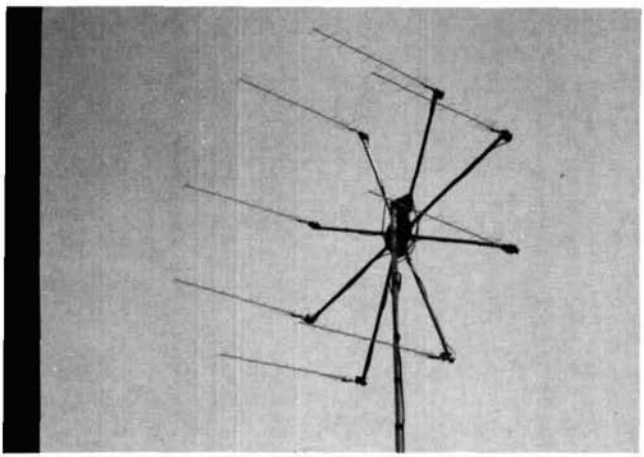

high-gain 1296-MHz Yagi Array

Construction of a light-weight high performance 104-element antenna for 1296 MHz

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The high-gain 1296-MHz array described in this article, which I call the "blowtorch array" and which consists of eight 13-element Yagis arranged in a circle, is light weight, presents little wind resistance, can be rotated with a small TV rotator, and provides gain equivalent to that of a 5-foot (1.5 meter) dish. The Yagis, based on a design by W2CQH,[1] use slightly shorter directors than he specified and are designed for use with low-loss 75-ohm CATV coaxial feedline.

yagi construction

The parasitic elements of the Yagis are lengths of number-14 (1.6mm) OD copperweld wire, soft-soldered to a boom made of ¼-inch (6.5mm) thick-wall brass tubing, 36 inches (91.4cm) long as shown in **fig. 1**. The copperweld elements provide both physical strength and high electrical conductivity, both of which are required for effective operation.

Before cutting the directors, make up a simple template as shown in **fig. 2** so that each of the directors is precisely the same length. This is extremely im-

*Any specific information desired regarding this array can be obtained by enclosing a self-addressed stamped envelope with inquiry to Paul F. Magee, W3AED, R2 Box 432, Berlin, Maryland 21811.

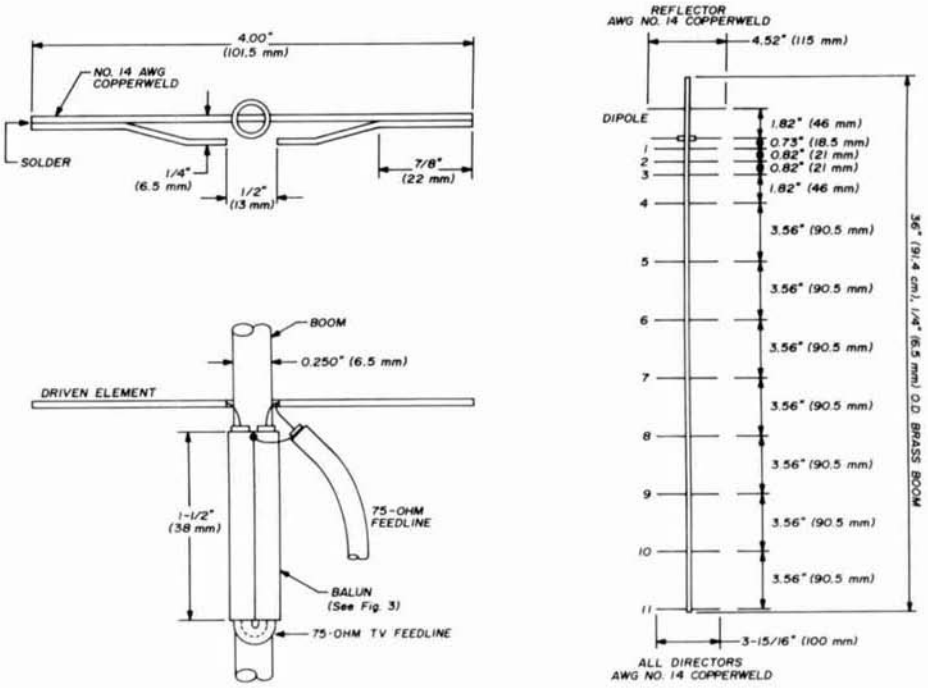
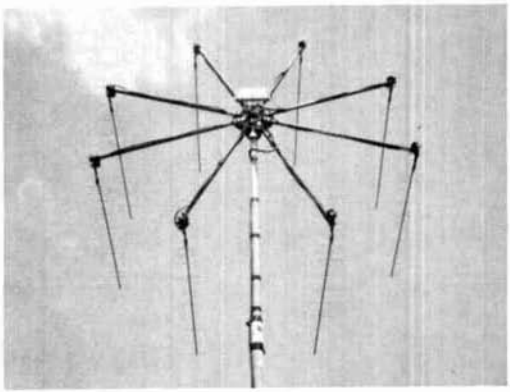


