Skylighter

Making Mini-bottle Rockets

There was a Time When Boys Got Chemistry and Erector Sets

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Making Mini-bottle Rockets

This is a little bonus project, for which the materials are already included with your Turbo Pyro Supplies Kit. There are enough materials to make 10 Mini Bottle-Rockets.

Until now, the step-by-step directions for each Turbo Pyro project have been very straightforward and by-the-book. “Do this. Now do that.”

And this project can be the same if you’d like. Just go to the last 2 pages; there’s a simple set of directions there which you can use to make some mini-bottle-rockets.

The first 10 chapters of this course were written the way they were, with step-by-step instructions, because we wanted to get you, the “student,” off to a good start with some good successes under your belt in this new fireworking hobby of yours.

We wanted you to learn some basic fireworking skills as quickly and as error-free as possible using a sort of a “paint-by-numbers” approach.

But, there can be something deeper than that going on here if you let it happen. When I was a kid 40-50 years ago, we didn’t have “virtual entertainment” to keep us occupied. We had to use “real stuff” to play with. We built forts in the woods, constructed go-karts out of lumber and wheels, and we got Erector Sets with real nuts-and-bolts and pulleys and girders and only a few basic instructions, out of which we made cranes and towers.

We were off and running with those Erector sets, with “crystal radio sets,” and with the chemistry sets we got for Christmas–with actual, real chemicals in them. We performed real experiments, and we made real stuff.

And many of us kids, mostly boys, grew up to be the kinds of engineers and scientists who invented all kinds of great stuff, and sent men to the moon, and brought them back safely after emergencies in space.

Note: I know that in today’s world, where girls are working on Turbo Pyro with their moms and dads, the above can sound a bit sexist. I don’t mean it that way, and I welcome the equalization of the genders in today’s society. But in my day, it was boys who were blowing stuff up, and girls were not. That’s just the way it was.

If you look around nowadays, that sort of experimenting and creativity is becoming a distant memory. We can't have our kids playing around with real chemicals, can we? After all, they might make a mistake in their experimenting and end up doing something unsafe, something dangerous.

We have to entertain our kids with "virtual realities" in video games, movies, TV, and virtual athletics. "Go outside and play," sounds a bit quaint nowadays. We won't allow our kids to risk doing anything unsafe as in days past.

But, I, and many others, see a much more dangerous possibility in the current state of affairs: the potential loss of our curiosity, our creativity, and our willingness to experiment, make mistakes, and learn from them.

So, having laid that philosophical groundwork, I'd like to pull the curtain back, and reveal Turbo Pyro for what it really can be. You thought you got a book and kit, which would show you how to make fireworks. Which it does, of course.

But what you also really got was a modern-day chemistry set and erector set combined. It may seem like a bit of a dinosaur in this day and age, but there it is anyway. There aren't too many of this sort of set available nowadays.

Turbo Pyro is aimed at budding scientists, experimenters, inventors, explorers, and do-it-yourselfers.

It is that group who make up the community of fireworks hobbyists that I hang out with. We are a little different. And we're glad we are. We're glad we've found others who are actually like us, after we'd almost given up hope of doing that.

Now, as you've worked through Turbo Pyro, maybe you've thought to yourself, "I wonder what would happen if I did this instead of that." Or "what would I get if I did it this way instead of that way?" Or "How can I make one of these a little bigger?"

Perhaps in the past you were told, "You aren't very good at following instructions, are you?" after heading off in your own direction and doing some experimenting.

The experiments don't always, or even often, turn out the way you thought they would, but you learned something in the process, and often something you won't ever forget.

So, to you who have made it to this far in Turbo Pyro and feel in your bones that you're really only just getting started, I say, "Welcome. Isn't this a blast?"

I'm about to describe a very simple variation of one of the rockets in one of the Turbo Pyro projects, and what the benefits of making these modifications might be.

But, more than that, I'm going to describe the *process* of how I got to that modified end result: how, through trial and error, I got little devices which do what I want them to do, and to do it consistently.

I'll describe a bit of my thinking that occurred as I went along, the experiments I had to perform, the "failures" I experienced, the research and development that went into such a simple little device.

This process of research and experimentation actually went into every one of the projects in this course that you've already accomplished. You just didn't know it because I didn't mention it back then.

But, now, as you ponder where you go from here if you continue in the art that is fireworking, a glimpse into the process might prove useful for you.

