Tom Warnagiris, K3GSY

18403 Crosstimber, San Antonio, TX 78258; twarnagiris@satx.rr.com

The "Chicken Wire Wonder" — A Unique Broadband Vertical Antenna for the HF Bands

I'll bet you've never seen a Tapered Area Small Helix (TASH) antenna!

Many so called broadband "wonder" antennas advertised to the Amateur Radio community dissipate most of the applied power in resistive loading. Nevertheless, these "wonder antennas" do have a few benefits.[1] They produce very little TVI or other interference, since they radiate almost no power! In addition to these broadband "wonder" antennas, there are several truly efficient broadband antennas suitable for the Amateur Radio bands. These antennas include the bicone, discone, helix and others. Each of these broadband antennas has certain benefits and drawbacks.

Also, a few years ago a new efficient broadband antenna was featured in two trade journal articles.[2,3] The antenna was called a "Tapered Area Small Helix" or TASH for short. Apparently, the antenna was given that "catchy name" to help the article readers remember the antenna. TASH rhymed with trash. Although TASH sounded somewhat derogatory, it should have made the antenna memorable. Either the TASH name was really not that memorable or, at the time, there wasn't much interest in wideband antennas. In any case, the articles received little response from the antenna design or amateur community.

The TASH antenna performs similarly to a quarter wave vertical at most frequencies. A quarter wave vertical is one of the most popular HF antennas, because it provides low angle radiation superior to a beam or dipole that is not far above ground.[4] As described in the journal articles, the original TASH antenna consisted of a right triangle of conductive material rolled to form the TASH element, as shown in Figure 1. This first generation TASH antenna provided vertical performance and low SWR over only a single octave frequency range. More compact versions were later designed with better SWR bandwidth. Most of the improvements were obtained by decreasing the TASH element height-to-diameter ratio while reducing and reshaping the element area. Low SWR bandwidths of more than 10:1 have recently been demonstrated.

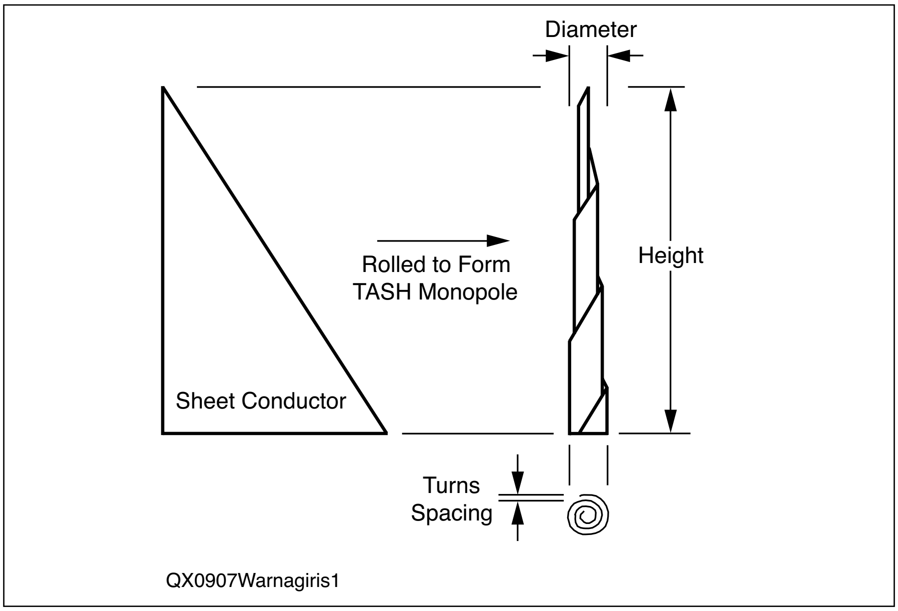

Figure 1 — Construction of the original TASH antenna element.

Figures 2A through 2D show several TASH variants, leading up to the most recent version. Figure 2A is one of the original 10:1 height-to-diameter-ratio designs with good SWR over a single octave. Figure 2B is a low profile variant with fair multi-octave SWR. Figure 2C is a wide spaced variant with good multi-octave SWR. Lastly, Figure 2D is a smaller element variant, also with good multi-octave SWR. Although these earlier versions provided wideband low SWR, they were not as compact as the most recent version, which successfully provides multi-octave SWR with a 3:1 height-to-diameter ratio, with only a one turn element.

