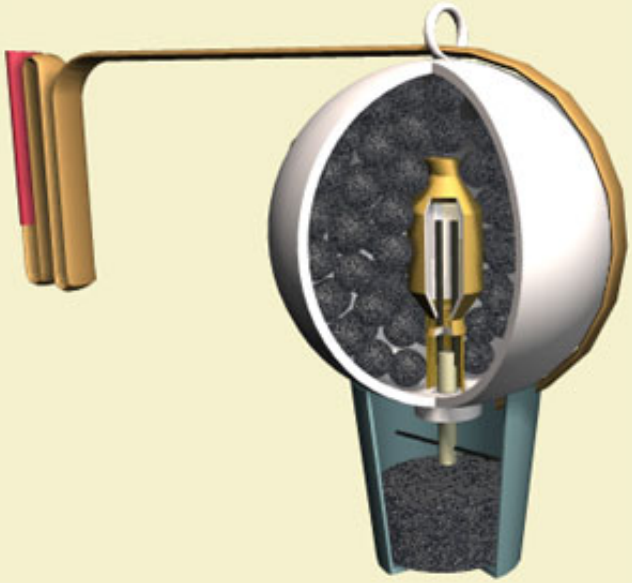
Build This...

4" Plastic Ball Shell

*by **Lloyd E. Sponenburgh***



January, 2006 Issue

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4" Plastic Ball Shell

Beginner Project:
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Summary:

This plastic ball shell produces a commercial quality break that is comparable with paper ball shells, and it doesn't require any extra steps such as pasting in or reinforcing with fiber tape. Take advantage of the rapid construction allowed by plastic shells and still have pride in the results! This is a perfect first time shell project for new shell builders as well as experienced builders who need a quality break with a short construction time.

Materials:

- Plastic shell halves (with fuse ring & eyelet)
- 120 grams of 4FA black powder
- 5 grams of good 7:3 flash
- 360 grams 1/2" or 3/8" stars
- Methylene chloride, xylene or plastic model glue
- Colored PVC cement
- Good twine
- Penny wrapper
- 3" piece of 1/4" time fuse
- 1-3/8" long 1/4" I.D. tube (4 turns of 70lb kraft)
- Hot melt glue
- 3 oz "Dixie cup"
- 4 inches of visco fuse
- Masking tape
- 36 inches of quickmatch
- White glue

Tools:

- Hot glue gun
- 1" Dia. wooden dowel rod
- Sharp, new single edge razor blade
- Measuring spoons
- Measuring cup (or gram scale)

4" Plastic Ball Shell...

Figure 1: All the materials you will need to build this shell.

Figure 2: Gluing on the time fuse ring.

Introduction

A beginner at any craft gains a lot from early successes. This project will teach you how to quickly make a high-performance 4" plastic ball (oriental style) shell. It's simple, quick to build, and works better than you'd ever imagine. If you can cut straight with a razor blade, measure length with a ruler, and measure volumes with kitchen tools, you can build a great shell.

Before you do anything else, figure out how the shell parts fit together. The "fuse ring" shown in Figure 2 is used to help seal the fuse entry so fire cannot get in around the fuse and cause the shell to explode prematurely. Soak the concave surface of the ring in a little plastic solvent, or apply an even layer plastic model cement to that surface, then push the ring over its mating stud on the shell, and make sure it seals all the way around, oozing glue out of the joint. Do NOT glue in the "leader hook" yet. It will get in your way during subsequent steps. We'll save that for last.

Plastic shell halves are not very accurately made. Trial-fit the two halves together, testing new positions until you find a position where the waist joint is as evenly matched all around as possible. This isn't absolutely necessary, but doing this step will help you better seal the shell. Mark a stripe across the joint to help you realign the shell properly later, as seen in Figure 3.

Alright - There are six basic components to a fireworks shell: The shell casing, the leader, the lift assembly, the time fuse assembly, the burst charge, and the stars. In order to keep things neat and simple, we'll assemble the leader and lift assembly as a single unit. We'll make the time fuse and burst charge into a single unit, also.

The burst charge is really two components. First, there's a 5g flash bag (coupette) that creates the heat and initial quick flash to get all the shell contents up to temperature. Alone, five grams of flash won't give as good a break as I like, although it will work with easy-to-light stars.

A secondary 4FA "filler" that gets mixed in with the stars is also part of the burst charge. The BP fill is used to create additional gas during the break. Flash powder is almost a 'negative' explosive, in that most of the combustion products (once cooled and condensed) occupy less volume than the original constituents. Flash gives a sharp hammer-blow break of very short duration. Adding a gas producer lengthens the time the stars are propelled, allowing you to use less flash while obtaining a larger break radius.

