A High Frequency Horn Antenna!

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Several high-frequency antenna configurations have evolved from antenna forms originally developed for u.h.f. service, such as the variations of the horn antenna. This article presents some background on horn antennas and the authors experience with a type of horn antenna which can be used for broad-band, unidirectional use on the high frequency bands.

HORN-type antennas (fig. 1) have generally been considered as being useful only at u.h.f. frequencies, primarily as a waveguide termination device used either to illuminate a reflector or to act as an antenna by itself. However, at least two forms of horn antennas have already found some application below 30 mc as broad-band antennas, namely the discone and conical types. Generally, they have been used as vertically polarized, broad-band types covering all or several of the amateur h.f. bands. Another interesting form of horn antenna which can provide broad-band performance plus directivity and choice of polarization on the h.f. bands is the so-called pyramidal horn.

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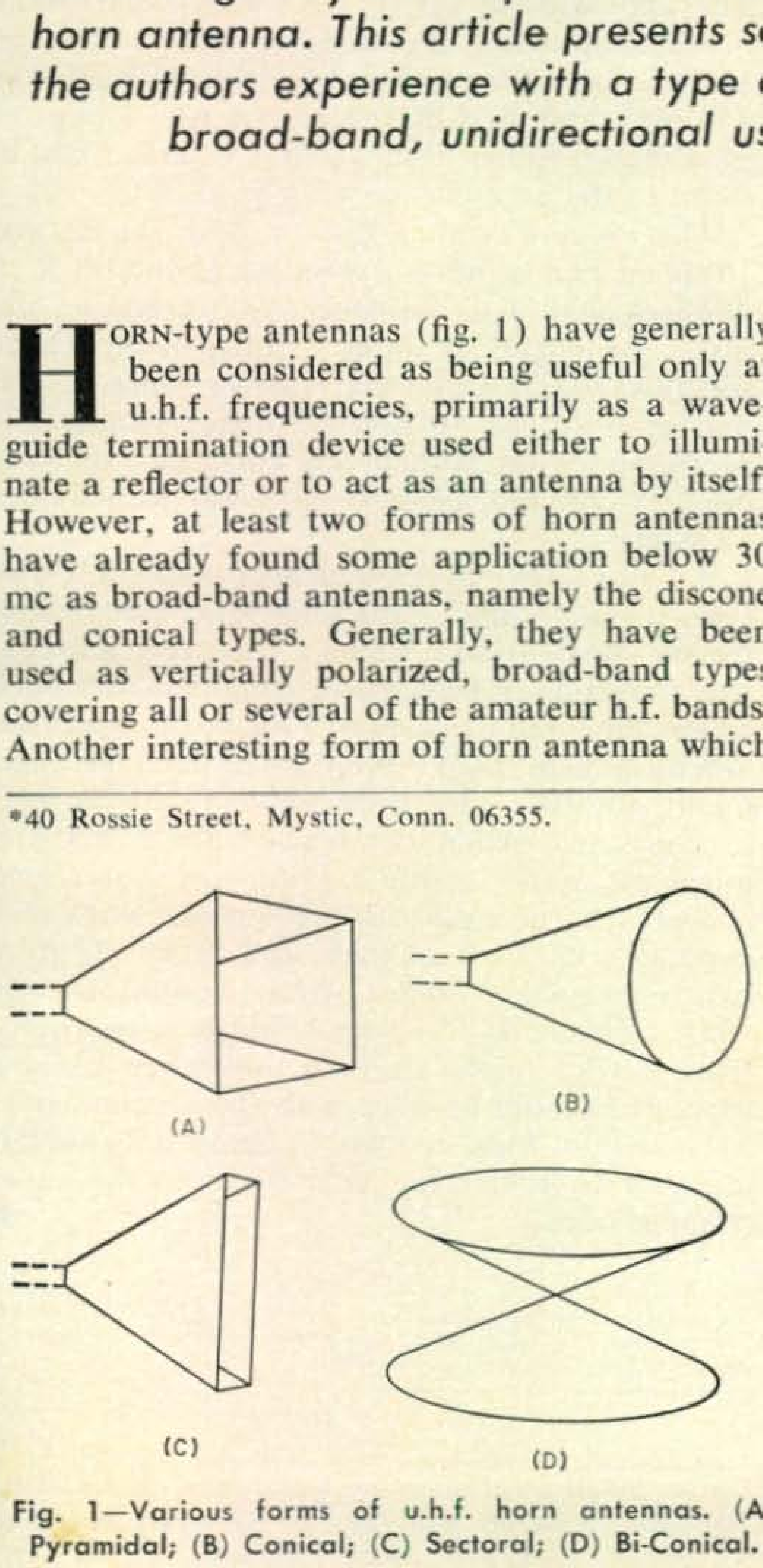

Fig. 1—Various forms of u.h.f. horn antennas. (A) Pyramidal; (B) Conical; (C) Sectoral; (D) Bi-Conical.

