May, 2008, Vol 19-1

Western Pyrotechnics Association Newsletter

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BRAND

WPA Newsletter, Volume 19, Issue 1

May, 2008
Volume 19, Issue 1

Western Pyrotechnics Association
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Canoga Park, CA 91309

E-mail: Tom@WesternPyro.org

Inside this issue:

From Your Editor
By Tom Calderwood, V.P. Publications

I trust you have had a safe and sane pyro year!

In this newsletter, you will find an article from Charlie Wilson concerning an incident at one of our Winterblast events. This led us to enforce the shade policy in the manufacturing area. It is a good reminder to us all to keep alert to possible scenarios that can raise our risk.

There is an excellent article from the Kosanke's about placement of e-matches and precision timing for choreographed displays. At WWB, I see more and more folks trying to accomplish this with digital firing systems — but there's more to it than meets the eye. While you will see vendor names long gone in this article, the placement of e-matches is an important part of every display so it is included in this newsletter.

We did have a few members submit articles (Thank you Susan, Charlie and Tom!), but there is usually a dearth of newsletter submittals after Winterblast. Because of this, we chose to include an excellent write up from Ned Gorski in a recent Skylighter article. Regulations not withstanding, we are being forced to find new and inventive ways that we can further our hobby and craft. This is a great article on making fast black powder for much less cost. (I did shorten the URLs that were in the article to tinyurl's.)

NOTE—the WPA neither supports or is supported by Skylighter other than the mutual efforts to provide safe and legal ways for us to enjoy fireworks. No monies were exchanged in the handling of this article. It's there for what it is, and that is good information.

On the Fourth of July, whether you are shooting a professional fireworks show or just lighting off some Class-C around the neighborhood, do be careful! We want you all to be at our events!

So read up and get ready to smell some smoke!

Important Notice:

WPA—2008 and Beyond

By Pete Wood, WPA President 2008

Here we are, over a quarter of 2008 behind us, and only months since WWB 19. By now, the adrenaline has thinned and our lives have returned to normal, but the memories live on!

It was a great WWB with many new faces and new additions to our displays and the art of pyrotechnics in general. I would venture that few among us could say that our events are "typical" or "routine". Think about it – where else could you see a rock have a hole burned through it, anvils launched skyward and a flaming bike of death routine!! These are only a few, but the point here is that we not only have some of the best of the best in the industry, that support and attend our events, but our membership contributes greatly to the variety and uniqueness of what we see today. Diversity is what makes (and keeps) our passion alive and our interest intact. It's a great club we have and I can only see it getting better.

To those of you who attended the General Business Meeting, held Sunday, Feb.17th at the LHC Aquatic Center, I thank you all for coming and being part of the inner workings of the club. It's a great thing to hear the different ideas and proposals, pro and con that face the club and the membership. Without your input, change cannot be implemented accurately. If we don't know what concerns or bothers you, we can't address it. We all have a say in how things are done, but if your voice isn't heard, we can't act on your concerns or behalf.

It was certainly an honor to assume the office of President, at the election on Sunday, and again, I thank those that attended and showed their support, not only for my candidacy but for the process in general. I hope to be able to guide us through whatever might confront us in the coming months and years, and to help those who will take my place when the time comes. I do have ideas and hopes for the club, but my primary focus is to have the WPA work closely with those that regulate and dictate our current policies. Through cooperation and better understanding, I truly feel we can coexist and actually prosper. Currently, there is much unknown about what we do and what we represent. This in turn, creates certain distrusts and preconceived ideas that only hamper our attempts to be viewed as a legitimate entity.

Things are improving on these lines, as our past WWB featured seminars from the BATFE and apparently were well received by both the membership and the BATFE officials that presented and attended the seminar.

I would like to see 2008 be the year of the membership drive. If you know of individuals who might be interested in joining, or know of others who have been past members but haven't renewed, talk to them and see if you can re-kindle the spark that draws us to this passion and hobby of ours. "Strength in numbers" applies and especially so for those of us in the field of pyrotechnics.

But! Let's get back to our events.

Pyro Playa has just past on May 14-19, 2008. This is a "bare bones" event for those inclined to create. It was being held at Delamar Dry Lake in Lincoln County, NV.

DO IT 2008 is next, on October 9-11th, in beautiful Lake Havasu City AZ. Keep an eye on the WPA website for further details. Yours truly, will once again be the Chair of this event, with

Bill "Flaming Bike O' Death" McGregor as my Co-Chair. Remember what you missed (or heard you did) last year? Plan now to NOT miss out on this one. Anyone wanting to reaffirm their desire to be on the DO IT Staff for this coming October, feel free to let me know, so I can put together the list. It's never too early! My contact info is – skyfire-pro@aol.com or pete@westernpyro.org

Last, but not least is WWB 20 !!! Our twentieth year to celebrate, and it shows promise of being one to remember! Kief Adler is Chairman of the event (the "Slack is Back! ") . For further info or questions, contact Kief at kief@sbcglobal.net, or the event co-chair, Kelly Goebel, at - kpgoebel@gmail.com.

I'll close by saying that although it seems we face obstacles at every bend, I truly believe we will reach that "middle ground" with our regulators, and find the path that will enable us to continue doing what we love so much – FIREWORKS!

Be safe and ever vigilant! I'd much rather see you than read about you!

- Pete

Secretary's Musings
By Rita Oesterle

I had a great time at WWB 19. I enjoyed all the displays and just being there surrounded with old and new friendships. I want to thank Lynden King for his efforts as WWB chairperson.

Job well done to all the staff and volunteers.
Just in case you are interested in WPA stats, here are some from WWB 19.

Paid attendance for WWB 19:
Members 467
Spouses 136
Children 44

2008 WPA stats:
Memberships 640
(This includes spouses as well as 16 life memberships.
There are 124 new members added since DO IT 2007 last October. The sad stat is that 224 members did not renew their 2008 dues from 2007.

If you know any members who have forgotten to renew, please remind them that they are missing out on newsletters and digest chat.

There is now a committee looking into new badge making for WPA events and membership cards. Hopefully they will be plastic cards the size of credit cards. The best part is that the new system will allow us to make single badges at a time for on-site registration. No more having to come back and get a permanent card.

I hope most of you will be busy during the year working on firework displays.

