

Black Powder

(Seminar by Steve Hubing)

What is Black Powder

- Combination of three chemicals in a 75/10/15 ratio by weight
 - Potassium Nitrate – 75%
 - Sulfur – 10%
 - Charcoal – 15%
- Definitions
 - Scratch mix or Green mix Black Powder
 - Black powder where the chemicals are hand mix together.
 - Pulverone Black Powder
 - Black powder where the chemicals are mixed together by hand then wet with water and granulated.
 - Milled Black Powder
 - Black powder where the chemicals are mixed together then places in a mechanical device to “pound” or grind the chemicals into very small particles that are very well “mixed” together.
 - Pressed and Corned Black Powder
 - Milled black powder that is press into a “puck” to a density of 1.7g/cc then broken up into smaller pieces
 - Commercial Black Powder is made this way.

Chemicals

- Potassium Nitrate (KNO₃)
 - Is the Oxidizer component of Black Powder
 - Of the three common pyrotechnic oxidizers, KNO₃ is the least sensitive
 - Grades
 - Analytical Reagent Grade (very high purity)
 - Laboratory Grade (very high purity, but < analytical)
 - Pharmacy Grade (high purity)
 - Food Grade (> 99%)
 - Technical Grade (99.8% 98.5%)
 - Purity depends on manufacturer
 - Generally the grade that comes from pyrotechnic suppliers
 - Fertilizer Grade (98%-99%)
 - Generally lower purity than other grades but could be better than a low grade technical

- Generally the green house grade (GG) is the best fertilizer grade for pyrotechnics



- Sulfur (S)
 - Serves as a fuel and also lowers the ignition temperature.
 - Two types
 - Flowers of sulfur
 - Generally considered a type of sulfur you should not use in pyrotechnics because of possible acid content.
 - However it works fine in making black powder
 - If used, avoid any use of chlorates with it

- Sulfur flour
 - The type of sulfur best used In making BP
 - Generally the type you will be buying
 - Sources
 - Pyro suppliers
 - Agricultural
 - Animal feed grade
- Charcoal
 - Serves as a fuel
 - Each particle contains microscopic holes and tunnels
 - The type of charcoal you use can dramatically affect the performance of your black powder