Although a TASH antenna resembles a helix antenna it doesn't share its electrical properties. Both helix and TASH antennas have wide SWR bandwidths, but a helix antenna is a circularly polarized narrow

[1]Notes appear on page 24.

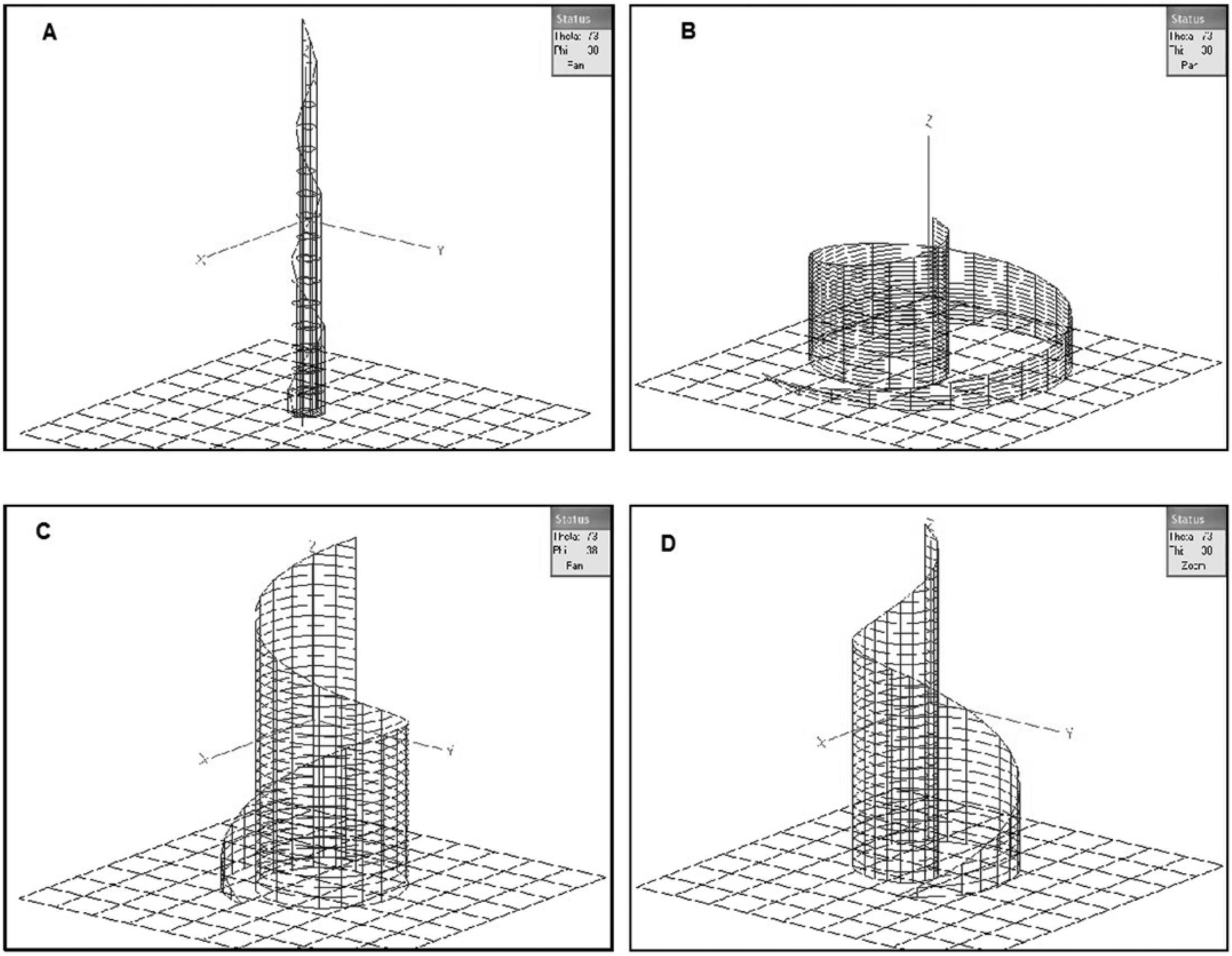

Figure 2 — Construction of several early TASH antenna variants.