Rita Oesterle

The Treasurer Speaks
By Ann Huffman

What can I say, another WWB gone by. I would like to thank everyone one from the Convention Chairs, Site Chairs and all the wonderful staff members, volunteers and members who again made this such a Wonderful Event. Welcome to our New President Pete Wood, it will be a pleasure working with you again and a Welcome Back to Kief as Vice President. I would also like to take this time to thank all of you for allowing me to come back for another two years as your treasurer. Our new New Year 2008 thru 2009 seems to hold lots of adventures for us all. Playa Pyro in May, Do It in October and the Big 20th Anniversary of WPA in Feb 2009. I hope to see many of you at all the events as possible and remember, VOLUNTEER!! During the events. Come to SET UP and STAY for CLEAN UP and the ever changing BURN PILES put on by our very own WPA Members! Remeber Guys and Gals, this is OUR Club and we all need to pitch in, if not you end up being just one of those people in the blenchers. Bad Back, No Time, donate $$$$ to the WPA Events. Help off set our costs. Just put a note on your registration form that these extra dollars go to the event. See You all At The Next Event. Have a good and safe summer.

Ann Huffman
WPA Treasurer

From the Vice President
Mostly Winterblast Stuff!
By Kief Adler

Here I am back on the Board and it's great to be working with such a dedicated group of concerned club members once again! Thanks for allowing me this privilege.

Winterblast 19 was the first Blast with a major ATFE presence and I'm happy to say that all 4 of the agents came away with a positive feeling about our club. Hopefully many of our members learned how they could apply for, and receive, their own user permits. Our industry members got to meet the new ATF industry Liaison, Bill O'Brien, and ask questions of him. I had been trying to get the ATF to come out to one of our conventions for many years and it was great to finally get them to say, "yes."

On another matter, I have been trying to get the club an exemption from typical ATF record keeping rules and regulations for our conventions. Unfortunately, I received word at Winterblast that my request has been denied. However, I have already been in touch with the club's attorney, Doug Mawhorr, as well as ATF chief O'Brien, about drafting a new request that might make it through ATF scrutiny. Stay tuned! Meanwhile, the bunker log system that we are currently using is our easiest yet so, for now, we have a workable system. We need to keep refining our magazine storage procedures due to the volume of

Continued next page

From the Vice President — Kief Adler

Continued from previous page

class B storage that has become necessary for Winterblast and, to this end, I am going to be making some suggestions to the Board regarding the staffing of the magazines. As Class B purchases increase, the amount of staffing required for the magazines increases as well. To this end I am going to suggest that anyone who orders B product to use at Winterblast MUST volunteer one hour of time to magazine duty. I am also going to discuss the issue of class B purchases for new members and will be suggesting that members who have less that one year with the club not be allowed to purchase class b product unless they hold a valid pyrotechnic license, or can validate their experience with class B. Look for more on this in future newsletters as well as our email list.

As your WWB 19 demo and PD chair, I want to personally thank all of those who performed nightly for us: Firelinx/Entertainment Fireworks, the Amateur Pyros of the West Coast Cakeathon, A M Pyro, Fireworks America, our cracker crew, Wolverine West, Raven Marquez and the Flying Monkees Pyro Team, Ace Pyro LLC, those great Canadian wheel makers, Susan Baldwin, Theresa Schiavo, Pyro Boy, Premier Pyrotechnics, Michelle Sykes, Chris Spurrell and Bill Zuber. These folks spend many hours and quite a few dollars showing off for all of us and we owe them all a heart felt THANK YOU.

Also special thanks to our Afterglow sponsors, Pyro Spectaculars, Fireworks America, Scott Stocking and Mudsharks Brewing Co. and John Riccio.

I also want to give special thanks to all those who gave generously at the auction, with special thanks to Matt, Jill and Raul for helping out.

Finally, to our corporate members and corporate sponsors, without whom the club would really be in a financial bind, thanks for your faith in this club.

Planning for WWB 20 has already begun and I've received some great feedback from several of you regarding our 20th anniversary event. If you haven't heard, we are hoping to make WWB 20 a 5 day event, with more time to shoot and manufacture fireworks. If you have any feedback on WWB 19, or ideas for number 20, please send them my way.

Meanwhile Pyro Playa has just finished and Do It is not too far behind that, so save your money, talk to your pyro friends about joining the club and get ready to smell that smoke!

In Appreciation of WinterBlast

by Susan Baldwin

With Joy in our hearts and a nod to our world neighbors in China we come together in the New Year to watch in wonder and awe the night sky painted in brilliant colors and flashing lights, to the WinterBlast celebration in the desert by the Colorado River.

Working together and mindful of each other's safety we celebrate our freedom of expression and the artistry that makes our hearts glad and inspires our souls.

Some express their artistry in building rockets that soar to the heavens and end in a brilliant burst of color and noise.

Others find happiness in the thrill of explosions and lighting the jewels that decorate the sky, or end in a brilliant flash and salute to the power of earth's elements and the human mind's ability to create.

Many delight in the creation of stories and ideas with music and combinations of bursts that entertain and leave all of us with a smile on our face and our senses aroused with the beauty and creativity that is pyrotechnics.

Suddenly, it is all over and we head back to our everyday lives wishing it did not have to end but happy with the knowledge that we will come together again, to work together to make it happen again, to be creative and entertain, to be entertained and rejuvenated in this special time that we call WinterBlast.

The Steel Bowl Accident

By Charley Wilson

At few WWBs ago, I was burned in an accident caused by a stainless steel bowl and direct Arizona sunlight. In the manufacturing area that was set up by the WPA, my friends and I were intent on making numerous rocket engines of all kinds.

WPA had new rules and procedures in place for the event; for one thing, there were large, red-painted ready boxes at locations where manufacturing was to be set up. The rule was, if it is not being made, it should be stored. These red boxes may have saved my life.

The scenario may be described briefly. One of my friends was pounding black powder rocket motors, and another was pressing whistle motors. Most pyrotechnists are aware that black powder rocket fuel is not very vigorous, but that it is certainly highly ignitable! We certainly confirmed that fact when a partially full stainless steel bowl burst into combustion, throwing charcoal sparks all over the place. One or more of the charcoal embers burnt through the whistle mix tub top, and ignited what was left before I could run behind our trailer. The resulting flash burnt my elbow to second degree burns, and singed the hair off my left arm before I could escape. I was wearing cotton clothing at the time, if I had been wearing a long sleeve cotton shirt I would have escaped almost all injury.

Note that no completed items such as shells, stars or rocket motors were present on the work table.

In an effort to understand what had happened, I devised an experiment to duplicate the ignition that caused my burns.

In previous picture, a short piece of Chinese visco fuse was suspended in the center of a steel bowl. The fuse was oriented vertically, and the bowl was oriented to maximize concentration of light.

