A Two-Band Antenna WITH LOW-IMPEDANCE FEED

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Antenna space for 80 and 40 is a problem for most amateurs. One antenna that will work efficiently without tuning on both these bands is W2ESO's solution

At 14 mc and above, compact beams giving worthwhile power gains are so easy to construct that there is little justification in considering a non-directional antenna for a permanent installation.

The picture is completely different on the 3.5 mc and 7-mc bands, however; not only are even the simplest beams out of the question for most of us, but the type of operation on these bands usually requires general coverage. To retain elbow-room for higher frequency directional antennas, (and also to keep the neighborhood from looking too much like the top of a 50-family New York apartment house) it is desirable to have one antenna serve for the two lower frequency bands. This can be accomplished in a number of ways, as reviewed below, but there is one solution which eliminates drawbacks inherent in the more conventional systems.

The End-fed Hertz

The end-fed Hertz has the advantages of simplicity and ease of adjustment, so far as the radiator itself is concerned. Disadvantages are unfortunately also numerous: With any appreciable transmitter power, r.f. appears in unexpected places, such as neighbors' radios, lighting circuits, key and microphone leads, and anything else around the shack, including your pet VFO and speech amplifier. In addition, a separate antenna tank is necessary to protect against radiating harmonics, bringing in one more control to complicate QSY, and one more coil to complicate band-changing.

In addition, such a radiator, close to earth and other objects, is bound to have an abnormally high end impedance (especially on 3.5 mc) and therefore loads the antenna tank poorly and requires unusually high voltage insulation and a high voltage antenna tank condenser.

