An Efficient Multiband Loop Antenna

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Take one quad-type element, turn horizontally, feed at the midpoint of one side with coax and produce a simple antenna with real and effective gain over a dipole.

WHILE recently attempting to produce a self resonant loop antenna for use on the l.f. bands the antenna system described below was devised. Although too large for the l.f. bands it could be useful on the h.f. bands and also for general listening purposes on the v.h.f. bands. The antenna's main attraction is that harmonic operation is possible while still maintaining a low input impedance. The antenna is ideally built in the form of a square and fed at the center of one side. It is horizontally polarized.

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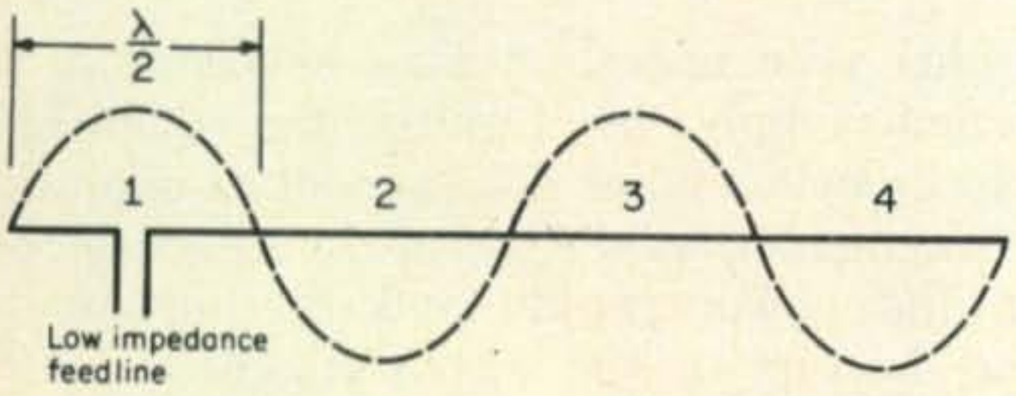

Fig. 1—Current distribution on a two wavelength antenna fed 1/4 wavelength from one end.