Figure 3: Marking the best aligned position before assembly.

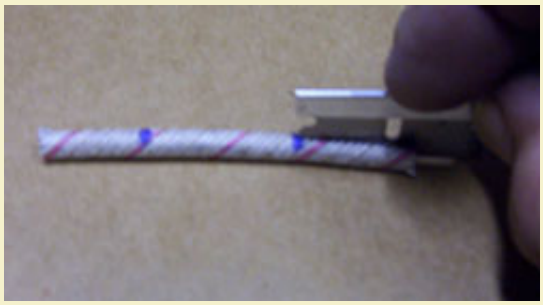

Figure 4: Splitting the flash bag end of the time fuse.

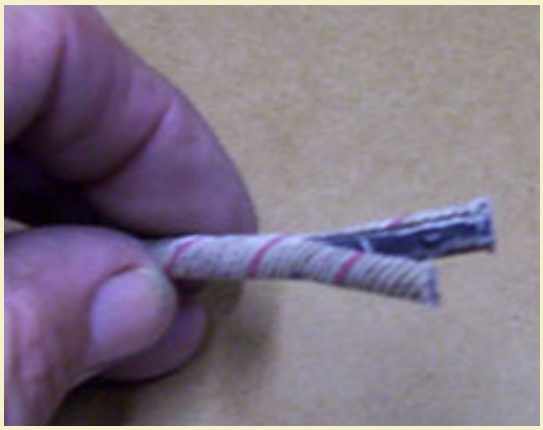

Figure 5: Split fuse after cutting.

This bursting method raises the internal temperature and pressure of the shell so fast that most of the stars are fully lit before the casing fails. I have experienced few problems with star ignition unless more than 7g of flash are used per 4" shell. Spiderweb stars can handle up to 8g!

The outer prime on the stars used in this shell uses a "weak powder", a 78-18-11 hand-mix with +5% dextrin. For hard-to-light cores like high-aluminum content flitter cores, I pre-prime with KP prime (75-15-10 KP,charcoal, red gum with +5% dex). This secondary prime is applied wetter than usual in order to get better integration at the junction between the star comp and the prime.

Time Fuse Assembly

First we'll make the time fuse assembly. This consists of a 3" piece of 1/4" time fuse, marked in the middle a distance equal to THREE SECONDS of burn time. This requires about 1-1/4" distance between the two marks on the fuse shown in Figure 4.

Using a brand-new SHARP razor blade, split only one end of the fuse exactly in half as seen in Figures 4 and 5. Be careful not to let the split go beyond the line marker, otherwise you will shorten your time delay. Gently pry the halves apart enough to insert your "cross-match". Be very careful not to disturb the powder core of the fuse - it's delicate. Slip two 3" long pieces of THIN bare match all the way to the bottom of the slit. Bend them up toward the end of the cut fuse and capture them along their length in the slit.

Now the next part is a little difficult. TIGHTLY HOLD the fuse and match together so they don't slip out of position, then feed the un-cut end of the time fuse through a 1/4" I.D. cardboard tube. While holding the cross match in position, pull it through the tube until the split end of the fuse is even with the end of the cardboard "standoff" tube. Some of the bare black match will (should) still protrude past the end, as seen in Figure 7.

Burst Assembly

Next, we prepare the "flash bag" burst assembly. This is the charge that causes the shell to explode, driving the stars outward. Pleat the end of a penny wrapper so that it fits neatly around the cardboard tube. Slide it down to about 7/16" from the bare-match end, then TIGHTLY secure the wrapper with a clove hitch about 1/4" up from the end of the wrapper. Test the seal… it should be tight, and you shouldn't be able to blow air through the wrapper and fuse. The knot should collapse the tube around the fuse (TIGHT!). Secure the knot with a drop of white glue.

Using a funnel to keep things neat, place five grams of flash powder (that's a barely over level teaspoonful) in the paper bag you've formed. Gently tamp the powder down by lightly tapping the fuse assembly down on your work surface a few times. Close the bag by twisting the wrapper over the top of the flash powder, then tightly secure the twist with a clove hitch. Make this joint as close to the powder as you can without pinching powder in the knot. You want the flash bag to be full of powder without excess air space.