fig. 1. Layout of the 13-element Yagis used in the 1296-MHz blowtorch array. Details of 75-ohm feed system are shown in fig. 3.

portant because very slight differences in length will adversely affect the performance of the antenna.

The driven element is a delta-matched dipole of number-14 copperweld which is soldered to the boom. The delta-matching system consists of two pieces of number-14 soft copper wire soldered to the dipole – this is fed by a balun made from two pieces of ¼-inch (6.5mm) OD copper tubing, 1½ inch (38mm) long, which are soldered on top of the boom as shown in **fig. 3**. Place the forward end of these two tubes as close as possible to the driven element to minimize lead length to the delta match.

To hold the two balun tubes in the proper position while you are soldering them, bend a small piece of sheet aluminum into a vee which can be held loosely in a vise. Note the short number-14 stud which is soldered between the quarter-wavelength balun tubes – this provides a convenient place to solder the shield of the 75-ohm coaxial phasing



Rear view of the 1296-MHz blowtorch array showing the waterproof enclosure which houses the quarter-wavelength matching transformers.

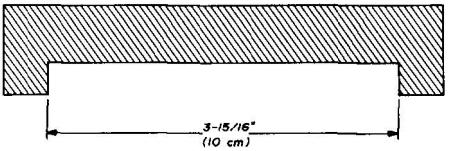


fig. 2. Use of a template is recommended to assure that each of the directors is precisely the same length. For best results, cut each of the directors slightly longer than necessary and file off the ends until each element just passes through the guage.

line (be sure the phasing lines are connected to the same side of the delta match on all eight Yagis).

After the two copper balun tubes and all elements have been soldered to the boom, strip off the outer jacket and shield from a section of 75-ohm TV feedling (which has a larger diameter than RG-59/U). Fold the balun wire into a U and insert it into the balun tubes. Connect the center conductors to each side of the delta match.

The antenna mount consists of a center hub of 1/8-inch (3mm) thick galvanized steel, 8 inches (20cm) in diameter, to which is attached a spider-shaped arrangement of 3/4-inch (19mm) aluminum tubes, each 31 inches (79cm) long. Short tabs on the top and bottom of the center hub provide space for the U-bolts which are used to attach the array to a mast.

The aluminum tubes are attached to the hub with 10-32 screws and strengthening members made from 3-inch (76mm) lengths of 1-inch (25mm) square aluminum channel (see **fig. 4**). The Yagis are attached to the ends of these tubes with special clamps which

