

**Build This...****4 x Drive
Tourbillion****Materials:**

- (2) 7" x 1/8" thick wood slats
- (1) 3/4" long segment of 5/8" dowel rod
- (4) 5" long x 1/2" I.D. x 3/4" O.D. parallel wound tubes
- (8) 5" long segments of 22 gauge wire
- (2) 9-1/2" long segments of match pipe
- (4) 10-1/2" long sticks of black match (only 2 pieces if match is thick)
- (8) 3/4" pieces of 4-strand cross match type black match
- (4) 5" x 3" sheets of 30lb kraft

Powdered Clay, string, slurry prime, meal powder, wood glue, aluminum tape

Compositions:

[Gold 1/2" Driver](#), [Meal](#), [Flash](#)

Tools:

Hammer, 1/2" flat rammer, 1/2" tapered rammer, 7/64" drill bit, wire cutters, needle nose pliers, scissors, anvil cutters.

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October, 2001 Issue**Build This:**

[Learn how to make the quad tourbillion.](#)

Autopsy:

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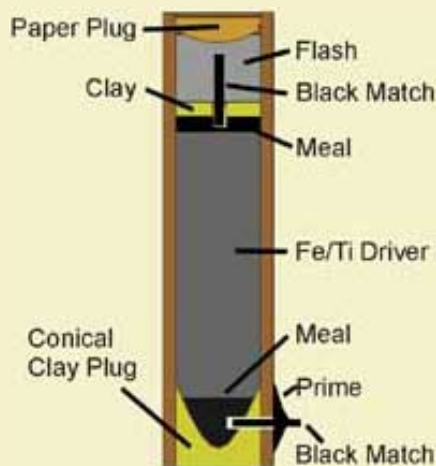


Figure 1: Driver Details

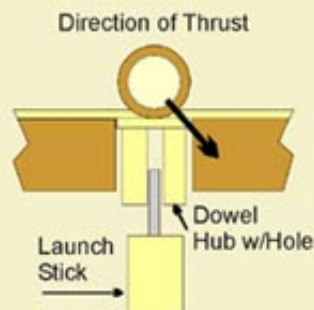


Figure 2: Exhaust Orientation

The conical plug is made with a special rammer that has a tapered end to it. The dimensions of this taper are not critical, so long as it produces a deep enough cavity for the exhaust hole to be protected. One issue with using tapered rammers is the increased tendency for the bottom of the case to expand and rupture during loading. There are several methods to dealing with this problem:

- Use high quality tubes made from virgin kraft.
- Use a sleeve that clamps onto the bottom of the tube to prevent bulging.
- Use lesser quality tubes rolled in Minwax Wood Hardener to strengthen them.
- Ram the first clay increment with a flat rammer and then ram the conical plug on top of that.

Once a method of preventing end splitting has been selected, the first step is to ram in the clay plug. This should be done using a single increment of clay (fire clay or bentonite) such that there is at least 3/16" of clay between the point of the tapered rammer and the bottom of the tube. There is no need for a ramming base and the case can be loaded flat on your ramming block. It is a good idea to load the clay plug in all the tubes before charging them, since this reduces possible errors from switching between rammer types, clay and comp.

Introduction:

The quad tourbillion consists of a simple frame around which four single tourbillion drivers are arranged. They can be launched from sticks that have metal pins protruding from the end that fit into a small hole in the center of the tourbillion wheel. They may also be launched directly from the ground if the surface is smooth enough. The exhaust from each driver is positioned so that there is a 45 degree offset from the directly downward position, which enables each driver to provide both upward thrust as well as horizontal spin. The result is a thick umbrella shaped plume of sparks that slowly rise to about 100 feet in the air.

Making the Frame:

The frame for this device is made by simply gluing two 1/8" x 3/4" strips of wood that are each 7" long so that they cross at their center. I prefer to use poplar, but any dry and light wood will do. It is easiest to use a band saw to rip the strips from standard 3/4" thick stock. A 3/4" segment of 5/8" dia dowel rod is then glued on its end at the center of the hub. This is clamped and allowed to dry. If the tourbillion is to be fired from a stick, then a hole must be drilled down the center of the hub that is slightly larger than the launch pin, which is usually around 1/8" in diameter.

Loading the Drivers:

The key to successful tourbillion drivers is the use of a conical clay plug at the exhaust end of the tube. The purpose of this type of plug is to protect the exhaust hole from enlarging due to burn-through during flight, which will cause the tourbillion to slow down and even fall back to the ground. With the clay being between the paper tube wall and the burning fuel inside, burn-through is not a problem.

