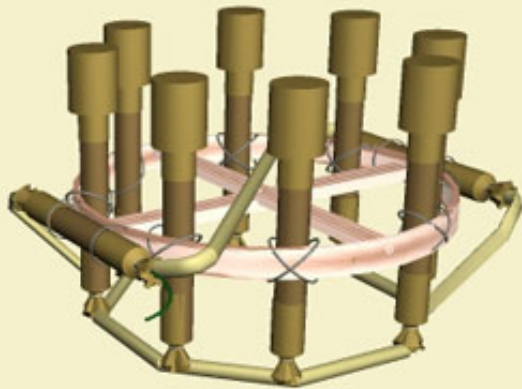




## Build This...

# 12" Girandola



## July, 2002 Issue

### Build This:

[12" Girandola](#)

### Design Notes:

[Girandola Design](#)

### Tool Tip:

[Building Girandola Frames](#)

### Autopsy:

[6" Smiley Face Pattern Shell](#)

### Summary:

This small girandola is a good entry point for learning how to make these flying wheels. The design shown here starts with two horizontal drivers that spin the wheel for about six seconds, after which a delay element ignites a ring of eight drivers. The wheel will then ascend to about 300 feet while the horizontal drivers continue to throw out an umbrella of sparks. The show finishes when the eight individual headers burst with a display of stars.

**Prerequisite Projects:** [Three Stage Triangle Wheel](#)

**Prerequisite Reading:** [Girandola Design](#), [Building Frames](#), [Fire Retardant Match Pipe](#)

**Formulas:** [1/2" Vertical Driver](#), [1/2" Horizontal Driver](#)

### Materials:

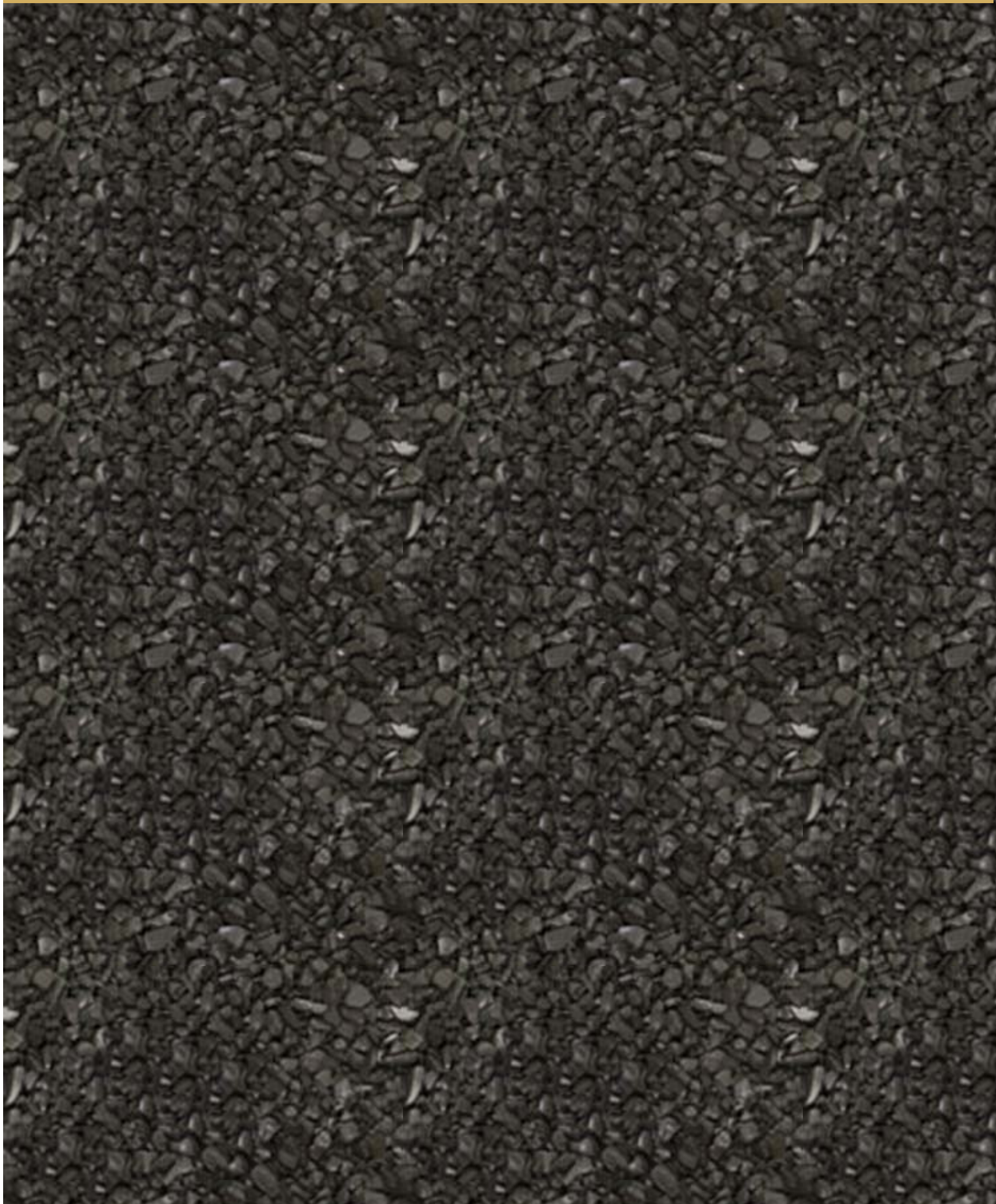
- ▶ (1) 12" diameter frame weighing under 100g
- ▶ (10) 5" long 1/2" I.D. x 3/4" O.D. kraft tubes
- ▶ (10) 3"x5" strips 30 lb kraft (nosings)
- ▶ (8) 3"x12" strips 60 lb kraft (headers)
- ▶ (20) 5-1/2" lengths of 18 gauge wire
- ▶ (2) 36" pieces of 3/8" ID fire resistant match pipe
- ▶ (1) 3-1/4" length Chinese time fuse
- ▶ (1) 4" long visco

