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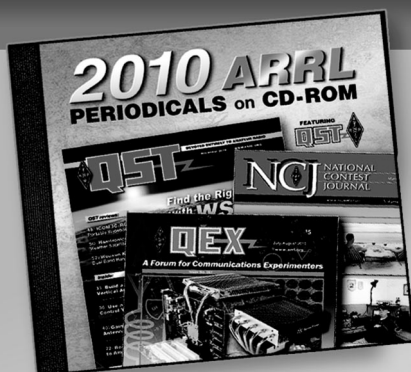
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# The Multimatch Antenna System

Unique Design Providing Essentially Constant Impedance Over Several Bands

BY CHESTER L. BUCHANAN,\* W3DZZ

• For a long time, hams have been searching for a single antenna that could be fed efficiently with a low-impedance transmission line on several bands. At last a simple but ingenious design by W3DZZ provides a solution. He has applied some well-known but neglected principles to both wire and parasitic-beam antennas.

RADIO transmitters and receivers have enjoyed rapid development in flexibility to the point where changing bands is a matter of only spinning a dial or two and flipping a couple of switches. In contrast, the operation of a single antenna on several bands is usually done only at the expense of high standing waves on the feed line, because of the wide variation in antenna feed-point impedance from band to band.

Some work done by the author several years ago in connection with a dual-band parasitic array<sup>1</sup> has led to the development of a simple wire antenna covering five bands, from 80 to 10 meters. This antenna can be fed with a low-impedance transmission line without incurring excessive s.w.r. on any of these bands.

## Basic Design

The fundamental principle of the system can be explained with the aid of Fig. 1. In Fig. 1A,

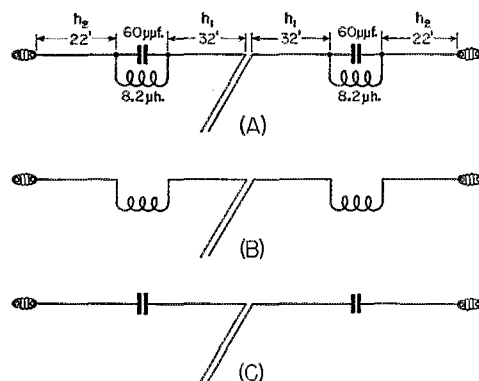


Fig. 1—Sketch illustrating the three fundamental modes of the multimatch antenna.

\* 4671 Lacy Ave., Washington 23, D. C.

<sup>1</sup> Buchanan, "Duo-Band Ham Antenna," *Radio & Television News*, December, 1950.

<sup>2</sup> Morgan, "A Multifrequency Tuned Antenna System," *Electronics*, August, 1940.

sections  $h_1$  constitute a half-wave dipole for some frequency  $f_1$ . This dipole is terminated in lumped-constant trap circuits resonant at  $f_1$ . Additional wire sections,  $h_2$ , extend beyond the traps. If the system is excited at frequency  $f_1$ , the traps serve to isolate the dipole much as though insulators were inserted at these points.<sup>2</sup>

At frequencies much lower than  $f_1$ , the traps no longer isolate the dipole, but act simply

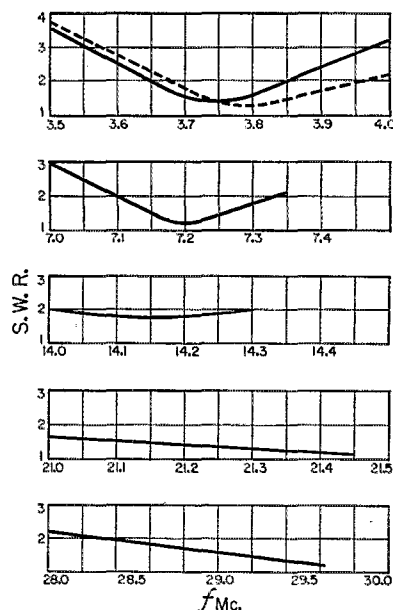


Fig. 2—S.w.r. measurements made on the antenna of Fig. 1A. The dashed lines show measurements made on a 122-foot dipole in the same location for comparison.

as loading inductances in a second dipole whose electrical length is made up of  $h_1$ ,  $h_2$  and the inductive reactance of the traps, as in Fig. 1B.