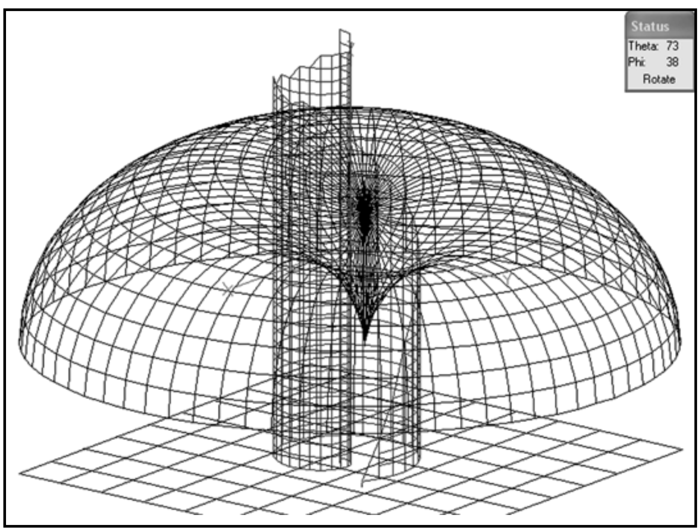

Figure 3 — Typical TASH antenna radiation pattern.

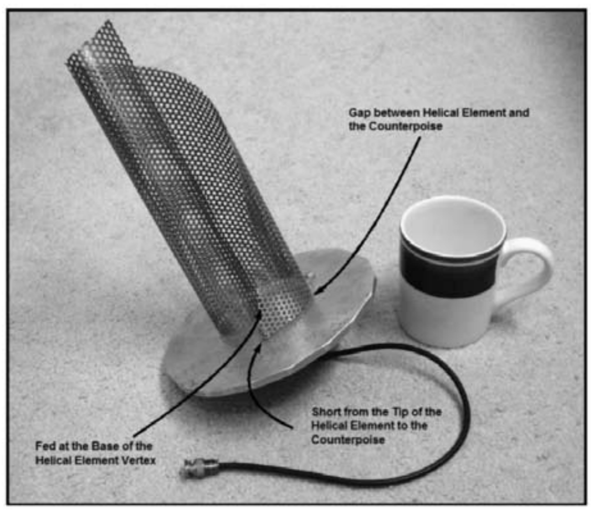

Figure 4 — Improved 225 MHz to 2.5 GHz TASH antenna (cup for scale).

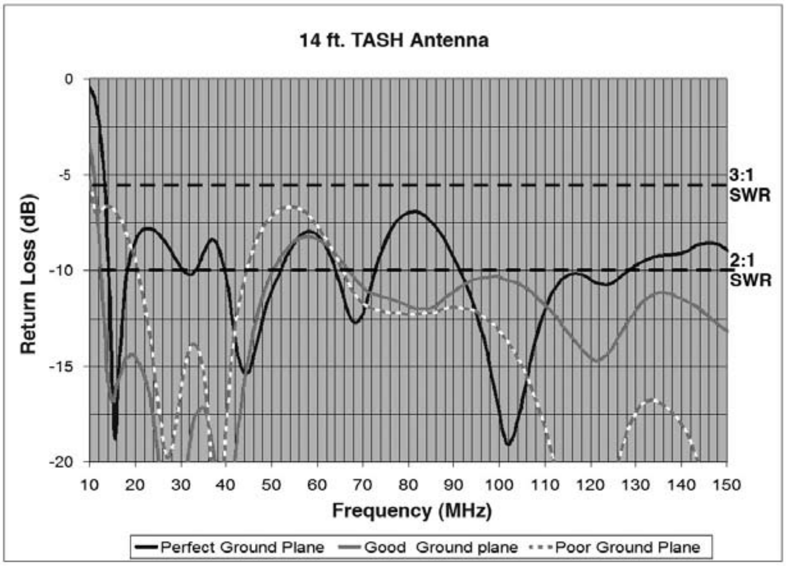

Figure 5 — Return loss and SWR simulations for a TASH antenna over various grounds.

