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Tool Tip...

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Crossette Productivity Tools

Figure 1: Removing the stop pin from a traditional 3/4" crossette pump.

Figure 2: Knurled end is sanded down so that it slides easily through a 3/4" I.D. tube.

Introduction:
Crossettes are among the more difficult and time consuming effects to achieve with any degree of reliability. There are many variables that can be hard to control, which can throw off the timing or ruin the effect. The ideal of having hundreds of splitting comets all break into four equal sized pieces at the same exact time is indeed a difficult thing to achieve. Even when you do get the procedure for making good crossettes down, it can be a very time consuming effort when producing shells that contain hundreds of crossettes. This article, which is a companion to the Wax Dipped Crossette article, shows how to build a few handy tools that help eliminate some of the inconsistencies between crossettes as well as make the process go faster.

The two primary areas of failure in crossettes are 1) timing of the split and 2) quality of the split. Timing errors result when the comet splits too early or two late relative to the other comets. Timing errors are most commonly caused by inconsistencies in the amount of composition charged into each crossette, failure of the break charge to take fire at the proper time or wrinkles in the paste wrap that allows fire to jet down the side and short-circuit the normal burn path. Split malfunctions include excess fragmenting into many pieces instead of the desired four, pieces being blown blind, pieces not being spread far enough or complete failure of the crossette to split at all. Splitting failures are generally linked to an improper burst charge or inadequate confinement of the burst charge.

Making a Fill Plate
The first tool presented here is designed to insure that the same amount of composition is used to produce each crossette, thus avoiding timing errors that result from differences in the amount of composition between crossettes of a given batch. This tool also results in faster production compared with the standard method using a traditional crossette pump. The traditional method requires a single sleeve to be rammed into a bucket of damp comp, pressed, and then shaved off to a given length. The problem with this method is that the amount of comp pressed in the sleeve is not the same each time, since there is some randomness in how much the operator loads before pressing. Since the pressure is not typically controlled when pressing crossettes, the density of the comp will not be the same between different pressings due to the difference in the amount of comp being pressed combined with inconsistencies in the pressing force. So even though the crossettes are trimmed to the same size after pressing, there is still the potential for differences in

Figure 3: Sixteen polycarbonate tubes are cut to exactly the same height.

Figure 4: A four by four array of 1" dia. holes drilled in a piece of plastic coated shelving board.

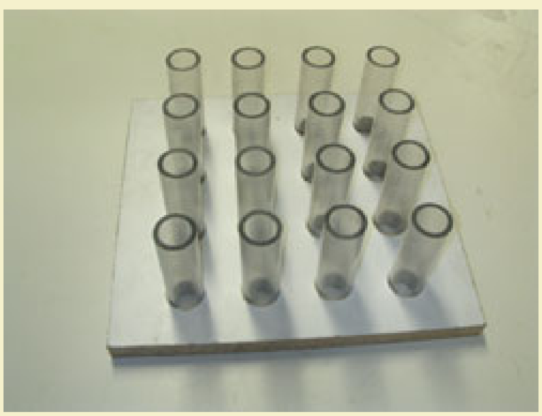

Figure 5: The tubes inserted into the holes should fit snugly.

density that can throw off the timing slightly. From a production standpoint, there is also the extra step of having to trim off the end of the crossette before ejecting it.

The multi-tube fixture described here uses the granulation method to insure that the same amount of comp is being pressed in each crossette. The method is similar to using a large star plate, except that the comets are still pumped one at a time instead of all at once. There is also a productivity gain from loading many pressing sleeves at once, similar to how other items such as rockets or whistles can be produced faster when loading an array of tubes instead of one at a time. The trimming step is eliminated, resulting in faster production and nice flat bottom surfaces on the completed crossettes. Note that this same fixture can also be used to produce regular comets as well.

The crossette pump used here was made by Wolter Pyro Tools and is the square cavity type that leaves a pin hole at the bottom. Cheaper pumps can be found that produce a round cavity, but crossettes made with these don't break into four pieces as reliably.

Standard crossette pumps have a stop-pin drilled into the side, which must be removed as shown in Figure 1. The pin can be clamped in a bench vice and then the rammer is rotated while pulling on it until the pin can be worked out. Wolter's pumps also have a knurled knob at the end, which unfortunately prevents the entire pump from sliding all the way through a 3/4" I.D. tube. The knurl must be sanded down until the point where it will easily slide through the tube as seen in Figure 2.