CAUTION!!! Do NOT use scissors for the next step, use only a

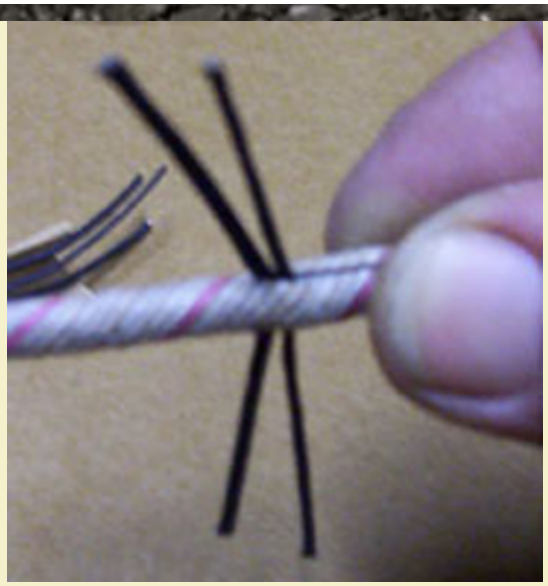

Figure 6: Inserting two strands of black match.

Figure 7: Cardboard tube slipped over the fuse.

Figure 8: Penny wrapper flash bag tied onto the fuse.

sharp razor. Trim the end of the flash bag about 1/4" away from the top knot to remove the excess paper. Scissors may cause friction that can ignite flash powder if particles get in between the blades!

Next you will insert the time fuse and burst assembly into the plastic hemisphere with the time fuse hole. Apply a bead of hot-melt glue around where the cardboard tube and fuse meet, then insert the fuse into your bottom shell half, carefully centering the fuse/burst assembly until the glue cools. It should look like Figures 10 through 12, being well-centered horizontally and halfway below the "equator" of the shell. When the shell is assembled, the flash bag should be located right at the center point.

When the glue holding the fuse in place solidifies, turn the hemisphere over and fill the empty space inside the "fuse ring" with hot-melt glue, which will seal the gap between fuse and shell. NO FIRE MUST PASS THIS JOINT, or the shell will explode prematurely. Try to avoid bubbles. The glue should be hot enough to "wet" the fuse, which means it absorbs into the paper instead of beading up around the outside.

Loading the Shell

Now we'll prepare and load the stars. First, punch a hole in a plastic sandwich baggie so it will fit around your burst bag. Neatly line the bottom shell half with the baggie as seen in Figure 12.

Using your "top" shell half as a measuring scoop, put an amount of stars in the baggie that will almost reach the middle of the joint between the shell halves. A few stars can stick out level with the top, but none should protrude past the edge of the shell.

Sprinkle about 40 grams of 4FA powder in over the stars, then put another (carefully measured) scoop of stars into the baggie. Sprinkle another 40 grams of 4FA powder onto the new stars, then twist the baggie tightly closed and secure with a clove hitch knot (Figure 14). If you get too few stars, your shell might not burst perfectly symmetrically, but with too many, you won't be able to properly close the shell.

Next you will close the shell using the other plastic hemisphere. Take extreme care not to let any part of the baggie get caught in the joint between the two shell halves. You can tell if you've got the right amount of stars when you first try to close the shell. If - when you squeeze the halves together TIGHT - they almost close, but not quite, you've got about the right amount. Then, while squeezing hard, gently tap around the shell halves with a wooden dowel to jostle the stars into a tighter fit. When the shell closes properly, **there should be NO gap at all in the joint**, and NO stars should "rattle" inside when the shell is gently shaken (you should only hear loose 4FA powder). Don't bang hard on the shell with the dowel rod. If it simply won't close tightly, re-open the shell, remove a few stars and then try again.

More...

More Pictures

Figure 9: Flash bag loaded and tied shut.

Figure 10: Fuse assembly glued into the shell.

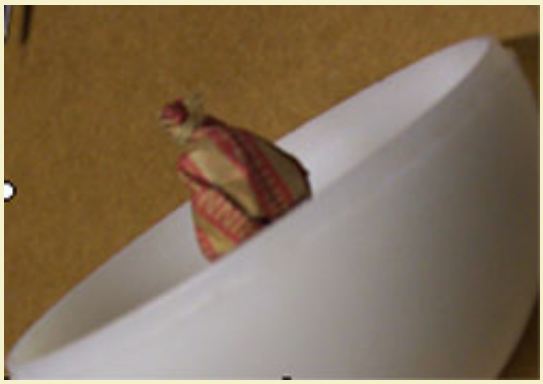

Figure 11: Side view to show flash bag placement at center.

Figure 12: Plastic bag inserted prior to loading.

Figure 13: Adding 4FA after half the stars are loaded.

Figure 14: Second half of stars are loaded and tied shut.

Figure 15: Closing the shell by tapping with a rod.

4" Plastic Ball Shell...

Figure 16: Close up showing glue seal around time fuse.

Figure 17: Splitting the outside end of the time fuse.

Once you have the shell closed properly, hold on tight to keep the shell tightly squeezed shut, and flood methylene chloride solvent around the equator to glue the halves together (don't wipe it on, liquid must flow into the joint). DON'T stop squeezing until the solvent dries! When you're done, you should see no gap and no pinholes in the joint. Melted plastic should ooze from the equator all around.

