

No. 408

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HEAVY-METAL-FREE CRACKLING MICRO-STARS

Ken Ganney and Richard Harrison
www.pyro-gear.co.uk

Polyvinylbutyral (PVB) is a material with remarkable properties when used in pyrotechnic compositions. Some of these properties – that it is an excellent binder when activated with alcohol, that it is also a useful fuel, and that it seems to enhance some strobe compositions – appear to have been known at least since the early 1990s, but there appear to be virtually no published formulae.

We rediscovered these properties while researching materials that might be useful in creating a crackling effect. Our attention was originally drawn to this substance by the observation that some proprietary nitrocellulose lacquers produce a mild crackle in a mixture of copper oxide and magnalium, but that solutions of pure nitrocellulose do not. Nitrocellulose lacquers that are intended for use as paints contain a mixture of resins and plasticizers, and PVB came up as one of the possible constituents. Once its name had arisen, we became aware of fascinating rumors that it was being used in China and in at least one of the Maltese fireworks factories.

Our research has occupied us for more than eight months, during which time we have investigated hundreds of variations of a range of different formulations, both with and without nitrocellulose. Most of the routes we took started from what seemed to us to be well-founded principles but

went nowhere, giving results that were, at best, mediocre and inconsistent. Eventually we found a formulation that showed promise; although still only modest in performance, the effect proved to be reliable and repeatable. Further development led to some highly effective compositions, examples of which are given in Table 1.

Table 1. Sample Formulations

Composition	A	B	C
Copper Oxide, 300 mesh	64.0	65.0	65.0
Magnalium, 250 mesh	32.0	32.5	29.5
PVB, Mowital 60H	2.0	2.5	2.5
Phenolic Resin	2.0		
Aluminium, atomized, 300 mesh			3.0
Nitrocellulose	+10.0	+10.0	+12.0

In all these formulations the nitrocellulose is specified as a dry weight. If used as a lacquer, the actual amount to be added will therefore depend on the concentration of the solution.

Composition A is the first truly successful mix that we found. In terms of both subjective impression and simple measurements of the noise level, we believe it compares favorably with many of the more traditional lead- or bismuth-based formulations. Given that there are many types of phenolic
Continued on page 3.

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resin on the market, we were at first concerned that the effect might depend on the particular resin we had used. However, a series of trials, first with a few different synthetic resins and then with a couple of natural resins – vinsol and red gum – convinced us that this factor was unimportant.

Having established that a number of different resins could be used, we wondered just how critical this component was to the performance and decided to see what would happen if we omitted it entirely. Composition B was the result, and is the simplest formulation that we have found. In terms of noise output, it is at least as good – and possibly better – than composition A.

Many people have found that adding a small percentage of aluminum improves the performance of crackle compositions. This consideration led us to composition C, which appears to give a better performance than either of the other two. We found that a small increase in the amount of nitrocellulose helped in this case.

The mesh sizes given in Table 1 should be regarded as guidelines, as we have found these formulations to be reasonably tolerant to moderate variations of the particle sizes. We have, for example, obtained similar results with a sample of copper oxide that passed 200 mesh but was 30% retained on 250 mesh.

Bearing in mind that PVB is manufactured in a variety of grades, it is important to stress that we have, so far, tested our formulations using only the variety specified in Table 1, and currently have no information about the suitability of other grades. Mowital 60H is manufactured by Kuraray, whose European and U.S. websites – www.kuraray.eu and www.kuraray.us.com – contain English-language data sheets that might help to identify corresponding types from other manufacturers. It is also worth pointing out that our lacquer contains pure nitrocellulose. Double-based powder is not readily available to us and we have no idea of the likely behavior of our compositions if combined with a lacquer made from that kind of material.

Our compositions work best as 2 to 3 mm (say, 1/10 inch) cubes. We find there to be no benefit to making the grains any larger, as there is then a tendency for them to produce a succession of crackles rather than a single report. We also find that they are most effective if the PVB (and, if present, the phenolic resin) is dissolved in the appropriate quantity of lacquer before the remaining ingredients are added. Solutions of PVB can be quite viscous and it may prove necessary to add a little more solvent to produce a suitable working consistency.

Once dry, the micro-stars appear to ignite easily and do not need priming if they are to be used in a matrix star, or as cores for colored stars. If they are to be used on their own, priming is advisable and we have found the most suitable prime to be a slight modification of the Spanish ‘monocapa’ prime, where the iron oxide is replaced by ferrosilicon, as shown in Table 2.

