

**Build This...****Color to Report Cake****Summary:**

Cake items are the king of consumer fireworks, and you never really gain full appreciation for the incredible state of refinement the Chinese have taken cakes to until you try and make one yourself!

This introductory cake project shows the construction of a typical color to report repeater. Like a true cake, the tubes are bottom fused and bound into a single disposable block.

**Color Formulas:** [Mag Red](#), [Mag Green](#)

**Materials:**

- ▶ (6) 6" square file folder sheets
- ▶ (6) 6"x4" 30 lb kraft sheets
- ▶ (24) 5/8" I.D. x 5" long tubes
- ▶ 20g star comp

**Unmeasured Materials:**

hot glue, 3Fg, meal, flash powder, thin black match, 1/8" visco, fire clay

**January, 2003 Issue****Letter from the Editor:**

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**Technique:**

[Making Chinese Fuse](#)

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**Tools:**

- ▶ Hot glue gun
- ▶ 1/2" rod
- ▶ 1/2" rammer
- ▶ 1/2" ramming base
- ▶ 5/8" rammer





## Color to Report Cake

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### Introduction:

Cake items are deceptively laborious items to create, which could explain why so little is written about their construction. On the plus side, cakes require very little composition to produce while also providing a long effect duration compared with chemical hungry items such as aerial shells. They are ideal for the beginner with a low budget or limited shoot sites, since 100g batches of color comp can make several cakes and shooting them does not attract much attention in areas where class C items are already legal.

Cakes can range from simple arrays of single shot star guns to complex assortments containing timed volleys of whistles, shells, tourbillions and essentially anything that can be shot out of a tube. The limited space constraints and timing issues provide many challenges for the pyrotechnician to master, and attempting to make this type of device brings a new level of appreciation for the extreme level of refinement the Chinese have achieved in this area.

Hobbyists who specialize in this particular spectrum of pyro are often referred to as "micro guys," since they must create very tiny effects to fit in the small tubes cakes require. A few micro guys even go so far as decorating their cakes with authentic looking wrappers, complete with warning labels, directions and of course a Chinese sounding name!

The construction method shown here is used in many common cake effects, so it is a good starting point for learning about basic cake construction. Many cake loads consist of a thin walled tube plugged at one end with a recessed clay plug, with a rising effect composition filling the recess and providing the timing. The tube can contain a report, breaks of colored stars, spinning effects, flying fish fuse or whistles to name a few. For this project the effect will be a colored rising comet to a report.

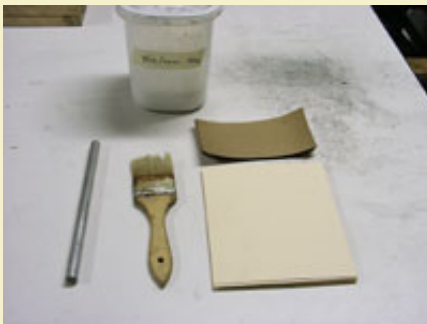


Figure 1: Materials for hand rolling tubes.



Figure 2: Applying diluted white glue to paper before rolling.

### Making the Shot Tubes:

There are two tubes you will need to make this type of cake: the mortar and the shot. If you can buy both tubes in the size you need, then you can save yourself some work. But usually you have one tube on hand and must roll the other. I prefer to roll the shot to match whatever I have laying around for mortars, since the shot tube is smaller. I happen to have a very large supply of 6" long x 5/8" I.D. tubes that were given to me by a very generous passfire member, so I will use that as the mortar and design around it. The size is not critical, so feel free to adjust things to match what you have. If you make the shot exactly as shown here, you can shoot it out of tubes ranging from 5/8" to 3/4" I.D. with a length between 4" and 6". Shorter tubes will just require slightly more lift.

The shot tubes are 1-1/2" long with a 1/2" I.D. and an O.D. just under 5/8". I make these by first rolling 6" long tubes and then cutting them into four segments as seen in Figure 3. Each tube is rolled from a 6" square sheet of file folder paper, which makes very strong tubes that are also easy to roll. The first turn is wrapped around the former, as seen in Figure 2, then a mixture of white glue diluted 50% with water is brushed onto the remainder of the sheet and also on the small strip of 30 lb kraft that will make up the last few turns. The purpose of the thin kraft sheet is to keep the stiffer file folder paper from



Figure 3: Cutting 6" tubes into 1-1/2" segments.



Figure 4: Clay plugs rammed and drilled.

unrolling once it is rolled.

Do not be tempted to use dry-rolled tubes for cake shots, as the lift pressure will blow the core through and telescope the case like a Chinese yo-yo! The layers of paper must be bound to each other to prevent this problem.

Cutting the tubes into segments while they are still on the former is the best way to get a nice clean edge, although it does tend to score up your rolling rod. Pressing down with a good sharp knife while moving it forward to spin the rod around should separate the tubes after about two complete turns.

You will need 24 shots to make this cake, but it is good to roll a few extra for tests. A food dehydrator can be used to accelerate the drying of these tubes, or even a wooden box heated with a 100W light bulb will do the trick.

