Build This C-T Quad Beam for Reduced Size

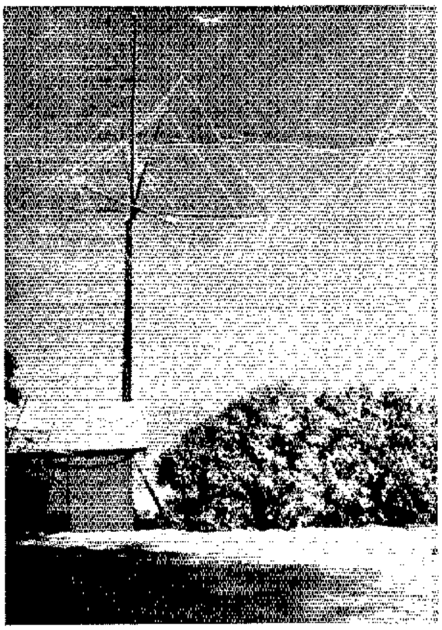
No inductors are needed. There are no costly accessories required. This quad-beam antenna, while smaller in size than a conventional quad, performs like a veteran. The trade secret is to use capacitive tuning. If you have the will to build, this is the way.

By Roger Sparks,* W7WKB

Ah! There's your friend's quad beam. He's already extolled its ability to work DX, and you're thinking of that upcoming contest. Yet, you look at that thing and say to yourself, "It's bulky, sort of overweight." Still, you know what a quad will do. Well, then, let me suggest the C-T treatment – the easy way to reduce that size at almost no extra cost.

One of the main drawbacks of the quad beam is its large size compared to the Yagi beam. Previous efforts to reduce the size of the quad have utilized systems of inductive tuning. Loading coils have been used on one or two sides[1] or in the corners. Linear inductors on the vertical sides have also been used.[2] The purpose of this article is to explain a simple method of capacitive tuning to reduce the size of the quad. The C-T (capacitor-tuned) loop is diagrammed in Fig. 1.

It is well-known that the physical size of the dipole antenna can be reduced by replacing a portion of the antenna with a capacitive body and adding an inductor to restore the system to resonance. It seems less well-known that the full-wave loop antenna also may be reduced in physical size while holding the resonant frequency of the system constant by adding capacitance at the voltage loops. No inductors are needed. The capacitance may be added by any of the methods shown in Fig. 2.



A winter snow sets the scene and accentuates the diamonds of the C-T quad-beam antenna at W7WKB.

The outside dimensions of the C-T loop may be anything chosen by the builder with the larger limit being the full-size, full-wave loop. The limit on the amount of size reduction effectively attainable depends both upon the electrical resistance in the circuit and upon the tendency in loop antennas for the current to become equal at all points in the circuit when the loop becomes very small in proportion to the free-space wavelength at the frequency under consideration. The geometrical shape of the loop is unimportant to basic operation provided that the capacitance is placed at or between the voltage loops. The bottom half of the chart in Fig. 5 shows the effective dimensional range of the

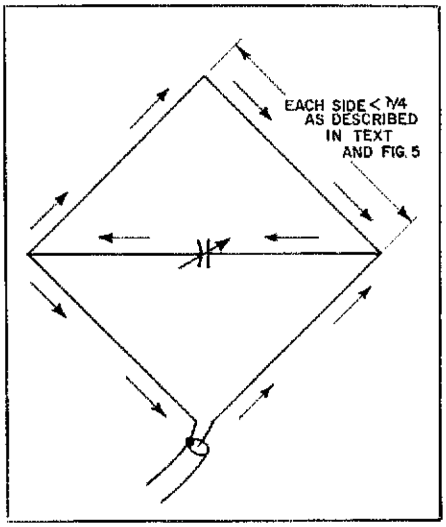


Fig. 1 – The C-T quad design with arrows indicating current flow for 1/2 cycle. The center capacitor is located at the minimum-current (highest-voltage) point in the loop. Each side is less than 1/4-wavelength long. See text and Fig. 5.

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[1] Footnotes appear on page 31.