The tubes used here are polycarbonate hollow rod purchased from McMaster-Carr, part number 8585K35. The polycarbonate is much nicer to work with than acrylic, since it won't crack or chip, and is much stronger as well. While any type of tubing with exactly 3/4" I.D. can be used, the polycarbonate seemed to be cheaper than PVC, Delren or metal tubes. It is also kind of neat to be able to see the composition in the clear tube as you are pressing it! If these tubes are used to press compositions containing titanium then they will most likely get scratched up on the inside. I was concerned that even magnalium might scratch up the tubes, but that does not seem to be a problem. Color and charcoal compositions will of course not be a problem, although acetone bound mixtures can not be used with the plastic tubes.

A tube count of 16 is used so that the jig size is manageable and also so that you don't have so many tubes to clean up afterwards. Larger array sizes would make it increasingly difficult to slide the retainer board from top to bottom of all the tubes after they are loaded, but the four by four array is no problem.

The length of the tubes were determined by experimentation using the most compressible composition I plan to use for crossettes, which is a 50% charcoal streamer type mix. The tube length will control how much delay there is before the crossette breaks, which is a variable the also depends on the size shell any given crossette will be used in. The tubes shown here were cut to 3-5/8" length, although you might want to go to 3-3/4" if you want to make charcoal

Figure 6: An open ended frame to support the board while loading composition.

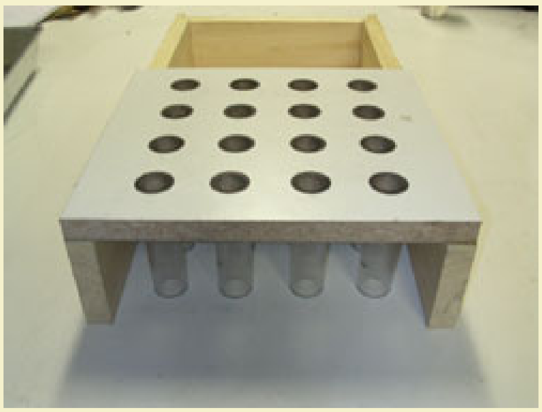

Figure 7: The tube array in place on top of the support frame.

Figure 8: A small nipple is used at the base of the tubes when pressing.

crossettes for six inch shells. The best approach would really be to cut a 4" long tube and then have a set of pin plates with different size nipples that control the fill height inside the tube. Since it is easier and cheaper to make a wooden plate with dowel rods glued into for various crossette types it than it is to cut a set of tubes for each type (especially considering the polycarb tube costs $30 with $24 to ship it).

Next you will need to make a hole plate for holding the tubes. The plate provides a working surface when filling the tubes, after which it is pushed down out of the way so that the tubes can be removed. I used a piece of white plastic coated shelving board commonly available in hardware stores, since it provides a smooth washable surface that won't get stained by damp powder. A set of 1" diameter holes are spaced on 2" centers with a 2" border around the outside of the holes so that composition won't drop off the edge while you are filling them. Figure 4 shows the completed hole plate, while Figure 5 shows the plate with the tubes inserted.

It might be possible to use the jig with just the tubes and the hole plate if the tubes fit snug enough. However, I use a frame for the board to rest on while loading the tubes just in case. Over time the tubes may become looser and the board could slide down during the loading process if there is nothing supporting it from below. The frame height should be cut so that when placed under the hole plate, the edge of the tubes sit flush with the top surface of the hole plate. This will vary depending on your tube length and hole plate thickness, but 3" was the height used for mine. The frame shown in Figure 6 is constructed with one end open so that the frame can be slid out from under the tube assembly after it is loaded. Really this could be simplified to just two pieces of wood used to prop up each side of the frame during loading- it doesn't need to be a whole frame as shown. Originally I was going to attach a platform to the closed section of the frame and build walls around the edges, with the idea being to pile powder on the platform and then drag it across all the tubes as a faster way of filling them. See the crossette loader tool in the next section to get an idea of how that would work.

