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Wax Dipped Crossettes

Figure 1: Inserting Chinese paper fuses into the crossette cavity ignition hole.

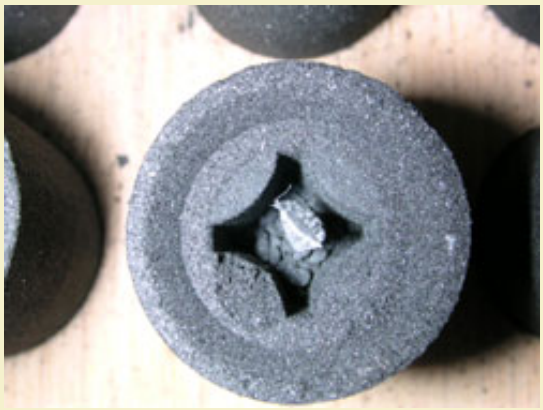

Figure 2: Crossette cavity filled half way with 2Fg.

Introduction:
Crossettes are among the more technically challenging articles to manufacture in pyrotechnics, especially in the smaller sizes. A shell that throws out a good many crossettes that all break at the same time into nice symmetrical patterns is an impressive sight that is worth the effort however, and the ability to produce such a shell will always earn you respect among your pyro peers. Such a feat displays both consistency in manufacture between hundreds of pieces, control over many variables and the patience of a saint!

Traditional crossettes are pasted in with an outer layer of thin paper, which prevents anything other than the end of the crossette from taking fire from the burst charge. This paper also adds extra confinement so that the crossette will break with more force. For more information on traditional crossette construction, click here.

The pasting of crossettes is among the more time consuming steps, and as a method of creating a fire block it is not without potential problems. A paste wrap can sometimes have wrinkles that run down the side if it is not applied perfectly flat, and these air channels allow fire to race up the side of the crossette. Paste wrap flaws and wrinkles are the most common cause of crossettes that break early, since the fire jumps ahead and reaches the burst cavity ahead of schedule.

A faster and more reliable method of fire protection is to dip the finished crossettes into a fire proof liquid that quickly dries and adheres to the surface of the crossette. This is often how commercial crossettes are manufactured in modern times, as the time savings can be considerable. There are several choices of material to dip the crossettes in, including wax, plastic, shellac and even the liquid rubber tool dip sold for coating tool handles. Wax is the cheapest, fastest drying and most readily available material, so that is what we will be using here in this article.

Crossette Construction
In order to get good performance out of a crossette that does not have a paste wrap, the crossette itself must stand on its own in terms of providing enough confinement. This means that the crossette must be very rigid with a strong seal on the end plug that covers the break cavity. If you can crush your crossettes between your fingers after drying them, then they will not work with the wax dip method. You should not be able to easily snap the crossette in half by hand or cave in the burst cavity by squeezing them between

Figure 3: Filling the remainder of the crossette cavity with flash.

Figure 4: Using hot glue to plug the top of the crossette cavity.

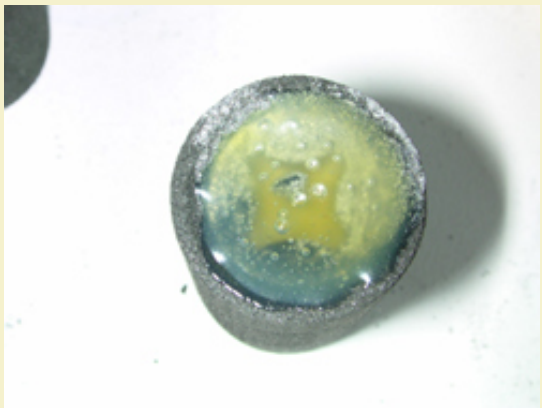

Figure 5: Close-up of hot glue plug.

your fingers. Because charcoal crossettes with high percentages of charcoal are among the weakest types, this was the type chosen to produce for this article in order to show that even the worst-case example can still be used with the wax dip method.

The primary key to making good strong crossettes is to use a solution containing gum arabic when pumping them. Simply dissolve 30 grams of gum arabic per one quart of water and use this to dampen the composition prior to pumping the crossettes. The dextrin component of the crossette formula is still added for extra binding, but relying on just the dextrin for binding the dry crossette will give inferior results. The crossettes made here are Shimizu's Tiger Tail formula using yellow pine for the charcoal, which are bound using 15% of the gum arabic solution.

The second factor to insure strong crossettes is to pump them with enough force to create a dense grain. The crossettes shown here were pumped with a 2 ton arbor press. They should not be pressed so hard that it takes a lot of force to push them out of the pressing sleeve, but they should not slide out easily either. Even properly pressed charcoal crossettes will still be fragile when they are wet, requiring great care when pulling them off the end of your rammer, but they will dry quite hard due to the gum arabic binder.