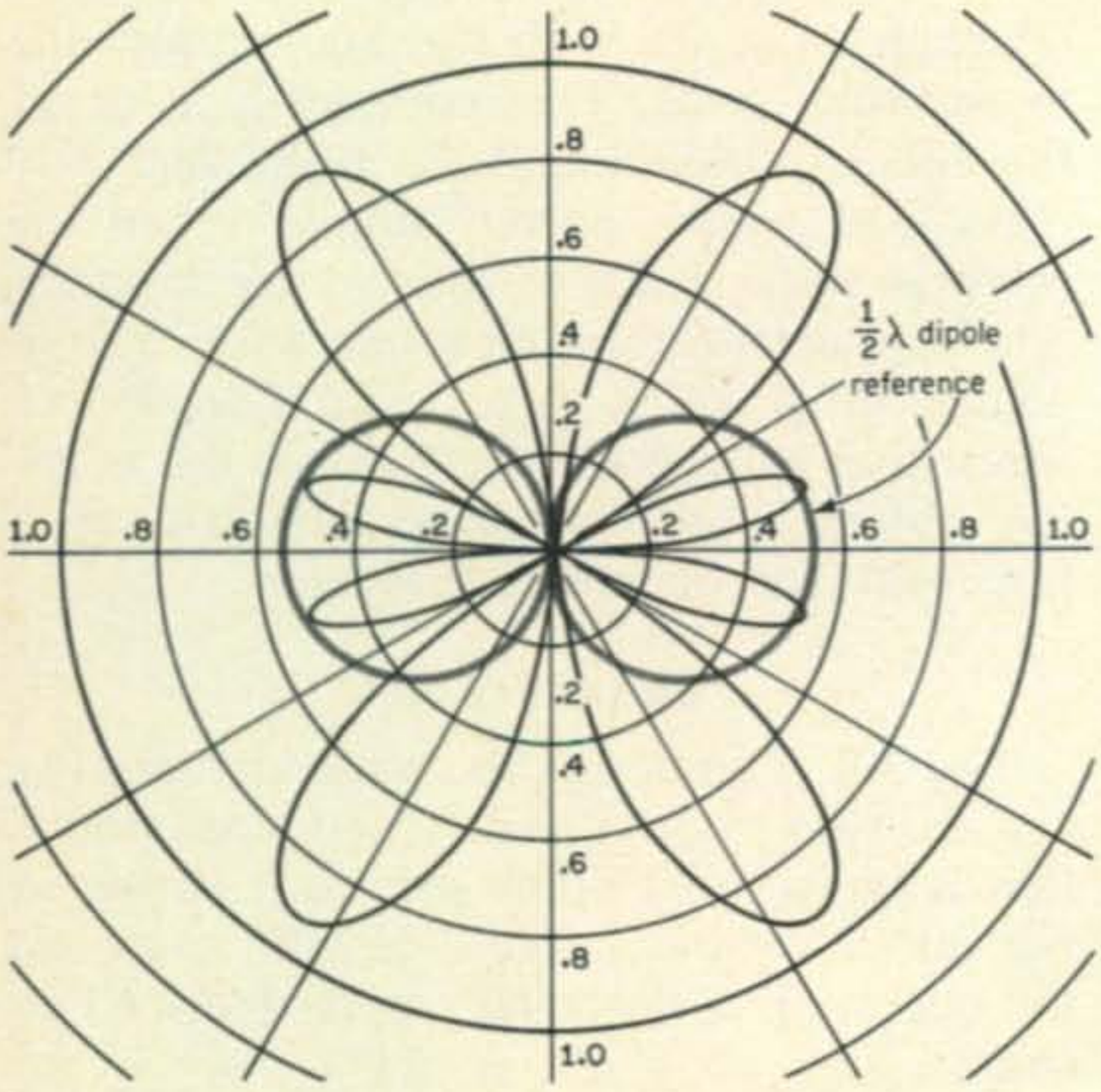

Fig. 2—Radiation pattern of the 2 wavelength antenna shown in fig. 1.

Theory

Consider the two wavelength antenna of fig. 1. The dotted line shows the current distribution both in magnitude and phase. Sections 1 and 3 are in phase with each other as are sections 2 and 4 but the latter are also 180° out of phase with the first and third sections. This has the effect of producing the radiation pattern shown in fig 2. When the antenna is bent into a loop the current distributes itself as shown in fig. 3. Although the currents in opposite pairs appear 180° out of phase they are also spaced 180° apart which brings the radiation back in phase. The radiation pattern for such a loop fed in the center of one side is shown in fig. 4. The feed point impedance is low, i.e., suitable for coaxial cable impedances. The 1968 ARRL *Handbook* (p. 361) indicates a gain of approximately 4db can be expected for a pair of half-wave antennas spaced a half-wavelength apart and fed 180° out of phase. Compared with a dipole the

