"BOW" AND "ARROW" SATELLITE ANTENNA PROJECT

3 julio, 2010 por DobleZero

I decided to build myself this Satellite Antenna as described by XE1MEX.

This "Bow and Arrow" shoots straight! Ask the birds up there, they will confirm it!

There has been continued activity on AO-51 in South Africa and the list of stations operational on this satellite is increasing daily. I had a very primitive satellite antenna setup at this QTH for satellite working. My outgoing signal was good but I had very bad reception. It was time to build a new antenna system that would solve this problem. I did not want to build a very elaborate fixed satellite antenna system and was looking for something simple, effective and portable. I looked at different designs and decided that the antenna must have the following criteria:

1. Portable Handheld Yagi.
2. Frequency 145/437 Mhz.
3. Mountable on a Camera Tripod.
4. Used for ground wave communications.
5. 10 watt maximum power output.
6. Elements made from aluminum that is locally available.
7. Must be sturdy and strong.
8. Must be mounted outside temporary or permanent.
9. Must be easy to construct and to tune.
10. Must be a homebrew project. (I hate to buy when I can build!)

I finally decide to design the "Bow" and "Arrow" Antenna deprived from the Yagi-Uda Antenna described by XE1MEX. Although similar the matching stubs and mounting of the elements on my version differs considerable from the XE1MEX design. More later about the gamma matches and mounting of the elements. The name given to the version I build was deprived from the fact that the antenna looks like a high-tech "bow" and "arrow" from outer-space. Enough said lets go to the construction side of the antenna.

Construction Details:

All dimensions are in millimeters and all elements are made of aluminum pipe that is locally available in South Africa at your hardware store. I used what I had on hand and constructed the antenna from surplus aluminum left over from a 10 element 2 Meter Yagi I constructed recently. Please note that if you use the same material I used you will have to excercise you biceps and arms muscles for portable work as this antenna is quite heavy. If you use different material you will have to re-calculate the elements and boom diameters.

Dimensions of the Antenna:

- Center VHF frequency = 145.850 Mhz
- Center UHF frequency = 436.800 Mhz
- Number of elements: UHF = 8 (10.5 dBd gain), VHF = 4 (6.46 dBd gain)
- Boom diameter = 25mm Square Tubing
- Elements and gamma pipe diameter = 10mm
- VHF elements lengths = R – 1017mm, D – 972mm, D1 – 917mm, D2 – 906mm
- VHF elements spacing = R to D = 380mm, D to D1 = 162mm, D1 to D2 = 370mm
- UHF elements lengths = R = 349mm, D = 325mm, D1 = 303mm, D2 = 298mm, D3 = 292mm, D4 = 287mm, D5 = 285mm, D6 = 282mm.
- UHF elements spacing = R to D = 127mm, D to D1 = 54mm, D1 to D2 = 123mm, D2 to D3 = 148mm, D3 to D4 = 173mm, D4 to D5 = 193mm, D5 to D6 = 207mm.

R = Reflector
D = Driven
D1 to D6 = Directors

I mounted the reflector, driven and directors through the boom by drilling 10mm holes in the centre of the boom. I used stainless steel self tapping screws to mount the elements to the boom. I used this method in the past, when constructing 145 Mhz and 433Mhz antennas.

Hardware List:

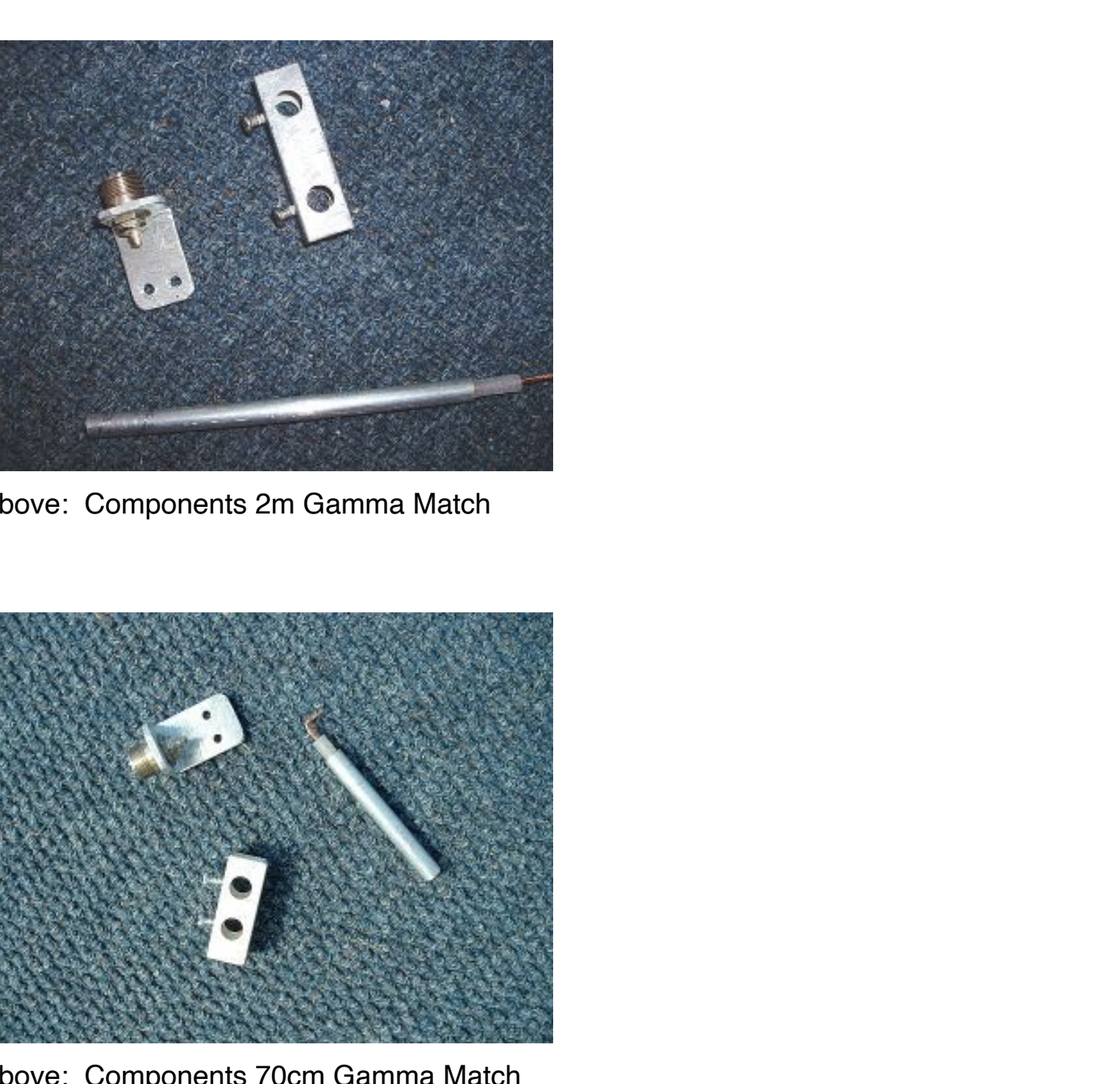
12 x 22mm x 5mm Stainless Steel Self tapping Screws
4 x 15mm x 3mm Stainless Steel Self tapping Screws
6 x 35mm x 4 mm Stainless Steel Machine Type Bolts
6 x 4mm Machine Type Nuts
6 x 4mm Stainless Steel Washers (plain)
6 x 4mm Stainless Steel Spring Washers
2 x SO239 Sockets (BNC advised but I used what I had on hand)
1 x 100mm Angle Aluminum for SO239's
1 x 120mm x 15mm Aluminum Square Tubing for Gamma Match
1 x 300mm RG213 Inner core Cable for Gamma Match
26 X 10mm Plastic Caps to fit over 10mm elements
1 x 300mm x 20mm PVC Electric Conduit
1 x Wooden dowel that fits snugly into the PVC Electric Conduit
1 x 40mm PVC End Cap
1 x 1300mm x 25mm x 25mm Aluminum Square Tubing (Boom)
6633mm x 10mm Aluminum Pipe or Elements and Gamma Match
1 x 25mm x 25mm Plastic End Cap to fit over or into the Boom.