Table 2. Priming Composition

Potassium Perchlorate	24.6
Potassium Nitrate	31.1
Charcoal, airfloat	11.5
Red Gum	4.1
Sulfur	4.9
Ferrosilicon	7.4
Magnesium	12.3
PVB	4.1

You may notice that we have also replaced the original dextrin binder by an equal amount of PVB. Another advantage of this material is that rolling PVB-bound compositions, using 100% isopropyl alcohol as the activating fluid, is so much easier than with any other binder we have encountered.

These crackle formulations are a very recent discovery and it would be surprising if there were not any further variations and improvements to be found. For reasons that we do not yet understand, the inclusion of a small percentage of PVB appears to be crucial to their performance. *

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ALCOHOL FUELED PYRO – THE QUEST FOR GEL

by Ian von Maltitz

As promised in the first article on this topic, this chapter describes various approaches to making gelled alcohol.

If one does a Google search on making gelled alcohol one will discover a large number of references to a popular method that uses two easily-obtained ingredients found in most kitchens: vinegar and egg shells. Here one creates calcium acetate, the essential ingredient used for creating an alcohol gel. Sadly this method has many drawbacks.

The chief drawback of the vinegar/egg shells method is the long time it takes to end up with an alcohol gel. Contrast this with the method that I described in the last chapter, and which I will expand upon in this one. Here one has almost instant gratification. One mixes a small amount of powder with alcohol and in a very short while one has the desired alcohol gel. Back to the vinegar/egg shells method.

Vinegar is essentially dilute acetic acid. Egg shells consist mainly of calcium carbonate. Mixed together they react to create calcium acetate in solution and carbon dioxide gas. The reaction can be speeded up by using calcium carbonate powder instead of the egg shells but what one gains here time wise is obscured by the long time it takes to get rid of the excess water left by the vinegar. One can either allow the water to evaporate over a period of time (usually several days) or boil it off. I opted for the latter in my experiments, using a laboratory glassware flask on a laboratory hotplate. The process still took an unacceptably long time.

Making calcium acetate using the above method is not only time consuming but also messy and somewhat stinky if one uses eggs shells instead of calcium carbonate powder. I do confess that I have not experimented much with this method so am not able to do a fair comparison with other methods concerning the final outcome. The gel that I ended up with had the approximate consistency of cottage cheese and looked similar in color. Perhaps it is possible to achieve a more gel-like product. I don't know and care not to fuss enough with this method to find out.

The best-known gelled alcohol on the market is *Sterno*. This is usually available at the local supermarket and comes in small metal cans with press top lids. Typically one removes the lid and lights the alcohol, letting it burn in the can. The original *Sterno* gel appears to be made from a mix-

ture of alcohol, water, and an amphoteric oxide gelling agent. Later mixes contained alcohol, nitrocellulose, and water. Indeed many of the alcohol gel patents over the subsequent decades focused on improving the basic alcohol, nitrocellulose, and water mixes.

There are tons of patents relating to alcohol gels. A lot of them focus on fuels similar to *Sterno* while others focus on fire starters, hand lotions, shaving gels and cosmetics.

Here is a table listing some of the more notable patents I have found:

Year	Patent Number	Title
1930	1,752,935	Artificial Fuel
1936	2,046,101	Solidified Composition
1952	2,613,142	Alcohol Fuel Gel
1969	3,472,940	Stable Gelled Alcohol Compositions Containing Sodium Acyl Lactates
1972	3,666,482	Gelled Alcohol Containing Comestible
1972	3,672,851	Gelled Alcohol Fuel Containing Nitrocellulose and Boric Acid
1973	3,754,877	Gelled Fuel Compositions
1978	4,084,939	Audibly Burning Gelled Alcohol
1984	4,436,525	Fuel Gel for Charcoal or Wood Fires
1990	4,908,044	Semi Solid Ethanol Based Fuel
1990	4,971,597	Solid Alcohol Fuel with Hydration Inhibiting Coating

One particularly notable patent is patent number 3,672,851, which contains boric acid as a stabilizing agent. Its proposed solution is a lot simpler than the other patents it refers to. And it refers to quite a number. This patent in itself is a very useful reference to other patents. But I am not fond of using boric acid as an essential ingredient because it in itself is a color producer that could interfere with other color producers.

Another particularly notable patent is patent number 4,084,939. This describes audibly burning gelled alcohol. There is a reason for this particular invention. One of the problems with some gelled alcohols is their stealth manner of burning. This poses a burning hazard to persons unaware that they are close to an alcohol flame, a flame that is also nearly invisible. I am not fond of the methods described in this patent, although there is quite a variety. There are much easier ways to get past the quiet burning problem. One way is to get back to the older, more primitive alcohol gels! Another is to use the method I describe at the end of this article.

