



QST



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QST Issue: Nov 1985

Title: 902-MHz Loop Yagi Antenna, A

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A 902-MHz Loop Yagi Antenna

Join in the fun on the newest Amateur Radio band with this fine performer that's also easy to build.

By Donald L. Hilliard, WØPW
ARRL Contributing Editor
P.O. Box 563, Boulder, CO 80306

Several years ago, M. H. Walters, G3JVL, designed and published information on a loop-Yagi antenna for 1296 MHz.¹ Since that time, numerous modifications to his design have been published in the RSGB journal, *Radio Communication*.²⁻⁴ These changes have mostly been minor ones. For some time, I have used one of the variants of G3JVL's design on 1296 and have been pleased with the results.

A few years ago, while studying various designs for 902-MHz antennas, I decided to scale the dimensions from the 1296-MHz loop Yagi and build one to check its performance. This article describes the results of my efforts and provides all of the information needed for you to build one for yourself.

Making the Boom

One of the first things to consider is the boom. I decided to make the antenna from readily available materials as much as possible. In most areas of this country, building-materials stores have various sizes of moderately priced aluminum tubing in

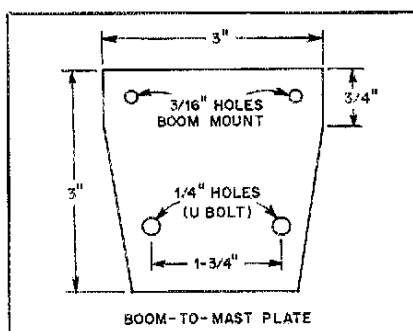


Fig. 1—Boom-to-mast details.

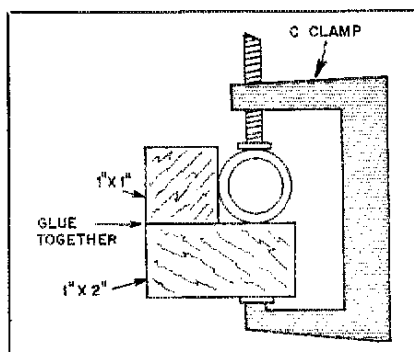


Fig. 2—A jig for drilling the boom can be made from some lumber and C clamps.

6- and 8-foot lengths. I decided to use two 6-foot lengths of 1-inch-OD tubing spliced to give me a 12-foot-long boom. The splice is made from a 2-foot length of 7/8-inch-OD tubing that extends 1 foot inside each of the two 1-inch-OD pieces. This technique yields a strong boom that is adequate for this application. Although I have not tried it, I think a 12-foot length of 1-inch-square aluminum tubing would work as well and would make drilling the element-mounting holes much easier.

The antenna is mounted to the mast with a gusset plate. This plate mounts at the boom splice, and its mounting bolts also secure the splice (see Fig. 1). Drill the gusset-plate mounting holes perpendicular to the element-mounting holes, assuming the antenna polarization is to be horizontal.

Once you have a 12-foot boom and mounting plate, you need some method of securing the boom while you drill the element-mounting holes. It's important to make the elements line up as closely as possible. Many gadgets that make this process easier than it might have been several years ago are available today. I use a jig constructed of two 12-foot lengths of pine lumber; one is a standard 1 × 2 and the other a standard 1 × 1. The boom is secured to the jig with three or four C clamps, and the holes are made with a

¹Notes appear on page 32.