At frequencies much higher than  $f_1$ , the traps again cease to isolate the sections, the traps now acting as series capacitances, as in Fig. 1C.

Another important consideration in this multi-band system is that low impedance at the center feed point of the antenna occurs not only at its fundamental resonance but also at any odd harmonic of the fundamental.

By applying these principles, and by proper selection of the values of  $L$  and  $C$  in the traps, and choice of lengths for  $h_1$  and  $h_2$ , it has been possible to arrive at a design where the system operates as follows:

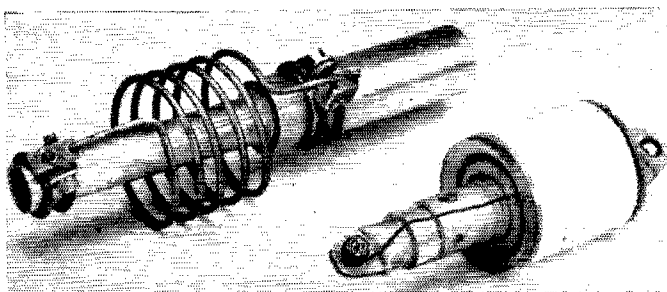
- 1) Sections  $h_1$  form a half-wave dipole resonant

in the 40-meter band. The traps, resonant at the same frequency, isolate this dipole from the outer sections.

2) The inductive reactance of the traps is such that the entire system, including sections  $h_2$ , resonates as a loaded half-wave dipole for the 80-meter band.

3) The capacitive reactance of the traps at higher frequencies is such that the entire system resonates as a  $3/2$  wavelength antenna on 20,  $5/2$  wavelength on 15, and  $7/2$  wavelength on 10 meters.

The antenna is fed with 75-ohm Twin-Lead, and Fig. 2 shows the results of s.w.r. measure-



Lightweight weatherproof traps made by the author. To the left is the type inserted in beam elements, while the other one is suitable for wire antennas.

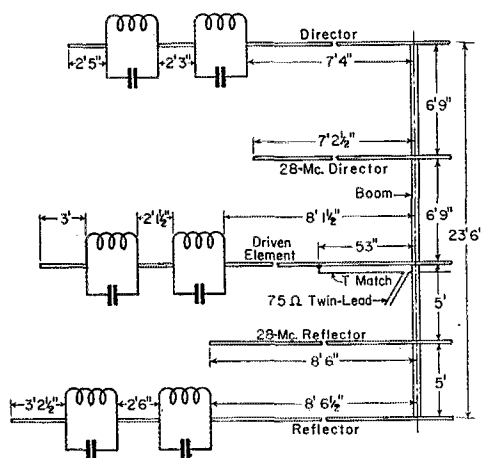


Fig. 3 — Dimensions of the 3-band parasitic beam found optimum at W3DZZ. Dimensions are, of course, duplicated on the opposite side of the boom.

ments made across each band. Proper dimensions are given in Fig. 1A.

### Trap Construction

The values of  $C$  and  $L$  used in the traps are quite critical. The capacitance should first be adjusted accurately to 60  $\mu\text{f.}$ , then the inductance should be trimmed until the trap resonates at 7200 kc. This should be done before the traps are inserted in the antenna. The inductance will be approximately 8.2  $\mu\text{h.}$  The traps made by the author are 6 inches long and weigh only 6 ounces and the  $Q$  is well over 100. They will withstand the voltage developed by a 1-kw. transmitter. Samples are shown in the photograph. The wire-antenna capacitor is made up of concentric lengths of 1-inch and  $3/4$ -inch aluminum tubing separated by polystyrene tubing with  $1/8$ -inch

walls, molded around the inner conductor. The polystyrene is also flowed into a series of holes in one end of the outer conductor so that the strain of the antenna will not pull the assembly apart. The inductor is wound with No. 14 wire and is concentric with the capacitor. The inductor is weatherproofed by molding it in insulating material. Other construction might be used, of course. As an example, a conventional inductor and capacitor could be enclosed in a plastic box, suspended across an insulator. This would, however, add to the weight.

### A Three-Band Parasitic Beam

The principle of isolating sections of an antenna with resonant traps has been applied to a parasitic beam antenna that operates on 10, 15 and 20 meters. This array with dimensions is sketched in Fig. 3. The array is a five-element job on 10 meters, with two reflectors spaced approximately 0.15 wavelength, and two directors spaced approximately 0.2 wavelength. On the other two bands, three elements are active. On 15 meters, spacings are approximately 0.22 wavelength for the reflector and 0.29 for the director. On 20 meters, the approximate spacings are 0.14 and 0.2, respectively.