It is that process of imagining, experimenting, being curious, being creative, failing often, and succeeding now and then, which keeps many of us involved and interested in this art for a lifetime. This hobby never stops being challenging for many of us. We can never master everything in fireworks.

So, maybe you are one of us. Don't be afraid (with some guidance from those of us who have been around a while) to ponder some experiments and "creations" of your own.

As I played with making the Magnum Bottle Rockets, and then the Stinger Missiles, using the combo-tool kit, I wondered if I could make a short-bodied mini-bottle-rocket, using a "hotter" fuel than the magnum-fuel, and a half-motor-tube and the stinger spindle.

Down in Mexico, the fireworkers make short-tube black powder rockets, called "cohetes," with report headings, and fire them during festivals. So, I pondered short-bodied bottle rockets, based on a combination of the magnum-bottle rocket and the stinger-missile design.

In my creative imaginings, these smaller bottle-rocket versions would have a few advantages:

- They would only use half of one paper tube.
- They would use about half as much fuel as a full-size version.
- They would be very quick and easy to make.
- They would be perfect for launching and testing stars, putting them way up in the sky before they are ignited.
- They would be good, easy, simple rocket projects for me to start my grandsons out on.
- A bunch of ‘em could be made quickly for a “flight” of several rockets ignited at the same time.

My reasoning behind using a “hotter” fuel for the mini bottle-rockets is that the shorter, stinger spindle will create a core in the fuel that is smaller in surface area than the core in the standard Magnum bottle-rockets made on the longer spindle.

Because of this, to create a similar amount of thrust using the shorter spindle a fuel, which burns faster, will be required.

The “hottest” fuel we’ve used in Turbo Pyro is the straight black-powder base mix.

For the Magnum Bottle-Rocket Fuel, we used 80% base mix combined with 20% 80-mesh charcoal. The added charcoal slowed the base mix down quite a bit, and added a lot of larger charcoal sparks to the rocket tails as they flew.

For the Stinger Missiles we only combined 5% of the 80-mesh charcoal with 95% base mix. This resulted in a fuel that was only slightly slower than straight base mix.

Note: One significant advantage I have when writing one of these articles is that I take detailed notes on each step of the project, and I actually write the article as I go along. That note taking is necessary to help me keep track of where I am and the changes I’ve made as I progress on developing a device. I cannot over emphasize the value of this note taking. If I didn’t do it, I’d be back to square one in a week if I wanted to duplicate my work. I would lose all the knowledge gained before. “Now, what was the final configuration of those versions which flew consistently well?” I’d be asking myself. Bottom line: take notes.

Trial #1

I decided to try Stinger-Missile fuel in the experimental mini bottle-rockets. I only wanted to make enough of the fuel to experiment with one rocket, and I knew each stinger missile uses about 3 grams of fuel.

So, I combined 3 grams of base mix with about 0.15 gram of 80-mesh charcoal. (I weighed out 0.1 gram of the charcoal, and then added a pinch more since my scale only weighs in 1/10-gram increments.) I mixed the fuel by swirling it in a paper cup.

I cut a paper tube in half, same as in the stinger project.

Following the instructions in the stinger-missile chapter, I rammed a clay nozzle in the tube, using a slightly rounded, ¼-teaspoonful of dry clay. I dumped any excess clay out of the tube, and made sure the hollow rammer hole was cleaned out.

No stinger-missile "spin-hole" will be drilled in the side of these mini-bottle-rocket motors.

I marked a no-pass line, and a top-of-spindle line on the tooling's solid rammer, once again as in the stinger-missile project. Then I rammed two ¼-teaspoonful increments of fuel in the tube with the hollow rammer, until the fuel was rammed above the tip of the spindle.

An increment of fuel rammed with the solid rammer took the fuel to within ¼" of the end of the tube. That was topped off with a clay bulkhead increment, and that little motor was done. Only a total of 5 rammed increments, between the clay nozzle and bulkhead, and the three increments of fuel. These babies get knocked together quickly.

To test-fire this first motor, I simply taped a bamboo skewer to it, and did not include any star-header, so as to minimize the weight of the rocket and also the risk of starting afire with a potentially underpowered flight.

Test Rocket #1 with 95/5 Fuel

Results of Trial #1

I stuck the stick into a little plastic launch tube, lit the Visco fuse, and that first rocket flew OK, but seemed a bit under powered, and didn't sound anywhere near a full-thrust rocket. I'm not sure it would have lifted much of a star-heading payload.