More recent developments in alcohol gels show a trend away from the nitrocellulose-based formulations of the past. Many of these use cellulose compounds of one description or another. Some of these are readily available from such places as the local hardware store but a word of caution: many

of these compounds have a generic chemical or trade name that discusses a family of compounds rather than just one. Some have wide variations in gelling properties.

Another problem that plagues the alcohol gel makers is that pH often plays a critical role. Here one typically adjusts the alkalinity of the solution to the required pH value. In some ways this is useful in that one can slowly raise the pH until gelling occurs. Controlling this process, however, can be tricky as anyone familiar with pH control probably knows.

When one talks about pH one assumes that the mix contains water. Such an alcohol mix will thus contain water whether one desires it or not. And there is another problem from a pyro perspective. Chemicals added to adjust the pH can produce undesired reactions with the chemicals added to produce colored flames. The first that comes to mind is boric acid.

I had a rather bad experience with a popular alcohol gelling compound. It has been used for quite a while in industry and is usually used with its own peculiar stabilizing agent that adjusts the pH to the right level among other things. When I mixed in the stabilizing agent a gel was formed very quickly, similar to the solid mix given by the calcium acetate method. Again this did not give the appearance of a true gel. The solid white substance burned OK but left a horrible residue after burning. It also, in a weird kind of way, appeared to separate from a notable percentage of the alcohol, creating an alcohol soaked sponge rather than an alcohol gel.

Yet again, further experimentation could result in a more successful outcome. But why mess with it if one has a virtually foolproof method without all the hassles? What follows is the method I prefer.

The secret is a substance with the chemical name of hydroxypropylcellulose. It is usually available under the trade name of *Klucel*. There are different grades of *Klucel* with different gelling properties. The most common grade is *Klucel G*. This is sold as a leather restorer or as a preservative for old books. I got my *Klucel G* from a supplier in Colorado who sells leather treatment products. He sells his product on eBay and Amazon. Note that one must buy this product in pure powder form rather than a product that is already mixed with alcohol.

To make an alcohol gel with *Klucel G* all one needs to do is sprinkle some *Klucel G* on the surface of the alcohol and stir it in. Gelling takes place almost immediately but it is suggested one lets the process run to completion over a 24-hour period. The stuff works with methyl, ethyl, and isopropyl alcohols. These need not be 100% alcohol. I have gotten good results with 70% isopropyl alcohol.

The next chapter will describe making alcohol gel that burns with colored flames (single and multiple colors) in detail. IvM

CONSUMER FIREWORKS OUTLOOK

By Jason Musselwhite

Now is the time for all pyros to check their calendars for more great pyro gatherings happening in the upcoming months.

I hope everyone had a pyrotastic time at the PGI convention. I was sorry Betty & I missed it. But, we will definitely be at next year's convention in La Porte. Dates are August 6-12.

Believe it or not, you should book your room now! Available hotels are already on the PGI website. You can find it under CONVENTION - 2016 CONVENTION - ACCOMMODATIONS. I've already booked my room at the Best Western and the nice lady at the reservation office said she can't wait for us to come back next year. Last time we were there, she had attended one night of displays and it was awesome. All the more reason to wear your badges around town to get the word out and get more people interested in fireworks!

The next major get-together is the National Fireworks Association's annual Expo. This year it is in Kingsport, Tennessee, September 7-12. Betty & I will be there and AFN will have a booth at the Trade Show. We'll be right next to the National Council on Fireworks Safety and Mile High Inflatables, so you can't miss us with those wavy arms flying about on those inflatables.

During the NFA Expo, a club event will be held by the Western Pyrotechnic Association, September 10-12 in Hawthorne, Nevada. Their annual *Do-It* event is more for the hobbyist. This event is geared towards those who like to develop and create pyrotechnic items." More info: www.westernpyro.org.

The following weekend after the NFA Expo and the WPA's *Do-It* event, is the annual St. Louis, Missouri shoot, which is now called *Pyromania*. It will be held at Brookdale Farms in Eureka on September 19th. *Pyromania 2015: Feel the Boom* is in its 10th year! I am fortunate to be attending this event for the first time. I'll be bringing a few items of my firecracker collectibles to show. Gates open at 10 a.m. For more information, www.pyromaniaevent.com.