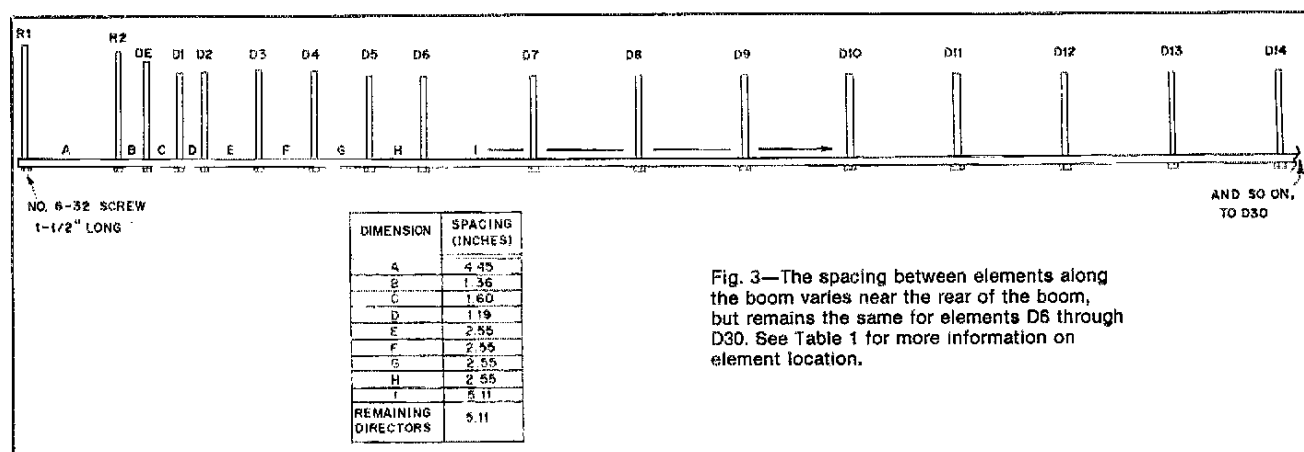


Fig. 3—The spacing between elements along the boom varies near the rear of the boom, but remains the same for elements D6 through D30. See Table 1 for more information on element location.

Table 1
Distance of Element-Mounting Holes from Reflector End of Boom

Element	Distance (inches)	Element	Distance (inches)
R1	0.50	D14	60.18
R2	4.95	D15	65.29
DE	6.31	D16	70.40
D1	7.91	D17	75.51
D2	9.10	D18	80.62
D3	11.65	D19	85.73
D4	14.20	D20	90.84
D5	16.75	D21	95.95
D6	19.30	D22	101.06
D7	24.41	D23	106.17
D8	29.52	D24	111.28
D9	34.63	D25	116.39
D10	39.74	D26	121.50
D11	44.85	D27	126.61
D12	49.96	D28	131.72
D13	55.07	D29	136.83
		D30	141.94

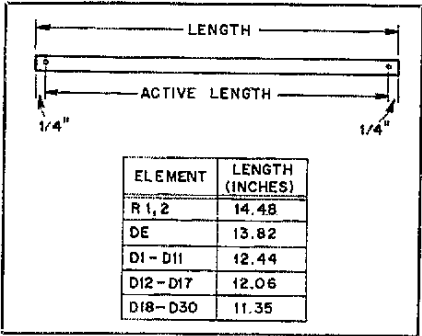


Fig. 4—The active length of each element is 1/4 inch less than the length of the element strap. Lengths given here are the overall length of the element straps, not the active length.

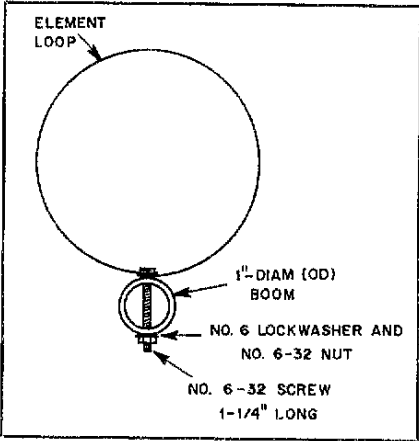


Fig. 5—Element-to-boom mounting details.

drill press (see Fig. 2).