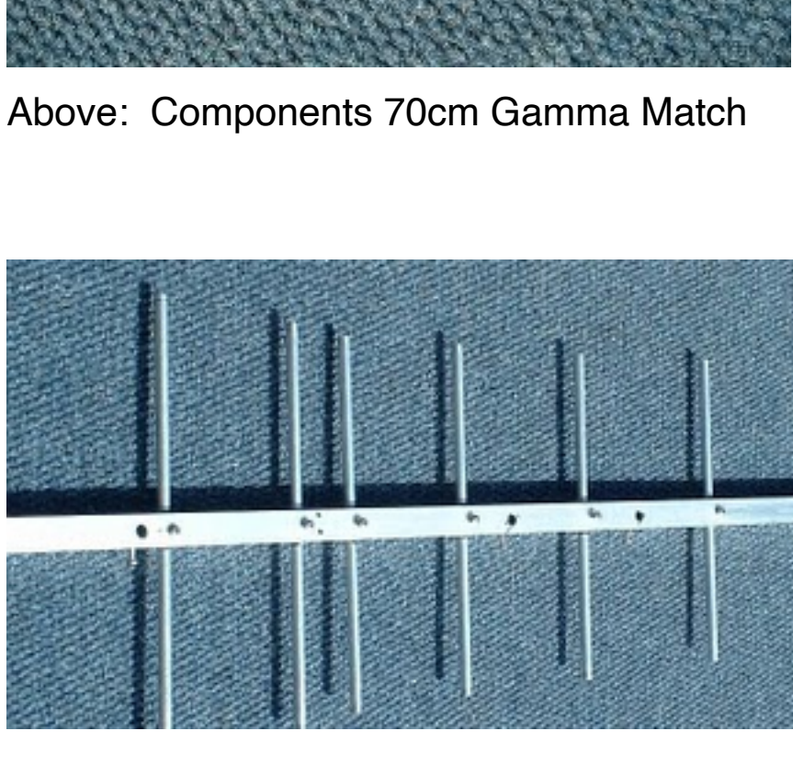
I start off with measuring the boom length, marking the element placements and center punching the spot were the holes will be drilled for the elements. One word of advice, never drill through both sides of the boom at once. First drill one side then the other side. This will ensure a centre hole on both sides. After measuring and punching I drill the holes, first with a pilot drill (4mm) and then with the correct size (10mm) to fit the elements. I start with the 70 CM side and then move to the 2M side.

Holes drilled, it is now time to drill the 4mm holes that will affix the elements to the boom. I then take a 5mm thick self tapping screw and turn it into the 4mm holes drilled. It will be hard to turn at first but this is necessary to ensure a good fit between boom and screw. It is now time to fit the SO239 holders onto the boom. Refer to the gamma match diagram where exactly they must be fitted. Also look at the photo's how to construct these holders. Once you've made them, affix them to the boom by drilling two 4mm holes through the boom and SO239 holders.