That's all for September, as if that wasn't enough! But, there is one more important event that I must mention occurring in October. The American Pyrotechnics Association 67th annual general meeting and convention will be held at the Grand Hyatt in Denver, Colorado, October 6-9. It's been a long while since Betty & I were able to attend an APA convention, but when we did, it was well worth the time away from work to gain valuable education and hear updates on the head-spinning multitude of regulations from the many alphabet agencies involved in our industry. There's still time to register (Sept. 15 is cut-off date) at www.americanpyro.com

Betty & I hope to see you at these various events. Looking forward to it! JLM





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DOT- AND UN-MARKED FIRECRACKER LABELS: 1971-1999

By Hal Kantrud, Howard Davis & Terry Borgendale

Updated from original printing in July, 2001. Hal Kantrud points out that the article covers only the old D.O.T. marked material that was supposed to be superseded in 1993 by the U.N. classification, but many companies did not comply, hence the dates shown may be confusing.

The purpose of this article is to list all the brands and major design variants of brands, based on the label graphics, of firecrackers exported from China and Taiwan to the United States and legally marked and sold here from about 1971 through the 1999 marketing season. We chose the year 1971 because this is when the government-imposed mark of I.C.C. (Interstate Commerce Commission) was changed to D.O.T. (Department of Transportation). Our list includes many old brands that were in production before any government labeling requirements were in effect. These brands include Anchor, Black Cat, Bo-Peep, Camel, Cock, Duck, Giant Panda, Peacock, Warrior, and Zebra. Early compliance with the D.O.T. regulations was not uniform, and the code was applied to some labels with a rubber stamp; some packs bear the code on stickers, obverse labels, or small pieces of paper visibled sealed inside cellophane wrappers. A few early labels bear both the I.C.C. and newer D.O.T. codes. The newest brands on our list are those with labels marked since 1994 with the United Nations code "UN 0336 1.4G Consumer Fireworks", or recognizable parts thereof. This code covers, for shipping and storage purposes, what are presently considered "Consumer Fireworks" in the USA. These were "Class C Common Fireworks" under the old I.C.C. and D.O.T. regulations. The UN 0336 1.4G classification indicates the product is considered "low hazard" fireworks by international standards.

Our interpretation of brands is conservative. Brands are differentiated on the basis of names, or graphics in cases where brands of the same name bear markedly different illustrations, e.g., Lightning "Bridge" and Lightning "Two Buses". Brands produced by various manufacturers, as evidenced by names or "logos", are not separated if differences in label graphics are minor. Major variants of brands (indented in list) are based mostly on changes in background colors or redesigns. No minor variants based on age classes or other criteria are listed.

We do not indicate age classes of brands, but, when known, we include the approximate year that the firecrackers entered the US market. We include brands of visco-fused, 50 milligram-powder-content tube salutes ("fake M-80's") sold in plastic bags or half-gross boxes because of the difficulty of separating these items from loose, boxed visco-fused firecrackers often called "watercrackers" or "safety fuse crackers".

We have included codes for the abbreviated names

of manufacturers, importers, or places of manufacture of these brands (next pages). For these codes, we have tried to follow the system used in *Gaston's Guides to Chinese Firecracker Labels* (1986, 1990, 1998, 2000, and 2000 suppl; Robert J. Gaston, privately published) whenever possible, but new codes are introduced where needed. We decided to keep the sometimes useful code PRC for the Peoples Republic of China, but not employ a code C for labels merely marked "Made in China". Many brands listed here bear the codes for classic manufacturers or wholesalers such as Him Yuen, Po Sing, Kwong Yuen Hang Kee, Li & Fung, Wang Yick, and Yick Loong. Later production labels of the same brands are often simply marked "Made in China." Hyphenated codes indicate that two names are found on individual labels.

This list does not contain modern brands that do not have markings imposed by the United States government even though many of these "China General Export" brands are familiar to most collectors. Some brands produced by the Horse, Link Triad, Flying Fairy, and Red Lantern factories, e.g., Flying Fairy, Golden Red, Huan Chu, Nitrate Lightning, Shun Lee Hung, and Superior Mandarin fall into this category.

We do not include Special Issue brands. These brands, or sometimes only their brick labels, may carry the government markings but were never intended for general retail markets. These were imported for special events such as the annual conventions of the Pyrotechnics Guild International Incorporated, or as part of advertising schemes. Such brands include Ass-Kickin' Mule Hoof, Black Rooster, PGI, Super Big Pig, and Country Style. The list does not include improperly marked replications of old brands such as Camel and Duck, nor does it include the "designer" labeled or fake "fantasy" brands that were never exported from the Orient, but have proliferated with the advent of electronic graphics and printing. These include A.T.F., Dolphin, Field of Stars, King, Mammy, Paradise, Sailor Boy, Super Spud, and many others.

