.

Be sure to weigh your payload and choose a balloon or group of balloons that will lift it quickly and reliably. Do a trial run with a tether string attached to the balloon to check the rate of ascent before doing a "live performance" with pyrotechnics.

Balloons can carry long strings of firecrackers, smoke devices, horizontal pinwheels, road flares and anything else you can imagine along those lines thousands of feet into the sky. They can even be used to launch radio controlled model gliders from an altitude of thousands of feet when used with a tether line. An extra channel should be installed in the glider for a simple release mechanism.

Any type of delayed ignition device or radio control signal can be used to set off your pyrotech-

nic masterpiece. Experiment and have fun. For those few unfamiliar with the term, a tether line is nothing more than a roll of kite string or monofilament fishing line tied to the balloon(s) like a kite. That way you can send up a display and watch it explode, burn, sparkle, smoke, etc., then reel in the balloon for another payload. However, be sure to suspend all pyrotechnic devices well below the balloon to avoid burning or destroying it.

These balloons can be disguised as flying saucers, alien warships or any other forms and shapes you want by using balsa or plastic struts, tissue, mylar and similar lightweight materials. Use your imagination, as the sky is the limit here so long as weight and size are kept within manageable proportions.

Daytime U.F.O.'s can carry firecrackers, smoke, banners, streamers and flags. Night U.F.O.'s can carry large spherical or cannister shells, flares and various display fireworks.

Large plastic trash bags and dry cleaning bags can also be used for lightweight payloads. Be sure that any small holes in the bag are covered with a dab of Scotch tape before filling with helium. Also, be sure to use a bag large enough to lift your payload. These bags make good one shot "disposable" U.F.O.'s.

### Rocket Aerial Bombs

These zip up hundreds of feet into the sky and explode with a loud report. They are easier to make than common skyrockets, are safer, and perform as well as or better than the commercial pyrotechnic offerings.

### MATERIALS

1. Estes Mini-Rocket engines, A34-T size or similar.

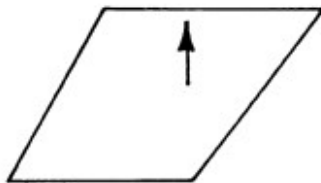
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2. Finger Long salute with black powder fuse (homemade).
3. Balsa wood fin stock, 1/8" thick.
4. Estes rocket body tube No. BT-5.
5. Safety fuse and match powder, or battery powered model rocket ignition system.
6. Launch pad, either homemade or commercially made.
7. Fin pattern (below).
8. Nose cone, either homemade or commercially made.

All the above components except the salute are available at most hobby shops or by mail order. Hobby shops also carry many catalogs and books on model rocketry, which is a fascinating hobby in itself.

Californians no longer need a State Fire Marshal's permit to buy rocket engines. This is a big step forward, as a lot of people have been severely injured trying to make their own rockets. Unless you have had a great deal of experience, it can be very dangerous. By using commercially available components and fuel, most of the work — and risk — is taken out of rocket making.

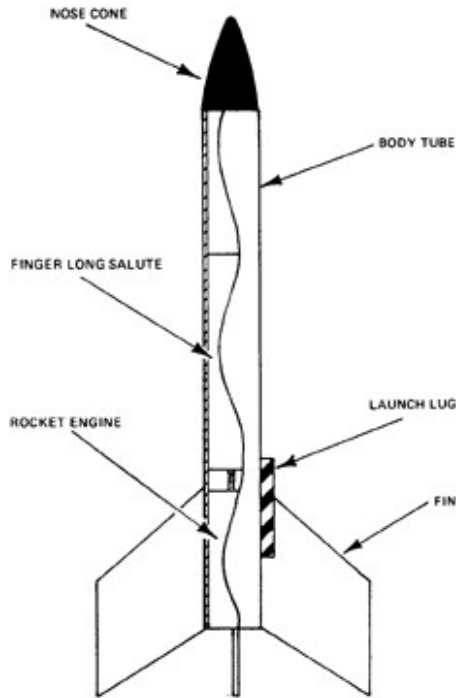
First, take a piece of tracing paper and trace the fin pattern shown below. Trace several patterns, as you will be using them as tracing templates and will need three fins for each rocket. The pattern is full sized. The arrow indicates the edge that is to be glued to the rocket body. After tracing the patterns onto the balsa fin stock, cut the fins out with an X-acto knife or razor blade.



