Staging a Terrier-Sandhawk

by Bob Wiersbe

One of my favorite rocketry projects is building electronically staged models. In my collection I've had 1/12 and 1/5 scale Nike-Apaches, a Gemini-Titan, a 1/5 scale Nike-Tomahawk, and a few non-scale models. My most recent project has been to convert the Estes Terrier-Sandhawk into a staged model.

This first time I saw this model I knew mine would have to be staged, and I found it wasn't very difficult to make the necessary modifications. Figure 1 shows the circuitry used to ignite the upper stage motor: the capacitor is C1, the mercury switch is MS1, the charging jack is J1, the arming jack is J2, the arming plug is P1, and the "cato switch" is SW2. Just before the rocket is launched the capacitor is charged using the circuit in Figure 2. When the booster motor burns out, the mercury in the mercury switch (hence, it's name) gets thrown to the top, making contact with the metal poles. When this happens, current flows from the capacitor to a flashbulb, setting it off. This in turn lights a fuse, which ignites the upper stage motor.

The "cato switch" is used for safety reasons. It's purpose is to short the capacitor out whenever the adapter section is removed from the Terrier tube. I call it a "cato switch" because I wanted to disable the staging mechanism in case the booster motor catos. The switch is also used to safe the rocket during flight preparation, or when it needs to be removed from the pad due to a misfire. The switch closes as soon as the adapter leaves the end of the tube, which shunts all the charge in the capacitor through essentially a short circuit. I've actually had this work twice, once when a C5-3 catoed on the pad, and another time when a B6-4 catoed in mid-air. In both cases the upper stages did not ignite.

The arming plug (P1) is removed while the rocket is being prepped, this prevents any charge from reaching the flashbulb. The arming plug is inserted into J2 just before launch, and only after the capacitor has been charged. If you need to disarm the rocket for any reason, simply remove the plug, then remove the adapter section so the capacitor is shorted out.

Terrier-Sandhawk Construction

Build the Sandhawk according to the instructions, except for the motor mount. Build the motor mount shown in Figure 3, and glue it inside the Sandhawk motor mount tube (BT-50) with the tube ends flush. Put one packet of clay in the nose, then glue it to the payload section.

For the Terrier, use LOC 24mm motor tubing, and make an extra centering ring out of 3/32" plywood. The aft centering ring is not attached during motor mount construction, but is glued in place after the fins have been attached and fillets have been made inside the Terrier tube. Use Figure 4 as a guide for building the Terrier motor mount.

Sand the Terrier fin tabs a little so they will fit properly with the thicker LOC tube. Use epoxy to attach the fins, with a small dab of CA on the corners of the tab to hold them in place while the epoxy cures. Add fillets inside the Terrier tube at the Terrier/fin junction and the motor tube/fin junction (see Figure 5). This makes the fins sturdy enough to handle an Aerotech E30 (and probably an F reload). Use the aft centering ring to make the balsa centering ring used in the adapter section (see text below), then glue it in place.

The Terrier needs a sturdy shock cord and mount; I used 5 feet of 3/8" wide elastic that was attached to a wire loop fed through two holes in the forward centering ring, and secured to the motor mount with epoxy (see Figure 4). Use whatever method you're comfortable with, but make sure it's strong.

Interstage adapter Construction

DON'T GLUE THE PLASTIC INTERSTAGE ADAPTER TO THE TERRIER! This piece needs lots of modifications and serves as the "nose" of the Terrier after staging.

Figures 6 through 10 show how the components are located inside the adapter. Several of these components must be made by hand. First, carefully cut off the part that extends inside the Sandhawk. Then, enlarge the hole created by this step until the expended E casing slides easily inside. Next, cut off the back of the adapter, leaving the straight section only (same as in Step M). Finally, cut all the material inside the "groove" so that nothing protrudes into the adapter.

Using the rear of the adapter like a cookie cutter, gently scribe a 1/8" thick sheet of balsa to create the outline for the outside of the centering ring. Using the aft centering ring from the Terrier as a guide, mark the inside of the ring where the BT-50 goes. Cut out the ring, sand it smooth, and test fit it into the adapter until it fits snugly.