Most crossette rammers have a small pin at the tip that produces an ignition hole in the bottom of the burst cavity. The purpose of this hole is to allow fire to get into the burst cavity before the bottom of the cavity completely burns away, thus allowing some additional confinement. However, just the cavity alone is not usually enough to insure that the crossette breaks before the cavity bottom burns away. A more reliable method is to insert a small diameter fuse into this cavity so that rapid fire transfer is insured. Some people use thermolite or small diameter visco for this fuse, but I find that the best results are obtained by making a fast burning Chinese type of paper fuse using fine-grained corning dust as the fuse powder. The method of rolling this simple type of fuse can be found here. Figure 1 shows how segments are trimmed from a longer length of fuse to fit each crossette.

The next factor in producing wax dipped crossettes is the break charge. Breaking a dipped crossette is a little like breaking a plastic shell compared with a paper shell-- meaning that a stronger break charge must be used. For the 3/4" crossettes shown here, which were made with Rich Wolter's crossette pump, a burst charge of 50% 2Fg black powder grains and 50% 70-30 flash made with American dark aluminum is used. The black powder grains are an important element that increases ignitability, eliminates the "jetting" problem, regulates burst strength and eliminates the white flash that a flash-only break charge would produce. Anyone who has ever seen charcoal crossettes break with a bright white flash of light knows how annoying this defect is, so don't identify yourself as a crossette rookie by making flashing charcoal crossettes.

For those that corn your own home-made black powder, getting the small 2Fa grains is no problem. If you don't make your own grain powder, then you could try granulating some 20% dampened meal through a window screen and using those grains as a substitute.

Figure 6: A portable mini-stove for heating the wax.

Figure 7: Dipping station includes wax pot, fan and screen.

Figure 8: Thin needle nose pliers bent at the tip for holding crossettes while dipping.

Figure 2 shows the burst cavity half filled with the small grains of home-made 2Fg black powder. A tool for loading the BP into many crossettes at once is described here.

The final trick to producing a strong crossette is to eliminate the traditional end disk altogether and just fill the top of each burst cavity with a solid plug of hot glue. Hot glue provides a superior plug compared with the traditional method of gluing a cardboard disk over top of the hole, and is also faster. Not all hot glue will work for this application though, so it is important to get the right kind. There is a yellow colored type of glue used for sealing cardboard boxes that bonds very well to almost anything and dries rapidly. The rapid dry time helps reduce the problem of air bubbles forming in the glue as the heated air in the burst cavity tries to escape. Slower drying glue will allow these bubbles to form and potentially breach the plugs integrity. Two varieties of fast-set packing glue can be found at PyroSupplies which will work well for crossette end plugs.

The hot glue plug not only adheres to the crossette better than a traditional end disk, it also flows into the top of the burst cavity and provides a bulkhead to help withstand crushing forces from the outside-- something an end disk can't do. Figure 5 shows a completed crossette with the glue plug. If you want to see just how strong these plugs grip the crossette, just try and pry that puppy off! Sometimes the paper fuse may stick up out of the glue, in which case you will need to add another drop on top of it to prevent it from igniting and spoiling your crossette. Care should also be taken to make sure there are no gaps around the edges of the plug that could allow fire to sneak in under the glue.

You may have anxiety about shooting hot glue directly on top of flash, which is not really as risky as you would think. Flash actually has a pretty high ignition point and is not easy to set off even when you are trying to ignite it sometimes! However, the charcoal in your crossette and the paper of the fuse inside the break charge have a lower ignition point so a low temperature glue gun should be used. A low temperature gun will also help the plugs dry faster and reduce the air bubble problem as well. The ignition point of paper is around 450 deg. F, so you want to stay well below that. The filling operation should also be done outdoors, away from any other pyrotechnic materials, while wearing shaded UV eye protection just to be safe.

Dipping the Crossette

The trick to making wax dipped crossettes is in making the crossette themselves. The dipping is the easy part! Paraffin can be found sold in large blocks in many craft stores for the purpose of making candles. This can be heated in a stainless bowl on top of a portable mini-stove as seen in Figure 6. The temperature of the heated wax is a critical factor that will control both the thickness of your wax coating as well as how far into the crossette the wax will penetrate. If the wax is too hot, it will absorb completely into charcoal crossettes rather than build up on the outside, which will also ruin the spark tail. The desired temperature is around 150 degrees F, which is pretty close to the melting point of the wax. Higher temperatures will result in thinner coatings, while lower temperatures will give thicker coatings. The usable temperature range is pretty narrow however, and fluctuations as small as 5 degrees during the dipping process

Figure 9: Dipping a crossette into the wax.