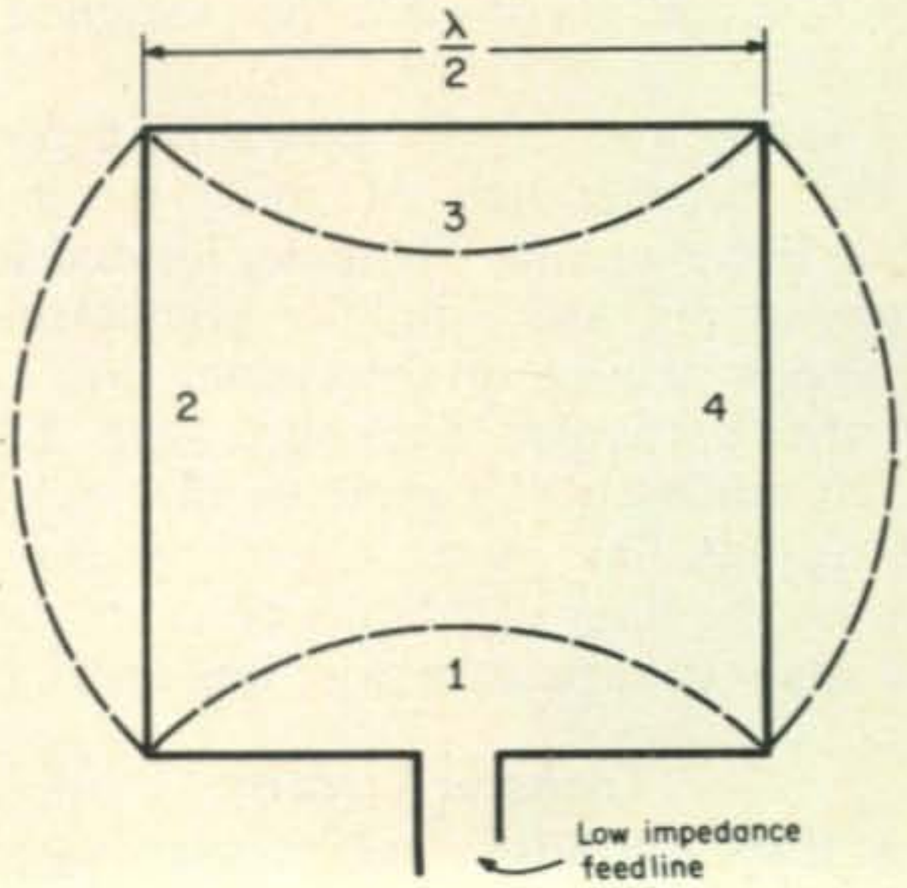

Fig. 3—Current distribution of a two wavelength antenna bent to form a continuous loop.