In this picture, the red arrow points to the "hot spot", where parabolic reflections have focused the sun.

In early April, at 7500 feet of elevation in Colorado under clear sun at about 1 PM, the fuse ignited in 19 seconds.

With even slight cloud cover, the fuse could not be made to ignite.

[This is the primary reason we require shade at all manufacturing sites! - ed.]

Making and Testing High-Powered Black Powder

by Ned Gorski

reprinted with permission from Skylighter Newsletter #96 (links at the end of the article)

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Black powder (BP) is an almost ridiculously simple pyro ingredient. Mostly just three chemicals, blended together in simple ways, but producing wonderful results. Black powder exemplifies for me the endless learning, experimentation, and creativity that fireworking holds for us. If so much fun can be had with BP, imagine what else fireworks-making has in store for you.

Introduction

In this article I'll be writing about two basic skills:
How to make black powder using 4 basic methods, ranging from the use of only two simple screens, through the use of a star-roller, hydraulic press, and/or a ball-mill.

How to test various black powders to compare their power, and to determine how much to use when lifting a typical fireworks aerial shell.

I hope this article will be useful for both the novice fireworker, and for the most experienced one.

What is Black Powder (BP)?

Have you ever taken the covering off of the bottom of an aerial shell and observed the black granules which are used as the shell's "lift powder?"

Black Powder Used As Shell Lift Powder

Black powder is perhaps the most basic and useful of all fireworks ingredients. It is used to lift shells, comets, mines, Roman candle stars, and as a base-composition in some rockets and many other fireworks components and devices.

Here is the definition of black powder taken straight out of the The Illustrated Dictionary of Pyrotechnics (Skylighter #BK0043):

"Black powder – An intimate mixture of finely powdered potassium nitrate (75%), charcoal (15%), and sulfur (10%). Commercial black powder may be granular or finely powdered. It serves as a propellant and has a wide variety of uses. Black powder should not be confused with smokeless powder, which is not a suitable substitute for black powder (in fireworks)."

Here is the definition of black powder taken straight out of the The Illustrated Dictionary of Pyrotechnics (Skylighter #BK0043): [1]

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So, What is "High-Quality" Black Powder?

For the sake of this article, at least, let's define high-quality BP as that black powder which will adequately serve the needs of the fireworker, and which comes close to, or exceeds, the quality and explosive power of commercially available black powder. Goex brand is a well-known, and often referred to, example of commercial powder.

Goex Brand Black Powder

Well, Can't I Just Buy the Black Powder I Need?

First of all, didn't we say, "Hey, I'd like to learn how to make fireworks"?

You can buy some types of black powder. There are two types available, sporting and blasting. The sporting grades of BP, made by Goex and others, are readily available from some gun and sporting goods shops, and some online sources. These are the "Fg, FFg, FFFg, FFFFg, " etc. grades listed in the black powder grain size charts.[2]

The blasting grade, "A" powders are most frequently used in fireworks. 2FA, 4FA, and Meal-D are the sizes we need the most. (See the article on black powder sizes and grades Size Does Matter[3] in Skylighter Fireworks Tips #44.) They are available only to holders of a BATFE explosives license.

If you can find BP at your local gun shop, it usually retails for $16 - $24 per pound. Beginner shell makers can easily use more than 50 pounds of 2FA per year. That's about $1,200 at retail!

It doesn't take long, buying commercial BP, before you start asking yourself, "Self, ain't there a less expensive way?"

Even if one has the BATFE license to buy commercial 2FA in bulk (50 or 100 lbs at a time), the current price of it is $7-8 per pound.

So, economics, practicality, availability, and the pride of actual fireworks-making, all eventually make it inevitable that most pyro-hobbyists will make their own BP. And the good news is that it is Federally legal to make it yourself, without an ATF license. But, check your state and local laws first to make sure you can comply with them as well.

Many would argue that the very first, important step to learning the art of fireworking is tackling the skill of making high-quality black powder.

What Affects the Quality of Homemade Black Powder?

Typically, these are the key variables in making powerful, high-quality BP:

#1: The quality of the chemicals and the type of charcoal (wood species) that is used. Willow charcoal is often being referred to as the wood of choice for BP charcoal. I use spruce/pine as the wood that I turn into homemade charcoal. (This subject is discussed in the Making Charcoal[3] article, Skylighter Fireworks Tips #90.) I'll be comparing BP made with this pine charcoal, with that made with commercial airfloat charcoal.[4]

#2: The method used to pulverize and intimately mix the ingredients. Screening through a fine-mesh screen or ball-milling can be employed. (This subject is thoroughly explored in Ball Milling 101[5], Skylighter Fireworks Tips #91.)

Classified Ads

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#3: How the mixed ingredients are consolidated and granulated.

#4: The size of the granules, especially with BP that is made into pucks that are broken up (corned).

Four Methods of Making Black Powder

I have played with several methods of making BP. Now I'm going to make black powder in four of those ways:

- Pressing BP pucks and breaking them up. (This method has been detailed in Skylighter Fireworks Tips #92[6] and #93.[7]
- Coating the BP onto rice hulls. (This method was detailed in Skylighter Fireworks Tips #92.[6])
- Ball-milling the composition, wetting the BP with red-gum and alcohol, and granulating it through a 4 mesh screen.
- Simple screening of the chemicals through a 100 mesh screen, and using the red-gum/alcohol granulation method.

First Step

I ball mill four 20-ounce batches of mill-dust BP, two batches using pine charcoal, two more using commercial airfloat. Each batch has 15 ounces of potassium nitrate, 3 ounces of charcoal, and 2 ounces of sulfur. I run the ball mill for 2 hours for each batch. I end up with 40 ounces of pine charcoal mill-dust, and 40 ounces of commercial charcoal mill-dust.

(Mill-dust is the term that is used for BP as it comes straight out of the ball mill, before any granulation.)

Second Step

I take 16 ounces of the pine charcoal mill-dust, add 1.6 ounces of water (10%) to it, and thoroughly incorporate the water into the powder with my gloved hands. Then I further incorporate the water with a screen colander. I press 1/8" thick pucks with that powder. I have found that if I apply about 1600 psi of pressure on the pucks when I press them, that they are as solidly consolidated as they are going to get. I put the finished pucks into the drying chamber to dry.

I do the same with 16 ounces of the commercial charcoal mill-dust.

(I have found that it is quite easy to break the pucks up a bit by hand while they are still damp. This makes it easier to granulate them later on.)