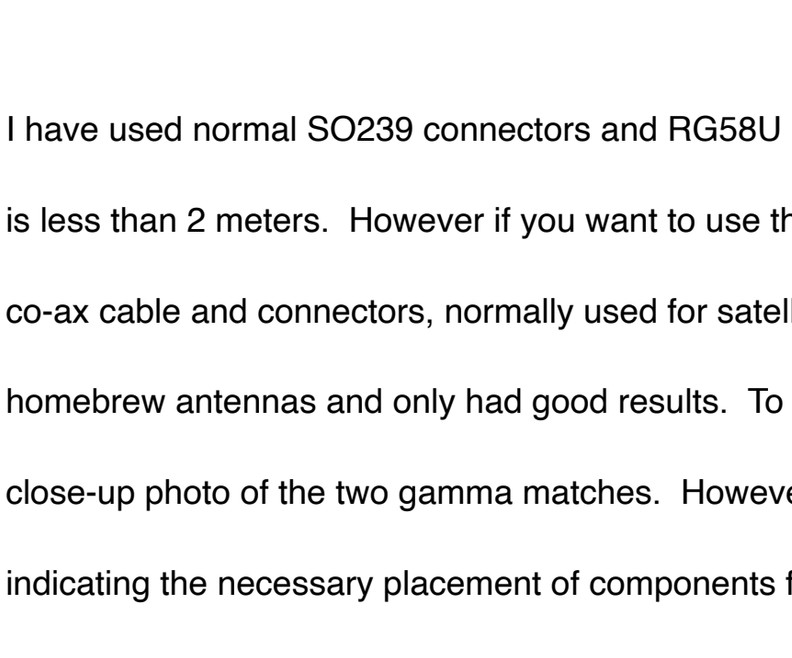
Put the boom aside as we will now first construct the gamma match. Again refer to the schematic diagram of the gamma match and also the photos in this regard. Cut one length of 150mm aluminum 10mm tube for the 2M gamma and then a 80mm length of 10mm tube for the 70cm gamma. Now cut exactly similar lengths of RG213 inner core. (clear plastic with copper wire inside) The RG213 inner must now be fitted inside the 150mm and 80mm tubing. You will notice that the RG213 is to thick to fit into the tubing. Find a method to grind the plastic off to fit into the tubing. I use my bench grinder for this purpose. Be careful not to pierce the plastic and ensure that it is grinded evenly to fit snugly into the tubing. Remove 20mm of the plastic from the one side of the RG213 and turn the wire together with a pair of pliers. This point will be soldered to the SO239. Fit the RG213 respectively into the 2M and 70CM gamma. So far so good.

Take the 15mm aluminum square tubing and cut two sections, one of 60mm for 2M and one of 50 mm for 70cm. Drill 10mm holes one above the other 40mm center to center for 2m and 20mm center to center for 70CM. Now drill two 2,5mm holes on the other side of both square tubes to hold the gamma. Affix the15mm self tapping screws in the two holes of each gamma. See photo's for clarity in this regard. Note: You can use narrower square tubing or a matching strap, but I used what I had available.