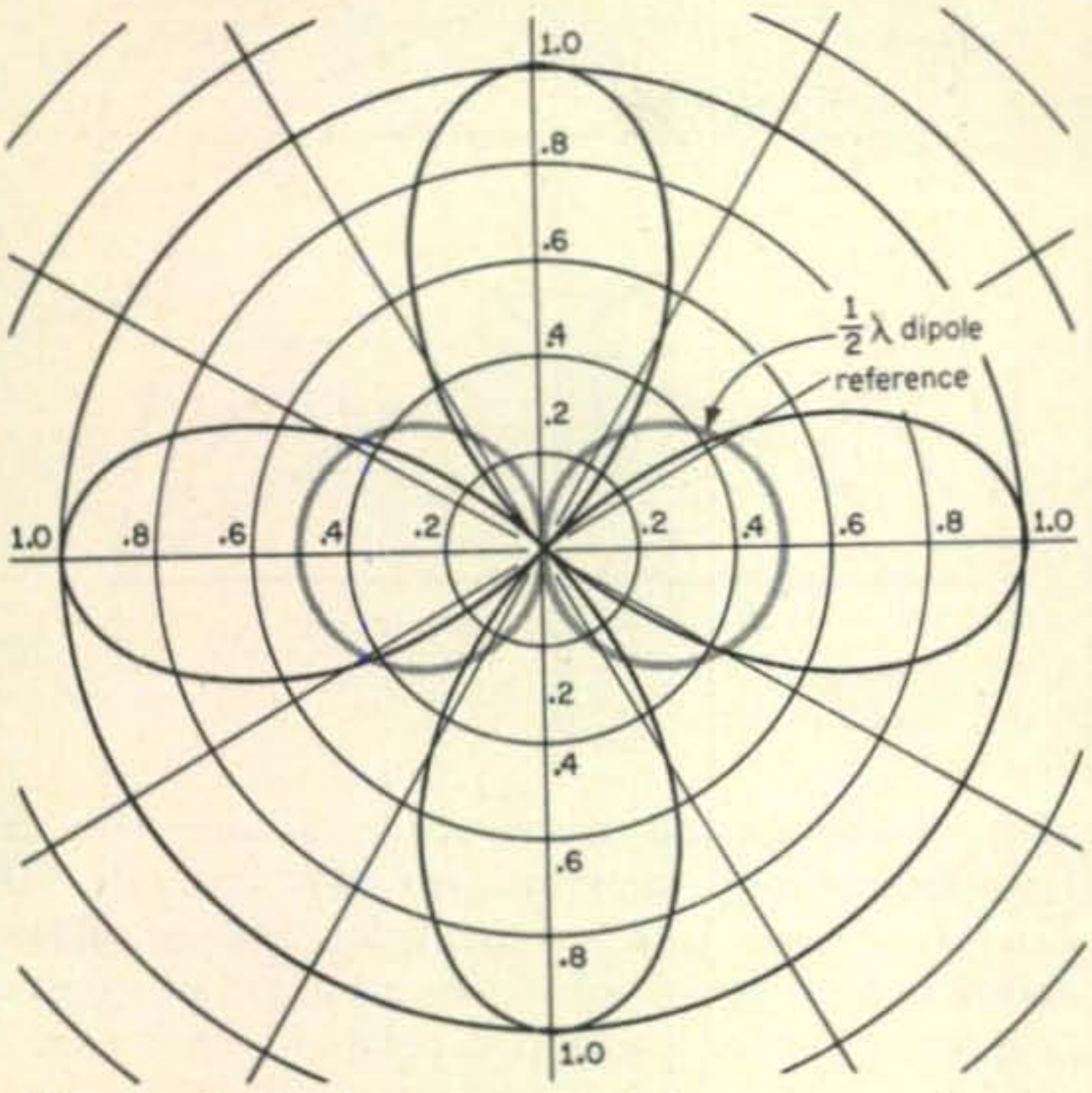

Fig. 4—Radiation pattern of the two wavelength loop antenna shown in fig. 3.