ROCKET FIN TEMPLATE

Cut the rocket body tubes into 6" lengths and glue the fins on straight, 120° apart. Be sure that they are glued on securely and that you attach the correct edge to the rocket body. Stand the body tube upright on the nose end and allow the fins to dry in place overnight.

Next, the rocket engine has to be modified so it will ignite the salute once it reaches its zenith. To do this, take a pencil and scrape out the clay



cap and ejection charge opposite the exhaust nozzle in the engine. The ejection charge is what blows the parachute or streamer out of a normal rocket. It must be removed for our purpose. When all the ejection charge has been removed, a black shiny surface will appear. This is the smoke tracking charge which should be left alone.

Spread a thin coat of glue on the modified engine and insert it into the rocket tube until it is flush with the end of the tube. Next, take an unpainted Finger Long salute (page 21) which has been fused on the end with about 1" of black match, smear it lightly with glue and insert it into the tube with the fuse down. Make sure that the fuse touches the smoke tracking charge in the engine, as that is what ignites it.

Finally, a nose cone and launch lug are added. The nose cone can be homemade or of commercial manufacture while the launch lug is nothing more than a piece of soda straw. It is glued to the rocket tube next to a fin as shown in the accompanying illustration. The launch lug fits over the rod on the launching pad and is used for guidance. Allow the

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finished rocket aerial bomb to dry overnight, then paint with model spray paint if desired.

Although just this one size rocket is described, any other size model rocket can be so modified as well as Class B, C and D rocket engines. Look through the various model rocketry catalogs for ideas. There is no reason why multiple stage rockets, clustered engines and group launchings can't be used. Just be sure to test each design in a remote area away from people and buildings.

Commercially manufactured launching pads are inexpensive, but a homemade one works just as well. A 10"x10"x1" square of wood with a 1/8" hole drilled in the center for a three foot long launch rod works just fine. At the time of writing, launch rods cost about 50 cents at most hobby shops. The pad itself should be covered with aluminum foil to prevent scorching from the rocket's exhaust.

For ignition, you have two choices: a commercially made electric launcher or match powder

and safety fuse. Any model rocketry catalog should have a description of the commercial systems, so we will concern ourselves solely with the homemade style ignition.

Put a bit of ground match head powder (see Delayed Ignition Devices) into the exhaust nozzle of the rocket engine and place a 3" length of safety fuse across it. Cover with a bit of masking tape to keep the match head powder from falling out. For safety's sake, do this just prior to launch.

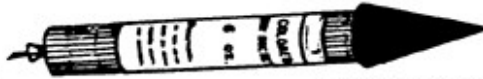
To launch, place the rocket on the pad with the rod fitting through the launch lug on the rocket. Attach the ignition system of your choice and blast off. The rocket will streak skyward and the smoke tracking charge will allow you to follow its arc across the sky, then your payload will explode. Have a good time!

An advertisement for commercially made pyrotechnic rockets appears below to give you an idea of the wide variety available where they are legal.

### Reports and Stars Skyrockets

When shot from a trough or a piece of eaves spouting, this item will shoot high into the air with a trail of sparks and then will burst into a canopy of colored stars.

2 ounce Skyrocket	3.49 Doz.
4 ounce Skyrocket	5.50 Doz.
6 ounce Skyrocket	7.99 Doz.
8 ounce NEW Skyrocket	10.99 Doz.
Butterfly	6.99 Doz.
Clustering Bees	6.99 Doz.
Wild Bees	6.99 Doz.
Snow and Red Plum - Color	6.99 Doz.
Extra Rocket - Double Grade	6.99 Doz.
Rocket Parachute	6.99 Doz.
Brightening Rocket	6.99 Doz.
Flower Scattering Child	6.99 Doz.
Moon with Silver Brightness	6.99 Doz.
Glimmerous Lights	6.99 Doz.
Emerald Meteors	6.99 Doz.
6 Dozen Assorted	37.99



### SUPER Bottle Rockets

Super Large ..... \$5.99 1/2 Gross

### Bottle Rocket Barrage

One dozen rockets fused together in a firing rack - all 12 fired in order ..... \$5.50 Doz.