The pyramidal horn is a special case of a broad class of horn antennas where the side lengths are equal. One very interesting feature of the antenna is that if only two sides of the antenna are used, a choice of polarization and plane directivity can be obtained as shown in fig. 2. The minimum length of a side must be ½λ at the lowest frequency used. The antenna can be considered as a non-resonant, high-pass device where the ½λ side length determines the cutoff frequency.

Theoretically, the response should extend infinitely high but in practice because of structural and other discontinuities response is limited to something less than a 10 to 1 frequency range. The gain varies linearly with the side-length and is equal (in db) to about 8 times the side-length. Thus, the smallest horn (½λ) will have a gain of 4 db and one with side-lengths of 2λ will exhibit about 16 db gain.

Pattern

The radiation pattern is similar to that for a Yagi type antenna of similar gain. The front to back ratio is at least as high and the pattern is free from any pronounced minor responses. The feed-point impedance for a two-sided antenna is about 400 ohms. Although at u.h.f. frequencies the antenna is constructed of flat sheet metal such construction is impractical at lower

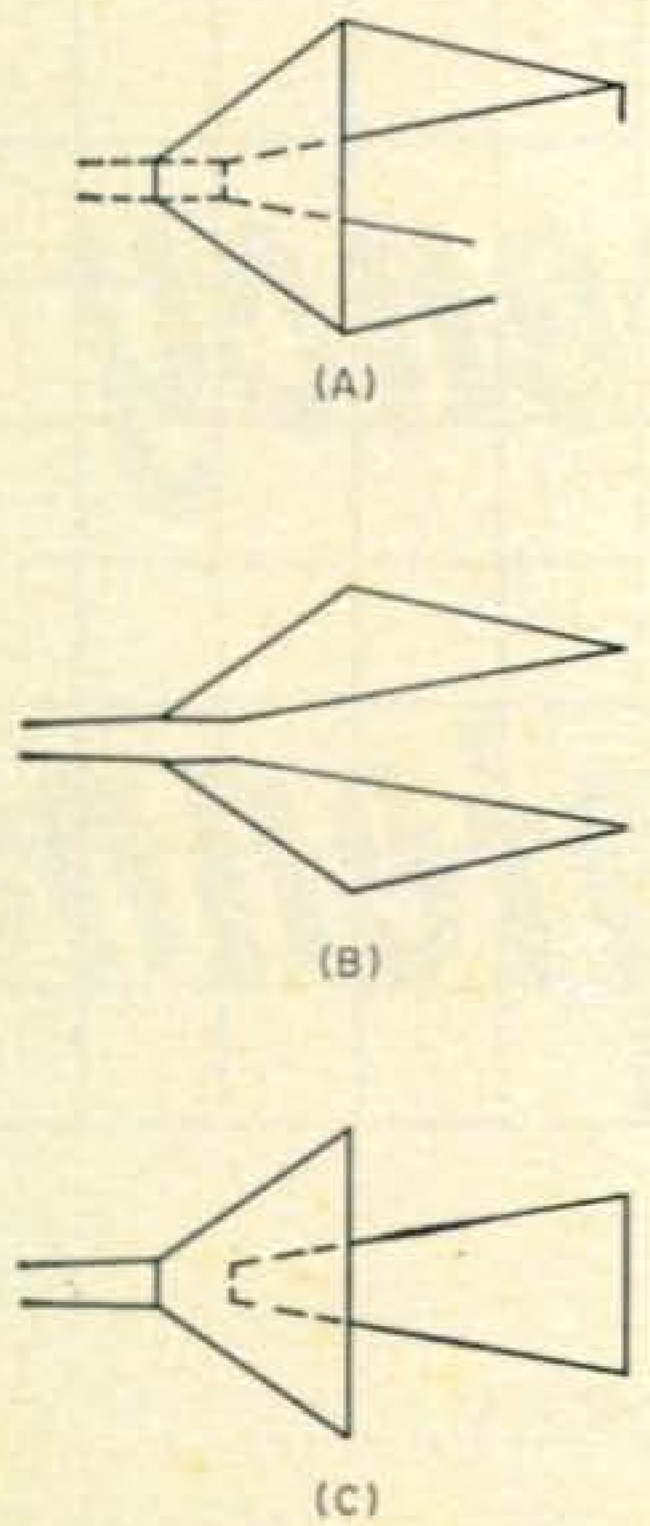

Fig. 2—If the 4 sided pyramidal horn is considered as 2 sided structure, the form at (B) will produce vertically polarized emmission while the vertically sided form (C) will produce horizontally polarized emmission. In (B) and (C) all angles are 60° and all sides are $\lambda/2$ or longer.