The remainder of the driver will now be rammed with a normal flat ended rammer. It is first necessary to load an increment of meal powder in order to prevent the hazard of drilling into a composition containing ferro-titanium when making the exhaust vent. The first increment of driver comp can be loaded on top of the meal before ramming. The driver comp should be rammed such that it takes about five increments to load the tube to within 1-1/2" of the top of the case. Scribing a line on your rammer at the 1-1/2" mark helps to know when the case has been loaded to the proper height.

Once the driver comp is rammed to within 1-1/2" of the top of the case, another small amount of meal is added, followed by the clay plug. Again, the meal is added to prevent drilling into the driver comp when making the passfire hole into the flash chamber. Some builders will omit the clay plug and just load loose flash over the last driver increment, but this method results in shorter and inconsistent burn times due to the powder blowing through as the flame progression nears the end of the tube. Driver comp does not grip the case walls as well as clay does, and it does not seem worth sacrificing 10% of driver burn-time for the sake of not having to ram a clay plug. Not using a clay plug will also result in the drivers not hitting their salutes at roughly the same time. The first salute that bursts will blow the frame apart and send the other drivers flying while they still burn. This is a nice effect when all drivers explode within a few seconds of each other, but not if one goes long before the others.

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Figure 3: Ready to Assemble



Figure 4: Quickmatch Coupling



Figure 5: Completed Matching

Finishing the Drivers:

Once all four drivers are loaded and plugged, the holes for both the exhaust and passfire must be drilled. This is easiest to do with a drill press on the lowest speed setting, using a 7/64" bit for both holes. The exhaust hole should be made about 3/8" from the end of the case containing the conical plug, and should be perpendicular to the case. When drilling, you should first see powdered clay removed by the bit, followed by black powder. When drilling the passfire hole, be sure not to drill to far beyond the clay plug to avoid the risk of drilling into the Fe/Ti driver mixture.

When all holes are drilled, a piece of 3/4" black match is inserted into each one. A pair of needle nose pliers or tweezers will assist in inserting the passfire match. Next the flash chambers are filled to within a 1/2" from the top of the case with flash powder. It may be a good idea to leave out the flash until a few trials have been conducted so that you will not risk being in close proximity of the salutes should the tourbillion fail to gain enough altitude. Once the flash is loaded, a 1/2" paper end plug is pushed into the top of the case and sealed with hot glue.

Next prepare a meal slurry to apply around the black match protruding from the exhaust hole. This is to ensure that the driver takes fire from the burst of sparks that shoot from the quick match. When the prime is dry, use anvil cutters to trim the black match down close to the level of the prime.

Attaching the Drivers:

Now that the hard part is done you are ready to put it all together. First the drivers must be attached to the frame so that the exhaust jet is facing the same direction on each arm. With the dowel rod marking the part of the frame that faces downward on launching, use the wire pieces to fasten the first two drivers so that the report ends butt up against the piece of wood that crosses the piece you are attaching them to. Be sure to angle the driver exhaust about 45 degrees from the vertical position. The next two drivers will actually go on the other side of the frame so that they can butt up against the other cross piece. Verify that all driver exhaust jets are aimed in the same direction by rotating the wheel and looking at each driver as it passes by.

Matching and Nosing the Drivers:

Place a piece of match pipe so that it reaches from one primed jet to the other across two in-line drivers. Mark the midpoint of the pipe and use a paper hole puncher to notch a hole at this point. This whole will allow the fusing between the two matches that cross over each other. Place two sticks of black match in the pipe and use a clove hitch knot to fasten it to both driver ends so that the match sticks fork around the primed fuses.

Place the remaining match pipe between the opposite driver pair and notch a



Figure 6: Applying Nosing Paper

hole where it crosses over the first hole. Insert the two match sticks and tie one end to a driver like before. Before tying to the last driver, insert a small piece of black match so that it connects between the two holes as shown in Figure 4. Also insert a piece of visco into one of the two holes at this time and secure with a piece of foil tape. Tie down the last piece of piped match and you should have something that looks like Figure 5.

The last step is to apply the nosing paper around the ends of each driver in order to protect the primed areas and provide a bucket to catch the match fire. Just over one turn of 30lb kraft is wrapped around the segment of driver that extends beyond the frame. The paper that overhangs the end of the driver is twisted like a candy wrapper to close it off, as shown in Figure 6.

At this point the tourbillion is finished and ready to fire. It may be launched by placing the dowel end down on a smooth surface like plywood or metal, or a launching stick can be made by inserting a nail or thin metal rod into the top of a 5/8" dowel rod that is inserted a few feet into the ground. 🔥