Fig. 4 shows a breakdown of a suggested method of construction of the three main elements. Each element starts out with a 12-foot center section to which various sections are added at each end. Provision is made for adjusting the length from the center of the element to the first (28-Mc.) trap, the length between traps, and the section on the outside of the second (21-Mc.) trap. The photograph shows an example of the array traps used by the author. Here,

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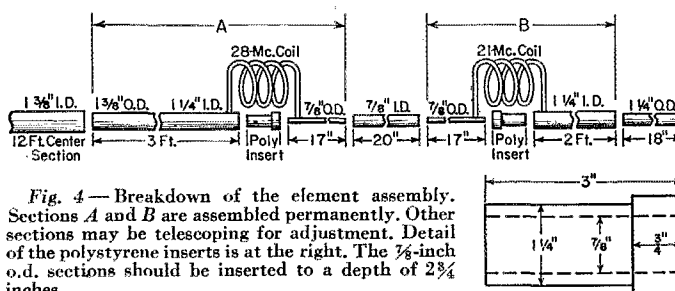


Fig. 4 — Breakdown of the element assembly. Sections A and B are assembled permanently. Other sections may be telescoping for adjustment. Detail of the polystyrene inserts is at the right. The  $3/8$ -inch o.d. sections should be inserted to a depth of  $2\frac{3}{4}$  inches.

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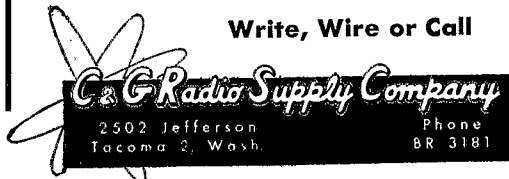
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## Multimatch Antenna System

(Continued from page 23)

again, the capacitor is made up of concentric aluminum or dural tubing separated with polystyrene, and the coil is concentric. In each capacitor, the polystyrene insert (Fig. 4) should provide a tight fit to both sections of tubing, and the insert should be driven into the outer conductor to the shoulder. The inner conductor should be driven into the insert for a distance of  $2\frac{3}{4}$  inches (thus protruding 2 inches inside the outer conductor). This gives a capacitance of approximately 25  $\mu$ f. The trap inductors are wound with No. 8 wire. The 10-meter inductors have 5 turns  $2\frac{1}{2}$  inches in diameter, with the turns spaced approximately  $\frac{1}{2}$  inch. The 21-Mc. inductors are similar, but have 7 turns. As with the wire-antenna traps, the inductors should be adjusted for resonance near the center of each band before they are installed. The ends of the inductors are wound around the element sections and fastened with clamps. The array is fed with a T match to 75-ohm Twin Lead.

Fig. 3 shows the element dimensions used by the author. Antennas of this type, in both wire and beam forms, have been installed by many amateurs, using traps constructed by the author. Without exception, all have been enthusiastic about the performance.

## "Hidden Gem"

(Continued from page 24)

A Vari-Loopstick is used for  $L_1$ , as suggested by W8E1Y. It is a commercial slug-tuned inductance which is widely used as a broadcast-receiver antenna. It sells for less than a dollar, and requires only a small hole for mounting. It comprises a very compact, adjustable tuned circuit consisting of its self-inductance and the distributed and stray capacitance of the circuit. It peaks very nicely on 75 meters using a transmitter or grid-dip meter as a signal source. Once the Vari-Loopstick is peaked at 75 meters, no further adjustment is ever necessary, since it is broad enough to cover the entire 75-meter band, and the increased radiation efficiencies on the higher-frequency bands more than compensate for the lack of a tuned circuit.

When it comes to the pick-up antenna, you can really let your imagination go to work. Only a short vertical probe from 4 to 8 inches in length is necessary if mounted on the rear gravel skirt or on the rear-window deck. An unused broadcast-receiver whip is efficient and inconspicuous. The antenna used here is a right front-fender guide which is insulated from the car body. This serves double duty because it works well as a pick-up antenna and helps the XYL in parking. Any insulated wire serves as a lead-in to the meter.

(Continued on page 132)