frequencies. One substitute is to use a grid of wires spaced 0.05λ at the highest frequency to be used. The 0.05λ spacing is used in a number of curtain and billboard type antennas where a grid of wires must form a reflecting surface and has been found to be an effective compromise between electrical performance and practical construction considerations.

Construction

In order to try out the performance of h.f. horn antennas, the author built the model shown in fig. 3. The dimensions were chosen to have a cut-off frequency of 20 mc in order to place it well below the low end of the 15 meter band. The antenna was constructed of #14 copperweld with a grid spacing of 1½ feet to correspond to 0.05λ on 10 meters. Actually, the antenna should be useful at frequencies far higher than 10 meters but the cost of sufficient wire plus the necessity of spacing the wires as close as ⅓ foot for 2 meters made the construction of a 15 to 2 meter model too complicated. In any case, the directivity such an antenna with side-lengths of 4λ on 2 meters would provide, would require that it be made rotatable for any sort of general usage. On the other hand, the broader directivity provided when the side-lengths are ½ to 2λ make it a good general-area DX antenna, to cover, for example, central Europe or northern Africa on two or more h.f. bands.

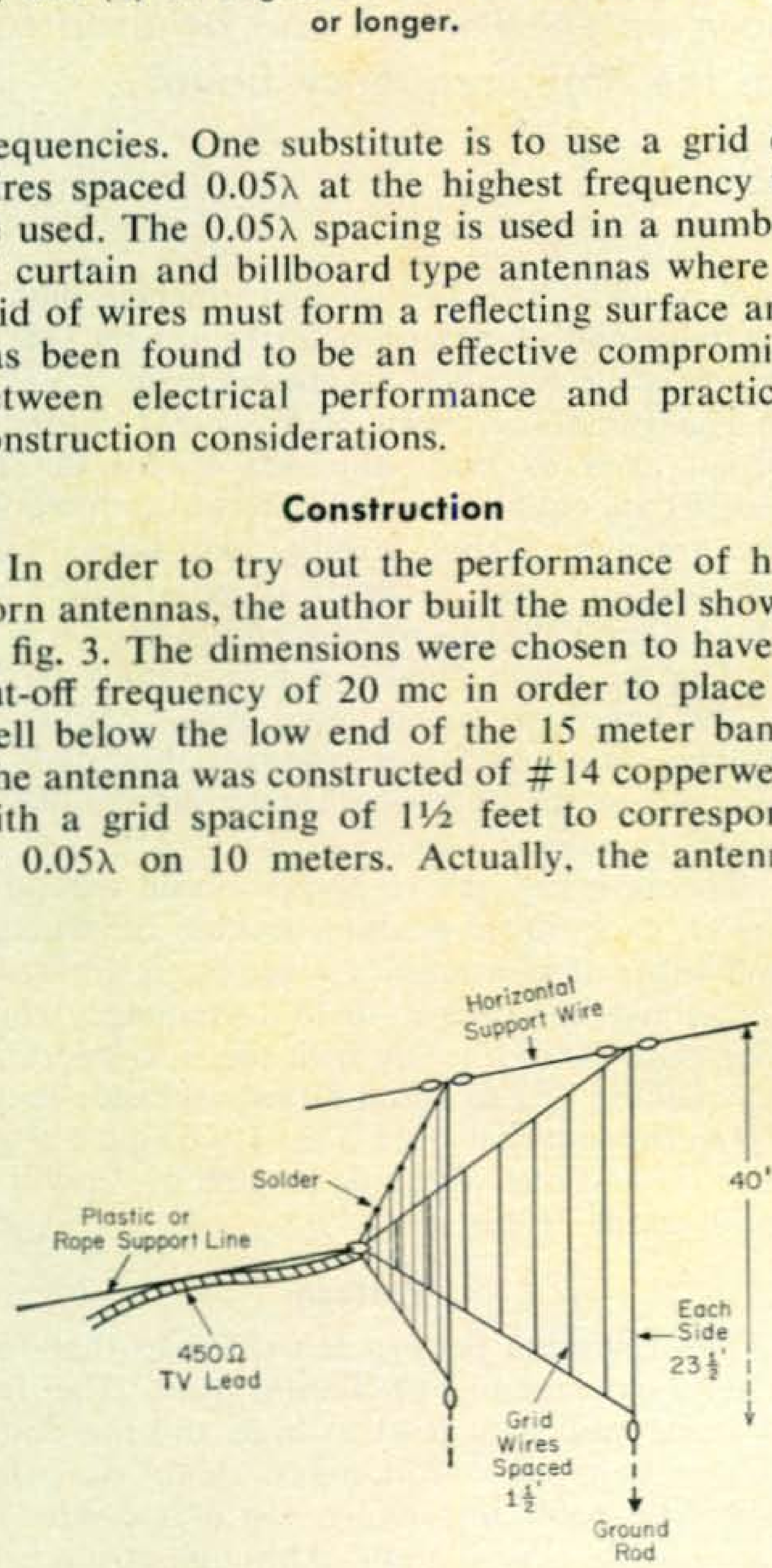

Fig. 3—Two sided horn with dimensions for use on 15 and 10 meters.

Feedline

The antenna was fed with standard 450 ohm open-wire television lead-in and a Transmatch. A quarter-wave matching section utilizing 150 ohm twinlead can also be used as shown in fig. 4 to transform the impedance down enough to provide a good match to 52 ohm coaxial cable. A possible alternative would be to feed the