Table 1
TASH Measurements

Band	*Test Frequency*	*Power Out*	*Power Reflected*	*SWR*
20 Meters	14.083 MHz	100 Watts	< 1 Watt	<1.2:1
17 Meters	18.080 MHz	100 Watts	9 Watts	1.85 :1
15 Meters	21.080 MHz	21 Watts	2.2 Watts	1.96:1
12 Meters	24.920 MHz	16 Watts	1.4 Watts	1.84:1
10 Meters	28.100 MHz	50 Watts	4.8 Watts	1.90:1

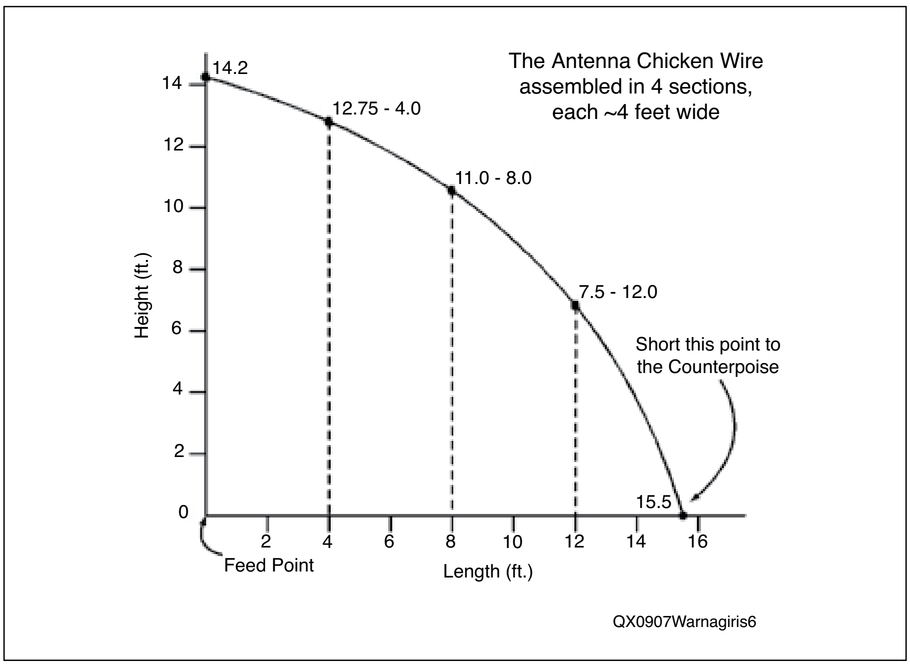

Figure 6 — Dimensions of the chicken wire TASH antenna element.

beam radiator, while the TASH antenna is a mixed polarization omni-directional radiator. Figure 3 shows a typical TASH radiation pattern.

Features and Problems

When compared to conventional discone or cone (half a bicone) antennas, the TASH antenna offered some physical as well as electrical benefits. The original TASH configuration had a few serious problems, however. First, it was difficult to maintain the optimum spacing between the turns of a multi-turn TASH element. The triangular "tapered area" was large and the spacing between turns fairly critical (see Figure 2B). Also, the height-to-diameter ratio made the antenna somewhat bulky. So, further software simulations were made in an attempt to reduce the number of turns and the element area.

Even after much effort the antenna simulation program did not give the desired result. Eventually some drastic changes to the configuration led in the right direction. The changes were placement of a ground plane short at the tip of the TASH spiral and tapering the element in a logarithmic fashion. A short at the element tip produced a TASH antenna with a much greater height-to-diameter ratio than was previously seen. The elements of all earlier TASH antennas were right triangles. The logarithmic taper proved to be the key to diameter reduction. It's now possible to build TASH monopoles with an SWR less than 3:1 over a 10:1 bandwidth, with a diameter only a third of the antenna height.

The first TASH antenna constructed, based on the revised simulations results, was a 13 inch high TASH antenna with a cut off frequency of about 225 MHz. It was intended for military applications at 225 MHz and above. Figure 4 shows the early prototype with a coffee cup for scale. This antenna gave acceptable SWR at frequencies of about 300 MHz with just the counterpoise shown in Figure 4. Doubling the area of the counterpoise moved the low frequency cutoff down to about 225 MHz without appreciably affecting the SWR at higher frequencies. This was in good agreement with computer simulations.