The last item you will need to finish off this tool is a small nipple to insert the tube onto when pressing the crossettes. Figure 8 shows a scrap of maple with a 3/4" aluminum rod running through it so that only about 1/8" sticks up. The purpose of this nipple is to avoid pressing powder right up to the end of the tube, which will result in powder squeezing out beyond the edges at the bottom of the tube. This powder flange would then need to be trimmed off with a knife, adding an extra step to the process that is easily avoided by just pressing on top of the base shown. Figure 9 shows how the wood was trimmed to allow it to fit into the channel of my particular arbor press.

While you can hand ram the pressing step using a rubber mallet, an arbor press of at least two ton capacity make the pressing go much faster and quieter. An arbor press also makes it easier to regulate the height of the pressed comet, since all you need to do is make a reference mark on the piston bar and press to the mark for each comet.

Figure 9: The base is rounded off to allow it to fit inside the arbor press cavity.

Figure 10: A ratchet type arbor press for easy pulling action.

The arbor press shown in Figure 10 is a ratchet type, which are a little more expensive than the standard ones but worth the extra money. The wheel on the left side is used to bring the rammer down on the work piece quickly, then the lever engages a ratchet so that you are always pulling from a position of maximum leverage. When pressing hundreds of crossettes in one sitting, any little bit of extra comfort can save a lot of time and fatigue.

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Figure 11: Granulating damp composition through a window screen.

Figure 12: Filling tube array with granulated composition.

Using the Fill Plate:
To use the fill plate, you must first granulate your composition into a free-flowing state so that it can be used to fill the tubes. This is done by dampening the composition with the required binder and then pushing it through a window screen as seen in Figure 11. When using plastic tubes to pump the comets in, only water or alcohol solutions can be used, as other solvents may damage the tubes.

The percentage of solution to use when dampening the powder will vary for each type of composition. When damp, the powder should be able to pass through a screen without clogging up the holes, and the resulting granules should not easily stick to each other or clumping will result. There is no concern for under-wetting the powder, only over-wetting can cause problems. The amount of solution required for making pumped comets generally works fine for the granulation step as well. Some common percentages are 15% for charcoal streamers that have 50% or more charcoal by weight, 20% for color compositions that have a lot of parlon and tend to be crumbly when wet and 10% for glitters and organic color compositions. A general rule is that you should be able to pump your comet without squeezing any water out of it. If water seeps out of either end, then the composition was too wet.

After granulation, the composition is scooped onto the surface of the loading plate, as seen in Figure 12. A piece of stiff cardboard or a spatula helps spread the pile around so that it falls into the holes and fills them. Because the holes are so deep, you can't really fill them all in one pass by scooping one large pile of powder over them because the powder pile would have to be about three inches high. If you were making large batches then you could build walls on each side of the hole plate and try the one-pass method, but most people will probably find it easier to just shovel the powder onto the plate as needed and shift it around until all the holes are filled.

Once the holes are filled, the excess powder is scrapped off one edge into a catch pan and returned to the holding container. Every tube should be filled level with the surface of the hole plate, as seen in Figure 13.

Once loaded, the support frame is removed from under the hole plate and the plate is then pushed down flat against the table surface as seen in Figure 14. The tubes are now easily removed one at a time for pumping. The crossette pump is first pressed into the tube while it is still in the hole plate and the composition is compressed by hand so that it will not spill out when the tube is removed. The tube is then removed and placed on the ramming

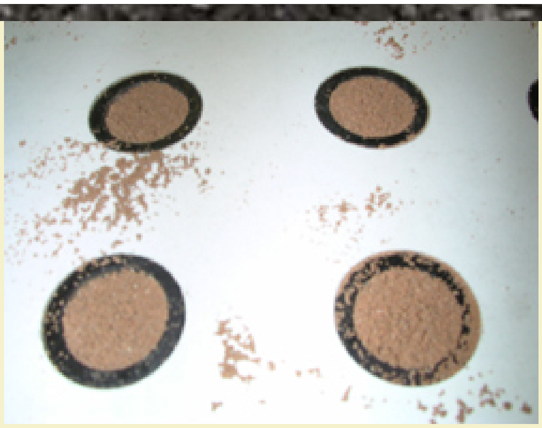
Figure 13: Tubes are filled to the top and leveled off with a scraper.


Figure 14: Loading board is pushed down to allow easy removal of the loaded tubes.


