Tech-Tip 008b-Supplement

Piston Launchers: (C.A.D., Metal & Floating Head)

Dedicated to the dissemination of detailed model building methods and techniques.

Materials and methods presented here are not intended as the best or only solutions to the modeling challenge(s) discussed, rather as methods and procedures which have a proven record of success in actual use. Please keep experimenting with new materials and techniques as this is the only way to expand the fields of knowledge. Written by: John E. McCoy Sr. NAR-15731 - Dec. 12, 2012

A Bit of Additional Piston Launcher History:

Piston History was briefly touched on in Tech-Tip-008, Competition Metal Head Pistons written May 1991 and revised Oct. 2003.

Stepping into the "Way-back Machine" we see in the stone-age 60's where the original idea for model rocket piston launchers began as a "Closed Breech" launcher. This type launcher was being used at the time with full size sounding rockets such as the famous rocket from Atlantic Research Corp. Arcas & Super Arcas.

This type launchers had the entire rocket loaded into and enclosed within a heavy launcher Tube with Sabot (fall away Shoe-Spacers) and a piston fitted closely to the launch tube with the motor nozzle or engine casing protruding through the piston head into a blast chamber under the head just above the Locked bottom loading breech. Model Rocketry and later HPR have adapted the concept to large diameter Heavy walled PVC and other non-metallic tubing with some sort of aft end closure sealing the system. Some use sabot or other shoes, some internal guild rails and standard 0-Volume pistons mounted to a screw in plug or twist-lock "Breech".

In the very early 70's as the NAR became concerned with pink book rulings on Closed Breech Launchers in Competition, Howard Kuhn developed the external slide-tube ***Zero-Volume Piston Launcher (Commonly ZVPL).***
ZVPL are still used today although not nearly as much in competition. To give a general description of a ZVPL, the apparatus consists of 4 pieces: Support tube or dowel 20-22" long. 16"-18" of standard 18 or 24mm body tube with a small centering ring or sliver of coupling glued to one end as a stop. And a spent motor casing or built-up head closely fitting the ID of the Slide tube selected. Most early 18 & 24mm devices used a standard 2-3/4" long motor casing size head. Later 3" brass tube clad heads. After the introduction of 13mm mini motors, 13mm pistons launchers used 1-3/4" spent casing or 2" built up brass tube clad heads. Currently many use 2" heads for MH-ZVPL's with much shorter 9"-12" long slide tubes.

All ZVPL's operate with the motor friction fit into the model with a minimum of 3/8"+ of motor extending from the rear. The motor should also be externally taped to prevent kicking the motor at ejection and to seal the top of the motor/slide-tube/igniter trapping process. I've used ½" tape for years letting the first ¼" of motor remain exposed. "External Taping" can be done with plain old masking tape but creates a better seal with a slipperier Mylar or packing type tape. This process has to be pressure fit into the slide-tube just right. Too tight almost guarantee's tip-off, too loose we gain next to nothing from far too early separation and loss of gas pressure. This is where the learning curve comes in.

Kuhn's Zero-Volume pistons ***(ZVPL)*** can be as quick and easy to build as the ***C.A.D. (Cheap & Dirty) spent motor Casing & wooden Dowel*** arrangements, or a little more involved *improved version* using a built up head finished with an outer layer Brass tubing commonly referred to a ***Metal Head- Zero Volume Piston Launchers***. These later MH ZVPL pistons created a good bit less cardboard to cardboard friction increasing smoothness of operation but did little to address the external "trapped" igniter & lead hookup dragging problem.

The next improvements to both CAD & Metal Head pistons were the introduction of all internal wiring to address the clip drag problem. In this arrangement the igniter is in one way or another connected or soldered to some form of insulated coupling, connector or tubing with soldered lead wires snaked down the interior core hollow support tubing of the piston and out the base for connection to the power supply controller clips.

Whichever contact point is chosen the forward end of the support tube & surrounding head space is filled with a good epoxy to seal, anchor and insulate the contact points for each other and the support shaft which is usually a Brass or Aluminum (read as Conductive) tube.

This improvement really added a good bit more complexity to the manufacture but "when they worked" added another 5-8% to the achieved altitude by eliminating the clip & wire dragging from the lift weight of the piston slide tube. I say "when that worked" because after the initial use build-up of motor exhaust debris & crud become an ever increasing contact continuity preventing problem. Telescoping brass and later Stainless Steel tubing were no match for the effects of a firing BP Motor. Cleaning between flights is necessary & time consuming generally involving disassembly, sanding the head, and needle file cleaning of the tele-tubes.