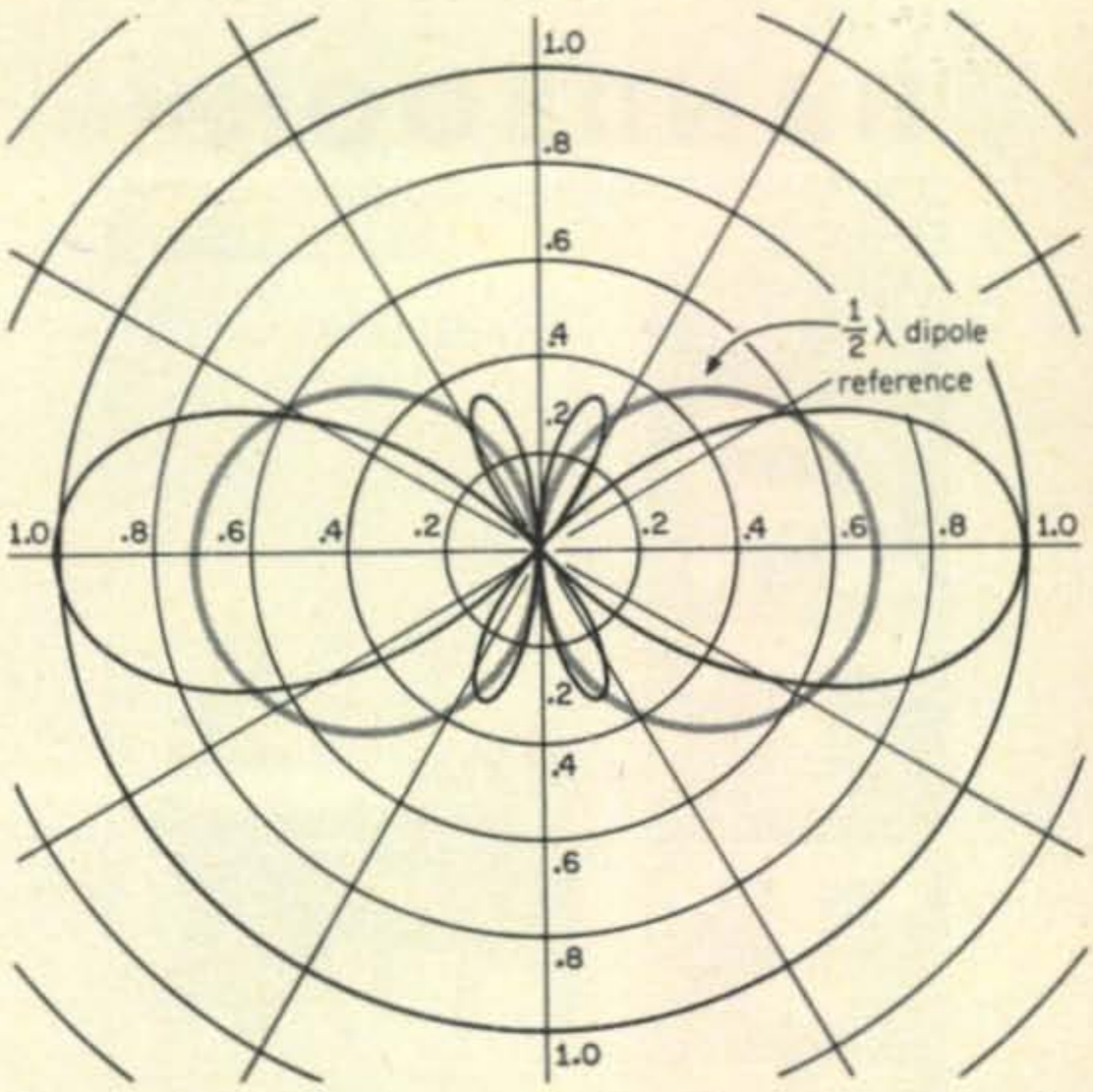

Fig. 6—Radiation pattern of a three wavelength loop.