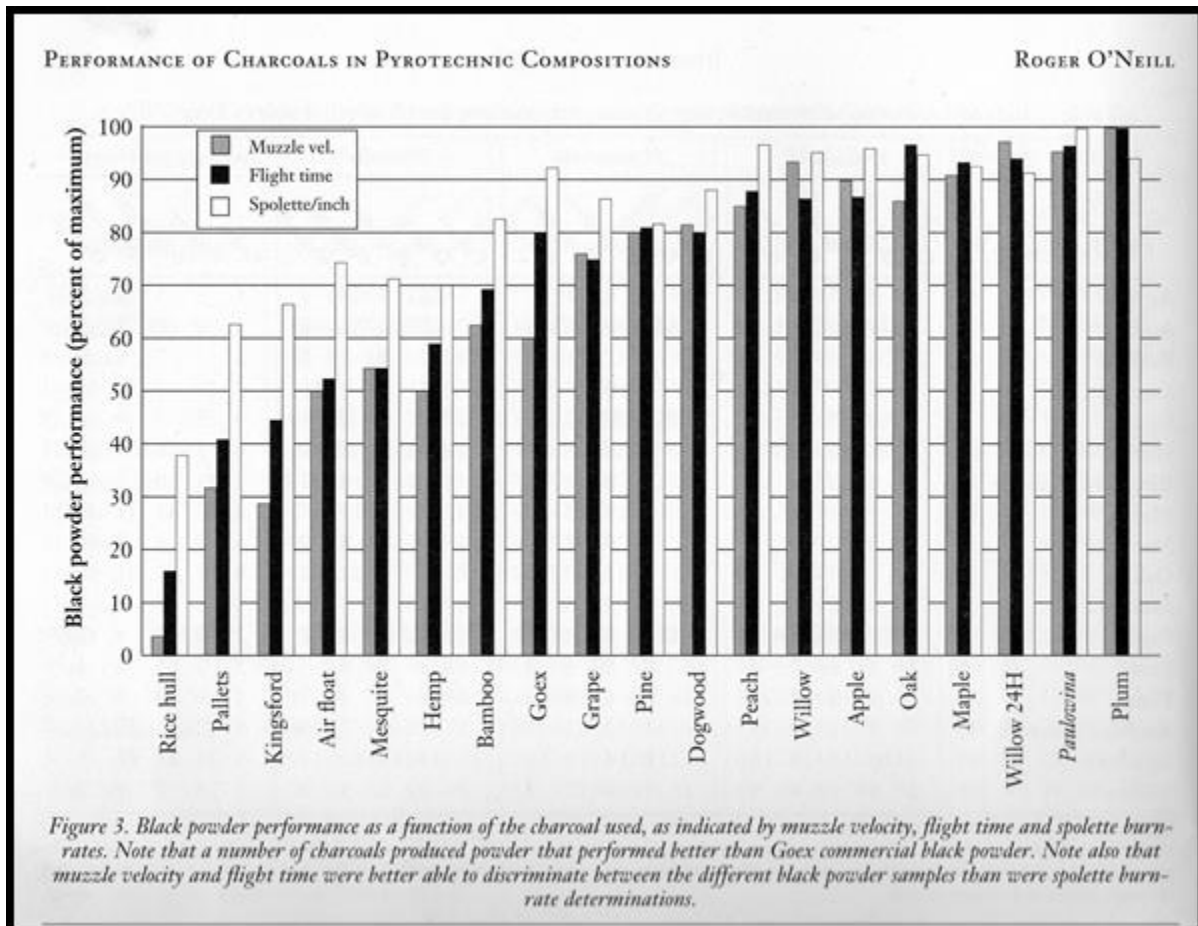


Table courtesy of Ned Gorski (www.fireworking.com)

- Purpose
 - Speed and Power (see above table)
 - Sparks and Fire Dust
 - Pine Charcoals
- Source
 - Pyrotechnic chemical suppliers
 - Generally will get a mixed charcoal, not very suitable for fast black powder
 - Mixed charcoal works good in applications where speed and power is not a concern
 - May find a pyro supplier that will furnish a single species charcoal
 - Home made
 - Best way to obtain single species charcoal for making fast black powder
 - Methods
 - Retort method
 - TLUD (top lite up draft) method