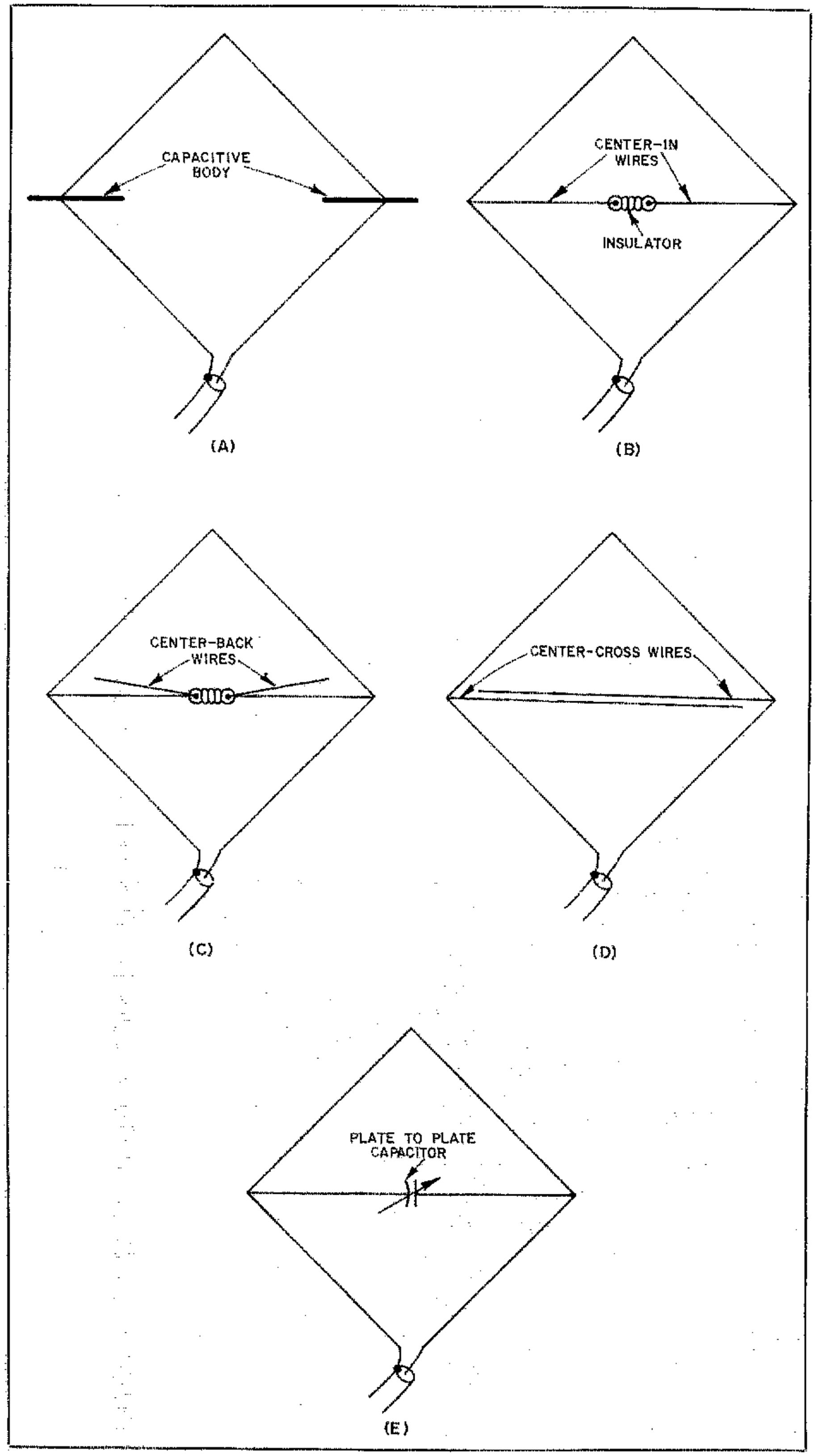

Fig. 2 — Methods of adding capacitance to the C-T loop are shown here. In Fig. 2C, if the center-back wires are placed too closely to the center-in wires, they become ineffective. A 12-inch spacing from the end of the center-back wire to the center-in wire is satisfactory. Wires running back toward the loop center may be attached to the outside ends of the center-back wires if more capacitance is needed. In Fig. 2D, the capacitance added by the center cross wires varies with both the length of wire and spacing between wires.