Finally, as collectors ourselves, we must add a note on rarity. All the brands listed here have been produced since at least 1971, and many are extremely common. However, some brands such as Black Mask, H-Bomb, Thunder Bomb with the Great Wall or Pandas graphics, and Twin Duck seem to have been imported in small quantities and are already highly sought after by collectors. Firecracker labels remind us of good times - joyous celebrations like Independence Day and Christmas - and are one of the few remaining examples of true folk art. Interest in collecting and preserving these treasures will surely continue to grow!

AMERICAN FIREWORKS NEWS

All Red H
 All Red Celebration "Lion-dance Lions" H
 Anchor WY
 Apollo PS
 Apollo of the Ozarks Silver Salute 1999
 Ass Kickin' Mule 1998
 Ass Kickin' Raging Bull 1998
 Atomic "The Best" PS
 B-99 Bullet-Crackers PS
 Baby Coyote MC
 Baby Gorilla
 Brown Gorillas in Grass KYHK, RB
 Brown Gorillas in Leaves PS
 Blue Gorillas in Leaves KYHK-RB
 Gray Gorillas in Flowers RB
 Bald Eagle
 Beauty J 1990
 Big Apple Bomb SCD 1981; HB 1992
 Big Bang HS-PRC
 Big Bear RB
 Big Bomb KYHK, KW, K, J
 Big Jake J 1987
 Big Stick CFI 1998
 Big Thunder 1999
 Bikini Beach 1999
 Black Cat LF; LF-PF
 Black Cat Premium 1999
 Black Fury PF
 Black Hawk KHT
 Black Jack Firework SCD 1981
 Black Jack HB 1992
 Black Jack Pirate FFW, HYYK
 Black Mask PF
 Black Widow WD
 Blazing Commando, The FFW
 Block Buster KYHK
 Block Buster "Dragon" MA 1992
 Block Buster Laser 1986
 Bob Cat BRK-YLH-PRC, MC
 Boomer
 Red RL
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 Striped AN 1997, RL 1978
 Boomer "Boy Lighting Crackers" 1991
 Boomer 1" BOO 1997
 Boomer HH 1991
 Boomland RBM 1997
 Boot-Legger Bombs 1993
 Bootlegger (Zeke's) 1995
 Bo-Peep YLH, PRC
 Bullet Cracker PS 1994
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Coyote BRK, MC
 Cracker Bomb SR 1999
 Crazy Debbie CRD 1999
 Crazy Debbie's Crazy Crackers CRD 1999
 DeathStalker Timebomb 1995
 Detonator CFI 1999
 Devil Dog SCH-YLH
 Diamond Head Hawaii C 1979
 Dixie Boy
 Dixie Dynamite FOA 1999
 Double Gold-Coin HY, PRC
 Double Lions HHL-NYP
 "Double Peacocks" PS
 Dragon Fangs
 Dragon Fire PS-CO
 Dragon Firecracker 1997
 Dragon Lady PS
 Duck YL-TBT
 El Torro 1998
 Emperor 1999
 Excalibur CD 1996
 Fat Rat 1998
 Final Countdown Celebration Crackers JF 1999
 Firecracker With Safety Fuse 1985 ("generic water crackers")
 Flashing Thunder 1988; HB 1992
 Flash Tomthumbs FB 1990
 Flower Basket Bomb ("Two Cranes") FB 1991
 Flying Dragon 1981
 Gangster B 1978, 1999
 Giant Panda LSH
 Giraffe 1992
 Globe Bear KHT
 Golden Deer RL
 Golden Dragon RL
 Goldenhorse SY
 Golden Red LT
 Gorilla
 Brown Rough Gorilla RB
 Black Smooth Gorilla KYHK-RB; YLH-RB
 Gorilla Throwing Firecracker KYHK; RB
 Great Emperor, The HKP 1999
 Great Wall G 1989
 Grenade Bomb KYHK
 Grizzly RS-YLH
 H-Bomb
 Hale Bomb 1989
 Happy Lightning LT
 Hawk KHT
 H.O.T. Giraffe
 Hot Shot LEW
 Island Dragon G-IF 1992
 Jaguar 1998
 Jolly Joe's 1994
 Kahuna 1996
 Kickapoo Kickers PS-WWR
 Killer Bee 1999
 Lady Cracker FB 1990
 Lady Crackers RL
 Blue and White
 Green and Yellow
 Red and White
 Lady Fingers KHT
 Lady Firecracker LT
 Red and Orange
 Green and Yellow
 Lady Fwngers (misprint)
 Lady Hawk KHT
 Lady Manhattan 1992
 Laser 1986
 Lightning Bolt 1998
 Lightning Bolt M-2 Crackers 1998