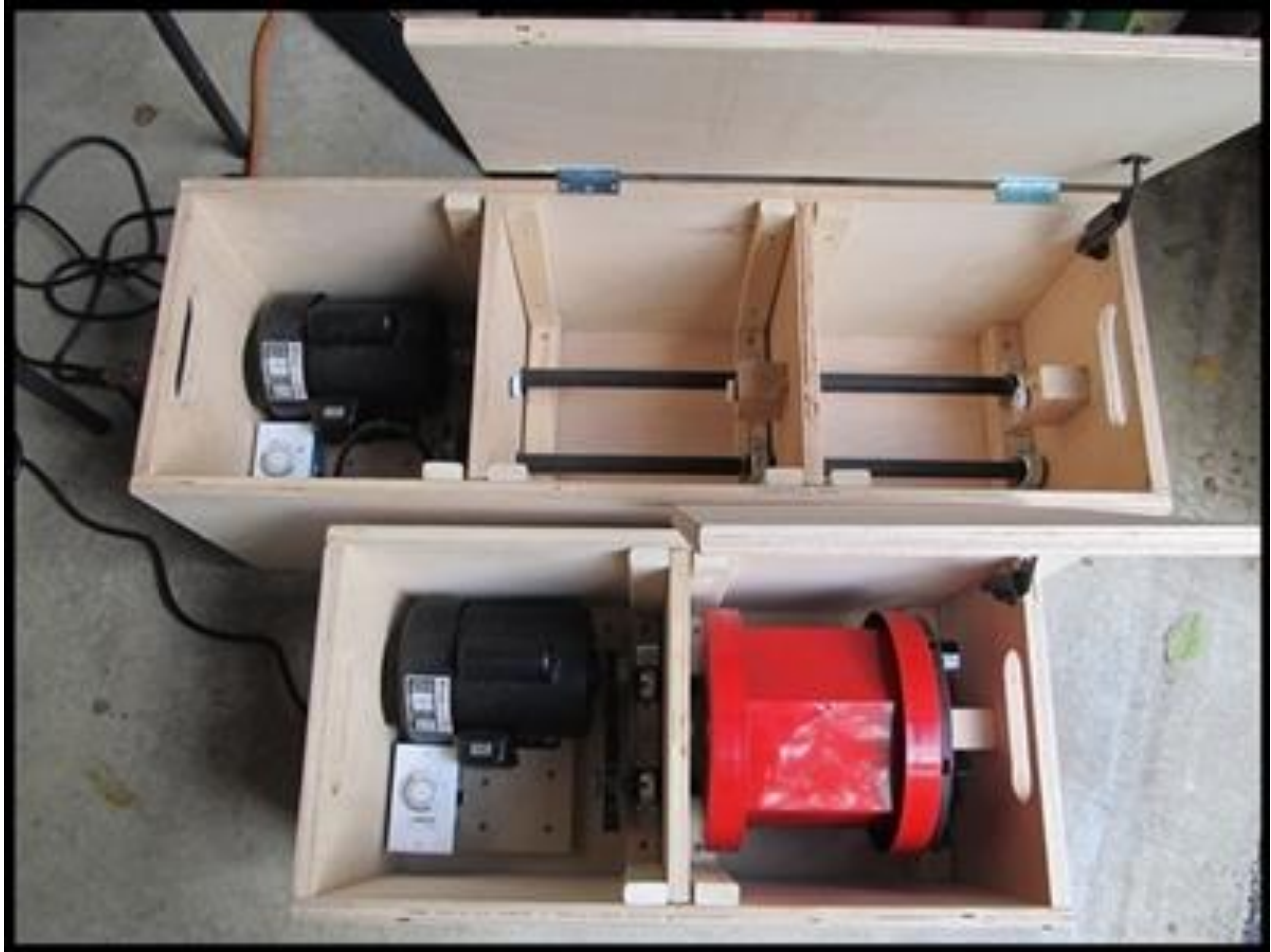
Particle Size

- The particle size of the potassium nitrate, sulfur and charcoal are very important to the performance of the black powder
- The smaller the particle size the better the speed and power of the black powder
- To make black powder with good speed and power you MUST grind the chemicals into a VERY fine powder

Mixing the Chemical

- The three chemicals MUST be mixed together VERY VERY well
- Methods of mixing
 - Hand mixing
 - Is a good start, but hand mixing cannot achieve the intimacy needed to produce good fast black powder
 - Scratch mix or Green mix is made this way
 - Good for primes
 - Wet mixing
 - Adding water (especially hot water) helps with the mixing by partially dissolving the potassium nitrate and allowing to recrystallize in to small crystals
 - Pulverone is made this way
 - CIA (cold isopropyl alcohol) method
 - Has been used with some success for fast BP
 - I do not recommend the use of this method. Too many variables and requires the use of heat.

- Mechanical mixing (pounding it together)
 - Mechanical mixing provides both grinding (reducing particle size and intimate mixing of the chemicals)
 - Actually “pounds” the potassium nitrate into the small holes and tunnels of the charcoal
 - Types of mechanical machines for making BP
 - Wheel mills
 - Used to make commercial black powder
 - Stamp mills
 - Used to make commercial
 - Ball mills
 - Best way for hobbyist to make good fast black powder
 - Easy to build or purchase yourself
 - Can use lead (recommended) or ceramic for milling media
 - Recommend getting Lloyd Sponenberg’s book “Ball Milling Theory and Practice” (\$19.94 at Amazon)
 - Using an efficient ball you can make high quality BP in less than 3 hours
 - For a complete article on how to make a very efficient ball mill join Ned Gorski’s site at www.fireworking.com



Pictures courtesy of Ned Gorski (www.fireworking.com)

15 lb. Capacity Thumlers Tumbler Barrel & Liner - \$85 at <http://www.therockshed.com/tumbler2.html>

Or Contact Jim Biersach – Hobby Horse to see if he can get you one.

