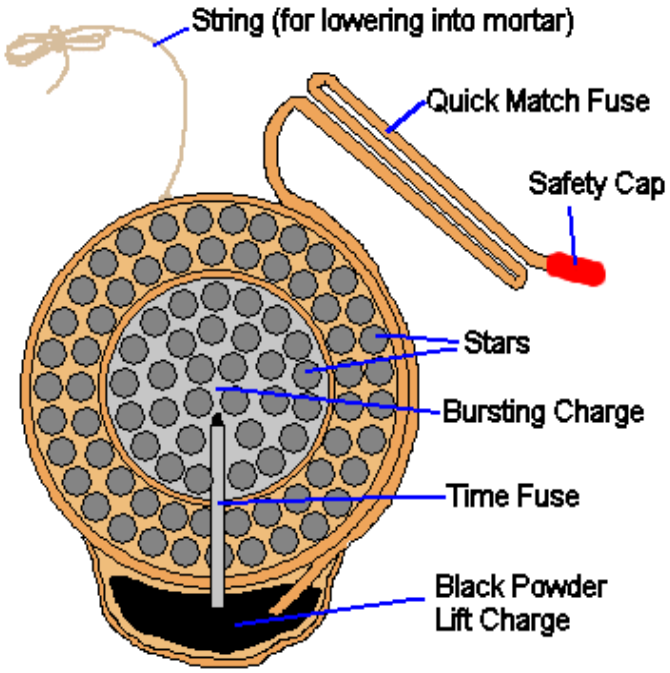
✷The Art Of Fireworks✷.

Spherical Display Shell



June, 2014
Eighth Grade
Project Paper
H. C.C.P.S

Taz Oborne

The silent darkness is all around you. But your surroundings light up when a loud noise followed by a small spear of fire that shoots into the faded blue sky. Suddenly streams of different colored lights shoot out of the path of the spear. The silent darkness engulfs you once more.

In reality, there is no flaming spear, even though it may seem like it. It is just a firework mortar. But that does not mean it is not interesting. A lot of people watch and enjoy firework shows without thinking much of what actually goes on. Me, on the other hand, I could not stop myself from wanting to figure what was going on inside the firework. How does it fly? How do they make the different colors? How do they even put this stuff together? If you have ever asked yourself any questions about fireworks after watching them, then keep reading! If not, then keep reading, because now you get a chance to ask yourself, "*How do fireworks, work?*" That question is what my whole project is based on. More specifically, "How do firework MORTARS work?" Firework mortars have a charge that shoots it into the air. There is fuse inside that gets lit when the charge goes off. The fuse then lights a second charge that shoots out flaming balls into the air.

To start this paper, I will review some history of fireworks. Then, I will analyze the different types of fireworks and what their uses are. Next, I will look into important tips about safety. For the third section, I will explain about the main firework that I am studying: the firework mortar. Then, last but not least, I will sum up all that I wrote about fireworks, specifically mortars.

Fireworks have been around for along time, in fact, they even had a couple of types of fireworks in the seventh century. Fireworks were used for celebrations, just like how we use them today (most of the time). Many people bought fireworks, and there were even firework shows! Fireworks really gained popularity in the 17th century.

There are very many different types/brands of fireworks, so listing the specifications on all of them would be practically impossible. I will describe the fireworks that are the most popular.

Firework mortars are fairly simple. All they consist of is a stationary tube with a small ball filled with different powders on top of a lifting charge. It is like a bullet. The shell is the tube, the bullet is the ball, and the charge, well, is the charge! When the fuse ignites the lifting charge, it goes off. It propels the ball high into the sky. Then finally, it explodes.

Rockets are very simple; they just have a small cylinder body that is packed with highly flammable powders, and sealed off on one side. So therefore when the powder ignites, all the force is pushing on the side that was not sealed, which shoots the rocket forward until the flammable powder is burned off.

Roman candles are like a mix of a firework mortar and a rocket. They have a sealed tube only open on one side. They also have flammable balls, also known as stars. Inside, the stars shoot out once they have been lit. Roman candles on average have as few as five stars, but there are also bigger ones that can have as many as 120, sometimes even more! The stars that shoot out of the roman candle are almost the same things that one might see shoot out of a mortar when it explodes with colors.

Fire crackers are some of the more dangerous fireworks. They are basically mini bombs. This yet again like the rocket. It has a small tube that holds the powders but is sealed on *both* ends. This causes it to explode, because there is nowhere for the pressure to escape. It pushes out until it breaks through, causing a loud noise.

Fountains are one of the most simple fireworks ever. A fountain is a container filled with slower burning powders that cause a lot of sparks and colors. More complex

fountains can, however, be made for special occasions. The more complex ones can actually have mortars in them that shoot out during the show.