Trial #2

So, I decided to try 100% base mix for the fuel in one of the motors. I constructed a motor the exact same way as the first one, using straight base mix fuel, taped a stick on it and fired her up.

Results of Trial #2

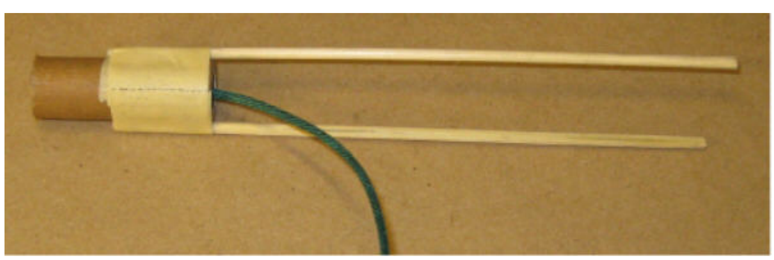
That second rocket really zipped out of the launch tube with a lot of force.

But, it tilted and started to fly on a bit of an angle right after it left the launch tube. Sometimes rockets, which can be surprisingly powerful for their size, do that because all the weight and air drag of the stick is on one side of the motor.

Trial #3

To try to solve that angled-flight problem I made a motor just like in trial #2, but I cut a stick in half and taped one half of the stick to each side of the motor, creating a two-stick rocket. This method can counteract the problems I thought the rocket in trial #2 was having.

The 12"-long bamboo skewer on the trial #1 rocket looked a bit out of proportion to my eye, anyway, so my hope was that the two shorter sticks would work well, and be more in proportion.



Test-Rocket #3 – Base Mix Fuel, Two Half-Skewer Sticks

Results of Trial #3

Well, that rocket zipped up there, but still did not fly as straight up as I'd like.

Trial #4

OK, even though the sticks look a little out of proportion, I'm gonna try one of the motors with two full-size skewers attached. Let's see how straight this baby'll fly.

Test-Rocket #4 – Base Mix Fuel, Two Full-Skewer Sticks

Results of Trial #4

Oh, Yeah! That baby flew nice, straight and high. Very nice. I repeated this test with another identical rocket to verify consistency and got the same results.

OK, now to attach a star header and see if the rockets will fly nice and high with that added weight.

Trial #5

I had some 5/8" diameter, round purple stars that I wanted to test in the air. So I figured I would try lifting one of these stars atop one of the rockets that I had dialed in so far.

I made a rocket motor, bringing the fuel to within ¼" of the end of the tube, and ramming a clay bulkhead as in all the previous motors.

I drilled a 1/8" hole through the clay bulkhead in the end of the motor. The passfire hole and the slight recess left in the tube atop the clay bulkhead were filled with base mix.

I put a star on top of that black powder, and taped it on with a few wraps of masking tape.

Test-Rocket #5 with 5/8" Single-Star Heading

Results of Trial #5

The rocket flew skyward nice and straight, but kept flying past apogee and started to turn downward. I could hear a hissing when the base-mix heading burst-powder ignited. A second later the star started to burn, but was heading downward as it did so.

It seemed as though there was too much fuel rammed atop the spindle before the clay bulkhead was rammed. This resulted in the long delay time as the rocket coasted and started to turn back down toward the ground.

Also, the base-mix burst powder burned rather slowly and did not really "pop" the star off the top of the rocket.

Trial #6

So, to try to remedy these two issues, I rammed a motor with only ¼" of fuel above the spindle, then rammed the clay bulkhead.

After drilling the passfire hole, I filled it and the void in the end of the motor tube with Hodgdon 777 black-powder substitute.

I taped another star heading onto that motor. I also heated the hot-glue gun up, glued the sticks onto the motor, and then reinforced them with masking tape. I had figured out that holding the sticks in place with the hot glue was much easier, followed by the band of masking tape.

Results of Trial #6

Aaaaarghhh…

The rocket flew up about 20-30 feet and blew its top, ejecting the star skyward.

That indicates that I didn't have enough fuel above the spindle and the pressure simply ignited the heading prematurely. It's also possible I didn't have a thick enough clay bulkhead to withstand that pressure.

But, when that hotter heading burst powder ignited, it really popped the star off the top of the motor. That's one improvement, anyway.