Table 1 indicates the distances of the element-mounting holes from the reflector end of the boom. Fig. 3 shows the relationship of the various elements in the finished antenna. The element-mounting holes are made with a no. 28 drill to clear no. 6-32 mounting hardware. After you drill all of

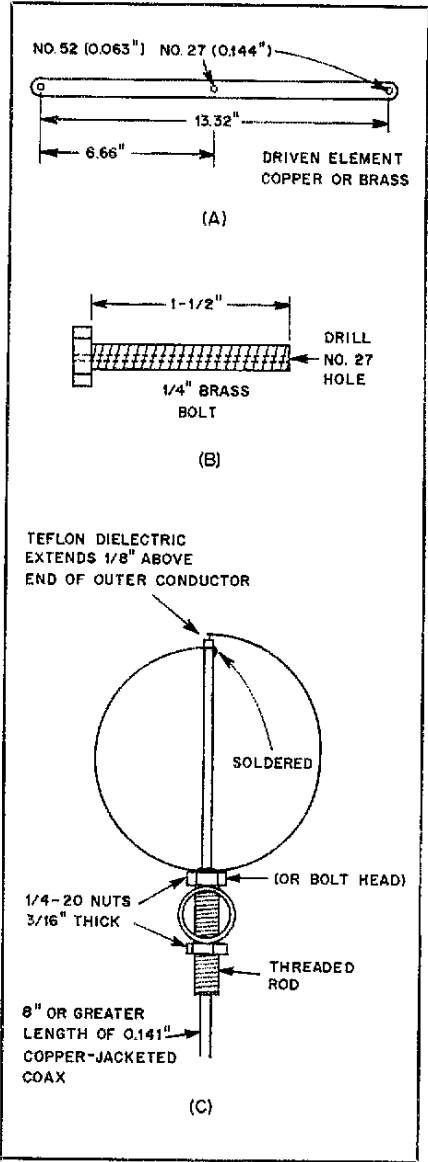


Fig. 6—Driven-element details. The element strap is shown at A. At B is the brass mounting fixture. Part C details the driven element assembly.

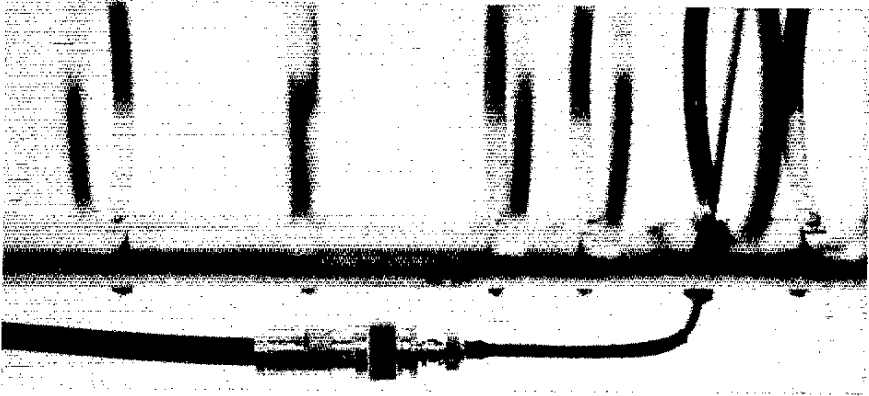


Fig. 7—A crimp-on BNC connector is soldered to the 0.141-inch Hardline that attaches to the driven element. An adapter is used to make the connection to the cable that runs down the boom to the main feed line.

the holes, drill out the hole for the driven-element assembly to 1/4 inch.

Making the Parasitic Elements

The reflectors and directors are cut from 1/32-inch (0.03125-inch) aluminum sheet and are 5/16 inch wide. Fig. 4 indicates the lengths for the various element straps. They should be cut with a shear. Although the elements could be cut with tin snips, amateurs who have tried this have been disappointed in the results—badly distorted straps. It's much better to locate a friend with a shear, or have the job done at a machine shop.

Once you have the straps in hand, drill the mounting holes as detailed in Fig. 4. The holes are made with a no. 28 drill, 1/4 inch in from each end of the element strap. After the holes are drilled, you must form each strap into a circle. This is done easily by wrapping the element around a round form. I used a 3-inch-diameter propane bottle.

Mount the loops to the boom with no. 6-32 machine screws, lock washers and nuts (see Fig. 5). It's best to use stainless-steel or plated-brass hardware for everything. Although the initial cost is higher than for ordinary plated-steel hardware, stainless or brass hardware won't rust and need replacement after a few years. When you mount the elements, make sure they are perpendicular to the boom.