### Tools:

- ▶ 1/2" Ramming Base
- ▶ 1/2" Ramming Drift
- ▶ Non-sparking hammer
- ▶ Wire cutters
- ▶ Hot glue gun
- ▶ Scissors
- ▶ Pliers
- ▶ Paper hole puncher
- ▶ Scale
- ▶ 7/64" drill bit
- ▶ 1/8" drill bit

### Unmeasured Materials:

White glue, bentonite, grog, black match, 4FA, stars, string, foil tape.





## 12" Girandola...



Figure 1: Loading the drivers on a pounding block.



Figure 2: Drivers fuses held in place with hot glue.



Figure 3: Rolling on the nosing paper.

### Making the Drivers:

The drivers used in most girandas are black powder end burners with no cavity in the powder charge. This is due to the desire for the longest burning driver possible while still having enough thrust to do the job. The duration/thrust tradeoff is very important to dial in when developing your drivers.

That's right, you will have to do some testing on these drivers even though the formulas are specified here. Black powder drivers of this type are very demanding creatures and it isn't as simple as mixing the formula and loading it into a tube. I wish it was, but there are too many variables such as mill times, charcoal types, ramming pressure and other issues that will give you different results than my own. The formula given is a good starting point, but you will most likely have to modify it. For a better understanding on how to go about this process, read [thrust calculation](#) section in this months Design Notes article.

You will need to produce a vertical driver that burns for at least 6 seconds and has about 200 grams of thrust, or capable of lifting a 35g stick (depending on your thrust measurement preference). This amount of thrust will blow out the cheaper varieties of recycled kraft tubes, so you may want to treat your tubes with Minwax Wood Hardener if this presents a problem.

The horizontal drivers should burn about 12 seconds. These will be under much less pressure, so there should be no risk of blowing these out. In the event that your driver burns longer than 12 seconds you can simply increase the time fuse delay that controls when the vertical drivers ignite (see page 4) such that the duration of the vertical drivers will match the remaining duration of the horizontal drivers at the time of liftoff.