Lightning "Bridge" RL
 Lightning Strike 1994
 Lightning "Two Buses" RL
 Link Triad LT
 Blue
 Blue and Yellow
 Link Triad Lady Firecrackers LT 1985
 Lotus APTG 1999
 Lotus Bomb APTG 1999
 Lucky Dragon Multi-Bomb Rainbow 1998
 M-1 Silver Bomb 1999
 M2K 1999
 M-60 G 1999
 M-70 WHFC 1996
 M-80 KHT, YL, YLH
 M-80 "The Best" 1997
 M-80's PS
 M-100 Air Thunder 1997
 M-100 Atomic Bomb
 White 1994
 Red 1997
 M-100 Black Panther J 1990
 M-100 Great Grizzly 1993
 M-150 1997
 M-1000 Salute M 1993
 M-5000 Ground Bomb
 Mad Dog 1997
 Mad Hornet 1994
 Mad Rat MFW 1979
 Magic Crackers
 "Maiden/Clouds" KW 1989
 Mammon J 1990
 Max-Pop M-66-1 1997
 Mighty Mini Bombs KYHK
 Mighty Mite AN, RL
 Striped
 Red and Yellow
 Mini-Bomb KYHK
 Mississippi Gambler 1998
 Missile HYYK
 Mobster 1998
 Monster KYHK
 Mule PS
 Mule "At Farm" 1994
 Mule "In Explosion" 1996
 Mustang LF
 Ninja 1994
 Nitro Bomb 1993
 Blue Burst
 Yellow Cracker
 OK PS
 Old Shanghai 1999
 Pagoda G 1989
 Panda H
 Panda TCT
 Pandas
 FB-AW 1986
 AW 1995
 AW "Street Scene" 1998
 Panther KF 1998
 Peacock PS SCH
 Penny Packs Crackers LB 1999
 Peony KYHK, J 1990
 Peony RL
 Petards Tom Pouce FB
 Pigeon J 1990
 Pitbull 1996
 Po Ha FB
 Po Ha H
 Po Ha TH
 Poha RL
 President 1997
 Python 1995

AMERICAN FIREWORKS NEWS

Rattlesnake 1991
 Red Cherry SDF
 Red Devil 1992
 Red Hot Firecrackers 1998
 Red Lantern Lightning (Red/Crackers) RL 1973
 Red Lantern Lightning (Blue/Lion) RL 1975
 Reservation RL 1989
 Rocket KYHK
 Rocket Super Bang KYHK
 Roller Coaster CB 1992
 Rolling Thunder
 Rolling Thunder Delux 1998
 Royal Dragon 1993, 1995
 San-Tee PS
 Scorpion PS
 Sheba 1995
 Shogun IOF 1999
 Shot Gun SDF
 Silver Salute G 1999
 Silver Salute KYHK
 Skull EG 1993
 Stars & Bars 1999
 Stinger RS
 Successive Happy News RL 1991
 Sunset KYHK
 Super 2000 LB 1999
 Super Blast 1990
 Super Charged RL
 Blue
 Red
 Red Bomb
 Super Flash 1990

Super Power RL
 Blue
 Red
 Superman B 1981, 1999
 Swallow YL
 Super Shark KYHK 1979
 Tank 1998
 Texas Giant
 Plain 1990
 Mighty Mite 1993
 Thunder JZ 1999
 Thunder Bomb "Pandas" H
 Thunder Bomb "Great Wall" H
 Thunder Bomb "Towers"
 Black D 1991, FF 1994, H 1971, SWR 1995,
 TH 1985, no logo 1987
 Blue H 1987, no logo 1993
 Red H 1986, TH 1992, no logo 1999
 Yellow TH 1987
 Thunder King Celebration Crackers 1998
 Thunder Crackers FB
 TNT Bomb
 Black HU, KYHK, PS, YLH
 Yellow HU, K 1986
 TNT 1996
 Tiger Crackers H 1975
 Tiger Firecrackers TH 1981
 Tiger-Head TH 1972
 Tiger-Head Celebration Crackers
 Tiger Head Bomb H
 Tom Thumbs RL, H, FF, YLH

Ton Crackers (celebration string) JZ
 Turtle PS
 Twin Duck HHL
 USA 1995
 Uncle Sam "Holding Flag" 1997
 Uncle Sam "Sammy McCracker" 1994
 Unicorn HHL
 Uzi Cracker Bomb 1986
 Viper PE 1994
 Volcano Flash Bomb WLB 1992
 Warhead RS 1972
 War Head FTH 1993
 Warpath 1999
 Warrior KYHK
 Water Dragon 1994
 Werewolf 1995
 Western Hero RL 1986
 Whale 1973
 Wild Carackers MRW 1991 "catlike animal"
 Wild Cats MRW 1990
 Wild Crackers MRW 1991 "doglike animal"
 Witch Super Bang KYHK
 Wolf Pack PH-ARC
 Blue 1992
 Red 1997
 Wolverine P-S 1998
 Y2K S 1999
 Zebra
 Blue LF
 Blue and Green LF 1986, GG 1993