Making the Driven Element

Read this entire section carefully and study Figs. 6 and 7 before you start assembly of the driven element. The driven element is cut from 1/32-inch (0.03125-inch) copper or brass sheet and is 5/16 inch wide. Drill three holes in the strap, as detailed in Fig. 6A. Trim the ends to form a semicircle, leaving very little metal outside of the end holes. Form this strap into a loop similar to the other elements.

To mount the driven element to the boom, you need to make a brass mounting

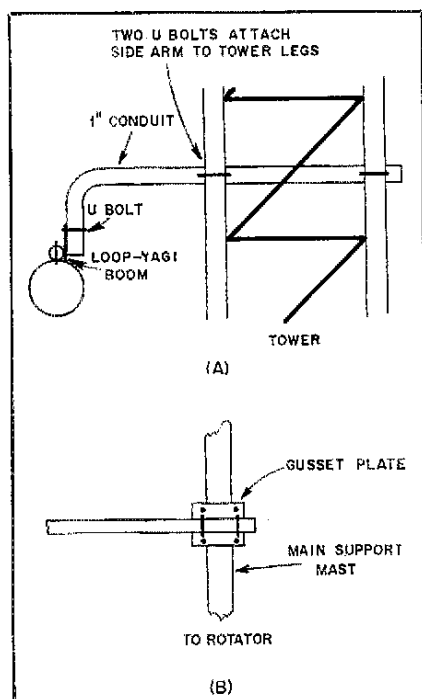


Fig. 8—Suggestions for a fixed (A) or rotatable (B) mounting.

fixture, as shown in Fig. 6B. The mounting fixture can be made from a 1½-inch brass bolt or from a piece of ¼-20 threaded brass rod. Bore a 0.144-inch (no. 27 drill) hole lengthwise through the center of the rod. A piece of 0.141-inch semirigid Hardline will mount through this hole and connect to the driven loop. Fig. 6C shows how the driven element is assembled and mounted to the boom. The point at which the 0.141-inch Hardline passes through the copper loop and brass mounting fixture should be left unsoldered at this time to allow for matching adjustments when the antenna is completed.

The 0.141-inch semirigid Hardline, RG-402 or equivalent, is available in short lengths from varied sources. One source that sells this cable in foot lengths is

J. Smith and Associates, Inc., 3540 N. Academy Blvd., Colorado Springs, CO 80907.

I use a jeweler's saw to prepare the cable ends. Only a few inches of this line are required, enough to get through the boom and mount a connector on it. At this frequency, you should use a minimum number of connectors or adapters; they frequently cause problems. Type-N cable connectors for RG-402 are available from various sources. One (Model no. 2707F) is made by Midwest Microwave, 3800 Packard Rd., Ann Arbor, MI 48104. Another source is Pasternack Enterprises, Coaxial Products Division, P.O. Box 26759, Irvine, CA 92713. A catalog that lists several suitable connectors for this application is available.

Or you may wish to make a connector the way I did, with a BNC connector and BNC-to-N adapter. I used a BNC crimp connector designed for use with RG-59 cable. The RG-402 outer conductor slips tightly inside the crimp body. The connector center pin may need to be drilled out to accept the RG-402 center conductor, or you can use the center pin from a BNC connector designed for RG-58 cable. The center conductor of RG-58 is the same size as that of RG-402, so an RG-58 center pin will work without modification. Solder the RG-402 copper jacket to the BNC crimp body and place a piece of heat-shrinkable tubing over the soldered joint to keep moisture and contaminants away. Fig. 7 shows the finished connection.

A low-loss RG-8 cable may be run down the boom and mast to the main feed line. For best results, your main feed line should be the lowest-loss 50-ohm cable obtainable. This cannot be overemphasized!