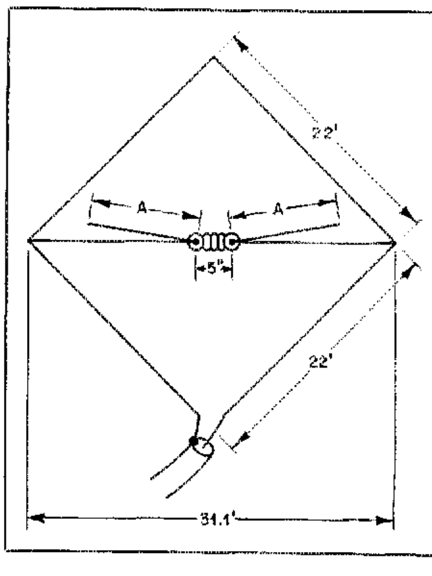

Fig. 3 — Dimensions for the 40-meter C-T quad are shown above. For the two-element beam the spacing between the driven element and the reflector is 20 feet. The length of the center-back wire (dimension A) is 12 feet, 9 inches for the reflector, and 9 feet, 11 inches for the driven element.

C-T loop, and the top half shows the tuning range that can be expected by using various methods of adding capacitance to the diamond quad. These dimensions are intended as guidelines only.

The feed-point resistance of the full size, one-wavelength loop is about 100 ohms. The feed-point resistance of the C-T loop decreases as it is made smaller but will offer a good match to a 50-ohm coaxial line over the entire usable range as shown in the chart. A gamma match may be used if an exact match is desired.

More than one C-T loop may be used to form the C-T quad beam. A parasitic reflector was used in this installation because of the higher radiation resistance attainable while maintaining good gain. Maintaining the radiation resistance as high as possible is particularly important in small beams both to keep efficiency high and to prevent the bandwidth from becoming too narrow.

Tuning and Mounting

The use of a grid-dip meter to attain initial band resonance is very helpful. By using a grid-dip oscillator, this beam was tuned initially with the driven element to resonate at the center of the band of interest. The reflector was then tuned to resonate at a frequency three percent lower than the driven element. Final adjustments were made using a test oscillator located about 1,000 feet away as a reference signal. The director was tuned for lowest SWR and the reflector for best gain. If you lack a grid-dipper, initial resonance can be established by listening to your station receiver for a strong signal while making the adjustments. A dramatic increase in signal strength will be noticed at resonance. Tuning is accomplished by shortening or lengthening the capacitance wires.

The single loop or beam may be mounted either horizontally or vertically for horizontal or vertical polarization, but in either case it should be mounted as high above the ground as possible. Loop antennas operating close to ground will show a much higher feed-point resistance than normal and will waste considerable power in ground-heating effects. A rough guideline is to mount the antenna so that the bottom point is at least half the loop diameter above the ground.

The working 40-meter version of the C-T quad beam had a diamond configuration because of the greater mechanical strength and because of the longer center wire for tuning purposes. Final dimensions are shown in Fig. 3. A good quality center insulator should be used because of the high voltages present at the center.

A tubular tuning capacitor was originally installed in the driven element and worked well until the kW power level was reached. It then promptly arced over leaving a conductive carbon deposit. A version using two-inch plates as shown in Fig. 4 adequately tuned the reflector even at the kW level for some time. The capacitors, as shown, were not tried under wet conditions, but would probably be satisfactory at power levels up to 400 watts. For long-term use, the method shown in Fig. 2D is preferred over plate-to-plate capacitors because the high voltages are handled more easily.

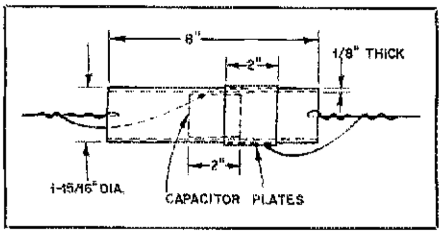

Fig. 4 — A variable capacitor is illustrated here. It can be used to tune the C-T quad. The eight-inch tubular portion is made from plastic water pipe. The cylindrical capacitor plates are formed from a copper sheet. One plate slides inside the eight-inch tube and the other over the outside of the tube. Maximum capacitance is approximately 25 pF.

Table 1

Data for plotting SWR curve. Information in this table is used for plotting the SWR curve for the 40-meter C-T quad beam, as described in the text.