Third Step

I take 16 ounces of the dry pine charcoal mill-dust, add 0.8 ounce of dextrin (+5%) to it, screen it to thoroughly incorporate it, and coat that BP onto 2.4 ounces of rice hulls in the star roller (7/1 ratio of BP to rice hulls). (See the Nice Shells in 2-1/2 Days, Part 2[6] article in Skylighter Fireworks Tips #92.) I put the coated hulls on screens and into the dryer[8]. Although puffed rice cereal can be used in this process, rice hulls make more durable grains.

I repeat the process with 16 ounces of the commercial charcoal mill-dust.

Fourth Step

I take 8 ounces of the dry pine charcoal mill-dust, and dampen it with 1/3 cup of denatured alcohol (from Home Depot) which has 1/10 ounce of red-gum (about 1% of the mill-dust weight) dissolved in it. I slowly add enough additional alcohol to the mill dust, only as much as necessary, to end up with a nice, putty-like "dough ball." Then I granulate that dough-ball through a 1/4" (4 mesh) screen onto a kraft-paper lined tray for drying.

Warning: Working with alcohol or any other solvent that puts a lot of fumes into the air, I do so outdoors so fumes cannot collect and be ignited, and I wear a mask-respirator to avoid breathing the fumes.

Fifth Step

I simply take 15 oz. of potassium nitrate and screen it through a 100 mesh screen. If all of it won't pass the screen, I mill it a bit in a small coffee grinder until it will pass the screen.

Warning: I never mill anything but individual chemicals in the coffee grinder. I use one coffee grinder only for oxidizers, and a different one for fuels. I thoroughly clean it after using it for one chemical.

Then I combine that 15 oz. of potassium nitrate with 3 oz. of pine airfloat charcoal and 2 oz. of sulfur, and pass them twice through the 100 mesh screen to thoroughly mix them.

This 20 oz. batch of BP chemicals is then wet with about 3/4 cup of the denatured alcohol which has 0.2 oz. of red-gum dissolved in it. More alcohol is added as needed and the putty is granulated as in Step 4 above.

I do the same for a similar batch using the commercial airfloat charcoal.

Many of you are now saying, "Aw, he's never gonna get a useful BP with that simple screening method. It has to be ball-milled." You just wait.

All of the powders produced above are left in the drying chamber until they are completely dry. (Skylighter Fireworks Tips #92 shows you how to make and use a drying chamber[8].)

Granulating and Sizing the Black Powders

Once the powders have dried in the drying chamber for a day or two, I process them in various ways.

Processing black powder pucks (see how to granulate black powder pucks[7] in Fireworks Tips #93.)

With the pine charcoal pucks, I end up with 10.7 ounces of the 2FA, and 1.75 ounces of the 3FA. (In reality, commercial 2FA powder contains grains from 4 to 12 mesh, but my 2FA consists of only the coarser grains.)

With the commercial charcoal pucks, I ended up with 10.15 oz. of 2FA powder, and 2.05 ounces of 3FA.

Note: I don't really like the process of pressing all these pucks, and then crushing and granulating them. It's a painstaking, time consuming, and messy process. On the other hand, it is nice to end up with such hard, durable grains, which are practically indistinguishable from commercial black powders.

Processing black powder coated rice hulls

After dumping the BP coated rice hulls from the drying screens into a rectangular tub, I then simply screened them on my 12 mesh screen to sift out the fine BP grains and dust. There was not a whole lot of that, but I wanted to end up with just the coated hulls.

Processing red-gum black powder

With the red gum/alcohol granulated powders, I dumped them from the drying screens and forced them through my 4 mesh screen to break up the larger clumps. Then I screened that powder on my 12 mesh screen to remove the fines and dust, ending up with nice, hard grains in the 4-12 mesh size.

Some Observations

Coating the rice hulls and processing the resulting grains is relatively easy, and the alcohol/red gum granulated powder is probably the easiest to produce. It is a bit more expensive to make, though, since the red gum and alcohol cost a little more than dextrin and plain water.

Results

So, now I have my 10 homemade powders to compare with each other. I also have some German Wano 2FA powder (equivalent to Goex 2FA) which I screen and separate into 4-8 mesh and 8-12 mesh powders, as I did with the homemade powder made from pucks.

-Pine charcoal 2FA
-Commercial charcoal 2FA
-Pine charcoal 3FA
-Commercial charcoal 3FA
-Pine charcoal BP coated rice hulls
-Commercial charcoal BP coated rice hulls
-Pine charcoal, ball-milled BP, processed with alcohol and red-gum
-Commercial charcoal, ball-milled BP, processed with alcohol and red-gum
-Pine charcoal, simply screened BP, processed with alcohol and red-gum
-Commercial charcoal, simply screened BP, processed with alcohol and red-gum
-Wano 2FA
-Wano 3FA

Now I'd like to test these 12 BP's and compare their relative performances.

The Big Experiment

So far, all of this is very interesting information, but, quantitatively, it does not tell me a whole lot that is useful for me in making fireworks.

I have some big questions I'd like answers to:

-To what extent does the type of charcoal affect the power of the BP?
-Consolidated and granulated using 4 different methods, how much variation in the BP's power will result?
-How do these homemade BP's compare in power with commercially produced powders? How can this be tested and quantified?
-How much should I use of one of these BP's to lift an aerial shell?
-How do the various methods of production compare as far as expense and labor? Are some methods significantly easier than others for the manufacture of BP?

I have to admit that the process I'm about to describe is where my creative juices really start flowing in this hobby. Being curious about something, thinking about it, doing some experimenting, pondering the results, and coming to some conclusions that are useful in my future activities--that's what this is all about for me.

We have quite a few variables in the above information when it comes to choosing how to make powerful BP and how to use it in our pyro projects.

I want to design an experiment to compare black powders which incorporate these different variables, in order to know how each of those variables affects the BP's power, and to be able to determine which materials and techniques are preferable when making my BP.

I have my 12 different types of black powder sitting in front of me. Now I'll test them in various amounts, lifting dummy shells, to compare their relative performances, and to find out exactly how much of each of them to use when lifting an actual fireworks shell.

Testing the Black Powders.

In years past there has been a "game," played at the Pyrotechnics Guild International's[9] annual convention, called "pyro-golf." Folks brought samples of their prize black powders, and a fixed amount of each was used in a mortar to shoot golf balls into the air. The flights were timed, and the longest flight time would be declared the First Prize black powder. This is a good method for comparing the power of different powders.

Homemade powders could also be compared to commercial BP's at the same time. Usually the homemade powders outperformed the commercial ones by quite a sizable margin.