Remove the outer layer from an AR-5055

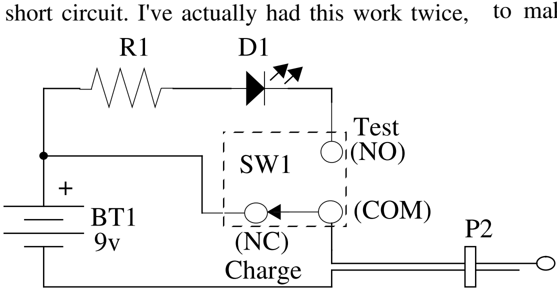


Figure 2 - Charging Circuit

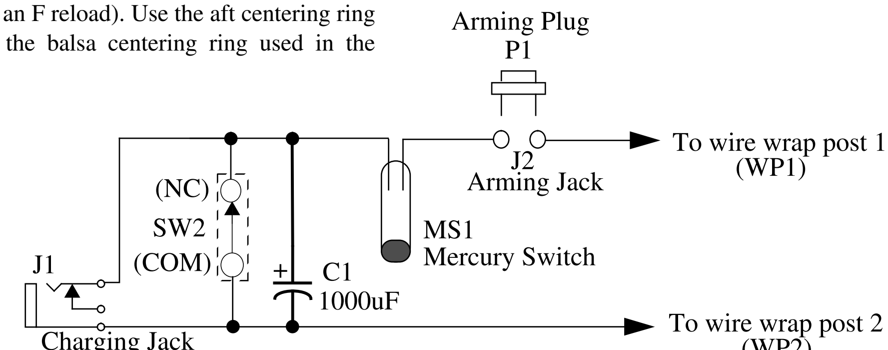


Figure 1 - Adapter Electronics

Part No.	Description
BT1	9v Battery
C1	1000uF, 16-25v Capacitor
D1	Red LED
J1	DC Power Jack, 2.5mm
J2	Wire-wrap socket
MS1	Mercury switch
P1	Wire-wrap header
P2	DC Power Plug, 2.5mm
R1	220 Ohm, 1/4 watt resistor
SW1	SPDT switch
SW2	SPST normally closed momentary switch
WP1, WP2	Wire-wrap posts
Misc.	9v Battery Clip
	Case for charging circuit

Qty.	Parts List
1	6” LOC MMT .95 (motor mount tube)
1	6” BT-20
1	1.5” BT-50
2	AR-2050
1	AR-5055
1	EB-20A
1	Expended Aerotech E motor casing
1	3/32” Balsa (1” x 2”)
1	1/8” Balsa (2.5” square)
1	1/2” Balsa (2.5” square)
1	Screw Eye
1	1/8” Launch Lug (1.5” long)
1	3/8” Elastic (5 feet long)
1	6” 50lb Test Leader Wire

centering ring until it fits snugly in the position shown in Figure 6. Glue this ring in place using CA. Cut a 1.5" length of BT-50. Using the balsa centering ring as a guide at the rear and the E casing as a guide at the front, glue the tube into the AR-5055 centering ring with wood glue. Don't glue the balsa centering ring or the E casing in place when you do this step!

The arming jack (J2) is held in place by 2 small pieces of 3/32" balsa. The jack is really made from two terminals from a SIP wire wrap socket. Cut the leads at an angle as shown in Figure 6, then solder 6" wires to them. Cut a 3/4" x 1/4" piece of 3/32" balsa, hold the jack tightly against it, then insert it into the adapter. Line the jack up so that it is flush with the adapter, then use CA to glue it and the balsa in place. Once the CA has set trim the balsa flush with the plastic, then add another small piece of balsa below the jack to fill in the gap (see Figures 6 & 7).

Cut a small "V" in the balsa centering ring at a point inside the inner circle, feed the leads from J2 through the "V", then glue the ring in place at the rear of the BT-50. When the glue has dried, drill a hole for the mercury switch in the ring near the BT-50 (see Figure 8).

