Inverted Rhombics and Biconical Beams

Some Ideas for High-Frequency Antenna Systems

We have received several sets of notes from Mr. Dean O. Morgan,* W2NNT, in which he describes some interesting antennas he has developed for TV work. In the hope that they may offer possibilities for further development of amateur-band antennas, he is passing along his findings to anyone interested in antennas, which means just about everyone.

The Inverted Rhombic

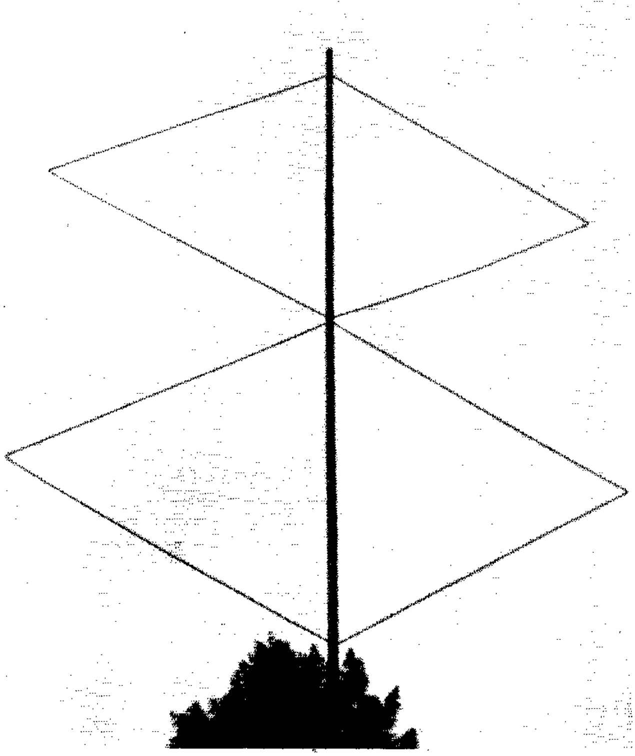
The first of these systems W2NNT calls the "inverted rhombic." In amateur circles the basic unit of this system will be recognized as the "bi-square" that has been used by itself or with a reflector by some of the 28-Mc. gang. The basic unit is shown in Fig. 1A, and it is seen to have a square configuration with half-wavelength sides. Fed at the bottom (or top) with either a tuned line or a flat line and matching system, it gives a horizontally-polarized signal at right angles to the plane of the antenna. Mr. Morgan's first contribution is some design formulas and a method for feeding the thing with 300-ohm line, as shown in Fig. 1B. He gives for the lengths,

$$l_1 = \frac{468}{f\,(\text{Mc.})}$$

$$l_2 = \frac{472}{f\,(\text{Mc.})}$$

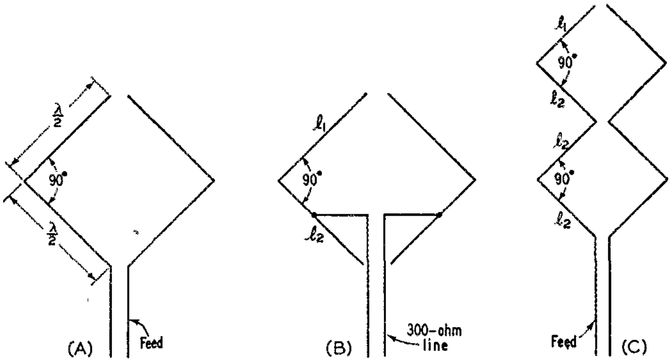
The 300-ohm line is attached at points $0.1l_2$ below the center of the l_2 sides. Thus an antenna for 29 Mc. would have upper sides of $l_1 = 468/29 = 16.15$ feet = 16 feet 2 inches and $l_2 = 472/29 = 16.25$ feet = 16 feet 3 inches. The feedline would be attached 20 inches below the center of l_2 ($0.1 \times 16.25 = 1.625$ feet = 20 inches). W2NNT's measurements indicate the gain of such an antenna to be 3.8 db. with an interior angle of 90 degrees (as shown), and with an interior angle of 60 degrees the gain was 3.6. Since the smaller angle represents a saving in the total height required, this would seem to be worth investigating for amateur work. Such an antenna backed up

*℅ Morgan Television Co., 725 Seward St., Rochester, N.Y.