There are other ways to compare black powder performances, but I like the golf ball test because it duplicates the real-life application of using black powder to lift aerial shells.

For testing my 12 BP's, I'm going to use my version: "Pyro-Baseball." With "Pyro-Baseball," I use baseballs and a 3" mortar to simulate the lifting of 3" spherical fireworks shells. Baseballs are just the right size and weight. They save me the time, expense, and hassle of having to build actual dummy shells.

For my tests, I'm using a one-piece, HDPE (high-density polyethylene) "gun." Whichever gun you use, it is a good idea to use the same mortar for all of the comparison shots. This will minimize variations from one test to another.

On page 140 of The Best of AFN II [10] (BAFN II) are some charts showing recommended BP lift amounts for various types and sizes of shells. Table 1 indicates that, for lifting a 3" ball shell, 0.6 oz. of FFg, or 0.75 oz. of 2FA would be appropriate amounts of commercial lift powder.

And, on Page 17 of the PGI's Display Fireworks Operator Certification Study Guide[11], one can find a nifty table that shows the typical (desired) heights that various size fireworks shells ascend to before bursting. This table shows that a 3" fireworks shell would rise to about 300 feet and then burst.

That's good information to have. Using about 0.6 to 0.75 ounces of my Wano BP ought to send one of my baseballs up to about 300 feet. I can weigh that amount, drop it down into the bottom of a 3" mortar, insert 4" of visco into the fuse hole at the bottom, drop a baseball into the gun, and light 'er up.

(Continued next page)

Making and Testing High-Powered Black Powder—continued

3" Mortar Loaded and Ready for Bear

But, how do I know if the ball actually ascends to 300 feet before it peaks out (at apogee) and starts to descend? One simple physics equation is all that is necessary to figger that out. If you drop an object and time its descent to the ground, the distance the object has fallen, in feet, is given by the equation, Distance = 16 x time x time (16 x time squared), when the time is measured in seconds.

For example, if I fire my baseball, and start a stopwatch when its flight peaks out at apogee, and then stop the stopwatch when the ball hits the ground, I'll be able to read the time it took the ball to fall to the ground from that peak. Let's say that my stopwatch indicates a time-of-fall of 4.18 seconds.

To see how high the baseball was when it started to fall (at apogee), all I have to do is multiply 16 x 4.18 x 4.18 and I get a height of 279.55 feet. That's pretty close to my desired 300 feet. So I know that using the amount of lift powder that I used, or maybe just a tad more, would be a good quantity of that BP to use in the future for this size and weight shell.

This is what I'll be attempting to determine with each of the 12 experimental powders. Once I know those amounts for each powder, I'll then be able to compare their relative powers with each other. I'll tabulate that info and have some very useful results and conclusions. Just what I was looking for to begin with.

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Stopwatch

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Note: An interesting relationship that I've noted during past tests is the amount of time a dummy shell takes to rise to apogee after being fired from the mortar, compared to the time it takes to fall to the ground. I've noted that it takes a spherical dummy shell approximately half the time to rise to apogee that it takes the shell to fall to the ground from apogee.

Another way of saying this is that, of the total flight time from launch of the dummy shell from the gun to it hitting the ground, one third of the flight time is spent rising to apogee, and two thirds of the time is spent falling to the ground from the apogee.

So, if I use various amounts of a lift powder and time the baseball's flight from the apogee to the ground, adjusting the powder amounts as I go along, until that time of fall equals 4.33 seconds, then I'll know exactly how much of that powder to use again to duplicate that height. 300' = 16 x 4.33 x 4.33.

If I want a slightly higher flight for a shell, for example one with a long burning willow star shell, then I'd use a bit more powder.

Pyro-Baseball Testing of Black Powders

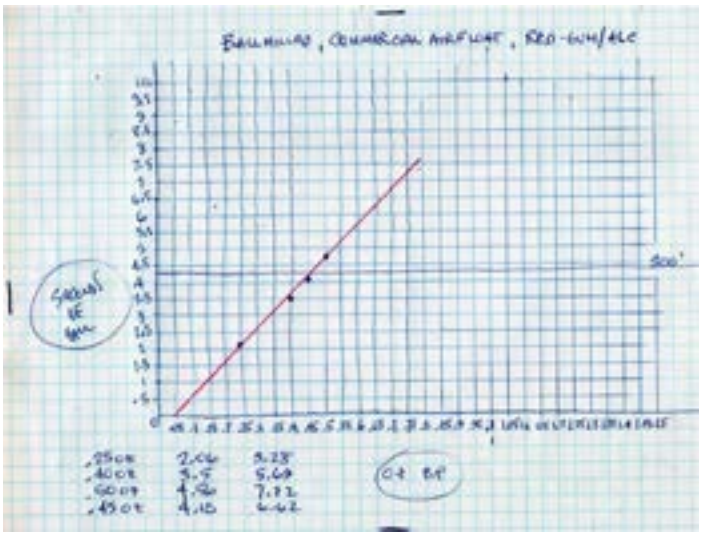
So, I go out to my shoot site with my lovely assistant and all my testing materials: BP's, scale, spoon, paper cups, notebook, pen, baseballs, mortars, visco, anvil-cutter (I never cut fuses with scissors, only with razor blade anvil-cutters), chairs, table, stopwatches, sunglasses, camera, re-bar, and duct tape.

My lovely assistant, ready to take the field!

No, she didn't really try to catch the balls. She had to man (woman) one of the stopwatches instead.

The mortar was taped to a piece of rebar driven into the ground, angled away from us, and the ammunition was prepared. I had previously drilled a small fuse hole near the bottom of the mortar.

I had prepared some charts in advance to take notes for each powder test. The vertical axis represents the time of fall in seconds, and the horizontal axis represents ounces of black powder in 0.05 ounce increments. I drew a horizontal line at 4.33 seconds since that time of fall represents a height of 300 ft., which is what I'm shootin' for.



One of my Hand-Plotted Graphs

Then, it was just a matter of starting to fire baseballs with measured amounts of one of the experimental BP's, such as the one in the above chart: ball-milled, commercial charcoal, alcohol/red-gum granulated. We used two stopwatches, recording the total time of flight, and the time of fall from the apogee to the ground.

Judging the exact apex of the flight can be a bit tricky, since there is a second before the apogee where the flight up really slows down, and there is also a bit of time after the apogee before the ball really starts to pick up speed. But, we just did the best we could. It's probably a bit more accurate to use a time that is 2/3 of the total flight time, from lift to landing.