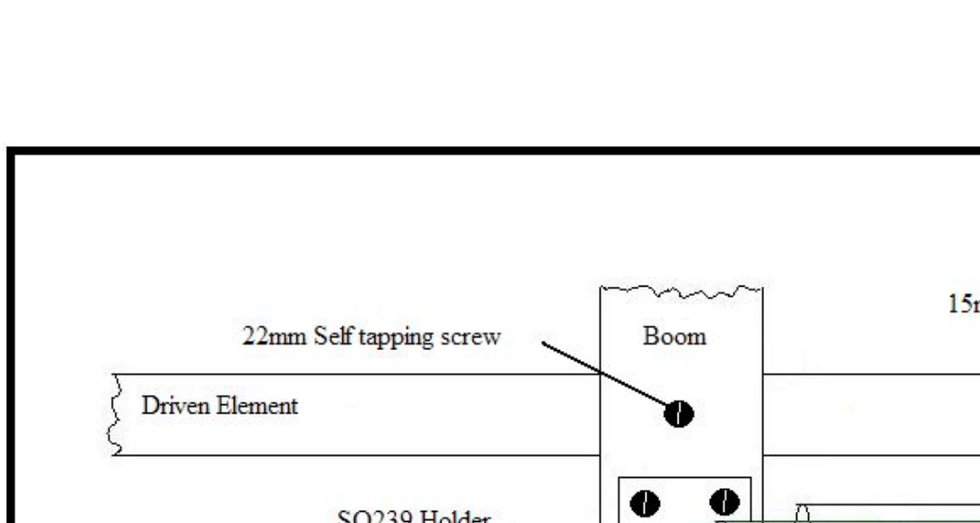




Above: Components 2m Gamma Match

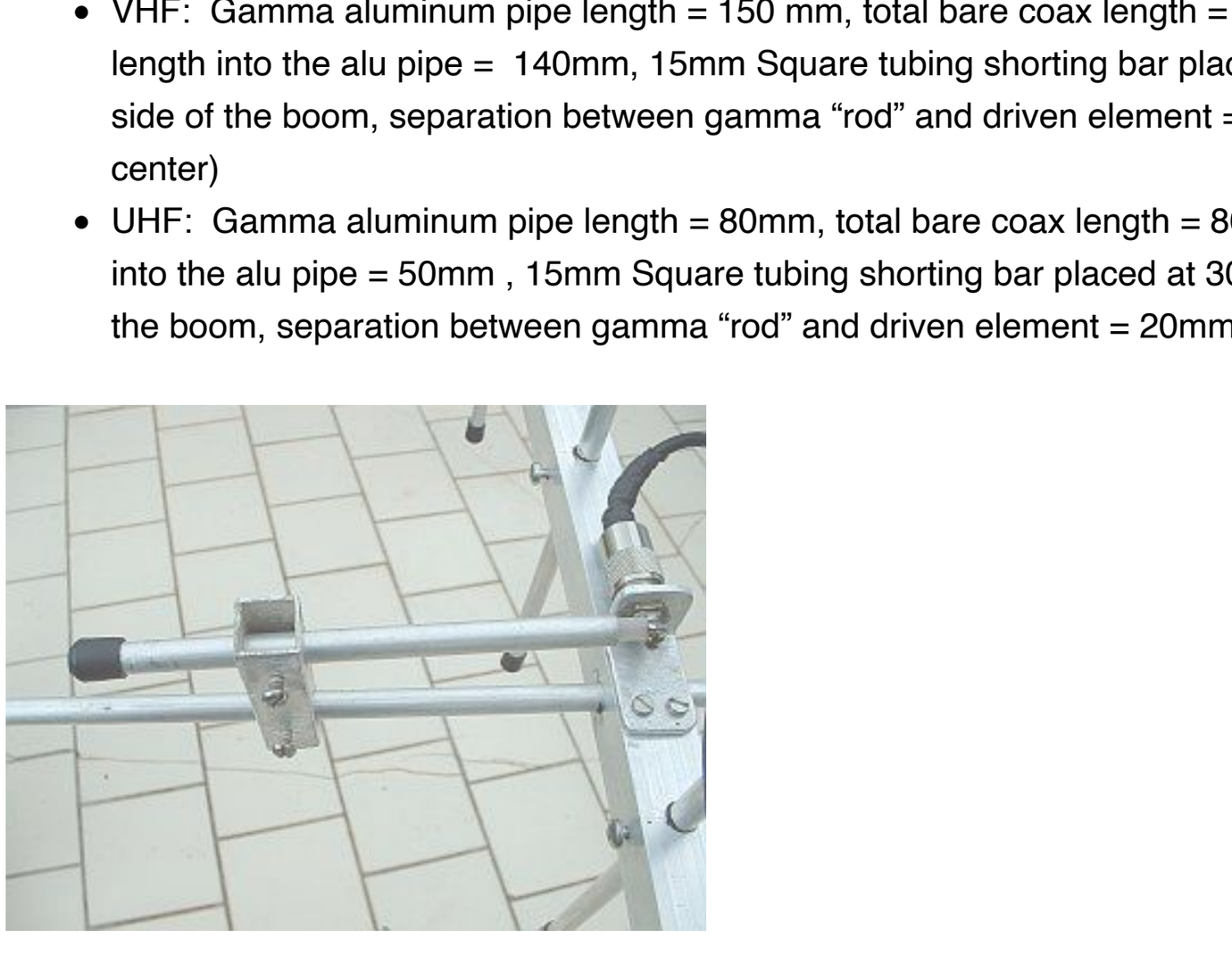


Above: Components 70cm Gamma Match



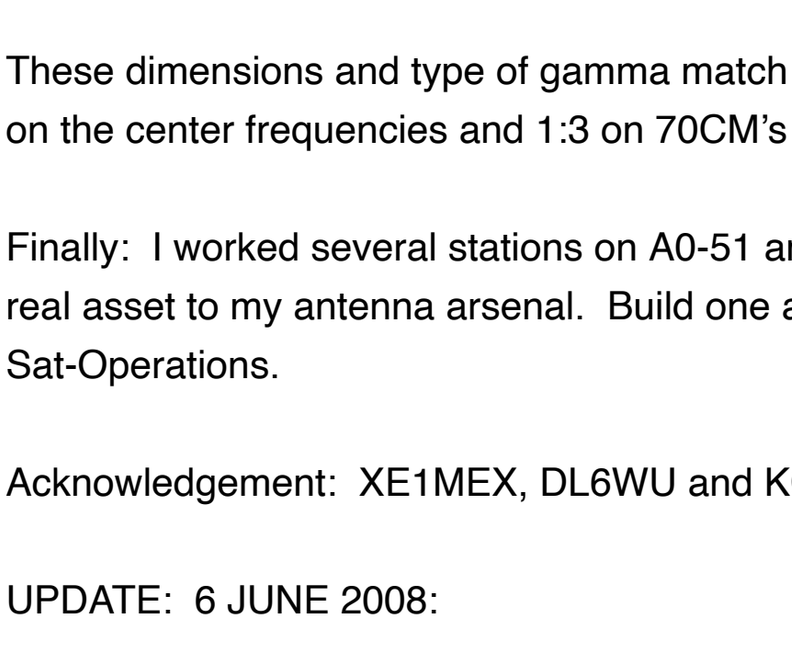
Above: Partly assembled 70cm Elements

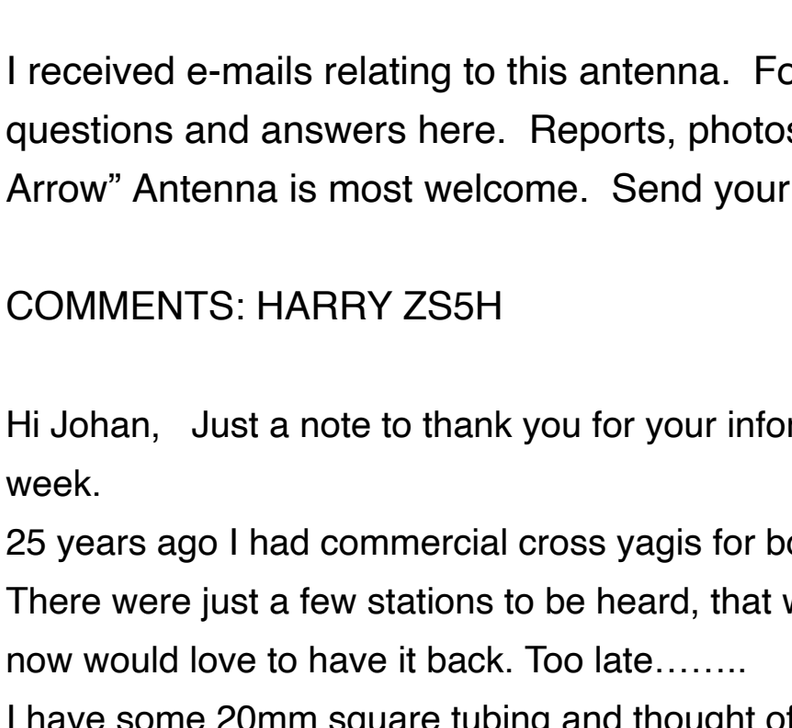
I have used normal SO239 connectors and RG58U (Mil Spec) cable as the distance between the radio and antenna is less than 2 meters. However if you want to use this antenna as a fixed antenna I would advise the use of proper co-ax cable and connectors, normally used for satellite work. I have used this gamma match with several of my homebrew antennas and only had good results. To install the gamma match I strongly advise you to look at the close-up photo of the two gamma matches. However to assist you further, I have drawn a schematic diagram indicating the necessary placement of components for the gamma-matches. Make notes about the construction of the gamma match as you will again make one in my Dip-Yag Antenna Project to be displayed later on these pages.