A double inverted-rhombic antenna for high-frequency work is easily supported by a single wooden mast. The TV antenna shown here uses an interior angle of 60 degrees — slightly more gain is obtained by increasing the angle to 90 degrees.

Fig. 1 — The 90-degree inverted rhombic at A is better known to amateurs as the "bisquare" antenna. It can be fed without special matching sections by tapping the feeders on to the elements, as shown in B (see text for dimensions). How several sections can be stacked and fed at the bottom is shown at C.



by a reflector from 0.1 to 0.2 wavelength away (tuned to the proper frequency either by adjusting the lengths or with a parallel-tuned circuit at the base of the reflector) might have some real merit. The point of connection of the 300-ohm line would change, of course, but the proper point of attachment shouldn't be too hard to find.

For TV work, the "inverted rhombic" is stacked,[1] as shown in Fig. 1C and the photograph. This arrangement results in a large structure for 28 Mc., but it shouldn't be out of proportion at 50 and 144 Mc. More than two can be stacked, to lower the vertical angle of radiation, but when four or more are used it is advisable to feed the system at the center, for better current distribution.

are joined at the point of crossing, and how the driven element is fed with 300-ohm or other line, by simply tapping on at the correct point.

The elements can be made with telescoping ends for adjustment of the lengths, in the usual manner. For 0.2-wavelength director spacing and 0.15-wavelength reflector spacing, W2NNT gives the element lengths (l in Fig. 2A) as

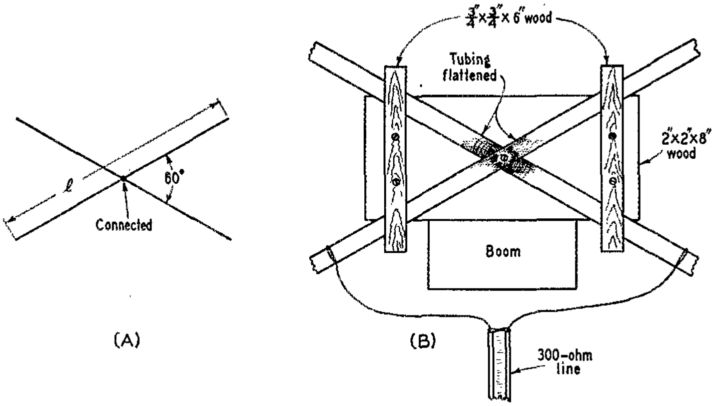
$$\textit{Director} = 450/f \text{ (Mc.)}$$

$$\textit{Antenna} = 452/f \text{ (Mc.)}$$

$$\textit{Reflector} = 466/f \text{ (Mc.)}$$

For a design frequency of 28.6 Mc., this works out to be 15 feet 9 inches for the director, 15 feet 10 inches for the antenna, and 16 feet 4 inches for

Fig. 2 — The "biconical" beam uses a double element for each element in the usual 3-element beam. Crossed elements as shown at A are used, and the 60-degree angle has been found to give maximum gain. The driven element can be fed with 300-ohm line by tapping it on the elements a little distance each side of center. See text for dimensions.



The Biconical Beam

The other antenna tried by W2NNT looks as if it might have considerable application among amateurs on 28 and 21 Mc. It follows the general scheme of the normal 3-element beam, except that the elements are "X"-shaped, as shown in Fig. 2A. The angle of 60 degrees between elements has been found to give maximum gain. The detail in Fig. 2B shows how the elements

the reflector. Using 300-ohm transmission line, the line taps on 10 inches either side of the crossover point.

In his experimental work, W2NNT has found this 28-Mc. beam to show approximately 3 db. gain over a similar beam with ordinary elements, or about 10 to 11 db. over a dipole. The bandwidth over which the s.w.r. did not exceed 2 to 1 was 3 Mc. There are, of course, many different mechanical arrangements that can be used to obtain this element configuration.

— *B. G.*

[1] And called the "Mor-Gain" antenna.