Now is the time to glue in the "leader hook" into the top hole of the shell. Use solvent, like you did with the fuse ring. Soak the tip for a few seconds before inserting it.

It's not a bad idea to label your shell now, before you forget what's in it!

To seal the joints, apply a thick coating of colored PVC cement to the equator joint and around where the leader hook inserts into the top half. Again, don't wipe the cement thin, but paint on a thick, uniform layer. Set the shell in a stand to dry thoroughly before the next step. AFTER DRYING, CHECK FOR PINHOLES, and re-seal them with a little more PVC cement, if necessary. Make sure the cement is completely dry (hard) before proceeding.

To complete the fuse assembly, you must "cross match" the time fuse so it will take fire from the lift more easily. Split the fuse right up to your mark the same way you did for the burst bag end. It's easiest to lay the fuse on a table edge to do this, as seen in Figure 17. Insert two pieces of bare black match in the slit, and tie the slit closed TIGHTLY against the cross-match with a clove hitch. Secure the knot with a small drop of white glue, then trim the excess twine. The match should be held snugly in the slit. Check it, and re-tie if necessary.

Lift and Leader Assembly

Let's discuss measuring black powder. Most people aren't aware that the apparent density of black powder is about the same as water. This means you can "weigh" powder with common kitchen measuring tools. For instance, an 8-ounce measuring cup of powder weighs - Eight ounces! A tablespoonful weighs about 15 grams. A teaspoonful weighs about five grams. This shell isn't too critical about measurements, so long as you're reasonably careful. You can use volume measures to "weigh" your powder and burst charges. If you wish to be more accurate, weigh them on a gram balance instead.

Your leader consists of a 33" long piece of quickmatch, some visco fuse (green fuse), and a safety cap for the fuse. The lift assembly is a 3oz Dixie cup with the lift powder contained in a plastic sandwich

Figure 18: Securing two strands of cross match.

Figure 19: Loading 35g of 4FA lift powder into plastic bag.

Figure 20: Quickmatch leader tied into lift

baggie.

First, measure 35 grams of 4FA lift powder. That's TWO level tablespoons plus ONE level teaspoonful. Put the lift into one corner of a lightweight sandwich baggie, as seen in Figure 19. Draw the baggie up, and cut it off with about 1-1/2" clear of the top of the powder.

Bare one end of your leader quickmatch for about 3/4". Place the bared end of the leader into the powder in the bag, then draw and twist the baggie around the leader. Secure it tightly with a clove hitch. Trim the twine short (but not too short), to make it neat. Secure the knot with a small drop of white glue.

Insert a 4" piece of visco fuse into the other end of the leader - making sure it goes into the space with the black match rather than between the layers of paper. Secure the visco to the leader with a clove hitch followed by a few turns of masking tape as seen in Figures 21 and 22. Cap the fuse (to protect it against sparks in the field) with a piece of light paper tubing long enough to cover the entire green fuse. Fold the end over and crimp it to stay shut. Finally, secure the leader match into the "lift cup" with a dab of hot-melt glue. (TAKE CARE not to get the hot glue on the plastic baggie or it'll melt a hole right through it!)

Invert your lift cup over the time fuse, so it's well centered on the bottom of the shell, and so the leader lines up with an "open" side of the leader hook. Attach the cup to the shell with a bead of hot glue using plenty of glue, then let it cool THOROUGHLY before you let go of the lift cup (otherwise it WILL slide out of position).

Thread the end of the leader through the leader hook as seen in Figure 27. Finally, lay a bead of hot-melt on the inside surface of the leader where it will curve around the shell, and carefully flatten it out onto the surface of the shell, so it doesn't protrude any more than its own thickness.

You just finished your shell! Wait until you're sure all the glue and cement is dry. Fire it safely according to proper shooting protocols, and enjoy your work! 🔥

bag.

Figure 21: Securing visco into leader using masking tape.

Figure 22: Tape is twisted to form a good seal.

Figure 23: Lift assembly loaded into a paper cup.

Lloyd Sponenburgh (left) working with a student during his shell building seminar at the 2005 Florida Fall Fireworks Festival. Lloyd spent the time to write this article and print it out in full color for all class participants to have as a reference. Sixty shells were built as described here (mostly by first time builders) and fired as part of a larger display that night. All sixty shells worked flawlessly.

More Pictures

Figure 24: Paper cup glued onto the bottom of the shell.

Figure 25: Leader runs up through the plastic eyelet.

Figure 26: Blue PVC cement used to seal joints.

Figure 27: Finished shell ready to fire.