### Imported Pop Bottle Rockets

Zip and away they go to a height of about 100 feet, leaving a trail of beautiful sparks. They're showy and inexpensive... a lot of fireworks for a little money.

With Report  
1 Gross Carton ..... \$5.75

## ROCKETS

### Tri-Color Rocket

Box of 12 ..... \$6.99

### STARRY SKIES

The only exploding floral shells -

5 reports ..... \$4.99 Doz.

### THOR MISSILE

Stands about 9 inches high and

reaches altitudes in excess of

2,000 feet and finishes with a loud

report or colors.

\$7.99 Doz., 2 Doz. .... \$12.99

### BLACK DIAMOND

Stands about 14 inches high and

reaches altitudes in excess of

5,000 feet and finishes with a loud

report or colors ..... \$16.99 Doz.

### FLAMING ARROWS

Stands about 12 inches high and

reaches altitudes in excess of

2,500 feet and finishes with a loud

report or colors ..... \$10.99 Doz.

### Mars Rocket

Box of 12 ..... \$6.99

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## Exotic Pyrotechnics



### Flashlight Torpedoes

These explode with a brilliant flash and sharp report when thrown against a hard surface.

#### MATERIALS

1. Squares of bright wrapping tissue about 2" square.
2. Flashpowder (any type).
3. Toy caps.
4. 1/4" lead ball (buckshot or pistol ball) or steel ball bearing.

Take a square of tissue paper and center a toy cap on it with the colored side up. Place the ball so it is centered directly on top of the cap.

Gather the edges of the tissue about halfway up, making sure the ball stays centered on the cap. Pour in a small pinch of flashpowder. Gather the edges of the paper up the rest of the way and twist them firmly together after moistening your fingers lightly with glue. The torpedo is finished and ready to use.

These torpedoes are perfectly safe to make and carry. Even children can enjoy them safely, provided they do so under an adult's supervision. Also, they are not so loud as to get the neighbors all hysterical.

### Contact Explosive

#### MATERIALS

1. Iodine crystals.
2. Pure non-detergent ammonia or ammonium hydroxide.
3. Glass jar with screw-on top.
4. Paper towels.

Grind about half a teaspoonful of the iodine crystals into a coarse powder, then set it aside. Next, pour about 8 ounces of ammonia into a

jar. Add the iodine crystals to the ammonia and cap the jar. Swirl the mixture gently for approximately 10 minutes, then pour the ammonia off slowly so as not to disturb the crystals. Collect the treated crystals (which are the explosive) with a teaspoon and transfer them to a few layers of paper towels. This is done just to remove the excess moisture, for the crystals must remain quite moist to be safe.

For storage, transfer the moist crystals into a clean pill vial. They should be used soon after treating, as once they are dry the slightest touch will set them off. The explosive goes off with a loud snapping sound. Some chemists make it a lot more potent by washing the finished product with alcohol, then ether. However, it is much more dangerous to handle this way.

Time each batch to see how long it takes to dry. Ten to twenty minutes is about usual. This stuff can be used as a practical joke by putting a small amount on stairways, sidewalks, and similar places.

### Carbide Cannons

Carbide cannons are sold in toy stores and hobby shops, as well as at some fireworks stands. The only problem with them is that they are too expensive, and aren't all that loud. I first saw a homemade version of the carbide cannon some years ago. It consisted of a length of pipe about three feet long and about 2" to 3" in diameter.

This pipe was capped or plugged on one end and propped up on some type of stand or support. About two cups of water were poured down the pipe. There was a 1/8" hole drilled into the side of the pipe about 1" above water level.

The cannon was fired by dropping a bit of calcium carbide down the barrel, inserting the fuse into the hole and then lighting it (or holding the match right up to the hole to look macho).



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Just a bit of carbide is needed for a good, loud boom. In fact, if you put in too much, too much gas will be generated and the thing will just dud out. So much for overloads.

Following the above guidelines, you can experiment with your own carbide cannon. Try different amounts of carbide and pipe lengths and diameters until you get the results you want. Keep track of the results in your log book.