Tuning the Driven Element

Check the SWR of the antenna. You may realize some improvement by making the driven element more oblong. The antenna shown here exhibited an excellent match with no adjustment to the relative shape of the driven element. When you have obtained the desired match, solder the

point where the RG-402 jacket passes through the loop and brass mounting fixture.

Mounting the Antenna

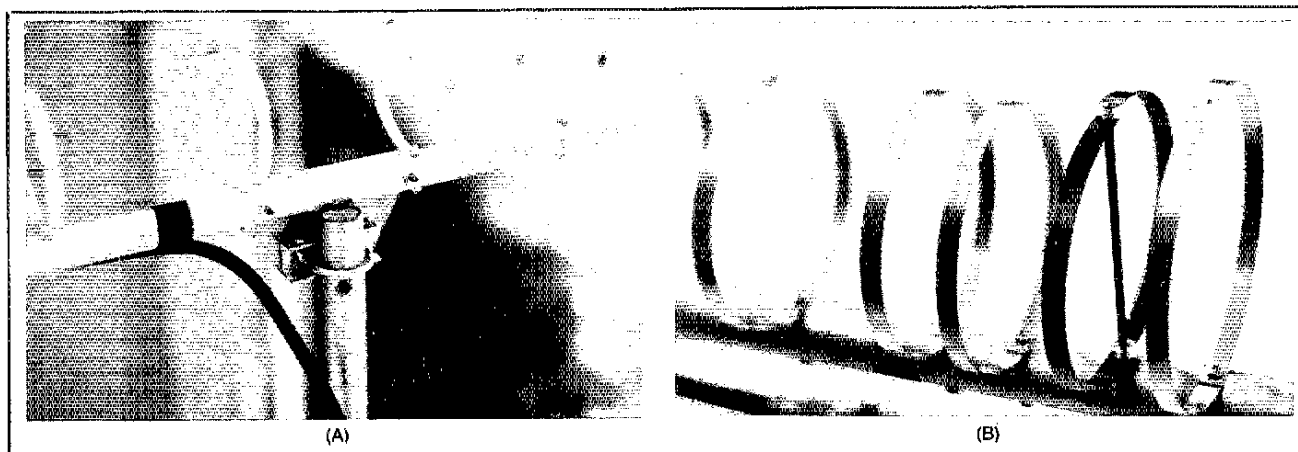
Now that the antenna is complete, it is ready to be mounted for use. You've probably noticed that the loops are not inherently strong. If you live in an area where there are no large birds, you may be able to mount it as shown in the photographs. I mount the single loop Yagi as shown in Fig. 8. The inverted loop Yagi provides a less desirable perch for birds. Other deterrents have been tried, such as attaching toy snakes so that they move in the wind. A U-shaped (inverted) length of conduit will allow two of these antennas to be stacked horizontally for additional gain. The stacking distance should be 26 to 32 inches.

The loop Yagi may be used as a vertically polarized antenna. Simply rotate the boom on the gusset plate until the loops are horizontal. Be careful when you mount—any mounting member that is of the same polarization of the antenna must be kept a couple of wavelengths away from the antenna itself.

The gain of loop Yagis of this design has been measured at between 17 and 18 dBi. Stacking two of them will yield another 2.5 dB, approximately. Similar designs have used up to 16 stacked loop Yagis at 1296 MHz; these arrays have performed well enough to make EME contacts. It is an antenna whose performance is proven. I have the antenna shown in the photographs installed at my Missouri location (near Joplin). Look for me on 902-MHz CW!

Notes

- *G. R. Jessop, ed., *VHF/UHF Manual*, 4th ed. (Hertfordshire: RSGB, 1983).
- *D. Evans, "A Long Quad Yagi for 1296 MHz," *Radio Communication*, Jan. 1975, pp. 24-25.
- *D. Evans, "The G3JVL Loop Yagi," *Radio Communication*, July 1976, p. 525.
- *C. Suckling, "The G3JVL Loop Yagi Antenna," *Radio Communication*, Sept. 1978, pp. 782-783.



Details of the boom-to-mast plate and element mounting may be seen at A. A view of the driven-element assembly is shown at B.