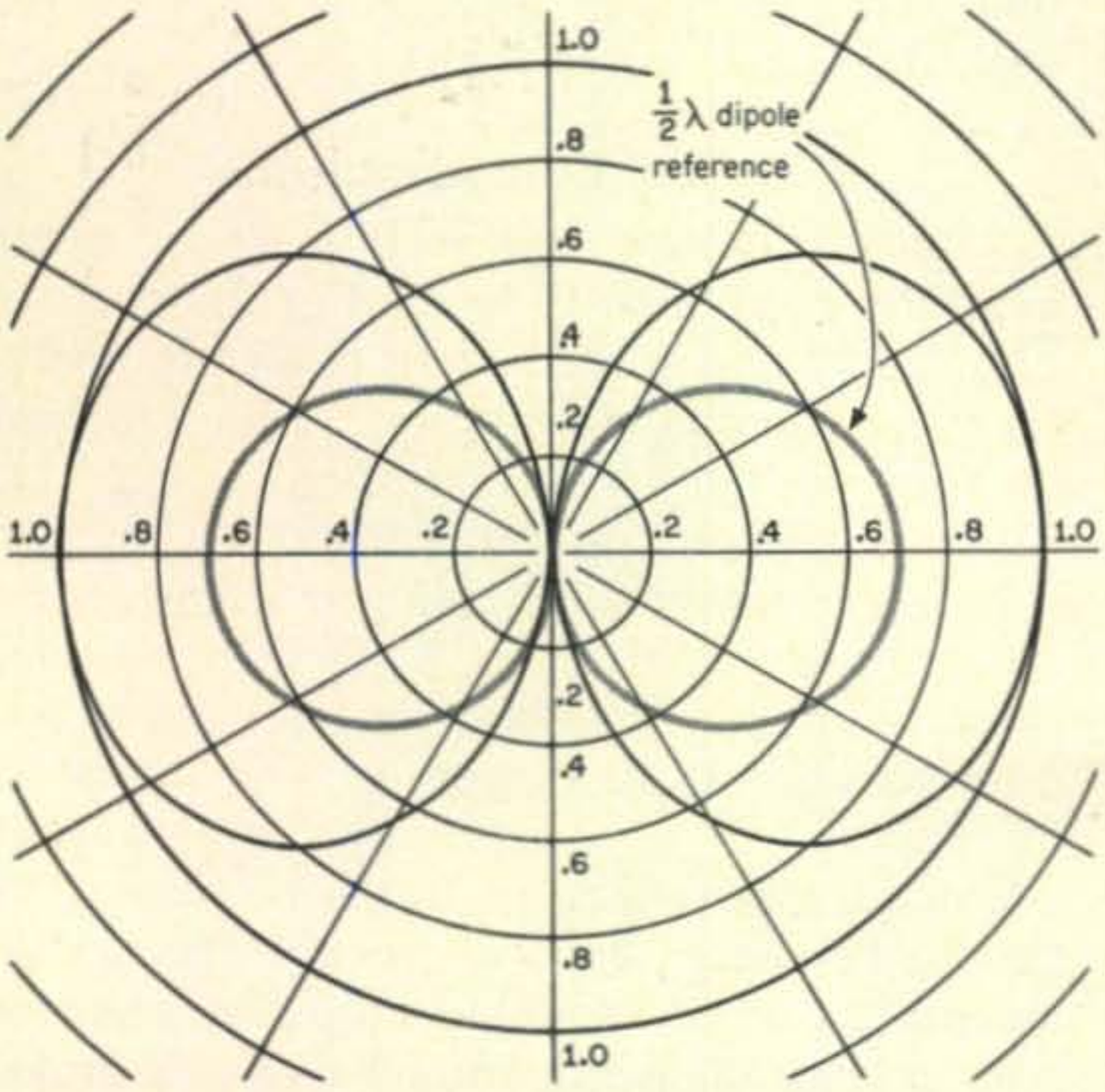

Fig. 5—A one wavelength loop antenna will produce this nominal radiation pattern.

