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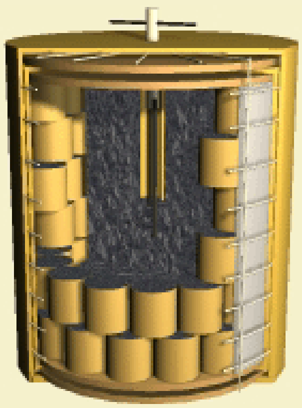
**Build This...**

# 6" Crossette Canister Shell



**Summary:**
Crossettes are among the more tricky effects to master, and this article shows many of the tricks for getting them to work properly. A method is shown for making clean breaking charcoal crossettes without the distracting white flash typical of flash broke crossettes.

The shell itself is constructed using a Maltese-Italian hybrid, showing one of the several ways these two shell building techniques can be combined to lower costs and make construction easier.



**Materials:**

- (1) 10" x 36" long poster board
- (1) 10.5" x 36" long 60lb kraft
- (1) 36" long x cut to width 30lb kraft
- (3) 24" long x cut to width 70lb virgin kraft
- (4) 5.5" dia. 1/8" thick chipboard disks
- (1) 3.5" long spolette tube
- (40) 3/4" dia. chipboard disks
- (40) 2.5" x 8.5" long 30lb kraft

**Tools:**

- Spiking horse
- 1-1/4" crossette pump
- Arbor press or mallet
- Thin metal blade

**Unmeasured Materials:**
chinese fuse or termolite, 4Fg, 2FA, meal powder, flax twine, sawdust, black match, white glue, wheat paste



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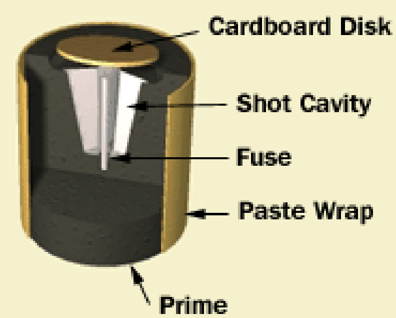


Figure 1: Basic crossette components.

**Introduction:**
Crossettes, also called split comets, are a special breed of comet that split into four pieces midway through their trajectory. Figure 1 shows a cross section of a typical crossette, which reveals an inner cavity where a high-energy break charge is placed. The comet is pasted in on the sides and top so that it can only burn from one end. When the flame front reaches the inner cavity, the burst charge blows the remainder of the comet into four pieces (ideally).

The inner cavity of a crossette is usually a tapered hole with the profile of a four pointed star or square. Although it is possible to make crossettes with a rounded cavity, the weak points caused by a four pointed polygon help insure that the comet breaks into four equal sized pieces. The taper is neccessary to ease the removal of comets from the pump after pressing, where they are fragile and prone to cracking.

Figure 2: Crossette pump and PVC sleeve.

Crossette shells typically suffer from two problems: crossettes that don't break properly and crossettes that don't all break at the same time. The first step in making a crossette shell is to make sure your crossettes break properly through repeated testing from a star gun. The illustration below shows two of the most common crossette failures seen when testing individual crossettes.

**"Jetting"** **Fragmenting** **Perfect**

Figure 3: Star shaped cavity former with pin at tip.

Jetting is the most common problem and can be caused by a number of factors. It most often occurs when testing from a star gun, since the setback from the lift can compact the break charge into one side of the cavity and turn the crossette into an end burning rocket. This is why it is important to test your crossettes from a star gun rather than just placing them on a post or hanging them from a string. Star guns create the actual conditions your crossettes will experience when being thrown from a shell, whereas other methods do not and may lead you to think that your crossettes are working only to find that many of them fail when fired from a shell.

The use of too little or too weak of a break charge can also cause jetting. Since the cavity can not hold much powder, a high strength flash type mix must be used. The types of aluminum used for the flash will effect it's strength, with Indian Blackhead being the strongest, followed by German Black and then American Dark.

Another method some builders prefer is to hand roll small firecracker-like "shots" that fit into the cavity, thus insuring that the charge will have adequate confinement to split the comet apart. I personally find that this method adds too much work to a component that is already a lot of work as it is!

The most common trick to eliminate jetting is the use of a fuse that inserts into a small hole at the bottom of the cavity. Most commercial crossette pumps have a pin at the end of the plunger, as seen in Figure 3, which is designed specifically for this purpose. The flame front will reach the small hole first, allowing ignition of the cavity while there is still some composition left at the bottom to help create containment. The passfire fuse, which runs the full length of the cavity, also helps eliminate the end-burner problem by providing a fire gap through any comp that may otherwise get compacted from setback.

