PASSFIRE.COM

Log Out

Volume 4, Issue 2

Build This...

1-3/4" Ball Shells

Summary:
These small shells are comparable in performance to the widely popular class C "festival ball" type shells. The small amount of materials these little shells consume make them perfect for beginners looking for a first shell project, as well as advanced builders looking for attractive insert shells for larger shells. These small shells also make ideal headings for 1/2" I.D. rockets and girandolas, or they can be combined to produce very attractive cake items that hold their own against commercial class C cakes.

March, 2004 Issue

Materials:

- (2) 1-1/2" O.D. paper hemispheres
- (12) 9/16" wide x 6-1/2" long 30lb virgin kraft strips
- (1) 1-3/8" long Chinese time fuse

Tools:

- hot glue gun
- cross match punch
- anvil cutter
- sharp knife or scissors

Unmeasured Materials:
7/32" dia. round stars, 1/2" wide masking tape, hot glue, wheat paste, 2Fg black powder, KP on hulls 7:1, cross match

Mail Passfire.com

1-3/4" Ball Shells...

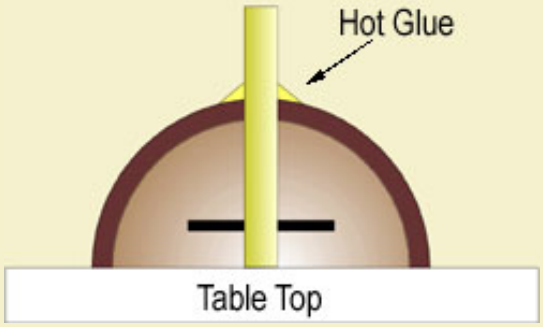

Figure 1: Sealing time fuse with hot glue.


Figure 2: Both hemis filled with 7/32" dia. stars.


Figure 3: Burst charge of 1/2 TSP 2Fg in each hemi.

Introduction

There is probably no single item more useful to have under your pyro belt than a high-quality small caliber shell, as the uses for them are many. They can stand alone as single shot reloadable shells that are ideal for testing stars or just having fun. They can be combined into cake items and even multi-shot candle items. They make great upper-layer effects in mines. They also make excellent headings for 1/2" I. D. rockets or girandolas. Small round shells are really the only option for building shell-of-shell ball shells, since cylindrical inserts do not stack efficiently inside a round hemisphere. The small size of the shell described here will allow over 40 of them to be loaded into an 8" shell!

We have all marveled at the ability of the Chinese to produce very small yet effective shells in their Class C products, yet duplicating such efforts tends to be an elusive challenge. Close to 20 trials were conducted in developing the shell described here, and the results are two variations on building them which will produce good results. Both methods use small paper hemispheres made as shown here, and they are strip pasted in the traditional way.

Time Fuse

The time fuse is installed as shown in Figure 1. The fuse is cross-matched 1/4" from the end, which results in a better break than if the fuse were simply cut at 45 deg. or slurry primed instead of cross matched.

One hemi in each pair is drilled with a 15/64" dia hole, which is just a hair below 1/4" so that the time fuse will fit snug. The cross-matched time fuse is inserted up through the inside of the hemi, then they are placed onto a table top as seen in Figure 1. Hot glue is used to seal around the time fuse on the outside of the shell, which prevents gas leaks and also prevents the fuse from getting pushed into the shell during lift. For the single-shot reloadable shells being made here, the full time fuse length is 1-3/8" from end to end. Both ends are cross matched 1/4" from the end, thus the timing delay is 7/8" long.

Stars

The stars used here are 7/32" dia. solid color stars, which allows a good many of them to fit into the shell. If you wish to use larger stars then it is recommended that they have streamer effects so that the lower star count does not look sparse. Perchlorate/magnalium based color stars are recommended for their slower burn rate and brighter color. Chlorate stars have good brightness but will burn out too fast, while non-metallic perchlorate colors will appear dim due to the small size.

Figure 4: Pattern produced by burst method #1.

Figure 5: Stars stacked around sides in single layer.

Figure 6: Burst charge of 7:1 KP on rice hulls.

The stars in these pictures appear silver because they have been primed with a mixture of meal and medium flitters aluminum in a ratio of 40 to 1. This creates a hot prime for igniting the MgAl color comp used, and also creates a small streamer effect if the prime is rolled thick enough.

Burst Charge

Two different styles of shell bursts were observed during testing, and since each is attractive in its own way, both types will be described here.

Burst Method 1

The shell burst resulting from this method of loading the shell will result in a smaller yet denser cluster of stars that expand at a slower speed than Method 2. This type of shell is useful for creating a splash of color rather than creating a large, rapidly expanding burst. This type of burst is ideal for insert shells used in mines or shell-of-shell effects, since the bursts will not overlap each other and is more attractive. This method is also faster to construct, which is important if you are making 40 of them for one shell!

Both hemis are simply filled with stars as seen in Figure 2. They are not packed to the rim, but close to it. 2Fg black powder is then used to fill in between the stars, which only requires about 1/2 TSP of powder in each hemi. The 2Fg used here was home made from spruce charcoal and tested stronger than Goex. The down side to this method is that results may vary depending on the 2Fg used. If yours does not work at first, try pasting 4 layers of paper instead of the 3 used here, or add a small booster such as slow flash or whistle mix.

Burst Method 2

This method produces a big break that spreads rapidly, making it ideal for use in cakes and rocket headings. It does not appear as dense as method #1 because there are not as many stars in the shell. The pattern is more noticeably round however, and the shell has less weight for rockets or other self propelled devices to lift.