Wire the capacitor to the charging jack (J1), positive lead to the tip, negative lead to the ring. Attach two 4" wires to the capacitor, one on each lead. These will be connected to the "cato switch", SW2. Wire one lead from the mercury switch to the positive lead of the capacitor, the other lead of the mercury switch is connected to one of the wires from the arming jack (J2) (shorten the wire, if desired). The other wire from the arming jack is connected to one of the wire- wrap posts. The last wire is also to a wire-wrap post and connects to the negative lead of the cap. These last 2 wires will be connected when the rear bulkhead is attached.

Using the adapter like a cookie cutter again, mark it's outline on a block of 1/2" thick balsa. Trim the block until you have a bulkhead that will fit snugly into the rear of the adapter. Drill a 1/8" hole in the center, and two 1/16" holes on either side (See Figure 9). Feed the wires to be connected to the wire-wrap posts through one 1/16" hole, and the wires to SW2 through the other. Solder the wires to the switch (normally closed and common pins), and to the wire-wrap posts.

With everything soldered, run a test using the charging circuit (Figure 2). Short the wire-wrap posts together, then connect the charging circuit with the Test Mode selected. With the arming plug removed and SW2 held closed, the LED should light then slowly go out. If it stays lit continuously, then there is a short in the wiring (or the wrong pins of the cato switch are connected). With the adapter held up (launch position) and the arming plug inserted, the LED should remain off. When the adapter is turned upside down, the LED should light. When the cato switch is released (opened) the LED should come on and stay on under all situations.

If it all checks out, glue the mercury switch into the hole (leads first!), glue the cap and charging connector to the centering ring (see Figure 8). Cut a hole in the side of the adapter where the charging plug will be connected. Push all the wires away from the center, then glue the balsa bulkhead in place. Glue the wire-wrap posts to the bulkhead, and push the excess wire back inside the adapter (or cut and re-solder). Align SW2 so that it will be open when inserted into the Terrier tube, and closed when outside, then glue it in place (see Figure 9 & 10). [Note: I used a switch salvaged from a defective disk drive, but a levered microswitch will work too. You'll have to mount the switch by either cutting a slot in the rear bulkhead, or adding an external support.]

Cut the E casing about 3/8" from the ejection charge end, and clean it out. Then glue the it into the adapter so that 1" extends past the end of the adapter. Finally, glue a 1/8" launch lug through the hole in the rear bulkhead to the nozzle of the E casing (Figure 10). This is used to bring the leads from the flashbulb to the wire-wrap posts.

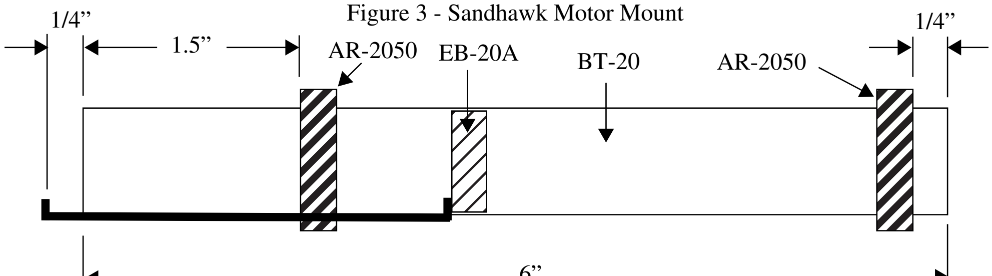
Tips

Check the flashbulb for continuity with a low current Ohm Meter first (just like you would continuity test an igniter). Look the thermalite fuse over carefully and if there are a lot of cracks in it, don't use it. I often use 2 pieces of fuse for added reliability. Always use a fresh battery to charge the capacitor.

