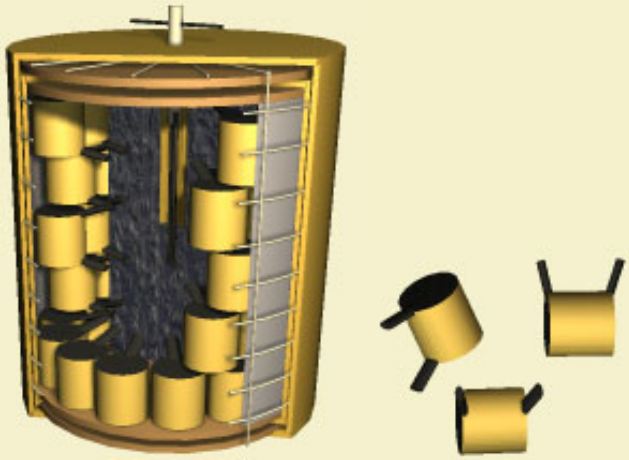
Build This...

5" Pill Box Star Shell



April, 2005 Issue

Build This:
5" Pill Box Star Shell

Design Notes:
Pyro Shop Design

Tool Tip:
Shell Builder's Workbench

Accident Analysis:
Ball Milling

Class C Corner:
Mayhem,

Summary:

Pill box stars, also called box stars, are a unique type of star that burn very brightly for a longer duration than a comet star of the same size. They are usually metal fueled color stars, with long illuminated smoke trails behind them as they burn through the sky. Because of the extended burn time, which results from the paper sleeve around the star that prevents it from igniting on all sides, these stars will droop like parachute flares and are generally fired as single break color shells. This article explains how to make pill box stars and then produce a typical 5" color shell with them.

Formula: John Albert's Green Pill Box

Materials:

- (3) strips 24" long x (star height x row count) + 3-3/4" wide 70lb virgin kraft, grain short (case)
- (1) 23" long x (star height x row count)+1/4" wide chipboard, grain short (liner)
- (3) 24" long x (star height x row count)+6" wide strips 70lb virgin kraft, grain short (paste wrap)
- (1) 36" long x (star height x row count)+10-3/4" strip of 30lb kraft, grain short (outer wrap)
- (4) 4-1/2" kraft or chipboard end disks, 1/8" thick
- (1) 2" piece of time fuse or spolette w/3.5 sec delay
- (1) 3/8" ID x 2-1/2" long pipette (2-3 turns of 70lb kraft)
- (1) 5-1/2"" of 4 strand cross match
- (1) 1" piece of 4 strand cross match
- (1) 17" piece of 8 strand black match

Tools:

- 4-1/2" dia. case former
- Rubber mallet
- 20" long x 3/4" OD dowel or pipe
- Cross match punch
- 7/32" drill bit
- Hot glue gun
- 3/4" pillbox tool (optional)
- paper cutter
- Scissors
- Anvil cutter w/length gauge

- (1) 30" quickmatch leader
- (7) 5" x 12" sheets 60-70 lb kraft, grain long
- (70) 2" long sticks of black match
- (700 gram) pillbox star composition

Unmeasured Materials:
flax twine, 2FA black powder, white glue or wood glue, masking tape, wheat paste

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Figure 1: Rolling 12" long tubes, 2 turns 60 lb kraft.

Figure 2: Cutting dried tubes into 1" long segments using a paper cutter.

Introduction

Pill box stars, also called box stars, seem to get little attention compared to the more popular cut, pumped and round stars. Pill box stars have been around a long time and have some distinct advantages over other types of stars. Because pill box stars are packed into a thin paper tube, they are stronger than regular pumped stars (comets) and can thus withstand stronger shell bursts without being pulverized. Pill box stars are "primed" using a built-in strand of black math, which results in much better ignition and less blind stars even when thrown from the shell at very high velocities. Since pill box stars are stacked along the sides of a shell just like pumped stars are, they offer the same structural integrity of pumped stars.

The performance of a pill box star is similar to a large pumped star, except that they tend to burn for a longer period of time due to the paper wrapper which prevents it from taking fire on all sides. A pill box star can be spotted by its brilliant light output, sparser star density, long burn time and the illuminated smoke trails that produce a drooping willow effect (see Figure 15 at end of article). This is a distinct effect that is not really produced by any other type of star.

To the first time observer, a pill box star appears to be some kind of insert or a pasted in comet. However, these stars are really quite simple to make and can be nearly as quick to produce as pumped stars made with a comet pump. Best of all, you don't need any special tooling other than a wooden dowel rod!

Making Pill Box Stars

Pill box stars look like regular comets that have been pasted in with a few turns of paper, but the paper sleeves are actually rolled first and then charged with composition afterwards. So the first step is to produce many tiny paper tubes that are the same diameter as the stars you are making, ¾" in this case.