Thermolite is the most common choice of passfire for the small inner fuse, probably because it is one of the few types of fuse that is thin enough to actually fit into the hole. However, Thermolite is quite expensive and is increasingly hard to find. I have not had much luck with thin diameter visco fuse as an alternative, as the burn rate is too slow.

My personal secret is the use of hand rolled Chinese paper fuse made from corning dust. This type of fuse is ideal since it is thin, takes fire easily and is very fast burning. For those of you who don't make black powder, corning dust is the fine grained dust leftover when granulating BP. It ranges in particle size from meal to 60 mesh and burns quite rapidly when made into tissue fuse. Corning dust could also be made from pulverizing commercial BP by hand, or screening dampened meal through a 40-50 mesh screen. The procedure for making Chinese paper fuses can be found here.

The other common crossette defect is an overly hard break that causes many small pieces instead of four large pieces. This is a simple matter of dialing in the strength and amount of break used in the crossette. The paste wrap around the crossette should also not be too thick. Two turns of a light weight 30-40 lb kraft paper is all that is required.

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Figure 4: Pin position when loading comp.

Figure 5: Arbor press used to compress comp.

Figure 6: PVC sleeve used as depth stop.

**Pumping Crossettes:**
The crossettes used in this 6" shell are made using the 1-1/4" Nituff coated crossette pump made by Rich Wolter, which can be purchased from his website. Note that there are no paid product endorsements on Passfire.com. Anything that is recommended on this site is found to be of exceptional quality, and Rich's tools fit that qualification.

The crossettes for this project are traditional charcoal streamer crossettes. The formula used is Shimizu's Tiger Tail streamer. You will need to mix up 1000g of this composition to make the 40 comets required to build the shell. A 1000g batch will also give you a few extra comets to trial and error with before building the shell. I prefer to mix half of the required charcoal with all the other ingredients in a ball mill for one hour, then screening in the remainder of charcoal afterwards. This gives a nice bushy head on the comet while still leaving behind a tail of decent length. You can vary the mesh size of the screened in charcoal to adjust the tail duration as well.

Begin by dampening the 1000g batch of Tiger Tail with 15% of water that has 20% isopropyl alcohol added to it. Note that isopropyl is typically 30% water, so your effective alcohol content is really only 14%. This percentage is not real critical, as the alcohol is only there to break the surface tension of the water (for easier incorporation into the comp) and to speed up drying.

I find the fastest way to get the water completely incorporated into the powder is to work it in a little by hand and then pound it all down into a solid mass in the bottom of the bucket. This allows the water to absorb equally through the solid mass instead of spending all your effort kneading the powder by hand or pushing it through a screen to break up lumps. Allow the mass to sit a few minutes, then scrape it back up and pound it flat one more time. Chip it back up into a loose mix again and you are ready to go.

Comet pumps have a pin on the plunger that is designed as a depth stop. This allows you to pump comets that are of equal length, which is even more important with crossettes. If your crossettes are not all the same length, they will break at staggered times and ruin the effect, not to mention present problems when stacking rows inside the shell casing.

For regular comets, the plunger is pressed until the pin contacts the sleeve, then the plunger is rotated until the pin is above the slot so that the comet can be ejected. Crossettes present a problem, however, since twisting the plunger in this way will carve out the star shaped cavity and defeat its purpose. The pin must be positioned above the slot before pressing the comet in order to avoid this problem.

Since I think the depth stop concept is critical to getting uniform comet lengths, I place the comet pump inside a PVC sleeve that is cut to the same

Figure 7: Composition shaved flush with end of pump after pressing.

length as the comet pump sleeve. This way the pin will hit the PVC sleeve, as seen in Figure 6, and create comets of equal length. If you had an exceptionally slow burning comet mix, you could make the sleeve even shorter in order to shorten the burn time of the comet. This same trick can be applied to regular comets as well.

The comet pump is loaded by holding the rammer such that the pin is at least a half inch above rim of the sleeve, as shown in Figure 4. Holding the pump in this way, simply ram it down into the loose comp several times until it fills up. It is important to make sure the pin stays a consistent height above the sleeve when doing this so that each comet will have roughly the same amount of composition pressed into it.

While a mallet can be used to consolidate these comets, I prefer the use of an arbor press because it is quieter, faster and less physical work. Figure 5 shows a typical arbor press in the 2 ton range. This ratchet type press with the quick-position wheel is highly recommended for it's speed and ease of operation. Because the comet pump is so long, it must be pressed against the table under the press. This requires that the press be firmly clamped to the table to keep from lifting itself during pressing, which is achieved with the bar clamps seen in Figure 5.

Once the comet is pressed and the pin hits the PVC sleeve, the pump is removed and the end is shaved flush with a thin blade as seen in Figure 7. Again, consistent comet length is critical and this last step insures that all comets will be the same length.