I flew my staged Terrier-Sandhawk for the first time at the National Sport Launch in Dallas. I used an Aerotech E15-4W in the Terrier, and a B6-6 in the Sandhawk. The flight was almost perfect, marred only by a jammed chute in the Sandhawk. Fortunately, the Sandhawk landed in tall grass and suffered minor damage to 1 fin. The last time I flew it, I was in a hurry and forgot to connect the flashbulb to the circuit. The resulting prang was spectacular, although disappointing (and embarrassing).

If you're looking for an extra challenge, try staging a Terrier-Sandhawk. It might stretch your modeling skills, and you'll end up with a rocket that's outstanding in flight!

Figure 3 - Sandhawk Motor Mount



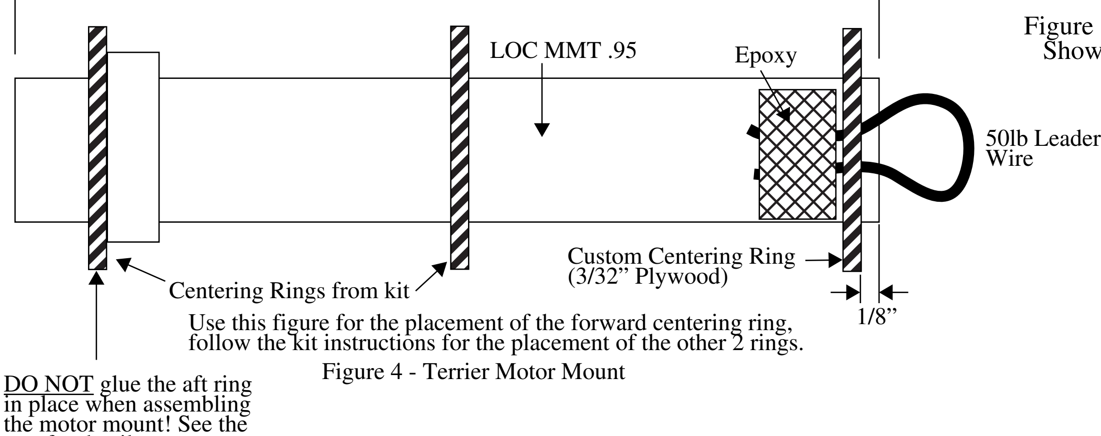


Figure 4 - Terrier Motor Mount

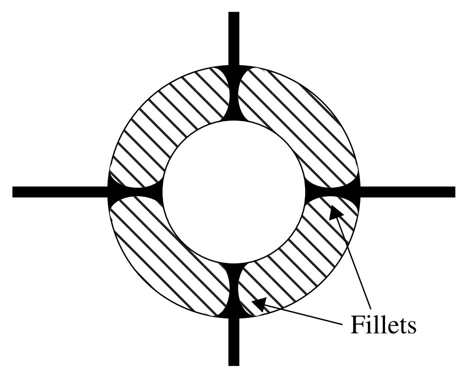


Figure 5 - Rear View of Terrier Showing Internal Fillet Detail

Mercury Switch Staging Tips

Mercury switch staging is not 100% reliable. Here are just a few reasons for this: the flashbulb could be defective, the capacitor may not hold the charge long enough, the fuse may not light, the charging circuit may not provide enough charge, or the mercury switch can fail (either by breaking the glass or not staying closed long enough).

There are ways to prevent some these failures. Always check the flashbulb for continuity with a low current Ohm Meter first (just like you would an igniter). I've found that 1000uf, 16V capacitors work nicely (a 3300uf cap works great too!). I know others have had success with 220uf caps, but I had several failures with this value, so I stick with 1000uf minimum. I always check the caps for how long they can store a charge before I put them into one of my rockets, sometimes you get a bad one. To check, just charge it up, let it sit for a couple of minutes, then check it with a voltmeter. It should still have close to the same voltage you charged it to. (A better test would be to let it sit for a few minutes, then try to pop a flashbulb with it.)