ABBREVIATIONS:

ALA = Alamo Fireworks, San Antonio, TX (Alamo)
 AN = Angel (Boomer)
 APTC = Asia Pacific Trading Co., Honolulu, HI (Lotus)
 AW = A&W Sales Co., Muncie, PA (Pandas)
 B = Buckeye Fireworks, Deerfield, OH (Gangster 1978)
 BOO = Boomer Fireworks, Grand Island, NE (Boomer)
 BRK = Brookings Fireworks Co., Brookings, SD (Coyote)
 C = Compton Fireworks (Diamond Head)
 CB = Cassorla Brothers (Rollercoaster)
 CD = C. Daniels (Excalibur)
 CFI = Celebration Fireworks, Indianapolis, IN (Big Stick)
 CO = Cornet Stores, Honolulu, Hawaii (Dragon Fire)
 CRD = Crazy Debbie's Fireworks, Joplin, MO (Crazy Debbie)
 CS = Consigned Sales Co. Inc., Grandview, MO (Killer Bee)
 D = Delta (Thunderbomb)
 EG = Egan Enterprises, Inc. (Skull)
 FB = Flower Basket (Flash Tomthumbs)
 FOA = Fireworks Over America, Springfield, MO (Dixie Dynamite)
 FTH = 4th of July Extravaganza (War Head)
 G = Guangxi, China (Great Wall)
 GG = Golden Gate Fireworks, San Francisco, CA (Zebra)
 H = Horse (All Red)
 HB = Herbie's Famous Fireworks (Black Jack)
 HH = Hoi Hing (Boomer)
 HHL = Ho Hsing Lung, Firecrackers and Fireworks, Taipei, ROC
 (Twin Duck)
 HKP = HKP Fire Hawk (The Great Emperor)
 HS = Him Son (Big Bang)
 HU = Hunan, China
 IF = Island Fireworks, Hager City, WI (Island Dragon)
 IOF = Inter-Oriental Fireworks (Shogun)
 J = Jiangxi, China (Beauty)
 JF = Jake's Fireworks, Pittsburg, KS (Final Countdown)
 JO = Johnson Enterprises, Ltd. (Missile)
 JZ = Jin Zi (Thunder)
 K = Kiangsi, China (Big Bomb)
 KF = Kathy's Fireworks, Rodeo, NM (Panther)
 KHT = Kwong Hing Tai (Cherry)
 KW = Kwangtung, China (Big Bomb)

KYHK = Kwong Yuen Hang Kee (Baby Gorilla)
 LB = Lightning Bolt (Super 2000)
 LD = Lucky Dragon (Rainbow)
 LFW = Liddell Fireworks, Shreveport, LA (Cowboy)
 LT = Link Triad (Happy Lightning)
 MA = Mid American Fireworks, Springfield, MO (Block Buster
 "Dragon")
 MC = M&C Fireworks Distributors, Egan, SD (Baby Coyote)
 MFW = Mike's Fireworks (Mad Rat)
 MWF = Mr. W. Fireworks, Inc. (Wild Cats)
 NJF = New Jersey Fireworks Mfg. Co., Elkton, MD (Celebration Red
 Cracker)
 PE = Pat Egan's (Viper)
 PF = President Firecrackers and Fireworks Ltd., Taiwan (Black Cat)
 PH-ARC = Phantom-Alexander Rori Co., Ltd., Hong Kong (Wolf Pack)
 PRC = Peoples Republic of China (Bo-Peep)
 PS = Po Sing
 P-S = Prism-Safety 4th Fireworks Company, Inc., Hammondsville, OH
 (Wolverine)
 RB = Rich Brothers Fireworks, Sioux Falls, SD (Big Bear)
 RBM = Reeves Boomland, Charleston, MO (Boomland)
 RL = Red Lantern (Boomer)
 RS = R&S Marketing, Bozeman, MT (Grizzly)
 S = Shogun Factory, China (Shogun)
 SCD = South Carolina Distributors (Black Jack Firework)
 SCH = Schneitter's Fireworks, St. Joseph, MO (Peacock)
 SDF = South Dakota Fireworks, Sioux Falls, SD (Red Cherry)
 SR = Swan River (Cracker Bomb)
 SWR = Swallow River (Thunderbomb)
 SY = Shen Yu Co. Ltd., Taiwan (Goldenhorse)
 TCT = TC Traders, Hong Kong (Panda)
 TH = Tiger-Head (Po Ha)
 V = Vulcan Factory, China (Uncle Sam)
 WD = Wald and Co., Kansas City and Greenwood, MO (Black Widow)
 WHFC = Wholesale Fireworks Company (M-70)
 WLB = Westlake Brand (Volcano Flash)
 WWR = Willcott, Walt and Ralph, Leavenworth, KS (Kickapoo Kickers)
 WY = Wang Yick (Anchor)
 YL = Yick Loong, Macau (Cherry Bomb)
 YLH = Yuen Loong Hong Firecracker Mfg., Hong Kong (Bo-Peep) *



