

Basic Single Petal Round Shell Construction

--- Steve Hubing 7/11/18 ---

The construction of a single petal (one layer of stars) ball shell uses pretty straight forward construction techniques. What I strive for when I make this type of ball shell is for it to have a nice and round appearance when it bursts in the sky. While this may seem to be something that is easy to achieve, it is anything but easy. There are many forces and variables that have to be balanced correctly to achieve this round break and in this article I will describe how I handle some of variables to achieve a round break. The techniques to build a 5 inch ball shell I will present are by no means the only way to achieve a round break from a ball shell, but I have found that these techniques give you a good chance of getting that round break. Pay close attention to the "Construction Tips:"

Shell Casing and Passfire

The shell casings I generally use are the standard Chinese pressed straw board hemi's you can get from many sources in the U.S. You will want to measure the hemi's to make sure they are of the correct size and it's also best to match the hemi's so that the two hemi's you're using fit together well. In the case of this 5 inch shell the casing will have an outside diameter of around 4.5 inches. The finished shell of course will need to fit into a 5 inch ID mortar and therefore the finished shell will be around 4.75 inches. This means that the wrapping on the shell would be 1/8 of an inch.

The passfire is a tube that carries the fire from the time fuse to the center of the shell. For shells 8 inches and smaller, I use a lance tube, which is a paper tube with a 7/16 inch ID.

Drill the hole on the casing so that the passfire tube will have a snug fit. Insert the passfire tube into the drilled hemi so the top of the tube is at the center of the inside of the hemi. Hot glue in place and cut off any remaining passfire tube on the outside of the hemi.



Construction Tips:

It's important to bring the top of the passfire tube to the center of the shell. You want the fire from the tube to be transferred by the passfire tube to the center of the shell, so that the explosive force created when the burst charge is ignited starts at the center of the shell. This helps to produce equal forces on stars so that they all get propelled out of the shell at the same time.

Putting in the stars

The heart of any shell is the stars. You have to have stars that perform and lite the way they should. To get a good round break, round stars work the best in a ball shell.

The size of the stars are also important. The size determines how dense or sparse the star pattern will be in the sky. For this 5 inch shell I chose a ½ glitter star which burns pretty quickly.

Line the inside area of the shell hemi. Try to get the stars uniformly positioned in the shell hemi with few if any gaps. At this point you can put in the stars until they are close to the top of the hemi. We'll put in more stars after we place the burst.

Construction Tips:

- Have a good lighting star.
- The rounder the star the better. Roundness gives better aerodynamic flight.
- Put in the stars until they are most of the way to the top of the hemi



Folding the tissue paper liner

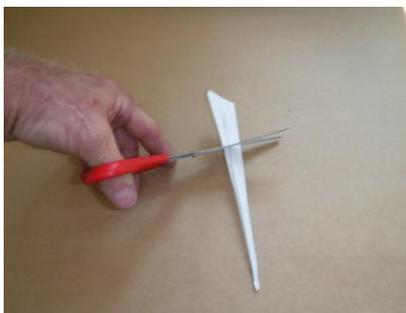
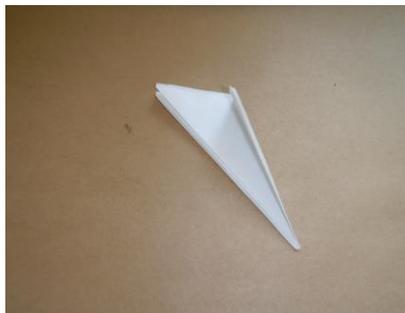
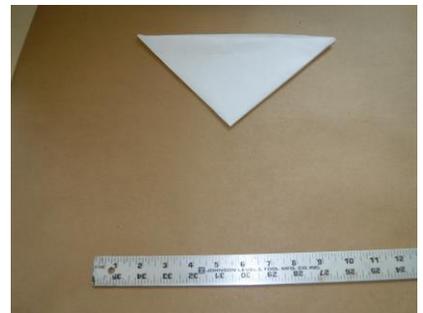
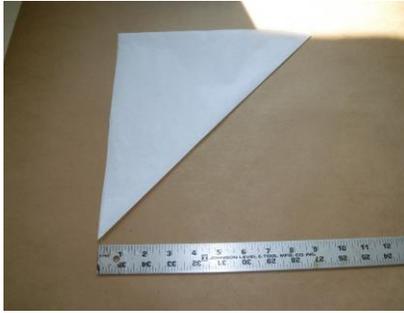
There needs to be a liner between the stars and the burst. The Japanese use Kozo paper, which is a thin, tissue, like paper that is pretty strong. While you can find Kozo paper on the internet, I found that medical pattern paper works pretty good. It's available on Amazon. You can follow these pictures to fold a nice pleated circular liner. The goal is to get a liner that fits into the stars in the hemi and folds closed nicely.