When making pill box tubes, it is much quicker to roll long tubes and then cut segments from them. The tubes rolled here will be 12" long and ¾" I.D., using two turns of 60 lb kraft. The paper can be recycled kraft, and even grocery bags will work. Start by preparing several strips of kraft measuring 5" wide by 12" long, with the grain running in the long direction. Having the grain run parallel to the length of the tube is important, since it allows the tube to be rolled much easier and prevents it from warping when the paste dries. If your tubes are bent upon drying, you miscalculated the grain direction.

The tubes are made by pasting half the sheet of paper as seen in Figure 1, then rolling them as tightly as possible around the dowel.

Figure 3: Cutting process tends to flatten tubes a little.

Figure 4: Using the anvil cutter with length gauge set to 2" for cutting 70 sticks of black match.

Figure 5: Inserting a stick of match and bending the ends to hold it in place during loading.

Making the tubes any longer than 12" can make this step hard. Note that white glue can be used in place of wheat paste, but the wheat paste is much faster to apply and the finished tubes are a little better quality.

These tubes can be dried in a drying box in about an hour or so, otherwise you can put them out in the sun for half the day or use a fan to help speed up the drying process.

Once the tubes are dry, a paper cutter is used to cut two or three at a time, making one inch long segments. A heavy object such as a box can be used as a depth gauge when cutting, as seen in Figure 2. Make sure both the box and the paper cutter don't slide around when using this method. The tubes will get squashed flat a little when cut, but this doesn't matter.

Pill box stars take fire from a stick of black match that runs up the side of the star, with a least ½" of match sticking out at both ends. Thus you will need to prepare at least 70 sticks of black match that are 2" long to build the pill box shell. This is a great use for those excess pieces of black math leftover when building other devices (you know, the ones that are too long to throw away but too short to fuse or lift any shells with). The anvil cutter with length gauge shown in Figure 4 makes the job of cutting all the match go pretty fast.

Note that the quality of your black match will make or break your pill box stars. Because the match will be severely bent on each end where it contacts the star, poorly made black match with only a shell of powder coating the outside of the string will result in many blind stars. If your match turns into floppy white string at the bending points, read here about how to make good quality black match first.

The composition you will be using needs to be dampened about 8 to 10 percent, depending on the formula. There are many formulas on record that are specific to box stars, but there is no reason you can't use any star formula you want. Most metal fueled bright colors look good, and you can use streamers as well. The break in Figure 15 is using the Buell Red magnalium fueled formula, which is not specific to box stars. There is some debate about weather box star compositions should burn slower or faster than normal star compositions, but really it all depends on how long you want your stars to burn.

Pill box stars are not primed, so you don't have to worry about fancy primes for hard to ignite formulas. The black match burning across the edge of these stars is very effective at igniting almost anything you use. If you are making chlorate box stars, then using KP match for the fuse would be a good safety measure, even though BP match has been used for chlorate stars in the industry for years. If you are using a hard to ignite formula such as a KP/Aluminum flitter, then KP match can also be used to provide a hotter flame for better ignition.

The formula being pressed into stars here is the Green Pill box MgAl #2 from John Albert, and was dampened with 10% water. You will need to prepare about 700 grams of this formula to make all 70 stars plus a few extras for testing. This is an excellent formula by the way,

Figure 6: Scooping up damp composition and pinching it into the tube.

Figure 7: A slotted nipple and rammer for consolidating comp after loading.

Figure 8: A couple of light taps from a rubber mallet for additional consolidation.

with minimal ingredients, no chlorate and awesome color quality. There are no orange sparks or yellowish magnalium fallout trailing behind these stars, only pure green floating through the sky! The color may look pale when testing on the ground, but this is typical with bright colors and they will look a deeper green when viewed a few hundred feet up in the sky.

To load the pill box sleeves, start by inserting a stick of match and bending the ends as seen in Figure 5. Pinch the match between your fingers and use it to hold the tube while scooping it into your damp powder bowl. As you scoop the tube to fill it up, use you're your thumb and finger to compress the powder solidly into the tube. Keep scooping and pressing until the tube is full. You may also need to squeeze the side of the tube to get it back into a round shape if it is still oval shaped after loading.

At this point there are two schools of thought, and you can just choose the one that you prefer. Traditional texts just describe pinching the powder in by hand and that's it, you're done. However, other people prefer to lightly consolidate the composition further using light taps from a lightweight mallet. This is done to remove any possible air gaps and produce a stronger star. This no doubt results in better quality, but might not really be necessary.

If you want to consolidate the star comp further, you will need to build the simple wooden tool shown in Figure 7. This consists of a small nipple about 1/8" tall and a matching rammer that is about 5" long. Both the nipple and the rammer have a small notch cut in the side so that they can accommodate the match sticking out from the pill box star. Figure 8 shows how the star is placed between the nipple and the rammer, then tapped a few times with a rubber mallet. You are not whacking drivers or pumped stars here, only a few light hits is all it takes.

That's all there is to it, just make 69 more of them plus a few extras for testing and set them aside to dry. Using the Passfire drying box I was able to dry these stars to a usable state in just 24 hours, although it is probably best to dry them at least 48 hours when force drying them. Otherwise air drying can take a week or more.