Baseballs after being fired from the mortar

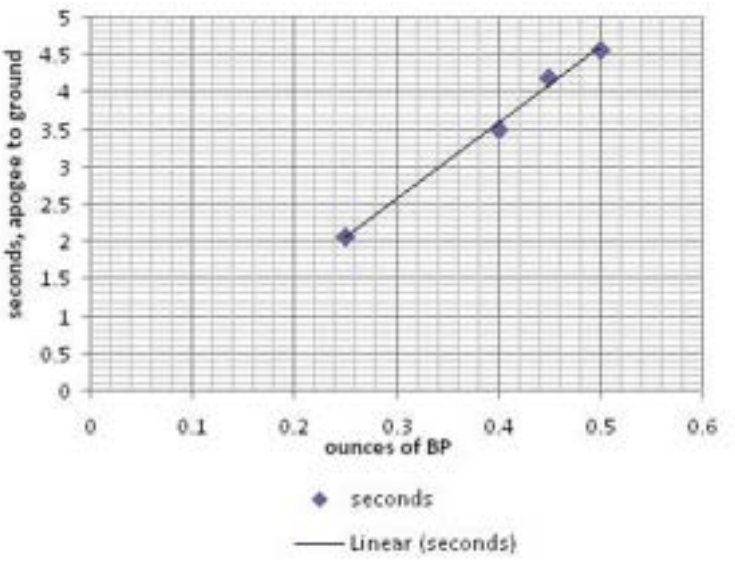
Warning: After each baseball firing, there may be hot sparks remaining in the mortar. I am careful to wait a bit before reloading. Then I insert the visco fuse, drop the next portion of BP in, and then carefully drop the baseball in. **I avoid getting any body part over the mouth of the gun when doing this, regardless of whether I know the fuse is lit.** A baseball fired at this speed could easily kill a person or remove a hand or arm.

I wanted to start with a small amount of the powder, gradually increasing it until I started to get flights that were a bit too high. I figured that would give me the spread of data which I could use to determine the right amount of powder for a 300' high flight. The following is a listing of the amounts of this one particular powder that I used, and the resulting flight times that we recorded.

Ball milled, commercial charcoal, red-gum/alcohol granulation

Amount of BP	Time from apogee to ground	Total flight time
0.25 oz.	2.06 seconds	3.28 seconds
0.40 oz.	3.50 seconds	5.68 seconds
0.50 oz.	4.56 seconds	7.22 seconds
0.45 oz.	4.18 seconds	6.62 seconds

Below is a computer-generated graph of the data above.



Ball-Milled, Commercial Charcoal BP, Red-Gum/Alcohol Granulation

When these coordinates were entered into the graph, a couple of things became obvious. There is a linear relationship between the amount of lift powder that is used, and the corresponding flight time.

This graphed line, if extended down to the bottom of the chart, points to an amount of BP which would not even get the ball out of the gun, about 0.05 ounce in this case.

That graphed line crosses the 4.33 seconds/300' line, between 0.45 and 0.5 ounces of the BP.

Indeed, when the average time from apogee to the ground, is divided by the average total flight-time, the time from apogee to ground is about 2/3 of the total flight time from lift to landing.

With this powder, I'd use 0.5 oz. to reliably lift a 3" ball to 300'.

We did this with each powder, firing baseballs about 40 times into the air.

Results

Repeating the tests described above with each of the 12 BP's, I was able to determine the optimum amount of each powder for lifting a baseball to 300'.

0.30 oz. Milled pine charcoal, red gum/alcohol

0.35 oz. Milled pine charcoal, pucks sized to 3FA

0.40 oz. Milled pine charcoal, coated on rice hulls

0.45 oz. Milled commercial charcoal, pucks sized to 3FA

0.50 oz. Milled commercial charcoal, red-gum/alcohol or on rice hulls

0.55 oz. Commercial Wano BP, 3FA

0.60 oz. Commercial FFg recommendation from BAFN II chart

0.75 oz. Commercial 2FA recommendation from BAFN II chart

0.75 oz. Commercial Wano BP, 2FA

0.75 oz. Milled commercial charcoal, pucks sized to 2FA

0.75 oz. Milled pine charcoal, pucks sized to 2FA

0.75 oz. Simply-screened, pine charcoal, red-gum/alcohol

0.90 oz. Simply-screened, commercial airfloat charcoal, red-gum/alcohol

Note: It was almost difficult to use a small enough amount of the pine-charcoal/red-gum-alcohol powder. A third of an ounce is a mighty small amount of lift powder.

Answers

To what extent does the type of charcoal affect the quality of the resulting black powder? Homemade pine charcoal produced powder that was marginally better than that produced with the commercial charcoal, but both can produce BP's that far outperform commercial black powders.

How did the 4 methods of processing/granulating the BP's compare when the resulting powders were tested? All three methods that employed ball-milling produced powders that were very comparable. The method that used simply-screened chemicals produced BP that, while not as powerful, was very functional in amounts comparable to commercial 2FA.

How does the size of the granulation of pressed pucks affect performance? For these 3" dummy shells, the finer 3FA (8-12 mesh) granulation far outperformed the coarser 2FA (4-8 mesh) granulation.

How much lift powder should I use for a shell? The amounts in the chart above indicate how much of each type of powder to use for a 3" ball shell. These amounts can be dialed in when manufacturing actual fireworks shells. In general, if I were to multiply the recommended amount of lift powder listed in the BAFN II table by 0.6 for the milled, pine charcoal BP's, or by .75 for the milled, commercial charcoal BP's, I'd arrive at a good starting amount of homemade lift powder.

How do the 3 methods of processing/granulating the homemade powders compare as far as difficulty and expense? The easiest powder to make is the screened red-gum/alcohol granulated BP, followed closely by the milled red-gum/alcohol BP, and then the BP on rice hulls. Pressing pucks and corning them is significantly more difficult and messy.

The red gum and alcohol make that method slightly more expensive in material cost than the other two methods. Milling requires an up front investment in a machine and milling media. Rice hulls are cheap, so using them does not make that method much more expensive than pressing the pucks. All of the methods of making homemade BP are much less expensive than purchasing commercial black powder.

Final Conclusion

For my purposes, either homemade or commercial charcoal produces completely satisfactory powder. I really like the ease of production, and the final resulting powder when the red-gum/alcohol method is employed to make BP, so I'll probably use that method when making lift powder for aerial fireworks shells.

To me, the simply-screened, red-gum/alcohol method looks like the method-of-choice for simple, field-expedient, very functional black powder, and it can be produced without any complex or expensive machinery. This method is ideal for the beginning fireworker.