The TASH antenna was simulated using several antenna simulation packages, but the package used most frequently was one called *GNEC*.[5] *GNEC* allows antenna surfaces to be constructed as a grid similar to actual wire antennas assembled from expanded metal or even poultry netting. (*GNEC* is only available to user's who are licensed from Lawrence Livermore National Labs to use NEC4. — *Ed.*) Figure 5 shows the simulated

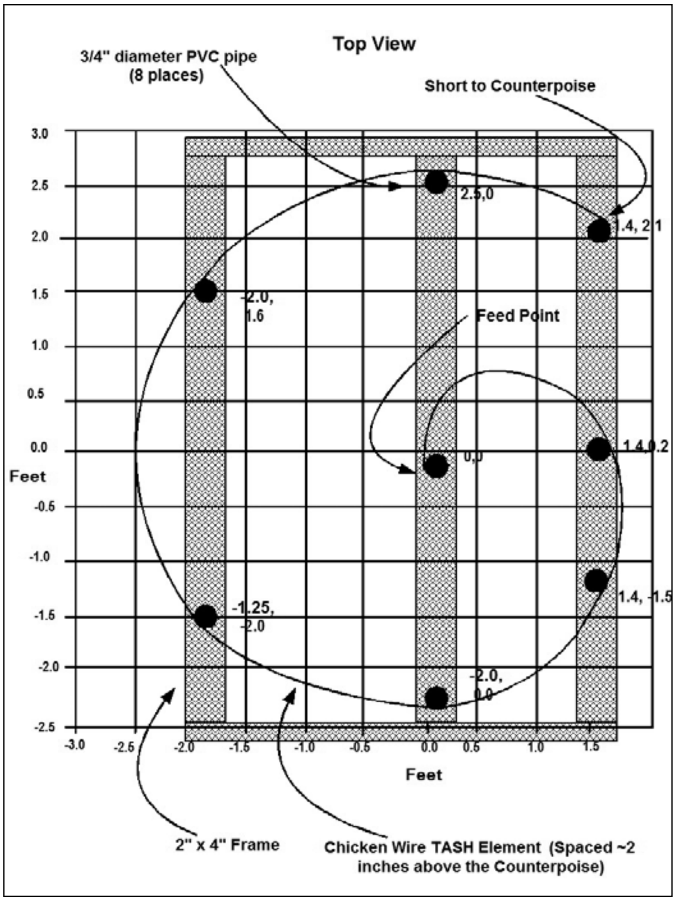

Figure 7 — Dimensions of the TASH antenna base and element curvature.

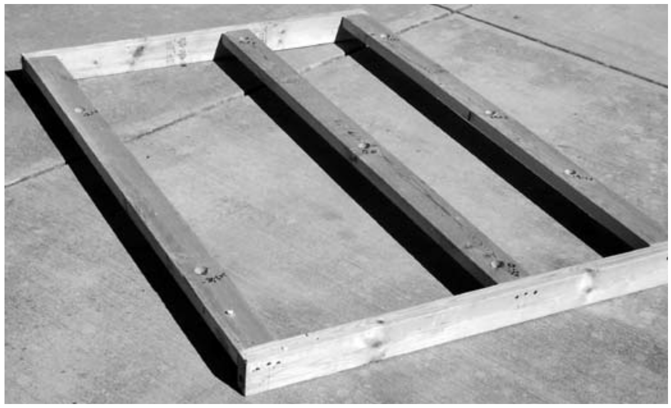

Figure 8 — TASH antenna base prior to assembly of the PVC framework.

return loss and SWR for a 14 foot tall TASH antenna over various grounds. Note that the ground condition does affect the SWR, but not significantly.

Construction of an HF TASH Antenna

Successful simulations of a 14 MHz TASH antenna over various ground planes situations eventually led to design, assembly, and test of a large TASH antenna suitable for operation on the 20 through 10 meter HF bands. Most HF antennas are assembled using copper wire or aluminum tubing. Both materials were out of the question for fabrication of the large element necessary for a 14 MHz TASH antenna. This led to consideration of other suitable materials, such as galvanized poultry netting, better known as "chicken wire."

Chicken wire is definitely a rather unique antenna material. Although chicken wire is not the best conductor (about ⅓ that of copper), its point to point conductance is still rather good. This is due to the large number of conductive paths through the many wire hexagons making up the chicken wire. Using an ohmmeter with the leads several feet apart, the measurement of the dc resistance of a large section of chicken wire gave a reading of less than a few ohms. Fortunately, since the TASH element has such a large surface area, the surface conduction loss is minimal even when fabricated using a poor conductor.