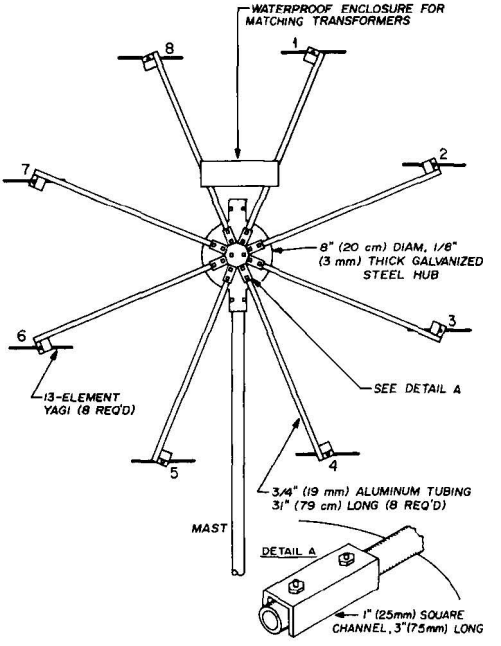


fig. 4. Construction of the antenna mount showing the center hub and eight aluminum antenna-support masts. Main mast is placed in front of the center hub and attached to it with U-bolts.

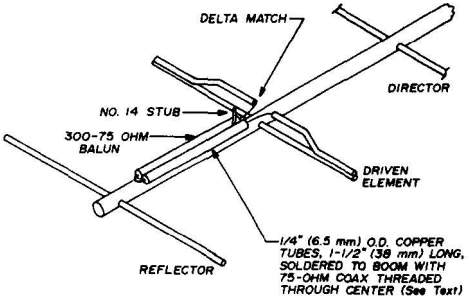


fig. 3. Construction of the 300- to 75-ohm balun used on each of the Yagis. The shield of the coaxial feedline is connected to the short stud.

allow the antennas to be oriented parallel to one another.

The Yagi clamps, shown in **fig. 5**, are made from 2-inch (51mm) lengths of 1-inch (25mm) square aluminum channel which is attached to the aluminum tubes with small U-bolts made from ¼-inch (6mm) threaded steel stock. Two small notched aluminum blocks are used to hold the antenna boom to the channel (cut the notch

slightly smaller than the diameter of the boom so the antennas are held very rigidly).

Be sure to use brass nuts on the steel U-bolts. The combination of aluminum clamps and brass hardware doesn't seem to cause any problem as my array shows no ill effects although it has been exposed to the salt air at my station for more than two years.

matching harness

The matching system for the blowtorch array is made up of a system of 50-ohm quarter-wave matching transformers and 75-ohm coaxial feedlines 16 half-wavelengths long (48 inches or 122cm). A schematic diagram of the system is shown in **fig. 6**. Since the 75-ohm matching lines are an integral number of half-wavelengths long, the 75-ohm input impedance of each of the antennas is repeated at the opposite

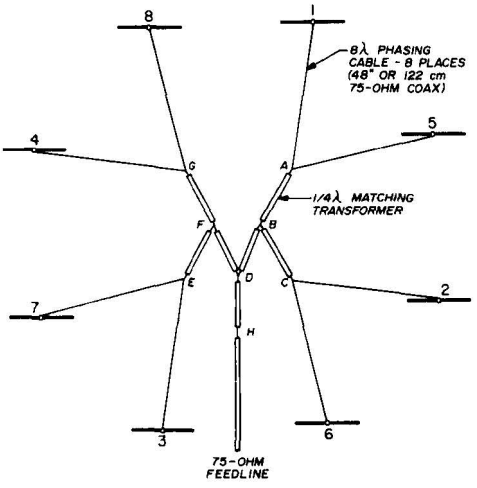


fig. 6. Schematic diagram of the phasing system used with the blowtorch array. Construction of the quarter-wavelength matching transformers is shown in fig. 7.

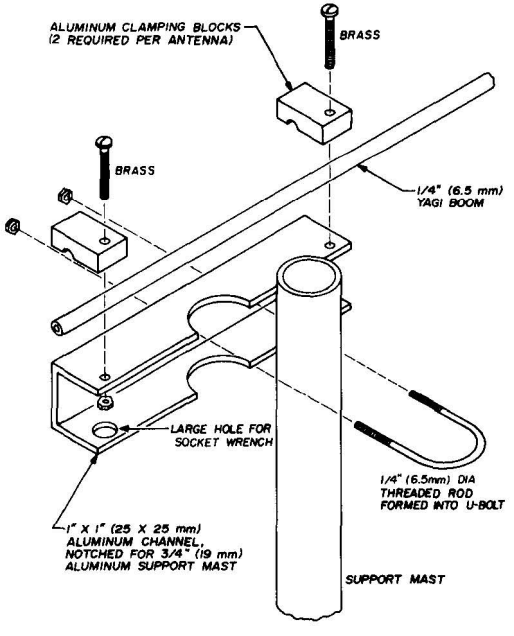


fig. 5. The Yagis are attached to the aluminum support masts with clamps (8 required) which allow all of the beams to be aligned in the same plane.