I think I'll bring my bucket of baseballs and a couple of 3" mortars to the next PGI convention, and whoever is interested can take to the field with me to go head-to-head with our prize black powders. May the best pyro win!

Enjoy and Stay Green,

Ned Gorski
ngorski@skylighter.com[12]

Making and Testing High-Powered Black Powder URL Links

(Note: There is a small bug so that I could not link directly to a specific part of an article as is in the original newsletter. Instead, I link to the article and leave it to you to find the specific part. –*Tom*)

1) http://tinyurl.com/52vcg6 (books)

2) http://tinyurl.com/3hw2f3 (BP Size Charts)

3) http://tinyurl.com/4ql35d (#44)

4) http://tinyurl.com/4v7f3c (#90)

5) http://tinyurl.com/3k46fo (#91)

6) http://tinyurl.com/6ams6x (#92)

7) http://tinyurl.com/6n9l76 (#93)

8) http://tinyurl.com/6rz22h (Drying Chamber)

9) http://wwww.pgi.org

10) http://tinyurl.com/5qp2lp (AFN II)

11) http://tinyurl.com/6s9s4t (PGI Guide)

12) http://tinyurl.com/58pg2g (Ned's Email)

Preparations for the ***Annual PGI Convention*** in Gillette, Wyoming are underway. The dates for the convention are August 9 - August 15, 2008. PGI will return to the Cam-Plex center and it is one of the best sites we visit with room to manufacture, shoot and see fireworks of all kinds. Camping on the Cam-Plex site is second to none with very modern facilities and 1761 campsites on the grounds with over 800 RV sites. You can easily walk to every convention event and activity, all of which are held on the grounds.

Cam-Plex staff have worked overtime with local hotel providers to obtain a block of 430 rooms for PGI members ranging in price from $100 to $129 per night compared with the advertised rates of > $170. Seminars and workshops of all kinds will be presented during convention week as well as a large trade show, vending of consumer fireworks and pyrotechnic supplies to PGI members, pyrobilia collections, they pyro art show, a live auction and more.

Competition in more than 40 categories of pyrotechnic devices and displays occur during the week. For those of you who have seen Aaron Enzer and Ace-Pyro at previous PGI conventions and Western Winter Blast, you are in for a real treat at the Grand Public Display on Friday, August 15 as well as other displays starting on Sunday August 11 and continuing during the week.

Whether pyro is your hobby, your passion, or your first love after your family, or you just love fireworks, you won't want to miss this years event.

You must be a member of PGI to attend. PGI membership deadline to attend the convention is June 1, 2008. Information and links to Cam-Plex, PGI membership applications, seminars and other information are available at www.pgi.org/2008conv.aspx.

- Tom Sklebar

Firing Precision for Choreographed Displays

By K.L. and B.J. Kosanke

An earlier version of this article appeared in Fireworks Business, No. 194, 2000.
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For maximum effectiveness of tightly choreographed fireworks displays, it is important that shell bursts occur very near their intended times. Two main sources of variation combine to affect the overall precision of the shell bursts. First is the preciseness of the shell firings; second is the preciseness of the time fuse burning. Other than by purchasing high quality shells, a display company generally has little control over the precision provided by the shell's time fuse. However, the display company can do much to control the firing precision for those shells. For the most part accurate firings are only possible using electrical ignition. For the purposes of this article, it is assumed that a computer or other means of accurately applying the firing current to electric matches (e-matches) is being used. This leaves the question as to the degree of firing precision achieved using various methods of attaching e-matches to shells and is the subject of this article.

There are three common points of attachment for e-matches. These are illustrated in Figure 1. In terms of convenience, safety and effectiveness (firing time precision), each has its own set of advantages and disadvantages. While issues of safety and convenience are quite important considerations, they are beyond the scope of this article. In terms of firing precision, common knowledge has it that installation of the e-match directly into the lift charge (point 3 in Figure 1) provides the most precise timing; attachment at the end of the shell leader (point 1) provides the worst timing; and attachment to the shell leader just above the body of the shell (point 2) is somewhere in between in terms of effectiveness. However, the authors are unaware of any reported test of this common knowledge. Further, there are those that claim that the precision achieved using attachment point 2 is just as good as using point 3. Accordingly, (and because it made an interesting short project) a series of instrumented shell firings were conducted as a test of these two schools of thought.

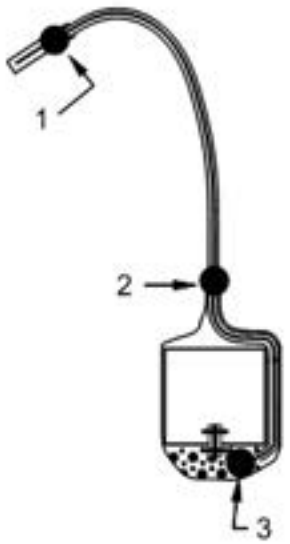

Figure 1. Illustration of the three common points of attachment of e-matches to aerial shells.

All tests were conducted using identical inert 3-inch (75-mm) spherical plastic aerial shells fired from mortars fitted with trip wires at their mouth. Firing times were measured using an instrument that provided the e-match firing current, and at the same instant started a precision timer, which stopped when the trip wire was broken. A series of eight tests were performed for each shell configuration, with the average and standard deviation of the firing times then calculated. To simulate actual field conditions, all test shells were assembled and fitted with e-matches, then placed in an environmental chamber [72 °F (22 °C) and 78% relative humidity] for three days.

In the first series of tests, e-matches were installed at the ends of 24-inch long shell leaders (point 1). Twenty-four tests were performed: eight with shell leaders made using a high quality quick match (from Precocious Pyrotechnics); eight with shell leaders taken from Horse brand shells; and two each with shell leaders taken from Yung Feng, Angel, Flower Basket, and Flying Dragon brand shells. The results are reported in the first three rows of Table 1. The firing times and their standard deviations for the third group of test firings are both rather excessive, due to the occurrence of two short duration hangfires (lasting approximately 2.5 and 1.2 seconds). In an attempt to give this method of e-match attachment the benefit of the doubt, the results were recalculated, this time omitting the two hangfire results. Finally, to approximate what would be expected in a typical display using a variety of different shell brands, all 24 (or 22) firings were considered as a single set, reported in Table 1 as "Combined".