ZVPL's seemed to have an almost perceptible hesitation or pause just as the model/slide tube hit the stop. Although inertia is carrying the model forward, separation of the friction fit motor/slide-tube at the end of the stop caused considerable deceleration and at times tip-off to non-vertical boost or worse. Eventually minimum 3" bamboo, light sticks or plastic guides were added to contain the model at the moment of separation helping eliminate this tip-off tendency. Some RSOs refused to allow "naked piston launchers" to be used in NAR competition unless surrounded by a tower launcher as well, nearly defeating the purpose for the piston and creating even more complexity to contest flight preparation. Some competitors learned to make Slip-on 3" to 6" guides that added minimum of mass to the pistons lift while creating the needed extra guidance at slide-tube stop separation. Today we have even lighter Graphite and Carbon Fiber super thin .020"-040" diameter materials from which to construct our ZVPL extension guides. It is a pleasure to acknowledge the Howard Kuhn 0-Volume Piston is referred to as the Standard Piston launcher hobby wide.

The Next BIG thing: ***Floating Head Piston Launchers: (FHPL).***
At Naram-28, in Aug. 1986 Team Odd Couple (Jeff Vincent & Chuck Weiss) presented an R&D and the first real in depth study on performance differences between the Standard ZVPL and Floating Head Piston Launchers (FHPL). The Long and Short of the presentation was that Floating Head Pistons improve altitude performance by as much as 34% over the standard ZVPL. It's been reported that the team invented Floating head pistons but that has not been confirmed as many competition flyers were flying Floating head pistons as early as 1982-83. My first exposure was in an article on piston launchers printed in an MIT mod rocket magazine in the spring of 1984. Putting this knowledge to use, flying from an 18"slide tube FHPL shortly thereafter. I've looked for and tried to research that old article but so far have had no luck retrieving it. Inventor or not: team Odd-Couples R&D reports went a long way in proving the flight performance advantage of Floating Head Piston Launchers (FHPL) over our old standard ZVPL in all it's forms.

That said we still had the igniter reliability issue to deal with. Ignition reliability is for me at least as important as launcher boost efficiency. Just like the ZVPL with internal wiring our new FHPL had much the same second and "there-after" flight intermittent ignition drawback. Crud build-up, contact tube burn-blast damage and wear cause faulty igniter contact creating considerable loss of continuity where the contacts were formed by using soldered telescoping brass, stainless tubing and telescope tubing with crimped in or soldered igniters. These 1/16" to 3/32" .014" wall brass or stainless close fitting tubes were great for the first flight. But after that they became less and less reliable causing many No-Go misfires that were simply a lack of good electrical contact.

To that end over the next 8-10 years many Piston Launcher users searched and experimented with different more positive means of providing fast but sure electrical and Igniter /launcher connections. Time went along for a decade or so fumbling with different igniter contact methods that ranged from physically wrapping the Nichrome leads around tiny machine screw heads to directly soldering igniters to wedge shaped brass cuttings. Some very innovative twist-lock custom made connectors along with tons of different plug & socket type contacts were tried, tested, evaluated and a few adopted. One competitor went so far as to use white vinegar to clear his plug contacts on the field between launches. All these things meeting with limited reliability success while adding some complexity & extra downtime between flights during competitions.

Christmas 2004 brought the Mill-Max .100"oc pin strip socket PCB connector to the attention of this author. These Mill-Max connectors come in strips from 6 to 20 pins. Each pin or for our use 2pin segments accept the pins for another or easily 30ga to about 22ga solid wire, stacking to whatever combination is required with complete positive Contact throughout the stack. With care and a fine tooth razor saw these strips are cut into 2pin "Connectors" 10 from a single 20pin strip. These can then be soldered to 22ga to 18ga stranded copper wire for installed INSIDE a ¼" or larger opening in our piston support tubes.

For use in Standard Zero-Volume Piston Launchers (ZVPL). Mill-Max 2pin connectors can have 3/8" to ½" overall length 30ga Nichrome igniter slipped into the sockets positive contact grip or soldered in place. This igniter/socket combo is then plugged into the 2-pin socket permanently epoxy installed in the piston support tube. When these socket-pin connectors are engaged there is immediate Positive Contact. In addition it has been discovered if the igniter-plug combo hasn't been charred too badly by the motor exhaust the remains of the Nichrome wire igniter can be pulled from the socket and a new igniter piece slipped into the same socket. Using 22 to 24ga Heavy Nichrome in one of these connectors creates what I'm calling a "Semi-Permanent" igniter which heats Red Hot but doesn't burn through when connected to 30feet or more of controller lead. Again complete instant positive continuity. In Testing and Sport flying I've used the same igniter/plug combination for 3 consecutive flights without a single continuity issue. While the semi-permanent 24ga igniter required between flight surface needle filing they can be reused 20 or more times before a new nichrome piece must be exchanged. It is still recommended that a new igniter/plug combo be used with each flight during competition events, but it's nice to know these little plugs can take a beating and keep on working flawlessly.