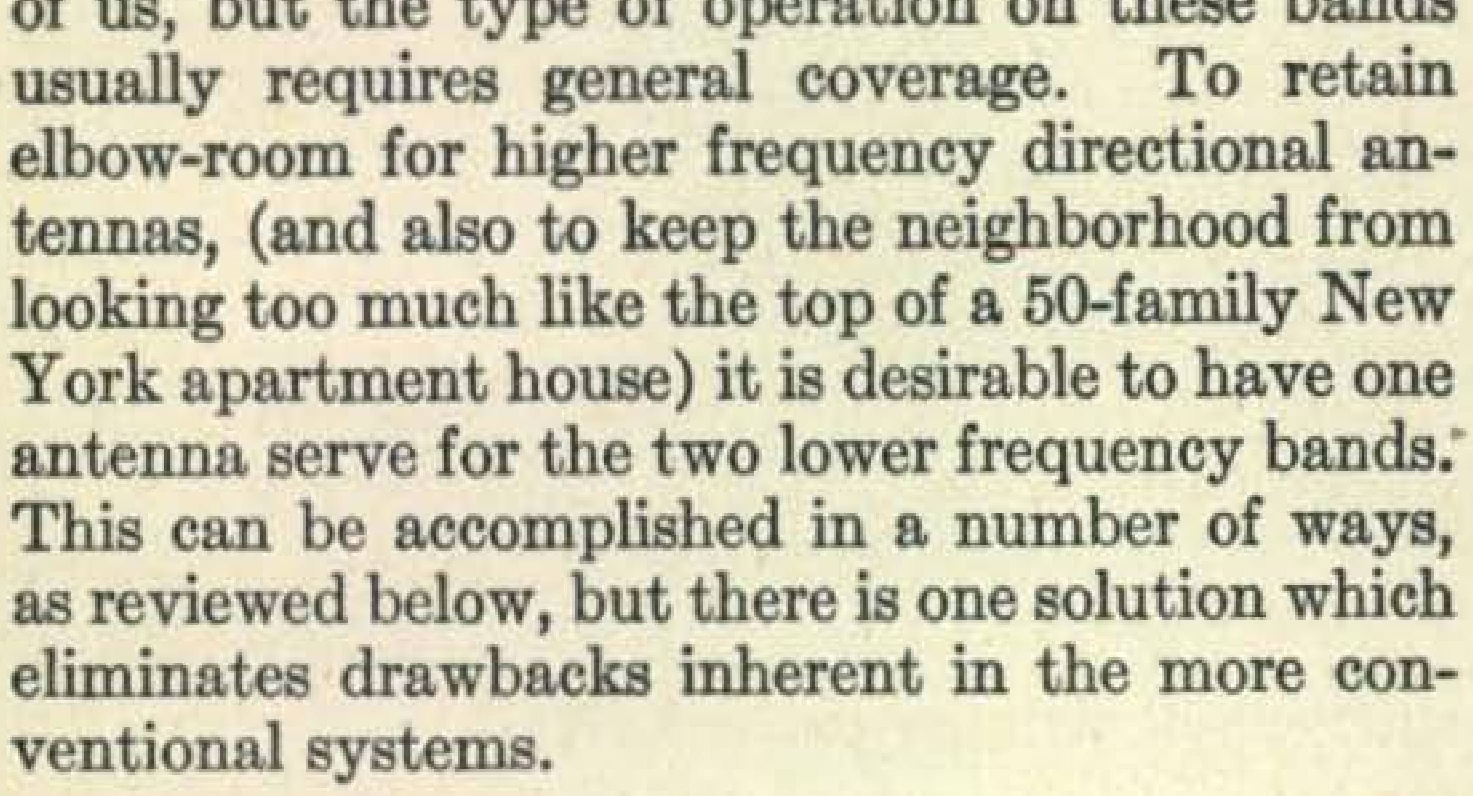

Fig. 1. The solution to the antenna problem for 7 mc—general coverage and no tuner required

Single Wire Feed Matched Impedance Antenna

In theory, at least for one band work, the single wire feed matched impedance antenna is fine. The feeder, being tapped on the antenna at a point such that it sees its own impedance, carries only moderate current and should radiate little energy.

In practice, all the disadvantages of the end-fed antenna apply here, with the possible exception of loading difficulties. The trouble is that the single wire feed antenna is a tricky system to adjust, and most amateurs just don't have the time and equipment to do the job right. When there is an impedance mismatch between the feeder and the point of connection to the radiator, a standing wave appears on the feeder, and feeder radiation goes up rapidly, since we have no counterbalancing feeder as with an open-wire or twisted-pair line. All of the Hertz troubles may appear, depending on the magnitude of the standing wave and the impedance at the sending end of the feeder.

When two-band operation is attempted, we are no longer backed up by theory. The things become a compromise, and a barrel full of trouble can be avoided only by juggling antenna length, feeder length, and tap point—simultaneously. Wonderful how simple these things can be—or is it?

The Center-fed Doublet and the Zepp

The Zepp, which is end-fed with open-wire line, and the center-fed doublet with a similar open-wire-feeder may be discussed together.

The chief objection to both these systems is that an antenna tuning system is required. A further annoyance is the fact that some feeder lengths result in an installation that is hard to feed, and it is sometimes difficult to find a suitable feeder length for easy tuning on two adjacent bands.[1] A minor nuisance is the occasional need for switching from series to parallel tuning or vice versa when changing bands—usually necessary when using center-feed.

Center-feed results, of course, in an elementary directional array when second harmonic operation is employed. The theoretical gain in the favored directions is so small that it would seem that the loss off the ends would be negligible. That's what we thought, too, and our enlightenment led to the development of a multiband job with none of the foregoing headaches.

A Multiband System

In our last location before Pearl Harbor, there was a dearth of trees, and only one possible place for an antenna in the clear—a 150′ span, on a line East and West, with the house in the middle. Up went a center-fed doublet for 80, 134′ flat-top, center-fed with 4″ spaced feeders, and on 40 we proceeded to get nice reports from W4 and K4—very nice, in fact, but when the skip lengthened in the evening, and there was nothing legal for us to QSO to the South, and, of course, nothing at all North, it didn't take long to find out that said antenna might as well have been buried in the basement as far as W5, W6, and W9 were concerned. The receiving antenna, a simple 66′ doublet running North and South and only 15′ above the ground, fed with very light twisted pair, was at least two or three "S" points better to the West when hung on the rig.