Calcium carbide can be ordered from chemical supply outlets and can be found in some toy stores under the name BANGSITE. It is also often sold at fireworks stands.

Be sure to keep the carbide in an airtight jar or tube, as it is very hygroscopic. Moisture in the air will cause it to gradually deteriorate and become useless. When it turns white and crumbly, it is no longer good.

## Sources

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At the end of this chapter is a list of sources for fireworks related books, plans, chemicals and components, as well as a listing of manufacturers of commercially made fireworks of all types. All of these companies have interesting catalogs which are updated from time to time. I would suggest that you order as many of them as you can for the best overall selection of items.

If you plan to order fireworks from out of state (legally, I assume), be sure to read the ordering instructions very carefully as well as all the fine print.

Some companies will ship anything anywhere while others are so paranoid that I'm surprised they're still in business at all. One such company wouldn't even send me a catalog just because I live in the Los Angeles area. The fact that I have been a collector of these catalogs for some time didn't make any difference at all. If you live in California, no catalog. Oh, well.

These companies usually ship their merchandise via motor freight or United Parcel Service. At this writing, I understand that UPS is starting to get a bit leary of hauling fireworks, and all shipments may have to be by freight in the near future.

No fireworks can be sent through the mail for obvious reasons. The package will be clearly marked and labeled, often dramatically, as to the contents. This is required by law by the Department Of Transportation.

Most, if not all, fireworks companies will require you to sign a waiver releasing them from liability in case you wipe out your neighborhood, hurt yourself or someone else, or otherwise botch it up. With the way some morons handle fireworks (see newspaper clippings on pages 4-10), who can blame them?

I don't know how much longer you will be able to order this stuff, so if you want it, get it while you can. The same applies to books (it's already

a no-no to ship certain titles to Australia or Canada), chemicals and components.

Various local fire departments are getting increasingly aggressive in trying to reduce the flow of illegal fireworks. As I said before, they despise fireworks, and are doing their best to combat them. However, like booze, guns, and pot, it has been proven that enforcement of prohibition was, and always will be an uphill battle and generally a waste of time and effort. A *reasonable* change of the present laws is the only realistic solution.

A law was recently passed in California that all delivery companies must report any shipments of fireworks to the local fire department. The same may be true in other states as well. The fire department gets word that fireworks are to be delivered to your address, and they send out a unit to confiscate the booty (see page 10). At this writing, such Orwellian tactics don't yet apply to chemicals and components.

Being an amateur chemist and model rocketry buff for several years, I have ordered chemicals and other goodies that would have the staff of our local fire station biting their nails and throwing fits, but I've never been hassled since my present activities are legal and are for scientific and academic purposes. I could care less if they know that I possess and use such materials.

At any rate, if one desired to obtain illicit fireworks, he could simply drive to a neighboring state that allowed their sale and load up and bring them back. It's up to you to be cognizant of state and local laws and act accordingly.

Our sources are broken down into three lists. The first covers books and literature. The second is devoted to chemicals and components. The third covers commercially made fireworks. Current prices for catalogs are also listed. These lists are by no means complete. Additional companies can be found in the classified ads of various science and

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gun magazines as well as in *The Shotgun News*. Other sources can also be found. Some libraries have reference materials pertaining to fireworks and their history and such material is recommended reading. Seek and you shall find.

The author has no financial or other interests in the companies listed below and lists them merely for your convenience and reference.

It is hoped that *The Firecracker Cookbook* will at least partially clarify the science of pyrotechnics and encourage further study into one of the most fascinating and yet least understood forms of art.

I hope that in the near future some of the current restrictive fireworks laws are changed so that people can legally enjoy a traditional Fourth of July, and that those who would make and use potent fireworks obtain the information to make their practice at least somewhat safer to themselves and others.

With caution, care and common sense, fireworks can be a tradition to be enjoyed for years to come and not outlawed and forced underground. I hope this is sooner rather than later.

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## HOW TO OBTAIN CHEMICALS

Some chemicals may be obtained at hobby stores that supply chemicals for chemistry sets. More complex chemicals will have to be purchased through a chemical supply company.

To find a list of suppliers, check the classified ads of a current issue of *Popular Science*, *Popular Mechanics* or any other related magazines.

