1 lb. Black Powder Rocket...

Figure 13: Securing the passfire match into the shell pipette with twine.

Figure 14: The shell hemis loaded and ready to close.

Figure 15: Side view of stacked pairs of pasted strips.

4" Ball Shell Header

Ball shells make ideal headers for rockets compared with canister shells since they produce a larger burst with a lighter payload. The shell shown here is a 4" single petal ball shell, which typically weigh around 250 grams and is about the largest header you would want to try and take up with this rocket. If you want to use a canister shell instead, you will need to drop the size down to a 3" canister in order to keep the payload about the same.

The shell shown here is produced using vacu-form hemispheres, which are lighter weight and produce a more symmetrical burst than commercial Chinese hemispheres. Because the vacu-form hemis get a little damp from the pasted outer casing, they often dry very wrinkly and pretty ugly looking, but don't judge them by their outer appearance because these will blow away any commercial 4" shell in terms of consistent roundness of burst!

Unlike regular ball shells, rocket headers do not require time fuse. In place of where the time fuse would normally go, a small hollow tube is inserted so that about 1/2" of it protrudes on the outside of the shell, with the other end reaching the center point of the shell. These tubes can be rolled from a 2" wide x 3-1/2" long strip of 60 lb kraft paper around a 1/4" former rod, which should give you a 2" long tube with a 5/16" outside diameter. Two sticks of thin black match are then routed through the tube, folded down around the inside and tied off as seen in Figure 13. Sometimes the header can get popped off the top of the rocket during the fire transfer, so it is important that the passfire match be secured to the fire transfer tube so that it can not pull out before the fire gets there.

The shell is loaded with a single layer of 3/8" stars, followed by a layer of tissue paper that is then filled with a burst charge of 7:1 KP on rice hulls. Figure 14 shows the loaded hemispheres ready to be closed. A sheet of tissue is placed over one hemisphere in order to keep the material from spilling out when it is inverted and placed on top of the other hemisphere. The shell contents are settled in place by tapping the outside with a wooden stick until the edges of the hemispheres come together. The excess tissue it then torn away and the seem is closed with a band of tape. If you are using the vacu-form hemispheres, then you will need to cover the outside with a layer of masking tape in order to limit the amount of water that leeches into the hemispheres from the pasted outer casing while it dries.

The paper used to paste in this shell is 30 lb virgin kraft, which is light tan in color and is quite strong when it dries. I believe this variety of

Figure 16: The paste pattern starts with one full wrap around the shells circumference.

Figure 17: The next strip crosses perpendicular to the first.

Figure 18: The remaining areas are pasted in with smaller strips .

kraft is known as "blonde" virgin, which lays down good when it is wet. I know what you are thinking… been there, joked about it. But seriously, this is good stuff.

The strips are cut so that the width is equal to 1/8 the circumference of the shell, which is 1.5" in this case. Twenty strips 24" in length are required in order paste in the shell, which are applied in sets of two strips stuck together. So each strip is actually two 30lb strips stuck together when you are applying it to the shell. I like to prepare two sets of five pairs of strips, as seen in Figure 15. Paste is applied to the surface of each strip, onto which the next strip is laid and the process repeated. It helps to offset the ends of the strips in a stair-step fashion so that you can peel them apart again when applying them to the shell. Once two stacks of 10 strips are prepared (five sets of two in each stack), they are crumpled up and squished around in a ball to work the paste in to the paper and "break" the fibers. Once the paste is worked in well, the strips are straightened out again and separated into sets of two so they can be applied to the shell.

Since this is a small caliber shell, you can get away with using a pretty simple pattern of strip pasting. The first strip runs from the time fuse, all the way around the shell and then back up to the time fuse, as seen in Figure 16. The second strip does the same thing, except crossing the first strip at right angles. The paste layer is half completed at this point, now you just tear off pieces to cover the four remaining quadrants and that completes a single paste layer. This shell requires six layers, so repeat the pattern five more times in order to complete the shell. You can rotate the pattern around at different angles if you like, but it really isn't necessary.

Final Assembly

Once the shell is dry, it is ready to be attached to the end of your rocket. First a stick of short black match is secured to the passfire hole in the rocket, using either hot glue or prime to hold it in place. If prime slurry is used, you will need to let it fully dry before attaching the shell.

The ball shell will need to fit flush against the top of the rocket engine, so you may need to trim off some of the fuse pipe if it sticks out too far to allow the engine to seat properly above the clay plug. The easiest way to attach the shell is to use a strong variety of hot glue to seal around the edge of the tube as seen in Figure 19. A fast drying type of glue designed for sealing cardboard cartons can be found at PyroSupplies.com which is very strong and holds the header in place with no further reinforcement necessary. To secure the header even further you can run a few turns of pasted lightweight craft around the seam, tearing it into pleats so that it fits flat against the shell.

The rocket is finished by inserting a hooked piece of visco type safety fuse into the nozzle, as seen in Figure 20. The hook at the end of the fuse prevents it from accidentally falling out of the large exhaust hole where it is inserted. The fuse is pushed up as far as it needs to be to lock it in place. An optional two turns of lightweight kraft can be applied around the end of the tube and tied around the fuse as an additional precaution to keep the fuse from falling out.

Figure 19: Attaching the dried header shell to the engine using hot glue.

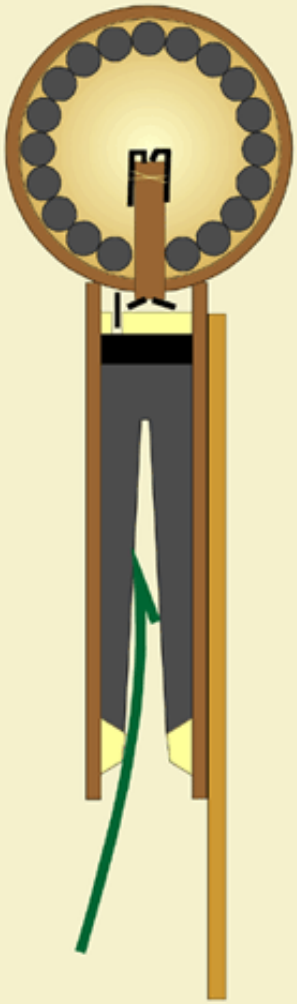

Figure 20: Cutaway view of completed rocket.

The stick for this rocket should be about 5/16" square and 42" long. The length of the stick matters more than the diameter of it, and it can be either round or square. A 1/4" dowel rod would work just as well. I like to cut sticks from cedar, which is a very light weight wood. The weight of the stick doesn't effect how straight the rocket travels, since it is the wind blowing against the stick that keeps the rockets trajectory straight. This is why when you fire rockets in windy conditions the rocket will actually turn and fly into the wind, which is the opposite of what you would expect to happen.

Launching

The easiest way to launch a stick rocket is to drive a piece of metal tubing into the ground. The stick should slide freely inside the tube and the rocket is placed so that the case rests on top of the tube. The tube can be angled in the direction you want the rocket to fly, but rockets usually have a mind of their own and will deviate in unpredictable directions. The spent casing and stick have enough force to dent a car when coming back down, so be careful where you shoot these. Your first dozen rockets should not have a header at all until you can get the engines working reliably without any malfunctions. When launching a rocket with a shell header, always assume that it will malfunction and the header will go off right at ground level, then choose your launch site and protect yourself accordingly.