Making Good Quality Black Powder

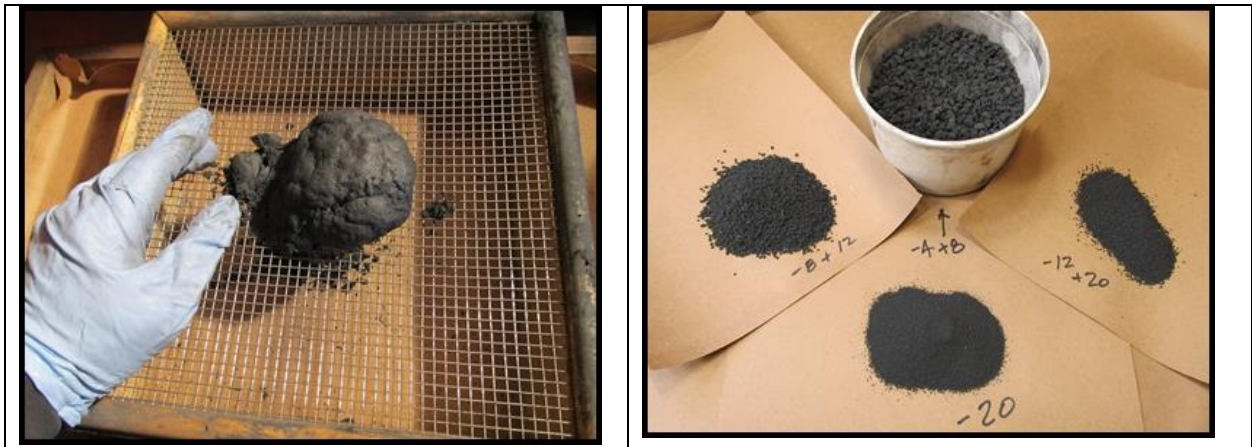
- Start with good chemicals
 - Potassium Nitrate (fertilizer grade works just fine)
 - Best if it's been dried
 - Sulfur (I use cattle food grade from my local feed mill)
 - Charcoal (I use Aspen (poplar), but others use white pine or eastern red cedar)
 - Best if it's been dried
- Use an efficient ball mill with lead media
- Weigh out the chemicals
 - Don't worry about the particle size, I use the periled GG fertilizer grade potassium nitrate, periled sulfur, and charcoal that is ¼ inch chunks or less in size.
- Put the weight chemicals in the ball mill and mill for 2 hours
- Open mill and check for clumping, if no clumping, mill another hour
- If wanted, this would be the time to add dextrin for granulation or rice hull coating.
- After the milling is done, separate the BP from the milling media



- Milling the oxidizer and fuel separately and then screening together is another method. See Chris Szot's article on the WPAG website.

Granulating or Pressing Black Powder

- Granulation of black powder is a process where the black powder (scratch mix or milled) is wetted and then pushed through a screen to make small granules of the powder.
- Granulation is done for several reasons
 - Cleaner to use when pressing (stars, inserts, rockets)
 - Is a way to grade your black powder into different sizes



Pictures courtesy of Ned Gorski (www.fireworking.com)

This chart contains black powder grain sizes of commonly used black powders as well as a comparison of Blasting and Sporting grades.

Black Powder Grades & Equivalent Sizes (in mm)			
Sporting Grades (G)	Grain Size (in mm)	Blasting Grades (A)	Grain Size (in mm)
		1FA	8.0-4.0
Cannon Grade	4.76-1.68	2FA	4.76-1.68
1FG	1.68-1.19	4FA	1.68-.84
2FG	1.19-.59		
3FG	.84-.29	5FA	.84-.297
4FG	.42-.15	7FA	.42-.149
		Meal D	.42
5FG	.149	Fine	.149

Commonly used Black Powder Grain Mesh Sizes

GRADE	MESH RANGE
FA	3 - 5
2FA	4 - 12
3FA	10 - 16
4FA	12 - 20
5FA	20 - 50
6FA	30 - 50
7FA	40 - 100
Meal D	+ 50
Fine Meal	+ 100
X-Fine Meal	+140
Cannon Grade	4-12
1FG	12-20
2FG	16-30
3FG	20-50
4FG	40-100
5FG	+100

- You can granulate with a binder, like dextrin, to make the granules harder
 - Additional 5% is typical but could be more or less
 - Adding a binder will slow down your black powder
 - Not adding a binder will produce soft granules
- You can granulate your black powder with
 - Water only (with or without binder)
 - Denatured Alcohol (without binder)
 - Said to made faster black powder
 - For more information see Ned's site
- Pressing black powder
 - Commercial black powder is pressed under high pressure to form a "puck" with a density of 1.7grams/cubic centimeter
 - Puck is then broken up (corning process) into small granules

- Granules are sized
- Granules are sometimes “polished” by tumbling them and possibly adding graphite.