Trial #7

I made a rocket the same as in trial #6, except I rammed 3/8" fuel above the spindle, and then a good, thick clay bulkhead, leaving only about 1/16" of the end of the tube empty.

A heading with the 777-burst powder and a star was attached to the motor.

Results of Trial #7

Oh, man, a beautiful, high, straight-up flight, with the star heading popping right at the top of the flight, up about 150 feet. Really nice.

Except. When the purple star popped out, it looked like it was trailing some burning masking tape, which burns yellow.

I could certainly imagine the star being ejected off the top of the rocket motor with masking tape stuck all around the star, since that's the way it was attached to the motor.

Trial #8

So, I made the same rocket and heading, except I attached the star to the top of the motor with masking tape, sticky-side-out, followed by a layer of tape, sticky-side-in, lapping over onto the paper tube and attaching the whole heading assembly to the motor.

That way there was no masking tape actually stuck to the heading star.

Results of Trial #8

Perfect straight-up flight, just like in trial #7, except the heading star was propelled up and away from the rocket at apogee, with an audible pop from the heading burst powder. The purple star flew upward 10-20 feet and then started to arc back down just as it burnt out.

I was able to easily see how the star would look in the air if it had been ignited by an aerial shell-burst, which is one of the tests I like to perform on any star.

I made another model of the rocket in precisely the same manner to see if the flight was easily duplicated, and it flew just the same way.

Success!

I started a stopwatch, cut a tube in half, and made up two more rockets based on this final design. 11 minutes and 45 seconds to make two rockets, not including making the base mix or the stars for the headings.

That's about as close to instant-gratification as you can get in the fireworking world.

This is what those rockets looked like in flight.

Mini-Bottle-Rocket Launching

(Click to play video)

So, you can see a bit of the trial-and-error research and development that goes into a very simple device like this after we start to imagine it.

You can also see how many little variables there are even in such an elementary firework, and how changing one of those variables can affect the performance of the whole device.

Often when we make fireworks, something doesn't go quite the way we'd expected, and we have to go back, visualize the whole process of its construction and performance, and troubleshoot each step as we go along.

Repetition of the construction of these fireworks leads to confidence and consistency, and good notes can assist us in repeating their manufacture in the future, with a good possibility that we will succeed again based on that foundation.

Final Construction Procedure

If you've jumped ahead to this point, and have skipped all the research and development that went into getting these little rockets to fly consistently, these are the simple steps for making the final version I came up with:

1. Cut one of the 3.5" rocket tubes in half.

2. Assemble all the materials on the workbench, keeping the fuel and 777 powder closed until they are to be used.

3. Put one of the half-tubes on the middle-length spindle on the combo-tool base.

4. Put a mark on the solid rammer where the top of the tube is when that rammer is in the tube and sitting on the top of the spindle.

5. Put a mark on the solid rammer ¼-inch down on the solid rammer, indicating a "do not pass" line.

6. Using a slightly rounded ¼-teaspoonful of clay, ram a clay nozzle in the tube, using the hollow rammer. Dump out the excess clay.

7. Ram a flat ¼-teaspoonful of the base mix fuel in the motor, using the hollow rammer.

8. Repeat that last step with the hollow rammer, and make sure the rammer hole is clean of fuel when you're done.

9. Ram a flat ¼-teaspoonful fuel increment with the solid rammer, making sure the rammer never goes past the "do not pass" line.

10. Ram as much more fuel as necessary to bring the fuel above the tip of the spindle by 3/8-inch. (The ridge of the recess on the solid rammer should be even with the top of the tube when the end of the rammer is 3/8-inch above the tip of the spindle, and makes a good gauge.)

11. Ram a clay bulkhead, which fills the tube to within 1/16-inch of its end.

12. Drill a 1/8-inch passfire hole through the bulkhead, just into the black fuel grain.

13. Dump out any excess clay.

14. Fill the passfire hole and tube recess with FFg black powder or Hodgdon 777 black-powder substitute.

15. Install a star heading with masking tape, first sticky-side-out, then sticky-side-in.

16. Install two bamboo skewer sticks with hot glue and masking tape.

17. Insert a piece of Visco fuse, and hold it in the motor by using an awl to press a small wad of tissue paper into the nozzle alongside the fuse.

18. Take that baby out and fly it.

Making a Mini-Bottle-Rocket

(Click to play video)

All of these steps and skills have been described and demonstrated in the previous Turbo Pyro projects, and should start becoming second-nature to you about now.