A little bit of head-scratching was in order here. We had no room for separate antennas, we disliked the necessity for the additional antenna tuner, and conceded that it would be necessary to continue feeding one antenna at the center. It was also obvious that on 7 megacycles, the two half-waves in the flat-top would have to be fed out of phase to get the usual four-lobe pattern, which past experience had shown to be good enough for general coverage.

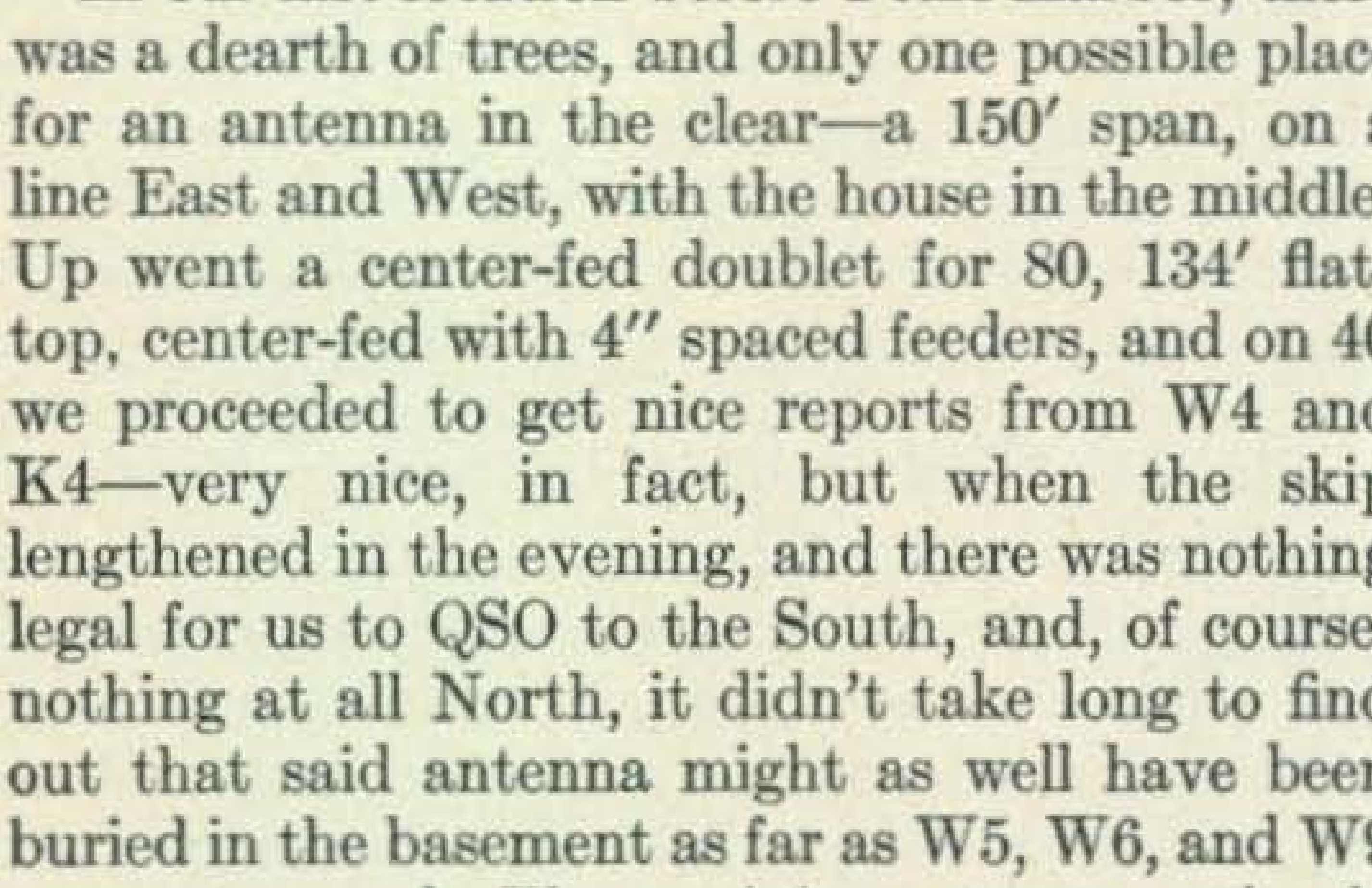

Fig. 2. The complete two band antenna uses low impedance feed on both 3.5 and 7-mc bands

With pencil and paper we first tackled the problem of 7-megacycle operation, and came up with one possible answer illustrated in *Fig. 1*. The high impedance at the center of the antenna could be transformed into a low (resistive) impedance at the transmitter by means of a quarter-wave open wire feedline. Quarter-wave length (approx. 33½′ on 7 mc) would be all right in this case, since the rig was in the upper part of the house. Phasing of the two half-waves in the antenna would be as desired, since they would be fed in parallel from the same point. Our handbook quoted 3000 ohms as an average value of impedance at the end of a half-wave radiator, so we assumed a value of 1500 ohms as the parallel impedance of the two half-waves at the center of the antenna. The characteristic impedance of our quarter-wave transformer would be around 400 ohms, and as this would be the geometric mean between our 1500 ohm load and the sending end impedance, we were able to predict that the sending end impedance would run around 100 ohms. It seemed likely that a small coupling coil would be sufficient, with no additional tuning needed.

Three and five-tenths mc operation would be most easily achieved by breaking the radiator at the center and using a twisted pair line. While we were pondering the advisability of a switch across the center insulator, suspended in mid-air and operated by mental telepathy when changing bands, it occurred to us that it might be possible to achieve the same effect, electrically, by merely shorting the twisted pair at the transmitter. It looked worth a try, so the next week-end we tossed together the combination diagrammed in *Fig. 2*.

Feeder length was purposely made somewhat greater than the calculated quarter-wave value, figuring that if necessary we could shorten the section by adding another insulator in series with the one suspending the dead feeder.

However, the length of this section was found to be non-critical; our initial set-up permitted us to load the final properly on 7 mc with the same fixed link that had been used to feed this 66′ doublet, and plate current under load decreased only about 10 percent in going from 7000 kc to 7300 kc. Some of this was, of course, attributable to normal variation in impedance of the radiator itself. We had hoped to investigate

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this a bit further, but had no chance to do this before the close-down. We had also intended to broad-band the affair for 80 meter work by adding another parallel flat-top resonating around 4.0 mc;[2] the effect of this extra radiator should be negligible on the 7.0 mc band.

The required changes in feeder connections were made automatically when changing coils; to accomplish this, one more banana plug was