At HF, the chicken wire element need not be cut to the exact dimensions shown in Figure 6. In fact, "chicken wire" and words like precise and exact should probably not be used in the same sentence. Keeping the wire within an inch or so of the antenna design is not easy and really doesn't matter greatly. Both simulations and measurement of a test TASH antenna have shown that input impedance and radiation pattern are rather insensitive to distortions of the TASH antenna structure. The key dimensions of ground plane spacing and overall size/shape of the TASH element seem to be the only aspects showing some criticality. Fortunately, these dimensions are not all that difficult to maintain on the large chicken wire TASH antenna element designed for a frequency as low as 14 MHz.

So, the HF TASH antenna eventually built was simply a scaled up version of the successful 3:1 height-to-diameter ratio 225 MHz TASH design. As mentioned, chicken wire was selected for the TASH element since simulation showed that the surface conductivity of the TASH element was not critical. PVC tubing was assembled as the framework for the element. Chicken wire was also used for the counterpoise. Figure 6 shows the dimensions of the chicken wire element and Figure 7 shows the dimensions of the base and the spiral spacing of the chicken wire element.

The antenna base consisted of several 2×4 boards cut and assembled as shown in Figure 8. The TASH antenna framework was assembled from short sections of PVC pipe interconnected by PVC T-sections. The approximate dimensions of the pipe are shown in Figure 9, in two dimensions. The assembly of the framework is shown in Figure 10. Part of the chicken wire counterpoise was placed on the wood frame prior to assembly of the pipes. Eight vertical ¾ inch diameter PVC tubing was placed in holes drilled at the locations shown in Figure 7. Each vertical piece of tubing was held in place by a wood screw into the 2×4 perpendicular to the tubing (see Figure 11).

Once the framework was assembled, sections of chicken wire were stitched together using galvanized wire to form a single element as shown in Figure 12. Before the element was wrapped on the tubing framework,