Medical Pattern Paper: 21" x 225' Single Roll of Patternmaking, Drafting, and Tracing Paper by Diagnostics Direct



Construction Tips:

- Once you get the paper folded, break it in by running across the corner of a table.
- For the liner in the passfire hemi, cut the very tip of the folded paper to create a hole in the center.



Loading the burst

For most all my shells I use a milled hot black powder with 3% dextrin that is pasted on rice hulls at a ratio of 7:1. That's 7 parts black powder and 1 part rice hulls. So for example if you have 1000 grams of a milled hot black powder, divide that number by 7 (the number of BP parts) to get 143 grams (1000 grams/7) which is the amount of rice hulls to use (1 part).

Place the tissue paper liner in the hemi and add a small amount of burst. Now for the important part, PACK the burst with a dowel so that your are pushing the burst into the stars. Notice I say pushing and not tapping. The idea here is to push the burst into the stars so that the burst locks the stars into place so they can not move. Continue adding small increments of burst and packing/pushing the burst into the stars until the burst is close to the top of the hemi. Notice how my dowel is angled into the stars and not just straight down.

Construction Tips:

- Pack the burst in to the hemi in small increments like $\frac{1}{2}$ inch at a time.
- Pack by pushing down the burst with slow steady pressure. If you tap the burst, your just loosening it and it won't pack.
- Push the burst into the stars with each increment added. This will push burst into the spaces between the stars locking them in place.
- Do not rip or tear the tissue paper. If this happens burst will leak into the stars and they will then loosen up.
- Locking the stars in place with the burst keeps them from moving when the shell is jostled around or when it is shot out of the gun.
- It's VERY important to lock your stars in place so they CANNOT move until the shell bursts in the sky.



Once the burst is close to the top, fold in the tissue paper and place stars into empty areas. The goal here is to complete the layer of stars so that they fill the hemi WITHOUT protruding above the top of the hemi. Notice in the second picture one of some of the stars are above the top of the hemi. You would need to remove those stars.

Once you have all the stars in place fold the tissue paper over the burst. To tamp it all down, I use a flat board to tamp and push the burst and stars down. Also use the board to determine if you have too many stars or too much burst in the hemi. Your goal is to have no more than 1/16 inch gap between the board and the top of the hemi.

Construction Tips:

- By packing in the burst and using the board to consolidate the stars and burst into the shell hemi, there will be little need to tap and bang on the shell to get the shell halves together.
- Packing the burst into the shell and locking the stars in place is one of the keys to having a successful round burst.
- Big point here is that the position the stars are in the shell when the shell bursts is how the stars will appear in the sky. If you have stars out of place inside the shell because of poor construction, jostling the shell during transportation, setback when shot out of the gun, etc., they will be out of place in the sky.