Mill-Max in Floating Head Piston Launchers: Floating Head Pistons use the same .100" spaced Mill-Max connectors in a combination stack consisting of three 2pin connectors. Before we get too far into this again let me pass on the important Manufacturer & Supplier information which will make obtaining a supply of these fairly inexpensive strips easier. Manufacturer Mill-Max number is 310-93-120-41-001000. I purchase mine in 25-20pin strip lots from Allied Electronics on-line (alliedelec.com) Cat # 900-0265. After cutting into 2pin segments that gives me 250 pieces to work with.

Back to installing these little jewels in our FHPL: The first is permanently epoxy installed in the support tube with soldered internal lead wires extending out the bottom at least 2". A second epoxy installed in newly designed light weight, Short length floating heads. The third being used to make up the plug-in igniter combination. These Mill-Max combinations have proven to be

both exceedingly light weight but very adaptable to all diameter Piston launchers from 7.1MM Micro Maxx to 24mm D12 Piston Launchers.

The addition of this simple although somewhat tedious to install connector in our Floating Head Piston Launchers has made this variation on FHPL piston flying much more enjoyable. I now use my MMX FHPL during sport flying launches just for fun often.

Even though "No matter how simple - Piston Launchers are still a pain" to deal with they have become not nearly as frustrating as they were with the old Telescoping tube igniter set-ups.☺

Last but not least Piston slide-tube length: Here again the Odd-Couple teams NARAM R&D report in 1988 caused a considerable change in piston construction and use. Prior to the NARAM most competitors used 12 to 18" slide-tubes regardless of motor class. I'd always used 18" feeling that was the best length to get optimum air-speed before hitting the stops. Odd-Couple gave convincing evidence that sufficient air-speed was achieved using as short as 7" slide tubes with the nominal 9" slide tube providing an additional safety margin for some of the Heavier models. Today all my various piston launchers use 7 to 9" slide tubes. MMX always 7", 1/4A3, 13mm to 24mm Mighty D12 motor class use 9"slide tubes. The good part is this makes them Range Box storable as well☺

While on the subject of slide tube length; The Alway brothers presented a fairly recent R&D report at Naram-5x? Their research on piston slide tube length with Egg loft or Payload models gave some advantage and increased separation air speed with long to very long slide tubes. Some as long as 36" showed extended slide tubes can have beneficial effect on Heavy Egg Loft, Dual Egg loft & competition Payload models. I can not comment further on these findings as I have not launched or observed others Launching Heavy Egg Loft or Payload models on any piston version with a slide tube longer the 18". To Date the heaviest payload model I've Piston launched tipped the scales at 218g (7.68oz) or about the average mass of a 63g egg loaded loft model on a D12-3 motor. That particular test model was flown from a 9" long unguided BT-50 slide tube FHPL to a very nice altitude, straight as an arrow in a 5-10mph breeze flight.

Building your Piston Launcher:

Attached below is a tools and materials list for this Tech-tip that should help with gathering the necessary materials & simple tools needed to construct any of the piston launcher types discussed. There will also be detailed 1-page plans for these launchers in a separate file with the Tech-tip-008b folder for your use in our web-site Library section soon.

For those who would rather purchase a Piston kit than make one from materials you have. Currently there are two manufactures from at least 3 sources.

Locally QCR (Qualified Competition Rockets) Located at 7021 Forestview Drive, Springfield,VA 22150 Offers 3 different kits: MMX 6mm (actually 7.1mm) #420 Ultimate moving (ZVPL) with a current cost of $12.00 each. #400 Ultimate-I 13mm moving (ZVPL) priced at 13.00each and #410 Ultimate-II 18mm (ZVPL) also priced at $13.00. All of Mr. Ken Brown's kits come in recycled plastic news-paper delivery bags with rather sparse but readable instruction sheet(s). Anyone having trouble following these instructions can always contact me or give Ken a call at 703-451-2801 or e-mail brown007@cox.net or visit QCR at http://cybertravelog.com/qcr to view his entire line of competition "qualifier" models.