Figure 15: Pressing a crossette in the arbor press.

nipple as seen in Figure 15. An arbor press is the best way to get both speed and consistency in pressing the comets, but a rubber mallet can be used as well. When using a mallet, you might want to make a mark on each tube that serves as a visual aid for when the composition has been compressed to the desired height.

Once pressed, the tube is removed from the nipple with a twisting motion to ensure that no composition will get stuck to the nipple surface. Before pressing the comet out of the tube, it is important to first pull the crossette pump out of the comet and then reinsert it back in place in order to help loosen the hold the comet will have on the pump. If you skip this step and just try to pull the comet off the end of the pump after it has been ejected from the tube, you will more than likely crush the comet with your fingers in the process. By extracting the pump will the comet is still protected by the tube walls, it will be much easier to pull it off once ejected. Just be careful not to rotate the pump while pulling it or your will damage the delicate cross shape of the burst cavity. You will need to re-insert it back into the cavity exactly as it originally was in order to prevent damage.

At this point the pump is inverted onto a table so that the tube can be pushed down around the pump in order to eject the comet. If you find that it takes a lot of effort to eject the comet, then you are pressing them with too much force. The comet should entirely clear the tube before carefully removing it from the end of the pump. Extreme care must be taken not to pinch the comet too hard between your fingers while pulling it or you will crush the fragile walls of the burst cavity.

You may find that bits of composition will stick around the base of the burst cavity former on the crossette pump, with matching chips missing from the top of the crossettes. This sticking problem is quite common and can be annoying to deal with. I find the best way to avoid it is to spray the tip of the crossette pump with WD-40 and then wipe it down to remove the oil. This will prevent sticking for at least four crossettes before having to do it again, depending on how sticky your composition is. It's an extra step in the process, but not as time consuming as removing the caked up composition off your crossette pump after each comet that is pressed!

Once all the tubes have been pressed, the hole plate is inverted and the tubes are placed back in their spots. I prefer to place the empty tubes back into the holes after pumping each one, then inverting the hole setup and pushing the hole plate back down to the table to reset the board into the loading configuration.

My timed tests show that, including the granulation step, I can pump about 70 crossettes per hour using this setup. With more practice I could probably get that number even higher, but that's somewhere around what a beginner might expect to see after going through the process a few times.

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Figure 16: A five by five array of holes drilled 1/4" deep into the base board.

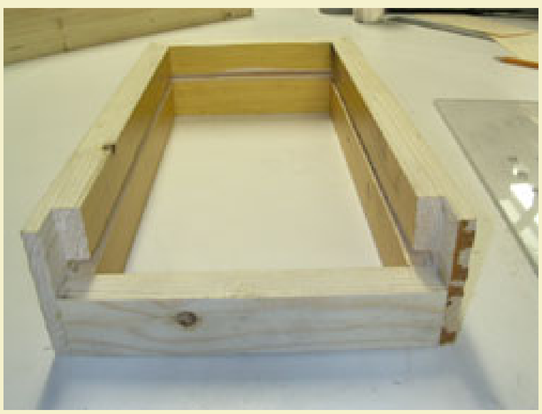

Figure 17: The box frame with a double track that holds both the hole board and a sliding sheet of formica.

Making a BP Charge Loader:
The key word here is "BP", as this tool should not be used to load other types of burst charge into crossettes due to friction concerns. Because there are sliding parts where trapped powder grains can be subjected to friction and grinding, it should not be used with granulated flash, granulated whistle or anything other than black powder grains.

Since black powder is generally not strong enough to break crossettes, you may be asking what use could there be for this tool? Well, one very effective burst charge for crossettes is small grain black powder combined with flash powder. This charge takes fire easier, does not cause the "jetting" problem, makes it difficult to accidentally add too much flash and it also avoids the white flash of light that typically ruins most charcoal crossettes when broken with flash. The black powder grains are loaded first into the crossette cavity, then the remaining empty space is topped off with flash. Trying to pre-mix the BP and flash in a separate container and then add them both at once results in inconsistent BP to flash ratios that are hard to control. The most reliable method is to add a controlled amount of BP first, then fill the remaining void with flash.