Once the tubes are dry, you will need to ram a thin clay plug at the end of each one such that it is recessed from the end by 1/4". A block of wood with a segment of aluminum or wood dowel sticking out by 1/4" is required for making the plug, as seen in Figure 4. The plug only needs to be about 1/8" thick, and it doesn't need to be rammed as hard as a rocket or gerb nozzle would be.

Next you will need to drill a 1/8" passfire hole through all the plugs. You can fabricate your ramming base with a 1/8" pin and use a hollow drift if you want to form the hole and the plug in one operation. Make the pin at least 1/2" long if you go this route.

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Figure 5: Chinese fuse inserted through passfire hole.

### Loading the Shots:

The tricky part of getting these shots to function correctly is achieving a reliable passfire from the color rising effect into the contents of the tube. The Chinese typically use a double strand of the paper fuse described [here](#), but I find this type of fuse to be unreliable when I make it myself. It will often fizzle out while making the transition through the clay plug. Small diameter black match of the type made for cross matching time fuse is my choice for this application. Not only is it easier and faster to make, it contains more powder and is thus less likely to lose fire.

If the stick of black match fits too tightly in the clay plug, it will be difficult to quickly assemble the shots and also cause a potential delay between the rising effect and the report. The hole in your clay plug should allow the match to easily drop through it without forcing it.



Figure 6: Damp color comp pressed into end cavity.

The problem with such a loose fitting piece of match is keeping it at the exact right height while loading the color composition into the cavity. The black match should only protrude a tiny amount above the clay plug, as seen in Figure 5. If it sticks up too far, or even protrudes all the way through the color comp, it will set off the salute too early while the color is still burning.

The easy solution to this problem is to load the shots on a wooden peg that acts as a depth stop for the pieces of match, as seen in Figure 6. Wooden dowels are glued into holes drilled in a sheet of particle board such that they stick up at least 1/2". It is important that they all be the same height, and also that your sticks of match all be cut to the same length. A good tool for reliably cutting all the black match pieces to the same length is described [here](#).

If you can not cut many pegs to the same length in order to make the jig shown in Figure 6, then just make one peg glued into a small block of wood and load each shot one at a time. Note that loading many at once with the multi-pin jig will save a considerable amount of time, so it is well worth making this jig if you plan to make many inserts of this type.



Figure 7: Loading flash into tubes with special scoop.

Once you have fabricated your fuse placement jig and inserted your black match sticks, dampen your color comp to the consistency of dough and press it into each cavity as shown in Figure 6. If you are using the mag colors suggested on page 1 of this article, adding 10 grams of water containing 15% alcohol to 20 grams of color composition will produce enough to load 24 shots. Note that dampening most other color comps with 50% water will over wet them, so you will have to determine the proper amount based on the formula you plan to use. The comp should be damp enough to seem like clay when it is pushed into the tubes, but not so damp that water oozes out when you press hard on the comp.

At this point I like to allow the color comp to fully dry before proceeding



Figure 8: Paper wadding stuffed into tubes.



Figure 9: Sealing ends with hot glue.



Figure 10: Brushing a prime slurry onto the dried color comp.

further. This can take at least 3 days even when accelerating the dry times using a food dehydrator or other type of speed-drying method. The color comps given on page 1 are not easily driven in, so you may employ forced drying methods without fear of ruining the devices.

Once the pressed color comp is dry, bind all your shots into a bundle using a rubber band and load them all 2/3 full with the flash powder of your choice, as seen in Figure 7. The special scoop shown here, which was crudely fabricated from a sheet of thin aluminum, allows the tubes to be charged without the use of a funnel to guide the powder.

Once loaded, the tubes can be plugged with either hot glue or a 1/2" paper end plug. When using hot glue, it is necessary to first plug the tubes with a wad of paper to prevent the glue from seeping into the flash charge. If these shots were to be used as inserts in a canister shell, then hot glue would be the required plugging method in order to prevent gas leaks from setting off the reports when the shell breaks. Figure 8 shows the wads of paper inserted into the tubes. The excess flash is blown off the tubes where the hot glue will contact the tube walls so that it will not reduce the adhesion of the glue.

Figure 9 shows the hot glue being used to plug the ends. If you are making these shots to use as shell inserts, it is very important at this stage to insure that there are no pinholes or air gaps in the glue where hot gases could leak into the salute tube from outside.

Once the hot glue solidifies, the bundle is flipped over and the dried color composition is brushed with a slurry prime of BP. It is important that the color comp is fully dry before applying the slurry prime, as well milled BP can act as a pretty severe moisture barrier after it dries.

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Figure 11: Basic fuse chain for single row.



Figure 12: Firing pace increased with double row sequence.