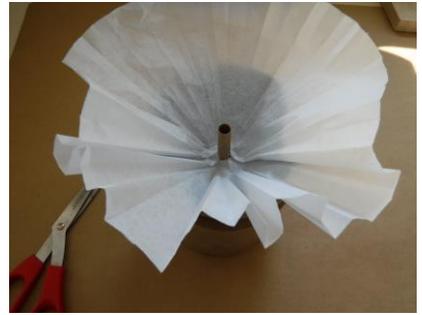
Loading burst in passfire hemi

Loading burst in the hemi that has the passfire in it is done in the same way as done in the other hemi. You will have to cut a small hole in the center of the tissue paper liner and work around the passfire tube, but otherwise packing the burst and placing the stars is the same. The one big difference is that you need to put some thin black match in the passfire tube. The number of pieces depends on the size of the black match. Here I use a thin black match and use 5 pieces. Put enough in so that the passfire tube is at least $\frac{1}{2}$ full of black match. The black match should extend about half way down the passfire tube. Once this is all done, fold the tissue paper over the burst as before. Use the board to make sure stars and burst are not over the top of the hemi.

Once the tissue paper is folded over the burst and all is packed down, I like to poke a few holes in the tissue paper to aid in fire transfer from one hemi to the other.

Construction tips:

- Be sure to pack your burst in good, it's the key to locking the stars into position.
- Multiple pieces of small black match in the passfire tube are better than one thick piece. I believe you get quick fire transfer with several smaller pieces.
- The black match only extends into the passfire tube about half way. More pieces will be put in the passfire tube from the outside of the shell after it's wrapped.
- Putting holes in the folded tissue paper aids in fire transfer. You want the fire to get into the non-passfire hemi instantly so the fire and gasses push those stars out of the shell at the same time the stars in the passfire hemi are being pushed out.
- Don't make the holes near the edge of the tissue paper or make them too big. You don't want burst leaking into the stars. This would cause the stars to loosen up over time.
- All these little things add up to make for a good burst and pattern in the sky.



Closing the shell

To close the shell, I like to use some stretch wrap (Saran wrap, etc.). Take a piece of stretch wrap and put it over one of the filled hemi's. Pull it down and around the hemi, then turn the hemi to twist the stretch wrap on the bottom side of the hemi to really tighten it up over the top of the stars and burst. Once it's really tight, the hemi can be turned upside down and placed over the other hemi. Make sure the stretch wrap is tight enough to hold everything in when you turn it upside down. I'll use this method for 8 inch shells and smaller.

Once you have the hemi's together, you should see no more than an 1/8 inch gap between the two. Having a smaller gap would be better. If it's too big remove the offending stars or burst so that you have a small gap. This small gap is closed by either just pushing on the top of the shell or pushing with a little tapping with wooden stick. The idea here is that you want a little gap so that you know both hemi's are packed full, but not too big that you have to bang on the shell to get it closed. It's all about having the right amount of stars and PACKED burst in the hemi's before you close the shell.

Once the hemi's have no gap between them you can tear off the shrink wrap by pulling it straight up a little at a time. If you pull it down, it may drag some stuff out of the shell.

After getting rid of the shrink wrap, tape the shell closed with masking tape.

Construction tips:

- Take your time when loading the hemi's with stars and burst. Keep everything no higher than the top of the hemi. If anything add a very little extra burst so that there is about 1/16th inch gap when using the board to measure how high things are.
- When you put the two hemi's together strive to get a small gap such that when you push on the top of the shell by hand it closes or almost closes. If you need a little tapping on the shell with a wood dowel, that's ok.
- Remember here that the goal is to get a tight shell with no rattling after it's closed.
- If you have to use lots of tapping to close the shell, you run the chance of dislodging stars. Not good.
- If the stars are put in right and the burst is packed and locking the stars in place, the shell is already compacted as much as it can get and there is no need for tapping to settle the stars and burst.



The last thing to do, if you're using a WASP to wrap the shell is place a magnet into the passfire hole. For safety, I like to use a cap plug (www.capplugs.com T-2 size) to isolate the magnet from the inside of the shell. These cap plugs fit snugly in the lance/passfire tube.

Now the shell is ready to be pasted. For those of you who have a WASP or access to one have it easy. Since WASP settings are pretty much tailored to each machine, computer, and user, I won't go into any detail on WASP settings. Your other choice is to hand paste it with either gummed tape or pasted paper. It will be up to you. Just get 'er pasted.