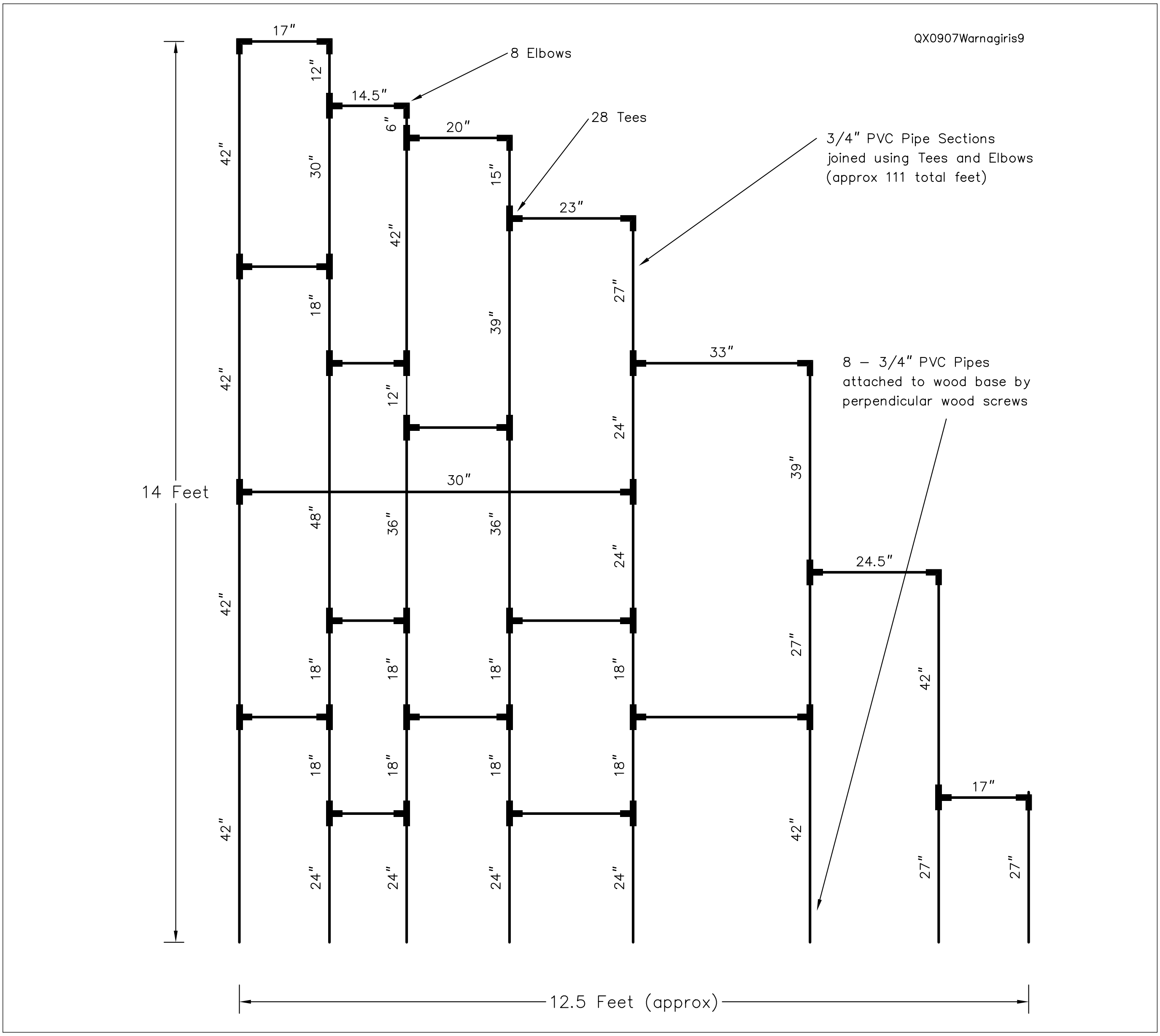

Figure 9 — Dimensions of the TASH antenna PVC framework laid flat for illustration.

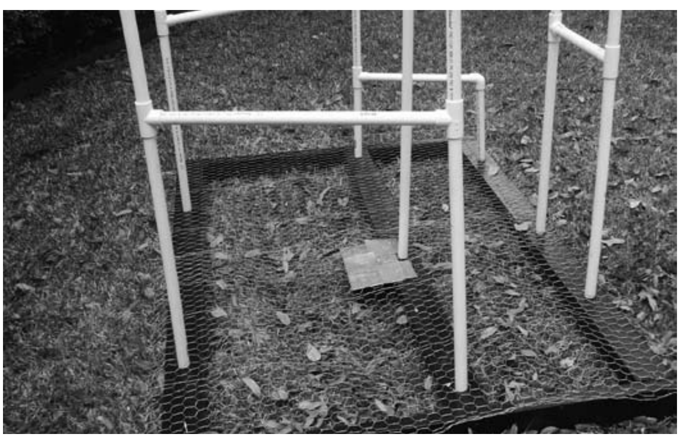

Figure 10 — PVC framework prior to installation of the TASH antenna element.

Figure 11 — PVC pipe secured to the TASH antenna base by a wood screw.

Figure 12 — Chicken wire sections stitched together to form the TASH element.

Figure 13 — The complete TASH antenna on its side showing the feed point.

a layer of chicken wire was stapled to the 2×4 frame to form a counterpoise for the TASH antenna element. Then the TASH element was wrapped on the framework spaced about 2 inches above the counterpoise chicken wire. The coaxial feed and element shorts locations are shown in Figure 6. Figure 13 shows the feed point with the antenna on its side. The complete HF TASH antenna is shown is Figure 14.

HF TASH Test Results

The return loss of the HF TASH antenna was measured using an HP 8754 Network Analyzer. Figure 15 shows the measurements with return loss and SWR scales overlaid. Note the similarity in the

Figure 14 — Complete HF through VHF TASH antenna ready for operation.

simulation data for return loss and SWR of the measured data with the simulated data shown in Figure 5.

On air tests were performed using an old ICOM IC-720A transceiver with no antenna tuner. The tests were performed on the bands shown in Table 1.

Full 100 W output was not obtained above 20 MHz due to the transceiver SWR fold-back circuits. Minor antenna adjustments or a simple tuner could easily reduce the SWR to allow full power from the IC-720A. Since the SWR was less than 2:1 on the five bands, newer transceivers could probably handle the SWR without a tuner.

Conclusions

The amateur radio community has several assigned bands at various frequencies in the 2 to 30 MHz range. Unfortunately, they are spaced several megahertz apart, so that few antennas can cover all bands of interest. A TASH antenna can be an excellent choice for situations requiring multi-band operation. The wide bandwidth of the TASH antenna would even allow operation on the VHF bands from the same HF antenna.

One of the best features of the TASH antenna is its dc to ground impedance at the antenna input. It's a short circuit to the counterpoise, which makes it inherently short circuited at frequencies below the lower frequency cutoff. This can reduce the occurrence of intermodulation products from broadcast, appliance hash, and other sources of low frequency noise. The short can also protect the rig from lighting damage and charge build up (a problem with cone and discone antennas), but a slight modification to the antenna might be necessary if lightning protection is a real concern.