More...

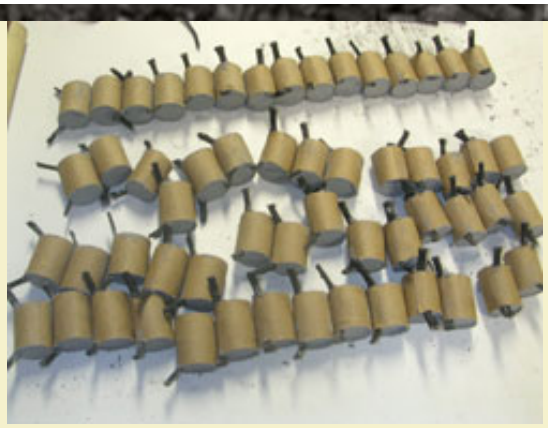

Figure 9: Completed pill box stars ready for drying.

5" Pill Box Star Shell...

Figure 10: Loading rows of 14 pill box stars, using sawdust to pack in the gaps behind them.

Figure 11: After all five rows are "dusted" in, the shell should be tight and resistant to bending.

Making the Shell:
The casing for this shell is produced in the standard way for a 5" canister shell, using 5 turns of 70 lb kraft that is 3" longer than the length of five pill box stars stacked end to end. If five of you stars measure 5 ¼" long, then you can roll the case from 5 turns of paper measuring 8 ¼" wide. The inner chipboard liner would then be rolled from one turn of 5 ¼" wide chipboard.

Normally two turns would be used for a typical canister shell, but one turn was omitted in this case in order to allow 14 stars to fit tightly into each row. If two turns of chipboard were used, you would have to use 13 stars and then shim a lot of extra space leftover between the stars.

The chipboard liner shown in the pictures was actually too tall for this shell and had to be cut down before the shell was closed. You don't want to have the excess chipboard seen above the last row of stars as seen in Figure 11 and 12, so be sure to measure a stack of five stars first in order to avoid this problem. A slight overhang is fine and can be fixed by filling the excess space with rough powder, but the overhang seen here is really too excessive for that.

This shell is loaded with five rings of 14 stars each, for a total of 70 stars. The stars are loaded so that the match strands all face inward, as seen in Figure 11. The first row of stars, which must sit on the bottom disk, need to have the bottom piece of match bent at a severe 90 angle so that the stars can sit flat. Some builders will clip the bottom piece of match off altogether to avoid this problem, which is probably the best approach.

Each ring of stars should be packed in using sawdust tamped into the space behind each star and the shell wall, as seen in Figure 10. You can actually be quite sloppy with the sawdust when pouring it behind the stars, since the stars will be locked in place when you are done so that you can turn the shell upside down to dump out the excess sawdust.

As when building comet shells, each row of pill box stars should be placed over the joints of the previous row, just like when building a brick wall. This is even more important with pill box stars, since the strands of match prevent stars from sitting directly on top of each other.

If properly consolidated with sawdust, the shell should hold its round shape when squeezed from the sides, rather than easily distorting into an oval shape.

Figure 12: Filling the remainder of the shell with burst charge.

Figure 13: This shell was finished using unpasted paper followed by another layer of spiking, known as the "rinfasciature" method.

Figure 14: Completed shell ready for firing.

Figure 15: The brilliant stars bursting from the red pill box shell shown above.

There are a variety of break charges you can use with this shell, due to the fact that these stars take fire very easily and they are not easily blown blind or pulverized. The break charge cavity is rather large to be filled with straight 2FA, although you could do that if you want. This shell could be broke with rough powder if your rough powder is strong enough. For the shell shown here, the burst charge is KP on rice hulls in a 6:1 ratio. You could also use KP on puffed rice or BP on puffed rice as well. These different charges will just change the burst diameter, with KP giving the larger breaks.

The shell shown here was fused using a traditional spolette with a 1 ½" powder charge. Chinese time fuse could also be used.

The spiking was done with a double strand of 8-ply cotton, with 32 verticals instead of the normal 24 of single strand when using a good flax twine. The horizontal spiking was spaced so that equal squares were formed when crossing the vertical threads.

Normally this shell would be pasted in with 5 turns of pasted 70 lb virgin kraft, but for the test done here a prototyping method known as "rinfasciature" was used so that the shell could be fired the same day it was built. This is a construction technique where the shell is not actually pasted in, rather it is "pasted" with dry paper and then spiked a second time, as seen in Figure 13. The second layer of spiking gives the added strength that is lost from not using pasted paper. While this method is more time consuming and costly, it does allow you to fire a shell the same day you make it and produces break patterns that are usually as good as if you had pasted the shell in the normal way.

Because pill box shells are very light for their size, the standard rule for calculating lift charge (1 oz of lift per pound of shell weight) can not be used here. At least 2 ½" oz of lift should be used for this shell.