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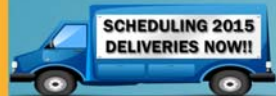
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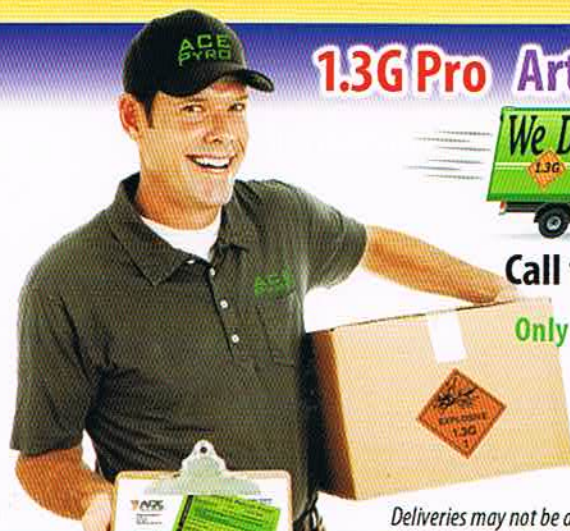
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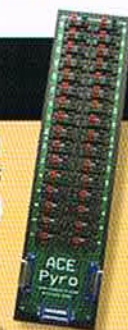
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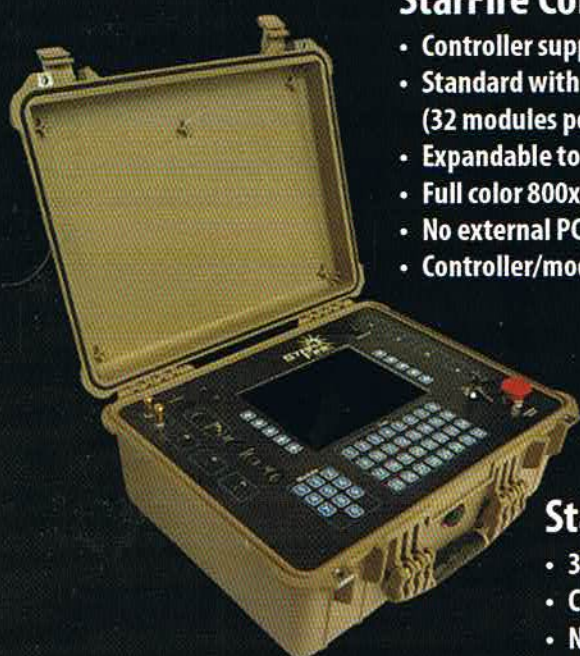
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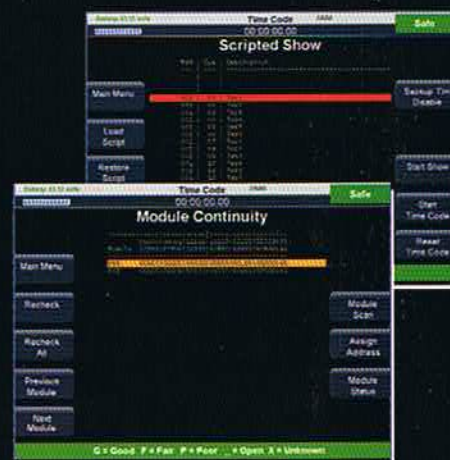
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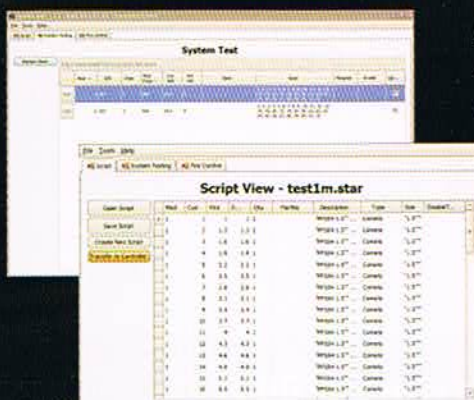
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