Testing Black Powder

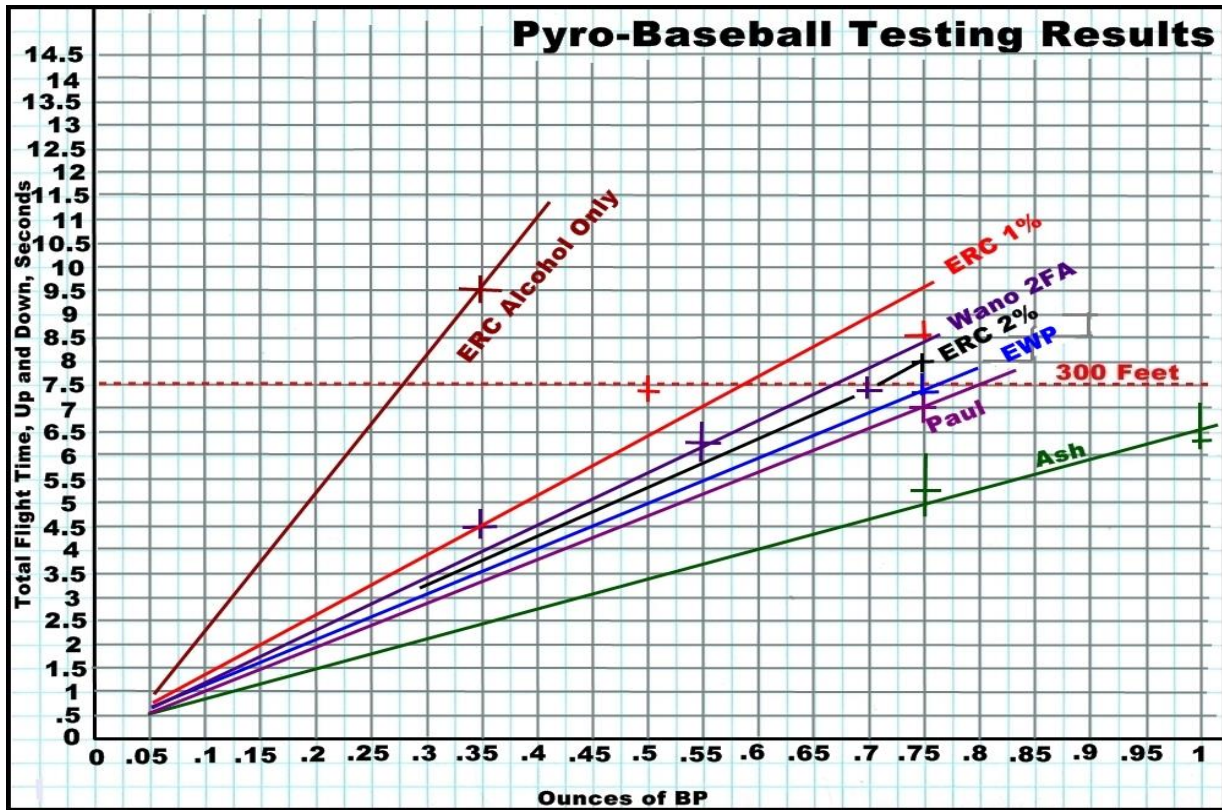
There are several ways to test your black powder and all of them will give you an indication of how fast or powerful your black powder is.

- Baseball testing
 - Using a baseball and 3 inch mortar use a measured amount of your black powder and shoot the baseball from the mortar. Measure the amount of time it takes from lift until it hits the ground



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- Here is a graph of tests done by Ned Gorski (www.fireworking.com) using various charcoals.



- Spolette testing
 - Ram 1 inch of -20 mesh granules from a BP batch in a spolette and time the burn rate with a stopwatch