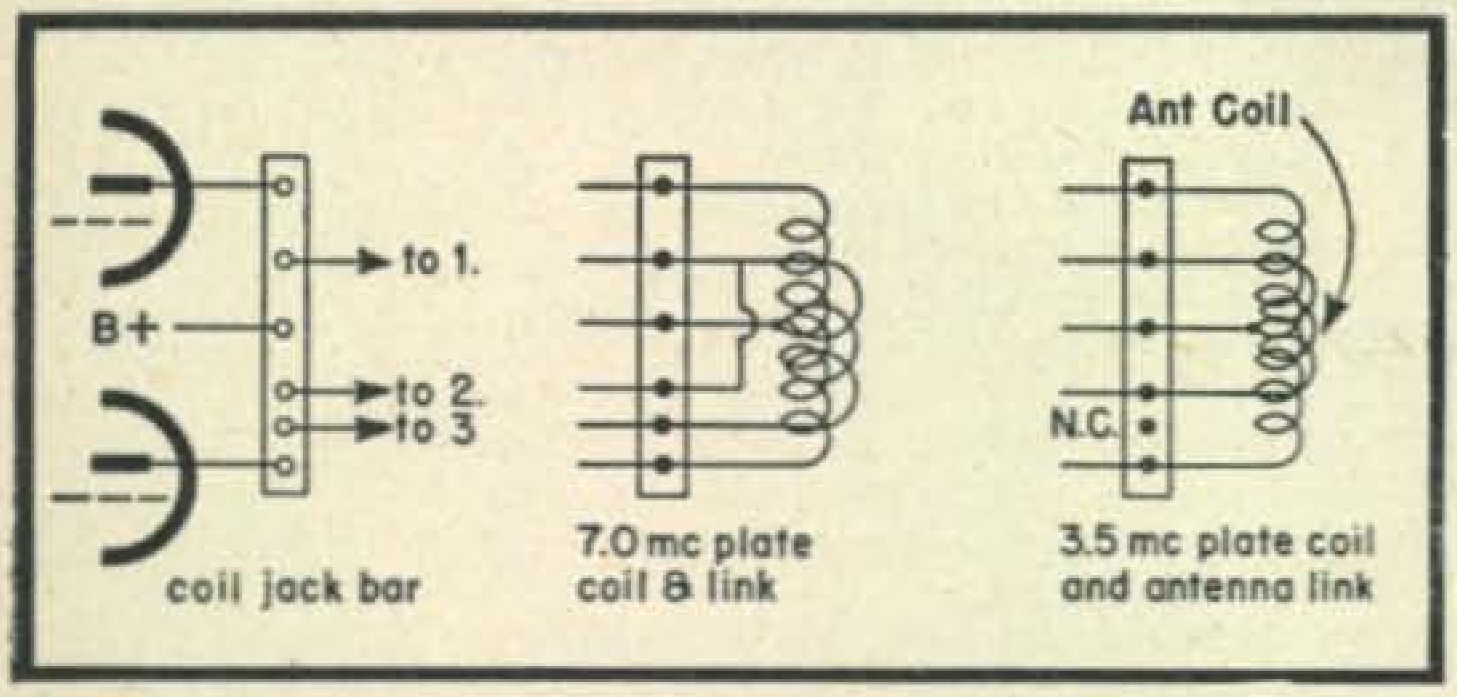

Fig. 3. Details of coil connections for two band antenna. Minor modification of transmitter tank coils is necessary. One more banana plug is used on the coil and jack bar

added to each tank coil base, and one more socket added to the coil jack bar. Details are shown in *Fig. 3*.

The antenna performed remarkably well! On 3.5 mc, it worked as a normal doublet—the extra feeder had no effect. On 7 mc, we had no difficulty in working any particular section of the country, also receiving good reports from K6 and K7. During the Sweepstakes, the XYL (W2OLB) also used it briefly on 14 mc, both with tuned feeders and, by tying all three feeder terminals together, as a "T". No real DX was heard, but three K6's were worked on the last Sunday afternoon of the contest, and reported signals as good as those from any other stations on the East Coast at the time. Stations outside the district noticed no difference between the two methods of feed, but W2's reported the "T" several S points better, probably due to the radiating 33½′ section, which represented a half-wave on this band.

[1]The explanation for this is that the feed line acts as an impedance transformer. The antenna impedance is resistive and relatively high in the case of end-feed on the fundamental and second harmonic, and similar for the center-fed wire on the second harmonic; it is resistive and low in value for the center-fed half wave. The feedline presents at the transmitter end anything from a pure reactance for multiples of an eighth-wave in length to a pure resistance at quarter-wave multiples. At intermediate lengths, the feedline looks like a complex impedance, of which the reactive component must be tuned out in the antenna tuner.

[2]Black, "Broad-Band Doublet," Radio, Nov., 1939.