Do not proceed to make all drivers until these specifications have been dialed in! If you can't get the thrust, then lower the charcoal content. If you have a lot of thrust but short duration, then raise the charcoal content. It helps to start by screening charcoal with ball milled meal in progressively larger amounts, making and testing a short driver with each new combination. Once you get an acceptable driver, then ball mill the final formula (without the metal added of course) to ensure a consistent and intimate mixture and test one last time.

The tooling for making these drivers can be made as described [here](#), except the ramming base will only have a small pin just long enough to mark the center point in the clay plug. Since there is no cavity, only a single solid ramming drift is required.

The basics of loading this type of driver can be found [here](#). Figure 1 to the left shows a driver being loaded on a ramming block, which was made by filling a



Figure 4: Using a former to make star bag headers.

2ft tall plywood box with concrete. It is important that a solid, vibration free path be created from the hammer surface to the rammer, through the case and spindle all the way to the ground. The use of rubber mallets, plastic hammers or other lightweight, shock absorbing materials is not recommended. Avoid ramming on anything other than a solid concrete floor or hard soil. Even when ramming on hard soil, at least two feet of solid material such as thick timber or concrete should be between the ramming base and the ground.

You will need to ram eight vertical drivers and two horizontal drivers. The vent holes of the vertical drivers are hand tapped with a 7/64" bit using a drill press to apply pressure to the bit while twisting the chuck by hand. Care should be taken to stop drilling once the powder has been reached, as too deep a cavity in the powder charge can cause the driver to over pressurize and blow. The top plug of all vertical drivers will also need to have a passfire hole drilled through the plug. Both horizontal drivers will get a 1/8" vent hole, but no passfire hole is necessary on the other end.

A bent piece of black match is hot glued into both holes on all drivers, as seen in Figure 2. This insures that the passfire into the small, shallow holes will not pull free during transportation and launch.

Scraps of 3"x5" 30lb kraft are rolled around the exhaust end of all the drivers. Figure 3 shows the glue pattern for applying the nosing paper.

Star bags for the top end of the vertical drivers are created by rolling a 3" x 12" piece of 60lb kraft around a special former shown in Figure 4. This former consists of a 2" long segment of 1-1/4" dowel rod that has another 2" long segment of 3/4" dowel rod glued into one end. The paper is rolled flush with the flat end of the larger former, then the overhang is crimped down around the smaller dowel to form a sleeve that fits nicely onto the 3/4" O.D. driver. Glue is applied around the top of the driver before inserting the star bag, then a clove hitch is used to secure the flange onto the driver.

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Figure 5: Wiring drivers to frame.



Figure 6: All drivers wired in place prior to fusing.



Figure 7: Sticks of black match tied into driver nosings.

### Assembly:

Once all drivers are nosed and the star bags are attached, they are ready to be wired onto the frame. Since this is a single hoop style frame, wire must be used to hold the drivers to the frame. If twine is to be used, the drivers must first be glued onto the frame using hot glue. Otherwise the vertical drivers will wiggle if only string is used. If twine is used, the best variety is the waxed linen twine sold by [pyrosupplies.com](#). The wax will help prevent the driver from sliding upwards during flight and also make cinching knots easier during assembly.

The advantage to using wire is that the drivers can be easily cut from the frame after use. Wire is also faster to apply than string. When using wire, use two pieces per driver so that they cross each other in an X pattern, as seen in Figure 5. Snub nose pliers are used to tighten down the wire by twisting, and then wire cutters are used to cut the excess. Galvanized steel wire is preferred, but copper will also work if you are worried about a spark hazard when cutting the wires. It is a good idea to attach all the wires and then cut them all at once outside on the remote chance that you do create a spark.

When all the drivers are wired in place, you should have something that looks like Figure 6. It is a good idea to weigh your girandola at this point so that you can estimate your maximum payload. This will give you your flying weight minus the header contents. If you have measured the thrust for your vertical drivers, multiply this value by eight to figure your total thrust. Now divide that number by two (for a slow rising girandola) or two and a half (for a fast rising girandola) and that will be your ideal weight. Hopefully this weight will be at least 100 grams more than the weight of your girandola you just measured. The difference between the ideal weight and the weight you measured is now divided by eight to give you the recommended payload for each header. The stars will be loaded last, so remember this payload calculation.