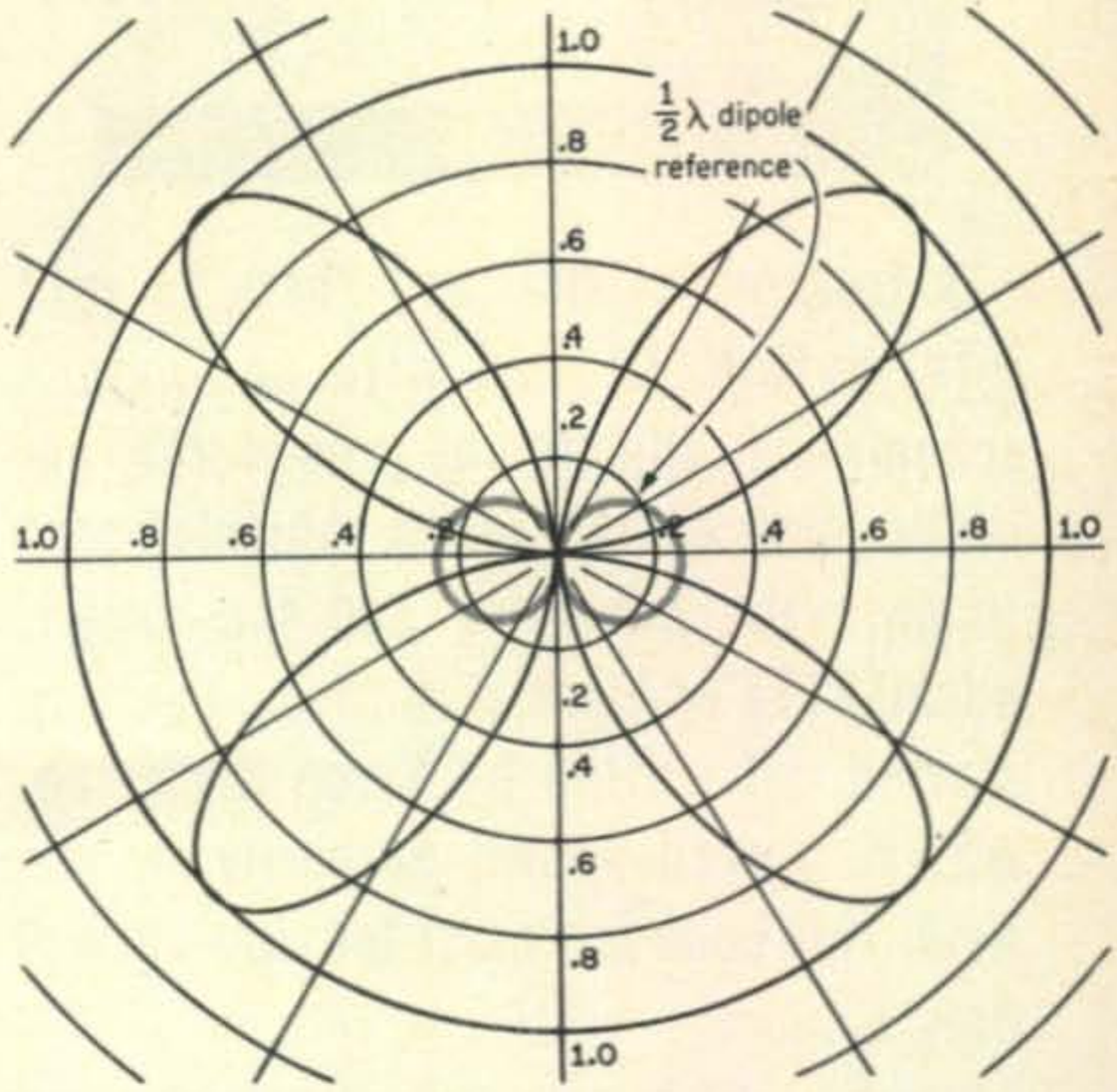

Fig. 7—Expected radiation pattern of a four wavelength loop antenna.

angle of elevation will be lower. For a fixed antenna the gain and low angle of radiation in a number of directions make it very attractive.

Multiband Operation

If the sides of the antenna loop are made one quarter wavelength the feed point remains low impedance. In fact this is identical to the driven element of the well known quad antenna—only mounted horizontally. The horizontal radiation pattern is shown in fig. 5. If the sides of the square are made three quarter wavelength or a full wavelength then the antenna still maintains a low feed impedance. The respective horizontal radiation patterns are shown in figs. 6 and 7. The patterns of figs. 5 and 7 were derived ignoring the effects of radiation from the corners (none occurs for figs. 4 and 6), and are intended more as indications of what to expect. In practice the gain of the main lobe will probably be reduced and the depth of the nulls also reduced. The radiation patterns are plotted as electric field patterns and not power patterns. A dipole pattern is shown for reference purposes. In figs. 4, 5, 6 and 7