Sunward Rocketry http://www.sunward1.com also offers two floating head all cardboard kits. These kits are intended for single launch use. I'm not sure how long the coupler/cardstock disc head will last. The construction is sound but these kits seem kind of expensive for a single use item though each kit is supplied with 3 one-time use slide tubes. Not sure if extra floating head materials are included. These kits are 18mm FHPL for 14.99 or 24mm for 15.99. Sunward also offers a laser cut built up box piston base one for each size with a cost of 24.99 each. Shipping direct from Sunward isn't all that bad with a flat rate of 7.95 per kit order (No MOTORS).

These Sunward kits are also available through Apogee Components on line. Contact them at http://www.apogeerockets.com

Piston Launcher Tools & Materials - Dec.06,2012

Piston Making Tools:

Tube Cutter (for Brass & Alum. Tubing)
Side cutter plier.
Wire Stripper.
Fine tooth razor saw (½"blade)
Cordless Drill- 3/8" Chuck or larger.
Sm Drill Press Vise or Vise-grip Plier
Drill Bit & Taps for 4-40" & 8-32" Threading.
1/8" & 3/8" HHS Drill bits (base holes)
1/4" Round file
Paper Floating Head glue Up fixture (printed).
Waxed Paper (Glue-Up fixture).
Double Faced Masking Tape (1" or larger).
Sandpaper (120-320girt).
Ultra fine Scotchbrite sanding pad.
40watt soldering iron.
Resin core solder.
Soldering paste or Flux.
Needle file set.

Materials:

CAD (Cheap & Dirty) Pistons:
Spent Motor Casings (MMX, 13,18 & 24mm.)
1/8" Bamboo Skewer 3/8" & 1/2" Wooden Dowel.
1/8" x 3" bent or broken Launch rod pieces
CA & Epoxy.

MH ZVPL (Metal Head Zero-Volume Pistons:)
1/4", ½" & 21/32"Brass Tubing (Head Clading) #8859K24, K33 & K38
7/8"-304 St.Stl. tubing (.950" Head) #89895K763
2"x .004" Stainless Steel tape (#76055A22)
3/8"x .065"wall x 12" Aluminum Tube #89965K24
7/32"x .014"wall x12 Brass Tube #8859K23
18/2 x 14" 2 conductor Stranded Copper wire (10,5-24mm)
22/2 x 12" 2 conductor Stranded Copper wire (7.1mm MMX)
20pin .100" Mill-Max Strip Sockets (Cut into 2pin Segments)
2" Duct Tape or Making Tape (Support to Head ID build-Up
Slide Tubes (T2+, BT-5, BT-20 & BT-50) x 9" to 18" long.
Slide Tube Stops: T2, CR-3-5,CR-5-20 & CR-5-50 Centering Rings.
Mounting block: 1.0" x 1.5 to 2.0" x 3/4" Wood or acrylic Block.
4-40" x ½"or 8-32" x ½" Nylon Thumb Screws
1/8" x 2" Piece Stainless Steel rod (mounting rod)
1/4" or 3/8" Aluminum Hex Nut with tapped 4-40 or 8-32 hole.
CA & Epoxy.

Add-on Guide tower extensions(useable on all piston types):
Slip-on body: T2++, BT-5+, BT-20+ & BT-50+ x ½"to 2"Long tubes.
.020" to .040" x 2.0" to 6.0" Carbon Fiber rods (groups of 3 & 4)

FHPL: (Floating Head Pistons):
3/8" x 12" x.065" wall Aluminum Tubing #89965K24
7/32" x 12" x .014"wall Brass Tubing #8859K23(Tapered to.192 Tip)
18/2 x 14" 2 conductor Stranded Copper wire (10.5-24mm)
22/2 x 12" 2 conductor Stranded Copper Wire (7.1mm MMX
20pin .100 Mill-Max Strip Sockets (Cut into 2pin Segments)
Head coupling material: T2, CPL-5, CPL-20 & CPL50 (ea.1/4" -1/2"long)
Head centering rings: CR3-5, CR-5-20 & CR-5-50
Slide Tubes (T2+, BT-5, BT-20 & BT-50) x 9" to 18" long.
Slide Tube Stops: T2, CR-3-5,CR-5-20 & CR-5-50 Centering Rings
Mounting block: 1.0" x 1.5 to 2.0" x 3/4" Wood or acrylic Block.
4-40" x ½"or 8-32" x ½" Nylon Thumb Screws
1/8" x 2" Stainless Steel rod (mounting rod)
1/4" or 3/8" Aluminum Hex Nut with tapped 4-40 or 8-32 hole
CA & Epoxy.
Nichrome igniter wire (30ga. to 26ga.) generally 30ga.
Dipping pyrogen (Optional).