I have gone over the basics on some fireworks, so now, I am going to explain a little bit about safety. This is very, VERY important; as in *one could die* important. Anyone who is lighting fireworks should always follow the instructions. It can save their life. For example, holding fireworks in ones hand, or having them anywhere on ones body, is very dangerous. The only time one should do that is if it is something like a sparkler or a popper. Only hold them if the instructions say to! Never ever let kids play with fireworks. Always have an adult present when there are fireworks going off. Modifying or building fireworks is a horrible idea, even though it might seem fun. 90 percent of the firework deaths in America are caused by people making their own fireworks. Another issue is legal problems. Most states do not allow fireworks. If you are reading this today, in Massachusetts, then it is probably illegal to possess fireworks where you live. So I am warning everyone that does live in a firework forbidden state: Do not "YOLO" it. One could get fined 100 dollars for each firework they were caught with!

Another problem with fireworks is injuries. There are on average, 9,300 firework related injuries and four firework related deaths per year in the USA (though four deaths per year IS impressively low). A good way to stop firework injuries is safety gear. It may sound stupid, but it can save a life. Just some simple plastic glasses can save ones vision from permanent damage. Earplugs can save one hearing. And if one was the one lighting the actual firework, then if they should wear even thin gloves, the gloves could help them keep all of there. fingers if it misfires or malfunctions.

The last safety issue is about environmental safety. Fireworks can destroy nature. The flame could burn

something down, and even the chemicals used in the fireworks might have a bad effect on the environment. Always make sure to not set off fireworks near other flammable objects or substances. But luckily for the environment, the chemicals in fireworks have come a long way. They used to be made out of ARSENIC!

My project is about fireworks, specifically firework mortars. I am narrowing it down to these because they interest me the most. Also, fireworks can be very complex. The timing, color, size, shape, sound, speed, and other variables can be changed.

Timing is extremely important with firework mortars. Timing is what keeps the firework from not exploding in the tube but instead exploding in the air. The timing is done with fuses. One can use slow burn or fast burn fuses. Slow burn fuses can take three seconds to burn an inch of fuse. Fast burn fuse can take three seconds to burn ten inches of fuse. The difference is not that hard to tell. With mortars, one would typically start off by lighting a fast burn fuse, which burns down to the lifting charge (The black powder). When the black powder ignites, it also lights a slow burn fuse. The slow burn fuse takes its time getting to the actual explosion that happens in the air. It makes its way into the middle of the firework shell, where another bursting charge is found surrounded by firework stars. When the bursting charge is lit, it shoots the stars everywhere. That leads us into the third variable, color.

The color of a firework totally depends on what one would put inside of it. Many different chemicals burn different colors, causing amazing effects. Mixing them together can have an even cooler outcome. Sometimes one might see a stream of color that changes colors. This is caused by layering. It will be layered with something that burns red, then something that burns blue, then something that burns yellow, causing a rainbow effect. The table below lists some chemicals and what they do when they are

burned.

RED	Lithium chloride.	Strontium chloride.
ORANGE	Sodium borate.	Calcium chloride.
YELLOW	Sodium chloride.	NA
GREEN	Cupric sulfate.	NA
BLUE	Cupric chloride.	NA
PURPLE	Potassium chloride.	NA

Size just changes how big or small the explosion is. But what causes it to be that big or small? A bigger bursting charge of course. But that means one would need a bigger shell. Which means one would need more lifting charge. Then, if everything else is bigger, one would need more stars! But if all of the stars, bursting charge, shell, and lifting charge, then one will also need a bigger tube. All in all, the bigger, the better and more expensive. To sum up what I just said, for a bigger explosion, one would need to make everything larger by the same ratio. If someone would want a ten percent bigger explosion? That someone would need ten percent more charges and ten percent more stars.

The normal shape for a firework mortar is a round explosions: Spheres. But firework mortars can come in a few different shapes. Firework manufacturers have actually made rainbows and smiley faces firework mortars! It may seem impossible but the answer is quite simple. Whatever shape one would want the stars to explode in, that is the shape or formation one would load the stars in. That is another reason why round mortars are the most common, because they are the easiest to make.

The sound variable does not really apply to firework mortars much, but more to rockets. I am not referring

about the explosion noise, I am referring about the whistle noise that rockets make sometimes. All it is, is they shape the tip like a whistle so when the wind blows into it, it makes a whistle noise.

The speed of a mortar can be adjusted a few ways. One way is changing how much black powder is put into the lifting charge. That will cause more pressure and send it higher. The other way also makes more pressure. Making the tube tighter. This can make it go really high or hardly move at all. If the tube is too tight, the mortar will not move, then, explode in the tube.

After the fuse is lit on a firework mortar, it burns down to the lifting charge. When the lifting charge goes off, it does two things: First, it shoots the shell high in the air, and second, it lights a timed fuse. After a few seconds, the timed fuse hits the bursting charge (Black powder). When the bursting charge is ignited, it also ignites all the stars inside. And because the bursting charge is sealed airtight, it explodes shooting the stars everywhere. Causing the ball of colors one could see in the air after the firework mortar is shot.