FREQUENCY (MHz)	*SWR*
7.5	4.87
7.45	4.00
7.4	3.08
7.35	2.33
7.3	1.82
7.275	1.78
7.25	1.94
7.2	3.44
7.15	5.25
7.1	8.08

Because some dielectric heating was noticed in this capacitor, the wire-tuned version was adopted. The wire version is recommended over the methods shown in Fig. 2D and 2E, anytime the loop is large enough to be tuned by no more than one doubled-back wire (as shown in Fig. 2C). Tuning wires eliminate the capacitor with its heat loss and allow somewhat better current distribution. Less center radiation occurs because of partial canceling effects in the doubled-back wires. It would be wise initially to cut each center-back wire 12 inches longer than shown to allow tuning. Pruning each center-back wire by one foot increases the resonant frequency by roughly 100 kHz in the 40-meter version. No. 14 Copperweld wire was used throughout.

Performance

The antenna described performed up to expectations and has prompted many complimentary reports. The SWR curve information shown in Table 1 was attained using a 75-ohm coaxial feed line without any matching network. The SWR would be lower if a 50-ohm line or if a matching network were used. Forward signal strength as compared to the strength to the rear showed a maximum 30-dB difference as measured by means of the receiver S-meter. Typical difference, as finally adjusted, was 12 dB.

The gain of the C-T quad over a comparable double Zepp (full wave on 40) was typically at least one S-unit better when both antennas were at a height of 45 feet. The Zepp was better on very short skip but the C-T quad consistently was favored on longer skip. When elevated to 65 feet, the C-T quad gave outstanding results. At this height, two S-units improvement over a vertical antenna at distant points was noted many times.

The C-T quad may be built for any band. It should be most useful in meeting requirements for an inexpensive easily tuned wire-beam antenna where the full-size quad is unsuitable for mechanical or economic reasons. QST

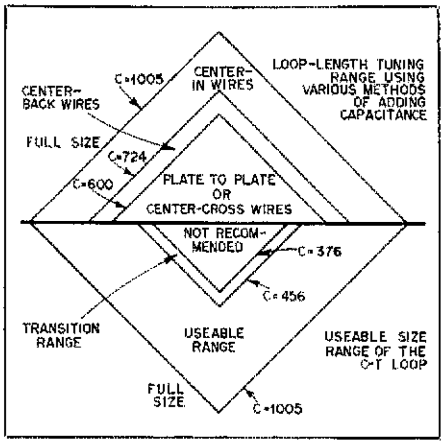

Fig. 5 — The chart shown above, providing dimensional guidelines for a single C-T loop, is based on the equation $LF = C$, where L is the outside dimension in feet, F is the frequency in MHz and C is a constant chosen for the size of the C-T loop to be constructed. Use the largest size possible for the best electrical results. This is particularly true when using C-T loop elements to form a parasitic beam.

To use the chart, pick the largest C (up to $C = 1{,}005$) feasible for your application. Use bottom half of the chart to see if the C-T loop will operate at the dimensional size selected. Then refer to the top half of the chart for the recommended capacitance method.

Footnotes

[1] Pinner, "The Short Quad," *QST*, Feb., 1964.

[2] Courtier-Dulton, "Some Notes on a 7-MHz Linear-Loaded Quad," *QST*, Feb., 1972.

Strays

STOLEN EQUIPMENT

□ SB-144 transceiver, serial no. 620565, stolen from auto in Kingsport, TN, on Jan. 25, 1977. James E. Rhein, K4ZEK, 404 Main St., Jonesboro, TN 37659.

□ Stolen from camper in Boston, MA, near old North Church in summer of '76. Drake TR4/NB, serial no. 29907. Marc Robins, WA6NJR, 6700 Warner Ave., No. 12B, Huntington Beach, CA 92647. Tel. no. 714-847-6904.

□ Clegg transceiver, serial no. HM-298, and mic taken from van on Feb. 5, 1977, in Bridgeport, CT. Jon P. Zaimes, WA3BGN, 681 Longhill Ave., Shelton, CT 06484 or telephone 203-929-4659. Bridgeport Police Dept. file no. 6856.

□ R. L. Drake R4C, serial no. 19003; Drake T4XB, serial no. 18403B, Drake TR72, serial no. 640050; Motorola Metrum III, serial no. ROC 47V; Drake TR22C; and JBL L100 speakers, serial no. 188892 and 188893. Harvey Hetland, WA6KZI/N6MM, Box 73, Altadena, CA 91001. Telephone no. (day) 213-578-7231, (night) 213-794-4419. Los Angeles County Sheriff file no. 577 00238 0773 503.