Lastly the plunger is pressed until the pin hits the bottom of the U shaped channel, then the comet is gently removed and placed on a screen to dry. Charcoal streamers are slow to dry, so allow at least a week before testing one. It is always good to make an extra one to break apart at various times to check for dryness.

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Figure 8: Tapered 1" conduit used as disk punch.

Figure 9: Punching poster board disks on a wooden block.

Figure 10: Granulated whistle mix.

**Punching End Disks:**
While you can buy thin 3/4" diameter chipboard disks to use for the ends of your crossettes, you can also make your own pretty easily. A standard piece of 1" metal electrical conduit will make the perfect size disks for snugly fitting into the recess on top of a 1-1/4" crossette. Simply use a grinder to bevel the cutting edge of one end, as seen in Figure 8. After you have a nice 45 degree angle around the edge, use a propane torch to heat the conduit until it glows red hot, then immediately submerge it into a bucket of cold water. This will help harden the edge for a longer cutting life.

The disks used for the tops of crossettes do not need to be thick. Simple poster board makes good disks, and you can punch through two or three sheets at a time. I like to use a 4 lb sledge hammer to punch disks over a block of hard maple, as seen in Figure 9.

**Crossette Burst Charges:**
There are several burst charges commonly used in crossettes, most of them involving flash powder of some kind. While standard 70/30 flash can be used to break crossettes, the amount has to be carefully regulated to keep from blowing the crossette to bits. This type of charge also has the disadvantage of creating a bright flash when the crossettes break. If the crossette is made from a bright mix such as silver flitter, then this flash isn't noticeable as much. But for low light charcoal effects, this flash is very distracting and takes away from the quality of the streamer effect.

Several variations of what is called "Dark Flash" exist, which involve the use of chlorate and antimony, with sulfur sometimes added. Chlorate/antimony/sulfur mixtures are very friction sensitive, so these mixtures require the utmost care when mixing. Only small batches of about 30 grams should be mixed at a time.

**Dark Flash Compositions**

| | A | B | B |
|---|---|---|---|
| Potassium chlorate | 1 | 4 | 3 |
| Antimony Sulfide | 1 | 1 | 2 |
| Sulfur | | 1 | 1 |

**Source:** *Pyrotechnica XI*

Use of granulated whistle mix is another way to break a charcoal crossette without creating a bright flash. This will not break the crossette very hard, but it will split the crossette into four pieces when the mixture is granulated correctly. A mixture of 70/30 whistle mix is first dampened to a crumbly consistency with a mixture of water and gum arabic (1 quart of water per 30g gum arabic). This is then passed through a 50 mesh screen and allowed to

Figure 11: Chinese fuse inserted and cut flush with top of cavity.

Figure 12: Cavity filled with whistle mix and glued around rim.

Figure 13: Pasting in crossettes from a stack of pasted strips.

Figure 14: Primed ends dipped in 4Fg insures ignition.

dry. The resulting granulated whistle mix is shown in Figure 10.

Since the whistle mix is not quite as strong as regular 70/30 flash powder, the entire cavity must be filled with the mixture. The finer your granulations are, the stronger the break will be. However, you can not get away with just using ungranulated whistle mix, as it will compact easily and result in jetting. The fast burning center fuse shown in Figure 11 is also important to insure proper operation.

**Finishing the Crossettes:**

For testing purposes, foil tape or masking tape can be used to wrap the crossettes prior to firing from a star gun. This allows a faster trial and error period, since each crossette can be tweaked and fired one at a time without waiting for a pasted wrapper to dry. Simply apply two turns of 2" wide tape around the crossette and fold it over on the top. Make sure there are no gaps under the tape that would allow fire to travel up the side of the comet. Hot glue can be used to glue on the end disk for each trial. You can try different center fuses, different break charges and different amounts of break charge until you get a properly working crossette.

Once your crossettes are dialed in, it is time to mass produce the rest of them. To finish them off using my whistle mix method, first insert a piece of the Chinese fuse and cut it flush with the top of the cavity, as shown in Figure 11. The cavity is now filled with the granulated whistle mix, a bead of white glue is run around the rim and a paper disk placed on top.

Once the glue has completely dried, the comets are pasted in with two turns of 30-40 lb kraft paper. The paper can be virgin or recycled, it doesn't matter. The pasted paper should be as wide as the height of the comet plus it's diameter, and long enough to make two turns around the comet. Figure 14 shows crossettes being pasted in from a stack of pasted paper strips.