antenna directly with 300 ohm twin-lead which can then in turn be connected to a broad-band 300 to 75 ohm, balanced to unbalanced transformer. The approximate 1.3 to 1.5 s.w.r. which would result should not prove detrimental unless an exceptionally long transmission line is used. The 450 ohm line used by the author was supported on a plastic runner line which was pulled taut to stabilize the antenna.

The s.w.r. was quite low on both the 15 and 10 meter bands, never exceeding about 1.8 to 1. A check with a signal generator showed an unusual rise in s.w.r. at about 25 mc. but the reason for this was not checked further since it was outside both the 10 and 15 meter bands. The performance on both bands equalled that of a popular commercial tri-band beam with loaded elements.

All in all, the pyramidal horn with only two sides seems to offer some interesting possibilities for the amateur who wants a relatively inexpensive directional broadband antenna. Certainly when compared to structures such as log-periodic antennas with their complicated feed arrangements, the two sided horn seems relatively easy to construct. When constructed for lower frequencies, some additional support wires will probably be necessary to prevent the wires of a vertical grid, such as that used in fig. 3, from twisting together under windy conditions. On v.h.f. frequencies the sides could be constructed from a wire mesh. Construction when using a wire grid should be done with the antenna sides stretched out fully and with a heavy duty soldering iron to solder the grid wires to the outer triangle sides. ■

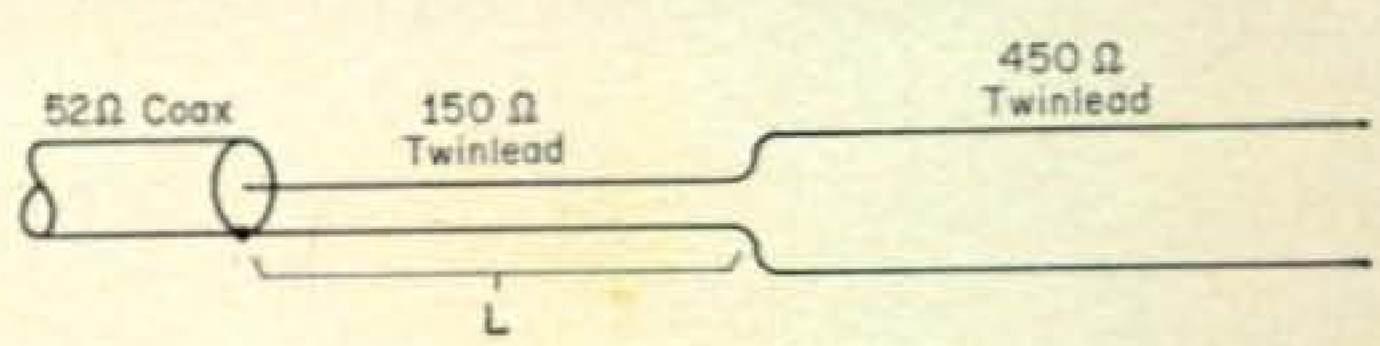

Fig. 4—Single-band matching transformer. *L* should be 101" for 15 meters and 75" for 10 meters based on $\lambda/4 \times$ velocity factor.