end. Since two 75-ohm feedlines are connected in parallel at points A, C, E and G, the impedance at each of these points is 37.5 ohms. This is transformed to 75 ohms by a 50-ohm quarter-wave transformer. These transformers are connected in parallel at points B and F, so the impedance at these points is 37.5 ohms. This is transformed to 75 ohms with another 50-ohm quarter-wave transformer (B-D and F-D).

When connected in parallel at point D and transformed with another quarter-wave transformer, the input impedance provides a close match to the 75-ohm feedline. Note that the 8-wavelength matching lines are not connected to adjacent antennas, but to antennas on opposite sides of the array.

The quarter-wavelength matching transformers are soldered to a 3x5-inch (8x13cm) copper sheet as shown in the photograph of **fig. 7**. The outer conductor of each quarter-wave transformer consists of a 3/16-inch (5mm) OD copper tube, 1½ inch (38mm) long. Short lengths of RG-58/U coax (strip-

ped of the outer shield and jacket) are threaded through these tubes. Short stubs of number-14 wire, about 3/8 inch (10mm) high, at the feedline end of each of the transformers provides a convenient point for connecting the outer shield of the 75-ohm feedlines. The completed transformer is mounted in a waterproof enclosure which is installed at the center of the array.

be checked individually before they are installed on the large array. First check the vswr and make adjustments as necessary to the delta match for a vswr of 1.2:1 or less. Then check the lobes on each side of the main pattern. If they are not at least 9 dB down, the antenna is not working correctly. This can be checked by connecting a low-power 1296-MHz signal source to the antenna

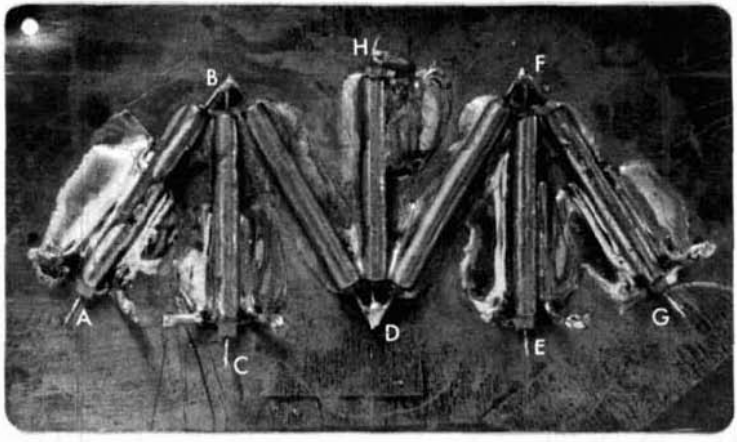


fig. 7. Quarter-wavelength matching transformers are made from 3/16-inch (5mm) OD copper tubing. Letters coincide with the points noted in fig. 6.

When soldering the tubes to the copper sheet make sure they are soldered from one end to the other. You can use a small torch for this, if you wish, but I suggest a husky 200-watt soldering iron. When the transformer assembly has cooled off, the rosin flux can be removed with lighter fluid. (Acid flux can also be used but thoroughly clean off any residue with hot water, baking soda and a tooth brush before you install the sections of RG-58/U.)

testing

Each of the 13-element Yagis should and measuring the relative field strength about 50 feet (15 meters) in front of the antenna.

When the blowtorch array is completely assembled check the field strength about five feet (1.5 meter) in front of each Yagi; if the phasing system is working properly the field strength in front of each of the antennas should be the same.

reference

1. Reed E. Fisher, W2CQH, "A Successful 1296-MHz Yagi," *ham radio*, May, 1972, page 24.

ham radio