Both hemis are lined with a single layer of stars in the same way larger shells are built, as seen in Figure 5. This of course requires more time and nimble fingers, so it is only desirable for making small numbers of shells. The center is then filled with KP on rice hulls in a ratio of 7:1, as seen in Figure 6.

Closing

Once the burst charge is loaded, both halves are clapped together in a quick motion to minimize spilling the contents. A slower but cleaner way is to use a piece of cardboard to hold the contents in one hemi as it is inverted onto the other. The cardboard is then slipped out from between them after they are together, as seen in Figure 8. Once together, a band of 1/2" wide masking tape is wrapped one time around the seam as seen in Figure 9.

More...

Figure 7: Pattern produced by burst method #2.

Figure 8: Sliding out a sheet of poster board used to reduce spilling when joining hemis.

1-3/4" Ball Shells...

Figure 9: Hemis held together with a band of 1/2" masking tape.

Figure 10: Pasting a 4-sheet stack of 30lb virgin kraft.

Figure 11: Stair-step alignment of pasted

Pasting

This is the part most people hate about building paper ball shells, and the idea of strip pasting such a tiny shell probably sounds tedious. I have made every effort to make it as painless as possible, allowing you to get through this part in under 10 minutes.

Because it only takes a very small quantity of paste and paper to make one shell, it is a good idea to paste many at once. Wheat paste is desirable over boiling flour, since you can make a small batch of it quickly by stirring the dry powder into cold water using a whisk.

The paper used to paste in these shells is important, as recycled paper in any percentage will drastically effect the break. You want to use only virgin kraft in a 30 lb weight.

We are going to borrow a trick from the Chinese for making the pasted strips we will need. Prepare four sheets of kraft that are 6-1/2" wide by 9" long. The 9" dimension is arbitrary and variable, but the 6-1/2" will be the length of you strips and is a good length. You need to be working on a surface that is "sacrificial," such as a chopping block or piece of wood, because it will get scarred up by the cutting process. The plastic type chopping blocks work good for this application.

Begin by coating your work surface with paste, then stack the sheets of paper one on top of each other, coating each one with paste before applying the next sheet over top of it. Align the sheets in a stair step fashion as seen in Figure 11.

Once the sheets are all pasted, there are two methods you can use to proceed. You can crumple up all the sheets and break-in the paper to get the paste integrated into all the fibers, then flatten it back out and cut your strips. This method saves time in pulling the strips apart because they will finish in a flat state, as seen in Figure 12. The disadvantage is that it is harder to cut the strips once they have been broken-in with the paste.

The other method is to immediately cut the strips after the paper has been stacked, which is how the Chinese do it. The paper cuts much easier this way, but requires you to crumple up all the strips after they have been cut in order to break in the paper. This results in a mass of strips that have to be individually sorted out and laid flat again in order to peal them apart. Breaking in the paper is important for producing soft sheets that lay flat and stick down well, so it is not a step I recommend skipping.

sheets.

Figure 12: Slicing off 9/16" wide strips with a sharp knife.

Figure 13: First two pasted strips meeting at the time fuse.

Figure 14: Remaining four quadrants pasted with overlapping strips.

The strips are cut using a thin, sharp knife and a metal straight edge as seen in Figure 12. They should be 9/16" wide in order for four strips to produce one layer on the shell. This way you are producing one paste layer for each set of strips you cut, and you will need three sets to paste in one shell (12 strips total).

The strips are separated and applied to the shell in the pattern described by Shimizu in Fireworks, Art, Science and Technique. The first strip starts at the time fuse and wraps all the way around the circumference of the shell, ending at the time fuse on the other side. The second strips does the same thing, only perpendicular to the first strip. This produces the cross pattern seen in Figure 13. The remaining strips are used to fill in the four quadrants in an overlapping fashion, such that each strip overlaps the strips under it by half. The strips are simply torn by hand to get the desired lengths, which creates a feathered edge that lays down well compared to the crisp edge that would result from cutting with scissors. Figure 14 shows one complete layer pasted onto the shell.

The second layer is pasted just like the first, only running in the opposite direction. Thus the first strip of the second layer would wrap around the seam where the hemis meet, then the second strips would start and end at the time fuse. The quadrants are then pasted in as before.

The third layer is pasted just like the first layer was, thus completing the shell. There now, was that so bad?

Finishing

It is important that these shells are 101% dry before using them. They may appear to be dry on the outside and still have soft paper on the inner layers, which will undermine the confinement strength of the shell and result in many blind stars. A dry shell should be rock hard and resist creasing when pressed against with your fingernail.

The shell is finished by punching and cross-matching the time fuse 1/4" from the end. A tool that makes this step easy can be found here.

Usage

For single firing these shells, a 1-3/4" I.D. mortar that is about 8" long is required. This can easily be made from PVC plugged at one end with a wooden disk, then mounted on a wooden platform.

Rather than attaching the lift and adding a leader to such a small shell, I prefer to bottom fuse the mortar by drilling a 1/8" hole just above the plug and inserting a stick of black match. A lift charge of 5 grams 2Fg is measured and placed on a small sheet of tissue paper, then the tissue is folded up and taped shut to form a square packet, as seen in Figure 15. These are simply dropped into the mortar followed by the shell. The shell can be fuse end down or fuse end up, it will take fire just as reliably in either orientation. The black match will burn through the thin tissue paper and ignite the lift charge quite reliably regardless of how the lift packet is oriented in the bottom of the mortar.

If shooting consecutive shots from the mortar, be sure all glowing

Figure 15: Finished shells with 5g lift bags.

embers are extinguished before dropping in a lift packet. Waiting several minutes and swishing dry sand around in the mortar between shots is one way to help clear out burning material. Never look down the mortar after a lift packet or shell has been inserted, least you become the subject of a future Accident Analysis article!