Table 1. Firing Time Results for Various E-Match Attachment Points

Test Conditions	No.[a]	F. Time[b] (sec.)	Std. Dev.[c] (sec.)
Precocious - long	8	0.26	0.15
Horse - long	8	0.32	0.12
Variety - long	8	0.76	0.76
	6[d]	0.41[d]	0.15[d]
Combined - long	24	0.45	0.49
	22[d]	0.32[d]	0.14[d]
Precocious - short	8	0.11	0.025
No Match in lift	8	0.08	0.020
E. Match in lift	8	0.04	0.005

a) Number of individual test firings.
b) Firing time is the average of the eight elapsed times between applying current to the electric matches and the shells exiting from the mortars, rounded to the nearest 10 ms.
c) The one sigma standard deviations of the average firing times were determined using the $n-1$ method.
d) These data are for the same tests but do not include the two short duration hangfires that had occurred.

While the average firing times for the various groups differ somewhat, the precision for each individual group and the collection as a whole are not all that bad, if the two hangfires are not included. (Note that an average firing time of 0.32 second, with a precision of 0.14 second, means that about 70% of the firings will occur between 0.18 and 0.46 second, a range of approximately 0.3 second.) As a point of comparison, humans can fairly easily discern timing differences of 0.1 second, or about 1/3 that seen in these test firings. Accordingly, these tests produced a wider range than would be preferred, even if the time fuses and shell bursts had performed with absolute precision (no variation at all).

For the next group of eight test firings, again Precocious Pyrotechnics' quick match was used; however, this time the length of leader was only about four inches, just enough to reach to near the top of the shells. Another group of shells was fired using e-matches installed on the ends of B & C Products' 24-inch No Match® API shell leaders. (These were shock tube shell leaders.) Finally, there was a group of firings with the e-matches installed directly into the shell's lift charge. These additional results are included as the last three rows in Table 1.

These last three firing methods produced average firing times less than those using the full-length shell leaders. However, more importantly, the timing precision is greatly improved, with each method producing a firing-time precision better than would be perceived by spectators. Thus, although the precision achieved with e-matches installed directly in the lift charges was observed to be better than the short shell leaders (attachment point 2), the improvement would not be detectable by spectators.

In conclusion, it must be considered that this was a single brief series of tests. While the results are probably valid, it is possible that significantly different results would be found for other conditions and materials. Nonetheless, it would seem that both schools of thought about e-match attachment are generally correct. Attachment at the ends of long shell leaders produced the worst firing-time precision, but not terrible—providing actual hangfires were not considered. Installation of e-matches directly into lift charges produced the best precision (lowest standard deviation). However, the firing-time precision for short shell leaders was equally satisfactory, because it is better than could be detected by spectators. No Match® also performed well in these tests but only marginally better than the short quick match.

The authors gratefully acknowledge the assistance of D. Kark for upgrading the firing and timing instrument, B. Ofca for providing the No Match® components, and A. Broca for providing the Daveyfire e-matches used in these tests.

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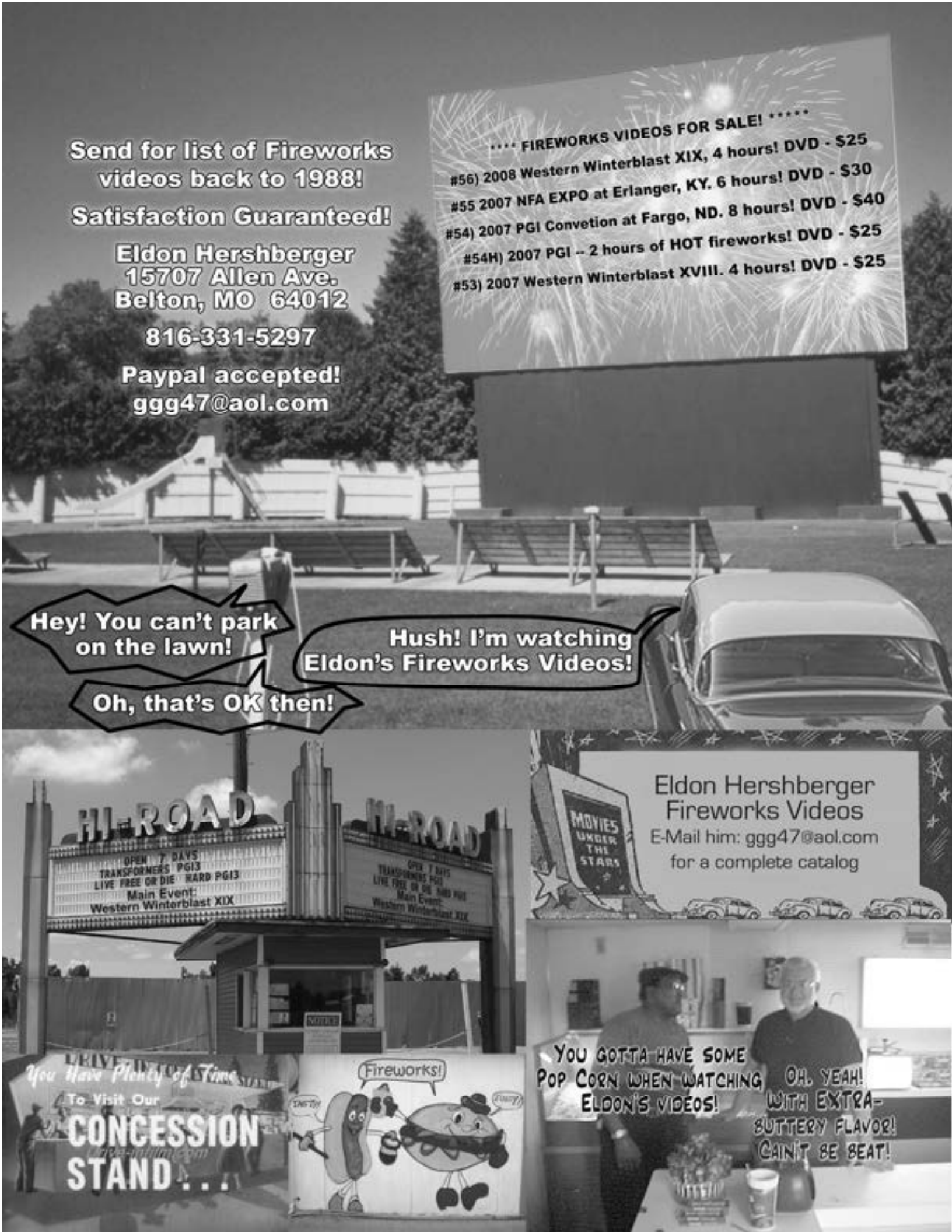
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