After the shell is pasted and before the pasting dries, find the magnet by using another magnet to locate the one in the shell. Using a razor blade, cork cutter, etc., cut through the wrapping to expose the magnet and cap plug. This is the point where a cap plug would prevent any sparks from getting in the shell should a spark be created during the cutting process. Pull the magnet and cap plug out of the passfire.

Construction tips:

- Don't forget to put your magnet in the shell before you wrap it !!
- Use a cap plug to isolate the magnet from the inside of the shell to avoid a spark getting into the shell when cutting out the magnet.
- Cut out the magnet before the wrappings dry.
- Oh, did I mention that when you shake the shell you shouldn't hear anything rattling inside. You won't if you do a good job loading stars and packing burst.



Fusing the shell

To fuse the shell, you will need some short pieces of thin black match, a length of time fuse, small cardboard ring, and hot melt glue.

Cut short pieces of black match to a length so that when you put them in the passfire tube they are even with the top of the pass fire tube. I used 4 or 5 pieces on this shell. These pieces will run past the black match you had put into the passfire tube when loading the hemi.

Cut a piece of time fuse with a 45 degree cut on one end. Make the time fuse long enough so that you have 1 ¼ inch between the top of the 45 degree cut and the cross matching. Mark this distance on the time fuse.

Insert the time fuse into the passfire with the black powder, on the 45 degree cut, facing the black match pieces you put in the shell. In this way the fire will spit fire from the time fuse right at the black match. This method works good and I've never had a failure.

Make a ring of thin cardboard (toilet tissue roll) about ¼ inch high and big enough to run past the cut edge of the pastings.

Fill this space with hot melt glue. This will give you a ¼ inch disk of hot melt glue sealing shell around the time fuse.

Cut the time fuse down to the 1 ¼ inch mark and tie in some black match for cross matching. You could punch a hole to do this, but I prefer cutting.



Lifting the shell

To lift the shell you will need a piece of quick match for a leader, some black powder for lift, and a lift cup to protect the black powder and fuse.

Weight out the 4FA powder (45 grams for this 5 inch shell) and place it in a small plastic bag (sandwich bag). Insert the bare end for the quick match into the powder and tape closed the bag.

Place the lift bag over the fuse and tape down. Use a lift cup (dixie cup used here) to cover the lift powder and fuse.

Run the quick match leader around and to the top of the shell. Use glue (hot melt works good) to adhere the QM to the top of the shell. Put a piece of tape or glued string across the QM to prevent it from coming off when lowering into the gun. Add a piece of visco fuse or an e-match to the end of the leader, label the shell, and your done.

Construction tips:

- 4FA black powder works good for all ball shells up to and including 12 inch.
- Be sure to secure the black match leader to the top of the shell. If it breaks free you won't be able to get the shell out of the gun.



APPENDIX

Standard Fuse Length

3 inch shell.....	1 inch
4 inch shell.....	1 1/8 inch
5 inch shell.....	1 1/4 inch
6 inch shell.....	1 1/4 inch
8 inch shell.....	1 1/2 - 2 inch
10 inch shell.....	1 3/4 - 2 inch
12 inch shell.....	2 – 2 1/2 inch

Note: This is the distance between cross matching or distance from top cross match to top of 45 degree cut.

Note: This is for a time fuse that burns approximately 2.2 seconds per inch.

4FA Black Powder Shell Lift Amounts

3 inch shell.....	17 grams
4 inch shell.....	25 grams
5 inch shell.....	45 grams
6 inch shell.....	80 grams
8 inch shell.....	150 grams
10 inch shell.....	350 grams
12 inch shell.....	450 – 500 grams

Note: Lift amounts for ball shells are based on shell size and not shell weight. You do not need to vary the lift amount because of shell weight.

Note: Lift amounts are based on a good commercial quality 4FA black powder.

WASP Gummed Tape Size

3 & 4 inch shell.....	3/4 inch tape
5 & 6 inch shell.....	1 inch tape
8 inch shell.....	1 1/4 inch tape
10 & 12 inch shell.....	1 1/2 inch tape