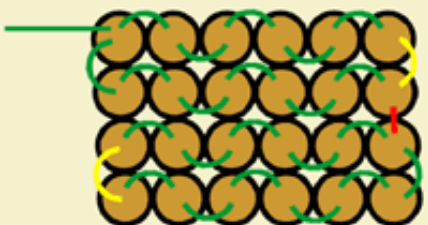


Figure 13: Complete cake consisting of two double row sequences linked together.



Figure 14: Glueing each row of tubes together before fusing.

### Fusing Sequences:

One of the defining characteristics of a true cake is that all the shots are fused from the bottom. Cakes that are produced by loading a rack of small mortars with small shells where the leaders are hooked into a time fuse chain are, in my humble opinion, just miniature versions of a display chain.

Half the battle in making good cakes is getting good timing out of your fusing sequence. Visco is the fuse of choice, since it does not easily ignite from the side from stray sparks. However, visco will side ignite other pieces of visco if in direct contact with it while burning, so care must be taken to insure that separate visco links do not come in contact with each other. Figure 11 shows the basic fusing sequence for a single row of tubes. The visco links alternate sides so that rows can be placed up against each other without their fuses touching, as seen in Figure 12.

Note that the entry and exit points of any given visco link do not directly face each other. While it would seem easier to just link the tubes right where they butt up against each other, doing so would frequently result in a chain reaction where two or more shots fire together. This is because the lift gases can shoot around the sides of the fuses from one hole into the next. I have seen entire rows blow all at once because of this.

Because the holes must point away from each other, longer pieces of visco must be used to bridge the gap. Due to the slow burn rate for visco, the configuration shown in Figure 11 would burn with rather large delays between shots. Figure 12 shows how the pace can be quickened by linking in a second row with a slightly longer piece of visco so that it fires in parallel but out of sequence with the first row.

Figure 13 shows the fusing sequence used for the cake described in this article. It is basically two blocks constructed as shown in Figure 12, then linked together by the short fuse shown in red. While this violates the rule of avoiding fuse holes that face each, I would rather have a double fire and get a quick connection to the next firing block rather than have a long delay. The optional fuses shown in yellow are backup paths in case there is a break in the chain. If one visco link fails to ignite, the other row will loop around and eventually fire the stranded shots. I suspect that a similar feature in commercial cake chains is responsible for the renegade, never ending cake that sometimes ruins a show segment by firing single shots at a slow pace for what seems like an eternity.

### Constructing the Mortar Block:

The tubes used here are 5/8" I.D. x 6" long cores that once were rolls of twine. A 1/2" plug of clay was rammed into the bottom of each one and a 1/8" hole drilled through both sides of the tube right above the plug. The tubes were then arranged in groups of six and held in position with a bead of hot glue, as



Figure 15: Cutting visco at a sharp angle to increase its ability to take fire.



Figure 16: Closeup of visco fuse links.



Figure 17: Bottom view after all tubes are fused together.



Figure 18: Pushing in retainer wadding after all shots are loaded.

seen in Figure 14. The tube rows are much easier to work with when they are connected together like this prior to fusing. Make sure that the fuse holes are angled towards each other in the alternating pattern shown.

Next a batch of 1-1/4" long pieces of visco are cut such that each end is at a sharp angle, as seen in Figure 15. Not only does this angle make it easier to insert the visco through the holes, it increases its ability to take fire by exposing a larger surface area of the powder core and also providing a sharp edge that will easily ignite. Prepare 20 pieces that are 1-1/4" long and 4 pieces that are 1-5/8" long. The longer pieces will be the connectors at the ends of the rows.

First insert the shorter fuse links into the hole pairs as seen in Figure 16. You will then have four rows of six tubes that are fused together. Arrange the rows next to each other so that the visco links don't contact each other, as seen in Figure 17. Choose one end for the connector link between rows two and three, which will be the red link shown in Figure 13. Use an ice pick or drill press to make the extra holes necessary to install this link.

After installing the cross link, bind all the rows together with fiber tape so that you have a sturdy block. Now you can install the 1-1/2" links at the ends that will connect the rows to each other. You may need to make a few extra holes to do this. Don't worry about empty holes that don't get used.

#### Loading:

The cake is now ready to be loaded. I lift each shot with about 5 grams of home made 3Fg black powder. The amount of lift required will vary widely based on your tube length, tube diameter, grain size and strength of your lift powder. Thus you will need to single fire a few shots until you can dial it in.

Each tube is loaded with lift, followed by the shot (prime end down) and then a wad of paper to hold things in place. Figure 18 shows a 1/2" rod being used to force a scrap of 30 lb kraft into the hole and down to the top of the load.

#### Firing:

The cake shown in Figure 19 can be fire as is, or wrapped in paper or plastic for weather resistance. It is always a good practice to paper or foil over the tops of the tubes to prevent sparks from falling inside and igniting things out of order.

Be sure to block this cake in using something like bricks to keep the recoil from bouncing it over on its side while it is firing. Other methods of securing it include driving wooden stakes around it, tying it to a single stake, fastening it to a wide wooden base or bagging the cake and digging it into the ground. 🔥



Figure 19: Finished cake held together with a few bands of fiber tape.