Data of the Gamma Match:

- VHF: Gamma aluminum pipe length = 150 mm, total bare coax length = 150 mm, bare coax length into the alu pipe = 140mm, 15mm Square tubing shorting bar placed at 95 mm from the side of the boom, separation between gamma "rod" and driven element = 40 mm (center to center)
- UHF: Gamma aluminum pipe length = 80mm, total bare coax length = 80mm, bare coax length into the alu pipe = 50mm , 15mm Square tubing shorting bar placed at 30mm from the side of the boom, separation between gamma "rod" and driven element = 20mm (center to center)





These dimensions and type of gamma match resulted in an SWR of 1:1 on 70CM's and 1.2:1 on 2M's on the center frequencies and 1:3 on 70CM's and 1.5:1 on 2M's in the band edges.

Finally: I worked several stations on A0-51 and AO-16. This antenna really performs well and is a real asset to my antenna arsenal. Build one and you will really experience a great "little" antenna for Sat-Operations.

Acknowledgement: XE1MEX, DL6WU and KC5JDG.

UPDATE: 6 JUNE 2008:

I received e-mails relating to this antenna. For the benefit of our readers I have decided to display the questions and answers here. Reports, photos and suggestions of your experience with the "Bow and Arrow" Antenna is most welcome. Send your comments to: zs1i@mweb.co.za.

COMMENTS: HARRY ZS5H

Hi Johan, Just a note to thank you for your informative and helpful web-page. I got to hear of it only this week.
25 years ago I had commercial cross yagis for both 2m and 70cms mounted on one boom with elevatror etc. There were just a few stations to be heard, that was using Oscar 10 mostly. I got rid of the equipment and now would love to have it back. Too late……..
I have some 20mm square tubing and thought of using brazing rid (3mm) or about 6mm tubing for the elements. Where could I find the calculator to give me the optimal spacing? The XE site caters for a folded dipole for driven element.
When you have a moment please share your thoughts with me on the subject.
God Bless Harry ZS5H

ANSWER
Thank you very much for your email and interest in my web-pages. From the outset I must inform you that I am not an expert in many fields of Amateur Radio however I do have the will to learn more every day.

Harry, the satellite antenna described by me works great. I am however of the opinion that if one deviate from the sizes and measurements, you could comprimize on the performance of the antenna. However it is possible to use other materials if you compensate correctly for the sizes. As they say if you do not try you will never know if it will work . I used the material on hand at the time.

Attach find a calculating program for the Yagi-Uda design. Maybe it could be of some help. I cannot vouch for its effectiveness. Looking at your age I am convinced that you will come up with a effective sat antenna as you are from the old school. At a mere 46 I am still a youngster. Looking forward to hear you on the sats and to make a satellite contact with you. Keep up the good spirit!!

COMMENTS: RORY ZR6RBJ

I am going to build the bow and arrow this weekend. I will getting all the materials this afternoon. Just a quick question regarding the coax for the gamma match. Does it have to be 213 or will LMR400 do the trick. This is the only coax i have in the shack, and would like to use it up for this project rather than try find some 213.. also if i where to use thinner material, say a 15mm boom with 6mm round tubing, how would i calculate the lengths for the elements given the new dimensions?