### Fusing:

Flip the girandola upside down and begin the fusing process by inserting a stick of black match into each of the vertical drivers. At least one inch of match should protrude when the nosing is cinched around the match with a clove hitch knot, as seen in figure 7.

Next you will create the ignition ring using a 36" piece of 3/8" I.D. match pipe. It is important that this match be made fire resistant (see article on [Tard Match](#)) so that the drivers do not ignite prematurely from the horizontal driver sparks.

First bend the length of pipe around all the drivers and mark where the fuses will intersect. The two ends of the pipe should meet at the midpoint between any two drivers. A hole will need to be cut at each of these marks using a



Figure 8: Using a paper punch to make holes in match pipe.

paper punch, as seen in Figure 8. The punch is used to pinch the side of the pipe and cut half a hole, which then unfolds to make a full size hole. Make sure all the holes are aligned on the same side of the pipe.

After all the holes are punched, two sticks of black match are fed into the perforated pipe such that they protrude about an inch from each end. The pipe is now connected to each driver by sliding the pieces of match extending from the drivers into the holes in the pipe. Figure 9 shows this procedure half way completed.

[More...](#)



Figure 9: Inserting match sticks into ignition ring.



Figure 10: Adding time fuse delay into quickmatch link.



Figure 11: Driver nosing ties in visco, delay link and passfire to other driver.



Figure 12: Adding small scoop of 4FA to star bags containing 3/8"

Once the ignition ring has been installed full circle, the two ends are fed into each other and sealed with a piece of foil tape wrapped around the junction. The junction where each driver connects with the ignition ring is now protected with a piece of foil tape. The tape is applied from the base of the driver, over the top of the ignition ring, then back down to the base of the driver on the other side. Make sure there are no gaps around the edges of the tape where sparks could reach the black match junction.

Next prepare a piece of pipe that is long enough to connect both horizontal drivers together. Two sticks of black match are again placed inside so that about 3/4" sticks out from both ends. The protruding pieces of match are folded over against the side of the pipe to form a hook, thus preventing the pipe from being pulled out of the nosing accidentally.

Tie one end of the pipe into one of the horizontal drivers, then place the other piece into the other driver but do not tie it in yet.

#### Delay Fuse:

Next you will need to build the passfire to the ignition ring, which contains a delay fuse that burns for about six seconds. Using a 3-1/4" long piece of Chinese time fuse, punch and cross match with a 12" piece of black match at 1/4" from each end. Cut two 6" pieces of match pipe and slide them onto both sides of the delay link, as shown in Figure 10. Allow the pipe to extend over the time fuse by about an inch on each side, then secure it in place with some twine. Two strands of cross match should be extending about an inch from the ends of both pipes.

This delay fuse will connect from the driver to the ignition ring, as seen in Figure 11. Use the paper punch again to punch the junction hole in the side of the ignition ring. Insert the bare match from the delay link into the ignition ring and seal the junction with a few turns of foil tape. The other end is routed into the driver nosing that also contains the passfire to the other driver. Finally, a 4" piece of visco is inserted with the other two pipes and the nosing is firmly closed with twine.

#### Loading the Headers:

Finally you are ready to load the headers. If you have strong drivers you may be able to load as much as 20 or 25 grams of stars into each one. If your drivers are not as strong and your payload is limited, you can use a lighter type of star such as firefly or aluminum flitter.

This type of heading is not a shell burst, rather it is more like a mine. Thus, only a small amount of 4FA is poured into each header to pop them open. Once the burst charge is loaded, the excess paper on top of each header is triangle folded and held down with a piece of foil tape.

round stars.



Figure 13: Completed girandola with foil protection covering star bags.

It is not a bad idea to cover the entire header with foil tape in order to protect the rather thin case from accidental burn-throughs that will fire your driver backwards and ruin the girandola. I have seen very elaborate girandolas crash and burn from this type of malfunction, so it is time well spent.

After all your hard work, you should have something that looks like Figure 13. You should also have an irresistible urge to fire your new creation immediately! But first, read these tips on [building a launch stick](#). 🔥