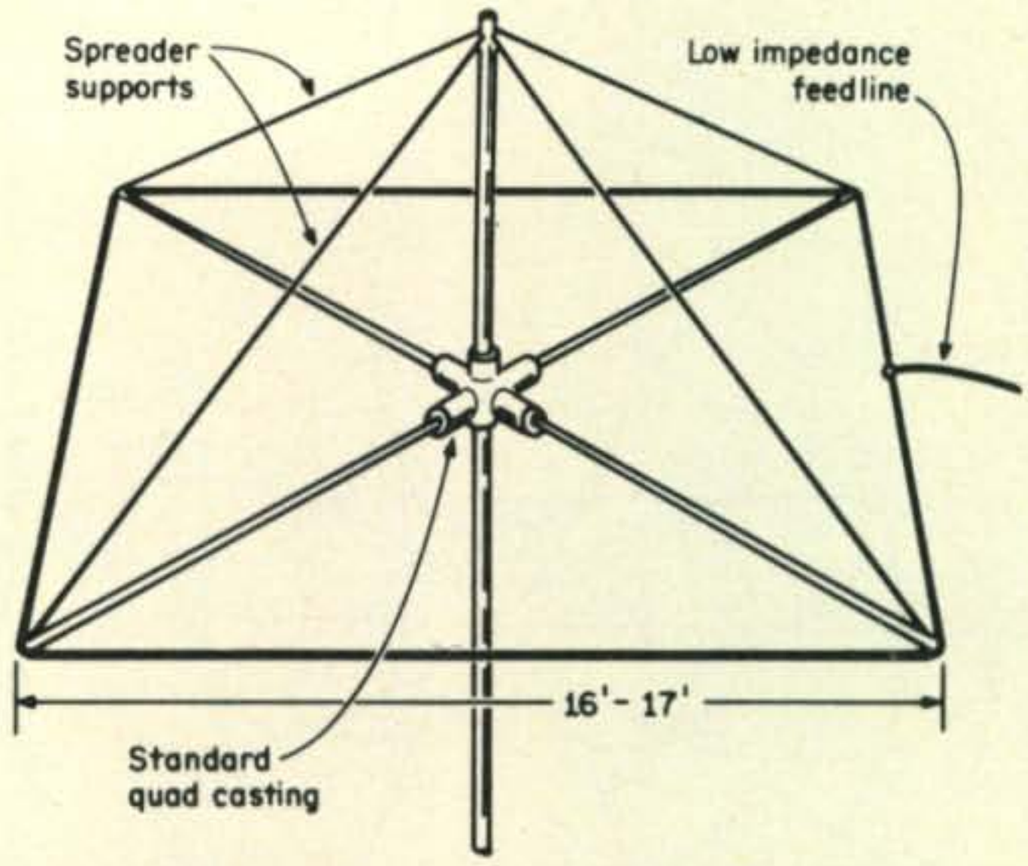

Fig. 8—Suggested construction scheme for a multiband loop antenna for 40 through 10 meters. Nylon guy strings from one or more corners to a secure object nearby will eliminate the tendency for the loop to rotate in the breeze.

the dipole pattern refers to the pattern that would be obtained if a single half-wave antenna was placed at the feed point and fed with the same power.

Practical Considerations

Unless someone has four trees or other supports conveniently located at the corners of a square and spaced 66 ft. or 134 ft. apart, then the antenna will not justify the erection of four supports for operation on the l.f. bands. However, on 20, 15 and 10 meters, it becomes practical to think in terms of the structure sketched in fig. 8. Here horizontal spider elements (bamboo or fiber-glass) are used to support the antenna. The positions of support will be at high impedance so that adequate precautions in terms of insulation should be taken at these points. The whole assembly can be mounted atop some sturdy pole or mast. The antenna needs a low impedance balanced feed system for which a balun and coaxial cable would be suitable.

Conclusion

A 33 ft. × 33 ft. antenna was used by the author at a recent QTH. This antenna was located in the roof space and fed with RG-58/U and a balun. On 40 meters c.w., contacts were regularly made with Europe, VK/ZL and S. America. Unfortunately a good s.w.r. meter was not available at the time so that the s.w.r. was not known on the four bands (40, 20, 15 and 10m.) A coaxial cable impedance of 75 ohms or 100 ohms would probably have provided a better match than the 52 ohm RG-58/U however. ■