The BP+flash charge also makes it easier to fine tune your burst charges to get the exact type of break you need. If the crossette is breaking too hard and fragmenting or blowing the pieces blind, simply increase the BP charge, which will automatically decrease the amount of flash that can be loaded. If the breaks are too wimpy, then decrease the BP charge so that more flash will fit in the cavity. It's a pretty nice system, it's just hard to consistently add the right amount of black powder to each crossette due to the inherently small amount of charges required for 3/4" crossette cavities. That's where this tool comes in to make the job easy!

Jigs like this one are commonly used in industry to drop lift charges for cake items into many tubes at once, and of course the tool shown here could be built with different dimensions to be used for that purpose as well. The idea is to fill a series of holes designed to measure out the proper amount of charge, then pull the bottom out from all the holes at once so that the powder drops down into the desired location (crossette cavities in this case).

Construction:
There are four components to this tool: 1) the base plate 2) the frame box 3) the hole plate and 4) the sliding plate. While the primary purpose of the base plate is to hold the crossettes in alignment with the hole plate, it also makes a good jig in itself for

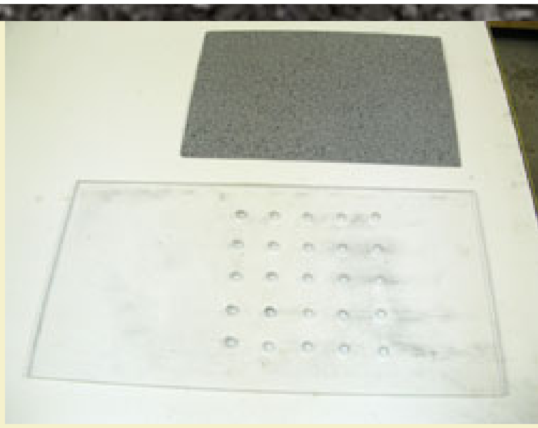

Figure 18: A 3/16" sheet of acrylic with an array of 1/4" holes that aligns with the holes in the base board.

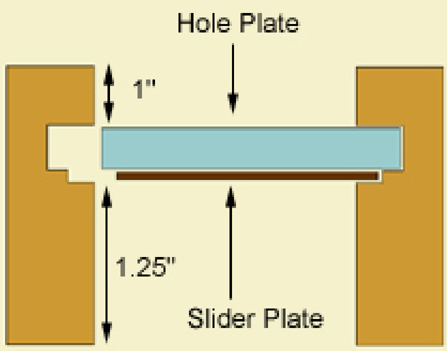

Figure 19: Slider track details.

Figure 20: The box frame with hole plate is set in place above the base board loaded with crossettes.

holding crossettes during the fusing and flash loading steps. The board is 12" x 7" and holds a five by five array of crossettes on one inch centers. These dimensions are arbitrary and could be made to hold more crossettes, but twenty five seems to be a good working number.

Start by cutting a 12" x 7" piece of good quality plywood or particle board that is 3/4" thick to use as the base plate. A piece of 1x8 oak could also be used, but pine should be avoided due to its tendency to cup, warp and cause other problems.

Mark a grid at the center of the base plate such that the left and right margins are 1.5" from the edge, with 1" between each hole. A 3/4" wood drilling bit is used to countersink 25 flat bottomed holes 1/4" deep into the base plate, as seen in Figure 16. The only other step to complete the base plate is to sink four 1/4" dowel rods at each corner so that they stick up about 1/4" above the surface. These will fit into holes on the bottom of the box frame so that the frame is locked in place during use.

The box frame is the tricky part to make for this jig, since you have to cut a very accurate set of channels into the side which will hold both the hole plate and the slider plate with very little slop between them. The configuration for this sliding track is shown in Figure 19.

It is best start with a 3.5 foot long board and cut the channel into the board first before cross cutting the box walls out of the board, that way the channel will be aligned on all pieces. The 1/4" thick hole plate channel is cut first using a dado blade or router, then the thinner channel for the Formica slider plate is trimmed away using a regular saw blade or router. Adjustable dado blades are ideal since that would allow you to cut the 1/4" channel just a hair wider so that the hole plate will easily slide in place. You don't want the hole plate sloping around during use though, so this is a critical cut to get right. Be sure to practice and trial fit some 1/4" plexiglass into a test cut before making the real cut.