The distance between the antenna connection center conductor and the outer return is approximately 20 feet. Measured dc input impedance at the connector of the large TASH antenna shown in Figure 14 was less than 4.0 Ω even after a few weeks in the weather. This is not a very good short to ground, but it in no way reduces the effectiveness of the antenna. Lower impedance for lightning protection is easily provided by adding heavier wire to the edge of the TASH element and shorting it directly to ground. This does not affect the RF performance of the antenna.

Cone and discone antennas, on the other hand, are inherently low pass, or all pass antennas. At dc, the input impedance approaches an open circuit. These antennas often build a charge when left unterminated and can easily damage a receiver without a dc input return. Also, lightning, broadcast signals and power noise can be easily coupled to a receiver. True, filtering at the receiver input can reduce the potential for interference problems, but it's always best to attenuate extraneous signals prior to reaching any receiver front end component including the coaxial input feed line.

Although comparable to a discone or cone antenna electrically, it has a smaller footprint for the same lower frequency cutoff. Another advantage of the TASH antenna over the discone or cone is its physical configuration. Besides requiring a smaller footprint and vertical height for a given lower frequency cutoff, it has most of its mass located near the base. This helps stabilize the TASH antenna during high winds.

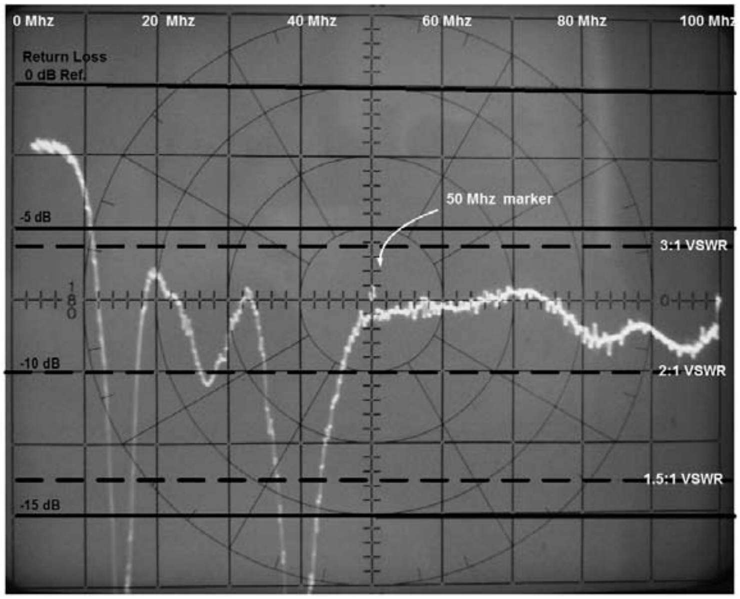

Figure 15 — Measured SWR and return loss of the complete chicken wire TASH antenna.

A TASH antenna is a new option in wide band antennas. It has features not available with other wideband antennas and can be assembled using inexpensive materials, such as chicken wire. Chicken wire can really work wonders on the HF bands.

Notes

[1]One source of information about various types of wide bandwidth antennas is this Web site: **www.g3tpw.co.uk/Page5OtherMulti-bandAntennas.htm**

[2]Thomas J. Warnagiris, K3GSY, "A Monopole with a Twist," *Microwave Journal*, Vol 44, No. 9, Sep 2001, pp 120-137.

[3]Thomas J. Warnagiris, K3GSY, "A Monopole with a Twist Revisited," *Microwave Journal*, Vol 48, No. 7, July 2005, pp 54-74.

[4]There is a brief discussion of antenna polarization at the Web site: **ham-shack.com/polarization.html**

[5]There is more information about GNEC at the Nittany Scientific Web site: **www.nittany-scientific.com/**

Tom Warnagiris, K3GSY, was first licensed in 1958 as KN3GSY. He received his BSEE from the Pennsylvania State University and has performed graduate work at the University of South Florida. He is currently a retired engineer from the Signal Exploitation and Geolocation Division of Southwest Research Institute (SwRI). He previously worked as an engineer at ARINC Research, the ECI division of NCR, C-COR Electronics, and HRB Singer. He holds several communications related patents and is a Senior member of the Institute of Electrical and Electronic Engineers (IEEE).

QEX