Note that some builders simply use the tape method for all their crossettes. I find the tape is actually more work when doing many crossettes, since it has to be smoothed down and is more prone to wrinkles along the sides that will cause timing defects. Some builders avoid wrapping the crossettes altogether and simply dip them in hot wax. This produces a perfect fireproof seal around the sides and top, and is a quick method as well.

Once your crossettes are fully dried, apply a slurry prime over the exposed end and dip the end into a container of 4Fg grain powder. This last step provides a primed surface that takes fire very easily and quickly.

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## 6" Crossette Canister Shell



Figure 15: Tamping sawdust around gaps behind crossettes.

Figure 16: All crossettes loaded into a Maltese style can.

Figure 17: BP on puffed rice break charge filled in around a spolette.

**Constructing the Shell:**
This shell is constructed using a Maltese style can, which is constructed as shown here. The poster board strip is 10" x 36" long, while the 60lb recycled kraft strip is 10.5" x 36" long. These are rolled around a case former that is 5.5" in diameter. This is a single break shell, so the bottom disks will not contain the hole shown in the article linked to above.

Since the traditional Italian method would require six turns of kraft paper around the former, pleating down this amount of paper can be a chore. Not only is the Maltese style can stronger, it is made from cheaper materials (virgin kraft is not required) and is quicker to produce for larger shells.

When many cylindrical inserts are loaded into a canister shell of this type, be they comets, salutes, tourbillions, shells etc., the symmetry of the break is proportional to how solidly these items are loaded into the shell. The shell contents should not be loosely stacked against the walls. Large gaps between the crossettes should be taken up using wedges, and the space behind the crossettes should be rammed with sawdust. After each row is loaded, the sawdust is poured around the edge and tamped down with a dowel rod, as seen in Figure 15. This locks the crossettes into place so that they do not fall out when the shell is inverted to dump out the remaining loose sawdust.

The crossettes are stacked into the shell like a brick wall, using 10 crossettes per ring running four rings tall. Figure 16 shows all four rows of crossettes loaded.

The remaining space left for the break charge is rather large, and using straight commercial black powder would be expensive, heavy and overkill to break this shell. A more effective break charge is the use of home made rough powder, which is made as described here. I prefer the use of puffed rice coated with BP in a 4:1 ratio, which consumes less BP and is a little stronger of a break charge than rough powder. The puffed rice type charge also makes the shell lighter than if it were filled solid with rough powder, thus reducing your lift charge requirements.

A hand rolled spolette is made from a 3.5" wide x 14.5" long file folder paper rolled around a 1/4" former. The technique for doing this is described here. This should produce a rock solid tube with a 1/2" outside diameter. The tube is rammed with enough meal to give a 3.5 second delay, which is a 1-1/4" long charge in my case. You will have to time your own powder to find the exact charge required for your own spolette. Otherwise Chinese time fuse can be substituted for the spolette.

Figure 17 shows the shell prior to closing. A disk is placed over the spolette and the remainder of the can is sliced into tabs and pleated down with glue. Note the white glue around the base of the spolette prior to applying the

Figure 18: Closing the can in the Maltese style.

Figure 19: Can is spiked with flax twine as for an Italian shell.

Figure 20: Pasting an initial 30lb wrap to insure a good gas seal.

Figure 21: Leader to passfire fusing.

second end disk over the pleated tabs.

Now we finish the shell using the Italian method of spiking and pasting. This is done to avoid the more tedious Maltese spiking process, which tends to consume a lot of twine and takes longer to apply. Figure 19 shows the spiked shell finished with 26 verticals of strong Italian flax twine.

One thing to be aware of when using Maltese cans is the gaps that lead into the can from the outside where the tabs were cut. Extra care must be taken to seal the outside of the spiked shell to ensure that lift gases do not get under the paste wrap and enter the shell through these slits at each end of the can. An initial paste wrap of 30lb kraft is used to form a good seal, since the thin paper lays down better and fully conforms around the spiking twine. Make sure this first paste wrap lays tightly around the base of the spolette.

The final paste wrap consists of three 24" long sheets of virgin 70lb kraft, grain short as usual.

Figure 21 shows the passfire connection to the spolette, which is made by baring a few inches of match and tying it over the exposed powder core using several turns of twine. I prefer waxed twine for its strong grip on the spolette, reducing the chances that the match could get torn away from the spolette before it takes fire.

The leader is connected to the passfire by looping exposed match around it and back up into the leader pipe for about four inches. This helps prevent the leader from getting yanked out of the shell when being lowered into the mortar. It also doubles the amount of match present at the connection point, producing a bigger flash of fire to help ignite the match passing over the spolette.

If you used charcoal crossettes and BP coated puffed rice as the break charge, you will only need about 100g of 2FA to lift this shell. Use an ounce of 2FA per pound of shell weight to determine the correct amount of lift for your own shell.