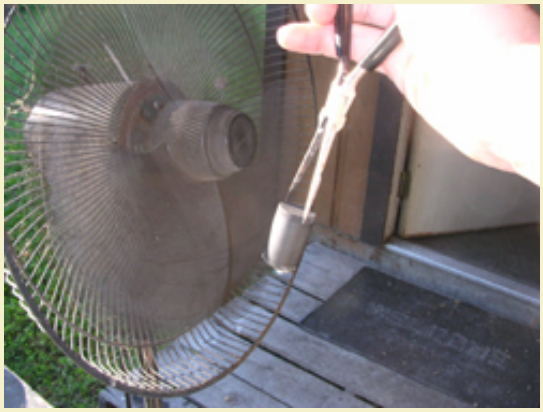

Figure 10: Speed drying the wax in front of a fan.

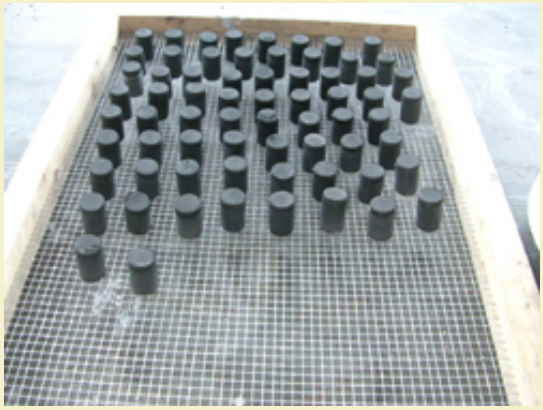

Figure 11: Screen filled with dipped crossettes.

can change the thickness of your coatings.

Figure 7 shows an outdoor dipping station, which consists of the wax bowl, a fan, a drying screen and some pliers for gripping the tip of the crossettes. Since the wax is not hot enough to burn your fingers, you could try gripping the tips by hand to dip them, but the pliers make it easier to control how deep you dip them. The pliers shown in Figure 8 is a small needle nose type where I bent the tips at a slight angle so that they can grip the crossettes better. After dipping hundreds of crossettes, I have yet to accidentally drop one into the wax (knock on wood). Care must be taken not to let any wax get on the ignition surface of the crossette, since that would prevent the prime from sticking and potentially render it useless. I like to dip them to within 1/8" of the top of the crossette, as seen in Figure 9. Also be sure to always dip them with the glue-plug end down!

If the wax is just above the melting point, you can get away with one coating, otherwise you will need two coats. When doing more than one coat, the fan helps to rapidly dry the crossette and blow off any excess drops that form on the bottom after dipping. Since crossettes are often stacked in a shell, you don't want any wax buildup on the bottom that can be formed when dripping wax hardens.

The drying screen helps keep the crossettes from getting stuck to anything while they dry. Be sure to inspect the bottom of each crossette after dipping to insure that no air gaps or holes exist in the wax coating. The walls will always coat without problems, but sometimes the bottoms will have missed spots. For color crossettes this is not much of an issue, since color compositions tend to not take fire without a prime anyway, but charcoal crossettes are very sensitive to ignition, especially around the edges.

Figure 12 shows the finished coating on two crossettes. The one on the left has been correctly coated and the one on the right may not have enough wax to protect against accidental ignition. The most ignition prone area is the edges around the glue plug, so the wax must be thick enough to completely cover this edge.

The wax will not effect the visible performance of the crossettes at all, so long as it was properly applied and did not absorb excessively into the composition. About the only side-effect of the wax I have noticed is that some sparks will burn longer than usual on charcoal crossettes and potentially make it all the way back down to the ground. This is not something that you would see at a distance, but it could be a fire hazard to consider when shooting in a dry area.

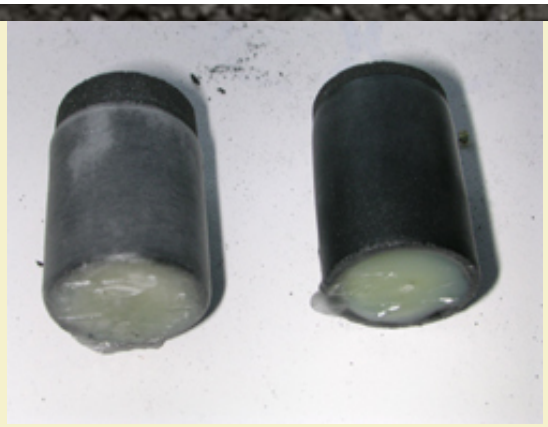

Figure 12: The desired thick coating at left compared with a thinner one that may not protect against accidental side ignition as well.