PERFORMANCE OF CHARCOALS IN PYROTECHNIC COMPOSITIONS ROGER O'NEILL

Table 9. Performance of black powders tested

Powder type	Golf ball launch				Spolettes			
	Flight time (seconds)	% of max.	Muzzle vel. (fps)	% of max.	Seconds per 10 g	% of max.	Seconds per inch	% of max.
Rice hull	1.18 ± 0.085	15.4	13.5 ± 1.5	3.9	13.84 ± 0.20	38.1	5.53 ± 0.12	38.3
Pallets	3.14 ± 0.447	41.1	112 ± 8.1	32.5	8.48 ± 0.09	62.1	3.37 ± 0.06	62.9
Kings, briquettes	3.32 ± 0.599	43.5	101 ± 19.0	29.3	7.63 ± 0.23	69.1	3.19 ± 0.07	66.5
Air float	4.02 ± 0.524	52.6	172 ± 9.6	49.9	7.16 ± 0.03	73.6	2.87 ± 0.10	73.9
Mesquite	4.12 ± 0.417	53.9	188 ± 17.3	54.5	7.47 ± 0.05	70.5	2.99 ± 0.05	70.9
Hemp	4.54 ± 0.179	59.4	173 ± 9.9	50.1	7.43 ± 0.03	70.9	3.02 ± 0.02	70.2
Bamboo	5.30 ± 0.078	69.4	220 ± 6.2	63.8	6.32 ± 0.04	83.4	2.56 ± 0.01	82.8
Grape	5.73 ± 0.520	75.0	262 ± 8.8	75.9	6.10 ± 0.04	86.4	2.45 ± 0.03	86.5
Goex	6.14 ± 0.732	80.4	208 ± 19.3	60.3	5.69 ± 0.04	92.6	2.31 ± 0.10	91.8
Dogwood	6.18 ± 0.439	80.9	282 ± 19.8	81.7	5.97 ± 0.06	88.3	2.40 ± 0.03	88.3
Pine	6.20 ± 0.630	81.2	279 ± 1.9	80.9	6.23 ± 0.17	84.6	2.60 ± 0.09	81.5
Willow	6.66 ± 0.710	87.1	320 ± 16.4	92.8	5.42 ± 0.17	97.2	2.25 ± 0.06	94.2
Apple	6.67 ± 0.341	87.3	311 ± 12.2	90.1	5.36 ± 0.21	98.3	2.23 ± 0.05	95.1
Peach	6.78 ± 0.539	88.7	295 ± 13.9	85.5	5.51 ± 0.04	95.6	2.19 ± 0.02	96.8
Maple	7.14 ± 0.810	93.5	313 ± 27.5	90.7	5.64 ± 0.04	93.4	2.29 ± 0.03	92.6
Willow 24H	7.17 ± 0.388	93.8	334 ± 8.0	96.8	5.64 ± 0.01	93.4	2.31 ± 0.05	91.8
Oak	7.33 ± 0.659	95.9	299 ± 12.2	86.7	5.62 ± 0.03	93.8	2.27 ± 0.06	93.4
<i>Paulownia</i>	7.34 ± 0.744	96.1	328 ± 5.0	95.1	5.27 ± 0.03	100.0	2.12 ± 0.01	100.0
Plum	7.64 ± 0.705	100.0	345 ± 12.5	100.0	5.36 ± 0.18	98.3	2.23 ± 0.04	95.1

Four indices of black powder performance; golf ball flight time, golf ball muzzle velocity, and spolette burn-time per 10 g and per inch of rammed composition, are given. Actual values in seconds or feet per second (fps) are shown, along with percent rankings relative to the best performing material for each indicator of performance.

These are the results of testing 1" spolettes, using the powders Ned Gorski made with various charcoals and dextrin content.

- #1, White Ash charcoal, 2% dextrin, cold water: 3.41 seconds/inch
- #2, Eastern White Pine charcoal, 2% dextrin, cold water: 2.7 seconds/inch
- #3, Paulownia charcoal, 2% dextrin, cold water: 2.69 seconds/inch
- #4, Eastern Red Cedar charcoal, 2% dextrin, cold water: 2.56 seconds/inch
- #5, Eastern Red Cedar charcoal, 1% dextrin, cold water: 2.4 seconds/inch
- #6, Eastern Red Cedar charcoal, 1% dextrin, hot water: 2.4 seconds/inch

Pyrotechnic Uses of Black Powder

- Black powder is the backbone of fireworks and is used extensively in the manufacture of fireworks.
- Uses include but are not limited to:
 - Lifting shells
 - Generally done with commercial black powder
 - Can be done with homemade black powder
 - Must be tested and calibrated with each batch
 - Can be granulated or coated on rice hulls
 - Maltese lift system uses homemade BP
 - Shell Burst
 - Generally done with black powder coated on
 - Rice hulls
 - Cotton seed
 - Cork
 - Puffed rice
 - Can be done with granulated homemade black powder
 - Usually done in cylinder shells.
 - Shell Filler
 - Typically cylinder shells use granulated, non-milled, black powder (Pulverone) as filler in the breaks.
 - Filler between inserts and shell wall
 - Filler with stars
 - Other areas
 - Making Stars
 - There are many star formulas that start with black powder as a base.
- Making shell inserts

- Shell inserts such as hummers, tourbillions, serpents, farfalle and other inserts often use a good hot black powder as a base.
 - Making Fuse
 - Black Match
 - Quick Match
 - Spollettes
 - Visco
 - Time fuse
 - Making Rockets and drivers
 - Many other uses as well
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- Acknowledgments
 - I want to thank Ned Gorski for all the work he has done to share information about the work he has done with making and testing black powder. And also thank him for allowing me to use many of his pictures and other information in this seminar
 - I encourage you to join Ned's web site at www.fireworking.com
 - As Ned says "Come for the information, stay for the conversation".