Once the set of slider tracks are cut, the board is then cut up into the pieces required to make a box that fits exactly onto the hole plate. I prefer rabbit joints for this type of box, but you can use butt joints, dovetails or whatever you like. Just be sure to cut the front end down below the track so that you can get the sliding plates in and out of the frame, as seen in Figure 17. The final step is to drill the 1/4" holes in the bottom of the frame so that they align with the dowel pins on the base plate. I find the easiest way to do this is to put a dab of white glue on top of each pin and then carefully set the frame on top of them so that it is aligned with the base plate. The glue will mark the points where you need to drill on the frame bottom.

Next you will need to make the hole plate. For a charge that fills my crossette cavities about 50% full, I experimentally determined that a 1/4" sheet of plexiglass with a 1/4" hole drilled in it will hold the proper amount of charge required for a 3/4" charcoal crossette that will use 70-30 flash made with American dark aluminum (809). You can see there are a lot of variables here, so you will need to get the break charges for your crossettes worked out first before even attempting to make this jig, unless you want to make the exact same

Figure 21: With formica barrier in place, a pile of 2Fg is dragged across the holes to fill them all at once.

Figure 22: Close-up of 2Fg in the charge holes after scraping away the excess.

crossettes used here. If you are making color crossettes, then this burst charge is too strong and will not work. If you are using German or Indian dark aluminum, then the charge will be too strong also. Crossettes are VERY sensitive to all sorts of variables, especially these small 3/4" size ones. For an exact description of how the crossettes designed to be used with the hole plate dimensions shown here, see the Wax Dipped Crossettes article in this issue.

Use a black marker or sharp scriber to maker the center points where each hole is to be drilled. You can either measure these out or simply place the plexiglass on top of the base plate (remove dowels first) and visually mark the center points of each hole. If using acrylic plexiglass, you will need to set your drill press at around 2000 RPM in order to prevent the bit from grabbing and cracking your work piece when drilling through the sheet. Be careful not to set the RPMs too high or drill so slowly that the plastic melts as you drill, otherwise the holes will have a rough side wall and the powder will not slide through it as easily.

After the hole plate is constructed, the last thing to make is the sliding plate. This is just a sheet cut from a scrap of Formica such that its width will fit the narrow track under the hole plate. The length of the sheet should extend from at least an inch before the hole array to about an inch outside the frame box so that there is enough to grab onto. It also helps to round off the corners on the end that is to be inserted into the frame. Note that there are thin types of Formica and a thicker type. The one you want is the thicker type. You should be able to get a scrap for free from any cabinet shop to avoid having to buy a full size sheet just to get a little piece. Otherwise you could also use 1/8" thick plexiglass as the slider plate and cut your track slot a little bigger than shown.

Using the Loader:
This is a fast tool to use once you have gone through the trouble to make it. Simply load up twenty five crossettes as seen in Figure 20, then place the box on top. Make sure the hole plate aligns with the center points of the crossettes, then insert the slider plate so that all the holes are closed off. A pile of 2Fg black powder (home-made in this case) is placed at the back of the box and dragged across the holes using a scrap of stiff cardboard cut to fit the entire width of the box as seen in Figure 21. The powder is then dragged back again to the back of the box on a second pass. Any excess powder should be scooped away so that the grains are level with the top each hole, as seen in Figure 22. Now simply pull out the slider plate as shown in Figure 23 and the charges will drop straight down into each crossette!

Sometimes a few grains will miss the cavity and collect on top of the crossettes. It is an easy matter to remove the frame box and tap the base plate from side to side while tilting it until all the grains on all the crossettes fall into their appropriate holes. This same tilting action also works for getting misplaced flash back into the holes after the flash loading step. Normally you would have to tap any spilled flash back into the hole one crossette at a time, but this holding fixture makes it easy to clean up batches of twenty five crossettes all at once!

Figure 23: Pulling the barrier plate will drop the equally measured charges into the crossette cavities.

Figure 24: Close-up of charge dropped into crossette cavity.

Figure 24 shows a close-up of a crossette after it has been loaded. Note the presence of a paper Chinese style fuse at the center, which is inserted into the pin hole and cut flush with the top of the crossette. This fuse, which is made from granular corning dust using the method described here, is one of the tricks to getting both better breaks and better timing out of your crossettes. Using corning dust instead of standard meal to make the fuses results in a very fast burning fuse that will break the crossette at the exact instant that fire reaches the pin hole.

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