I always look the thermalite fuse over carefully, if there are a lot of cracks in it, I won't use it. I often use 2 pieces of fuse for added reliability. Charging problems can be eliminated by using fresh batteries. I haven't had a mercury switch break on me yet (even after a severe prang), but it can happen. The trick here is to use the right booster motor, you want to use a motor that will give the rocket a kick and get it off the pad in a hurry. If the mercury is thrown with too much force it can crack the glass, and cause a failure on the next flight. I also don't use mercury switches on models flown with anything over an F motor.

Small mercury switches are better than big ones for small models (less mass to throw around). Only use mercury switches that have both leads at one end! The others are tilt switches that will close when the switch is angled too much, and can be jarred enough to close when you don't want them to.

If you're going to use a G or H in the booster, go with one of the Adept timers. It's more reliable, and can handle just about any type igniter you care to use in the upper stage.

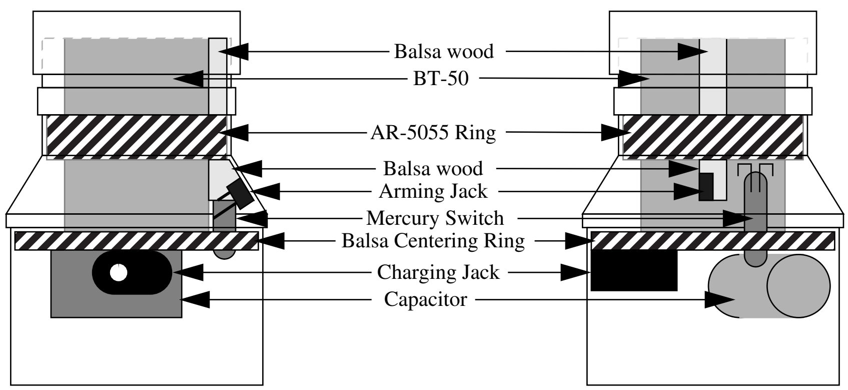


Figure 6

Figure 7

(Note: Figures 7, 8, & 9 are shown in the same orientation)

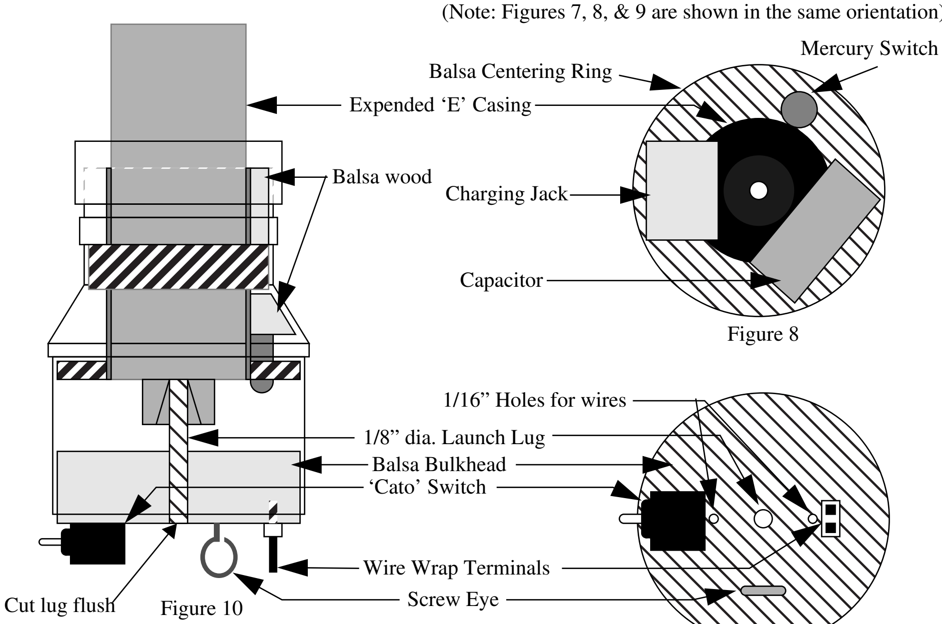


Figure 8

Figure 10

(Note: charging jack and capacitor omitted for clarity)

Figure 9