Manufacturing fireworks is a dangerous job, but it has to be done if people want fireworks. Alot of firework facturing today is done by robots. But there are still places that do it by hand. Fireworks that are done by hand are typically more expensive, but they are also better made than ones by robots. Making fireworks by hand is also more dangerous. There is a lot more potential for harm or even death.

To sum up what I wrote, I explained exactly what happens when when the small fuse is lit on a firework mortar. I also explained the exact chemicals one would need to make different colors of flame. So when the color of the

flame is red, it shows that the chemical that is being burned is strontium chloride or lithium chloride. I also explained all of these fancy words like "lifting charge," or "firework stars". Now, I am not assuming that one will need this skill later in life, but maybe, one will become a famous firework show-maker all because of this paper.

Alabama - Allows some or all types of consumer fireworks.

Alaska - Allows some or all types of consumer fireworks.

Arizona - Allows only novelty fireworks.

Arkansas - Allows some or all types of consumer fireworks.

California - Allows some or all types of consumer fireworks.

Colorado - Allows some or all types of consumer fireworks.

Connecticut - Allows some or all types of consumer fireworks.

Delaware - Bans all consumer fireworks.

District of Columbia - Allows some or all types of consumer fireworks.

Florida - Allows some or all types of consumer fireworks.

Georgia - Allows some or all types of consumer fireworks.

Hawaii - Allows some or all types of consumer fireworks.

Idaho - Allows some or all types of consumer fireworks.

Illinois - Allows only sparklers and/or other novelties.

Indiana - Allows some or all types of consumer fireworks.

Iowa - Allows only sparklers and/or other novelties.

Kansas - Allows some or all types of consumer fireworks.

Kentucky - Allows some or all types of consumer fireworks.

Louisiana - Allows some or all types of consumer fireworks.

Maine - Allows only sparklers and/or other novelties.

Maryland - Allows some or all types of consumer fireworks.

Massachusetts - Bans all consumer fireworks.

Michigan - Allows some or all types of consumer fireworks.

Minnesota - Allows some or all types of consumer fireworks.

Mississippi - Allows some or all types of consumer fireworks.

Missouri - Allows some or all types of consumer fireworks.

Montana - Allows some or all types of consumer fireworks.

Nebraska - Allows some or all types of consumer fireworks.

Nevada - Allows some or all types of consumer fireworks.

New Hampshire - Allows some or all types of consumer fireworks.

New Jersey - Bans all consumer fireworks.

New Mexico - Allows some or all types of consumer fireworks.

New York - Bans all consumer fireworks.

North Carolina - Allows some or all types of consumer fireworks.

North Dakota - Allows some or all types of consumer fireworks.

Ohio - Allows only sparklers and/or other novelties.

Oklahoma - Allows some or all types of consumer fireworks.

Oregon - Allows some or all types of consumer fireworks.

Pennsylvania - Allows some or all types of consumer fireworks.

Puerto Rico - Allows some or all types of consumer fireworks.

Rhode Island - Allows some or all types of consumer fireworks.

South Carolina - Allows some or all types of consumer fireworks.

South Dakota - Allows some or all types of consumer fireworks.

Tennessee - Allows some or all types of consumer fireworks.

Texas - Allows some or all types of consumer fireworks.

Utah - Allows some or all types of consumer fireworks.

Vermont - Allows only sparklers and/or other novelties.

Virginia - Allows some or all types of consumer fireworks.

Washington - Allows some or all types of consumer fireworks.

West Virginia - Allows some or all types of consumer fireworks.

Wisconsin - Allows some or all types of consumer fireworks.

Wyoming - Allows some or all types of consumer fireworks.

OWorks Cited

"Firecrackers"
http://topnews.net.nz/images/firecrackers.jpg

"Firework injuries chart"
http://www.cpsc.gov/global/image/safety/hl4ha/info/fireworks/halkvn34stuff9jpg/6904x1356.jpg

"Firework interview."
North hampton firework chief gavin in interview

"fountains"
http://fc07.deviantart.net/fs71/i/2010/362/2/3/gold_fountain_firework_by_twilightxdream-d35vz7d.jpg

"Mortars"
http://www.cambridgefireworks.com/wp-content/gallery/types/shells.jpg

"Rocket time lapse"
http://humour.amulyam.com/images/humour/medium/1210/100240.jpg

"Roman candle"
http://ryan-doherty.com/wp-content/uploads/2014/02/Roman-Candle.jpg

"Timeline"
http://www.timetoast.com/timelines/history-of-fireworks--3

Tu, Youngling. "2012 Fireworks Annual Report Fireworks-Related Deaths, Emergency Department-Treated Injuries, and Enforcement Activities During 2012." *2012 Fireworks Annual Report Fireworks-Related Deaths, Emergency Department-Treated Injuries, and Enforcement Activities During 2012*. N.p., n.d. Web.