ANSWER
Rory, the satellite antenna described by me works great. I am however of the opinion that if one deviate from the sizes and measurements, you will comprimize on the performance of the antenna unless you compensate accordingly. However it is possible to use other materials if you compensate correctly for the sizes. As they say if you do not try you will never know if it will work . I used the material on hand at the time.

I am of the opinion that you can use the inside of LMR400 instead of the RG213. Should not have any effect on the capacitance side of things. You might find that the LMR400 might not fit into the 10mm Aluminium tube. You can just trim the isolation as described om my web-page. Please note you must not remove the copper coating on the LMR400 as the inner wire is aluminum and will be difficult to solder.

Attach find a calculating program for the Yagi-Uda design. Maybe it could be of some help. I cannot vouch for its effectiveness as I have not used it in the design of this antenna. I used the material on hand at the time and the proof is in the "pudding".

It works!!

Hope to work you soon on AO-51.

TESTING THE "BOW" AND "ARROW" ANTENNA:

I have been successfully using this antenna since 28 February 2008 and it is a real pleasure to use. The only drawback is that it is getting very cold in the evenings to do portable satellite work. But what must be done must be done! I have worked many stations with this antenna and must still find a portable antenna with the same or better performance.

Tests: 6 June 2008:

Many thanks to Roy ZS6MI and Hal ZS6WB who assisted in tests carried out on AO-51 this morning. (6 June 2008)

Myself and Johan ZS2I setup station on a high point in Mossel Bay with an open horizon to the North and the South. We used the old faithful "Bow and Arrow" Hybrid Antenna connected to two Jingtong handhelds. The aim of the tests were to calculate the workable fixed elevation with a fairly reasonable pass. between 10 and 40 degrees. We used a GPS to determine North and Orbitron for the pass prediction. The antenna was clamped into a vice at 30 degrees on a 1 meter upright stool and fixed onto the direction that the satellite will make it's first appearance above the Northern horizon. The satellite moved from North to South at 30 degrees in a Westerly direction. At 5 degrees above the horizon the first carrier was heard. Hal was contacted at 11 degrees. Contact was made with Roy at 15 degrees above the horizon. The satellite were followed by only using an azimuth "armstrong rotator".

No elevation adjustments were made and both Hal and Roy were heard very clearly at times with 5/9 signals during the pass. Signals were audible up to the point where both stations could not access the satellite. The carrier could still be heard at 8 degrees above the Southern horizon. The aim: "Will it be possible to work satellites with a fixed elevation setting say at 35 degrees and work 50% of the available satellite passes?" I am convinced that this will be possible and that you will have to sacrifice all passes above 45 degrees. We will have to do some more experiments but from the tests carried out this morning this seem possible. Any comments will be appreciated.

Once again many thanks to Hal ZS6WB and Roy ZS6MI and also to any other station who allowed us to do the tests.

This antenna works and the proof is in the pudding with many contacts confirmed on AO51.

BOW AND ARROW SATELLITE ANTENNA OF JOHAN ZS2I

Above: "Bow and Arrow" Antenna of ZS2I. (NOTE: The plastic end caps must still be installed on the tips of the elements to complete the antenna. The plastic black box houses the homebrew diplexer.)

Johan ZS2I constructed the "Bow and Arrow" Antenna. He however used a different approach all together with the gamma matching. To curb the use of connectors and possible losses he decided to connect the coax cable directly to the antenna. This was clevely done with teflon stand-offs. Both the 2M and 70CM matching stubs were connected with the inner of the cable to the gamma match while the braid goes directly to the boom. The antenna will be mounted at an angle of 30 degrees upwards with 15 degrees to the left.

Above: Photo of the gamma match showing the teflon standoff. To the left of the top section of the teflon the braid connection can just be seen going to the boom and to the right the inner connection.

For more photos of this antenna in action click **HERE**

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