Indoor Antenna Farming

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Suburban home owners with average size real estate will find the author's treatise on indoor antenna installations well rewarding.

IF YOU, Mister Reader, own a bank account in six or more figures, separate kilowatt finals for each band, and several acres of salt marsh for a backyard, proceed right to the next article. This one is for people with antenna problems, and the only obvious problems you have are those involving tax collectors, fund raisers, and mosquitos.

But if the old homestead is perched on a city lot about the size of a ping-pong court, if the thing you jokingly refer to as a backyard is forested with 60 foot trees and a generous thatching of utility lines, if you are about to trade the family ham gear for a hi-fi set and a postage stamp album, then read on. As long as you are still breathing and the filaments still light, all is not yet lost.

It is sometimes amazing what a little imagination and a little improvisation can do to make a seemingly impossible situation quite livable. The author, although residing in a location which would cause any sensible radio engineer to cover his eyes in horror, has used nothing but indoor or partially indoor antennas on the low frequency bands for the past eleven years. The results have not been unimpressive. The score thus far is approximately 70 countries on 80 meter c.w. (including a solid S-7 contact with England when running only 10 watts), close to the 100 mark on 40 meter c.w., and numerous odds and ends on the higher bands. Sound interesting? Then keep on reading.

Feed Problems

Because of space limitations and the physical layout of his house, the indoor antenna horticulturist must frequently approach his task in a seemingly illogical fashion. The man with the fifty acre lot, for example, strings up the antenna of his choice and then feeds it with whatever type of line and matching devices are most suitable electrically. The problem is considerably tougher when the feeder must be run down stair wells, around 90 degree corners, and under closely fitted doors and windows. The feedline itself, therefore, will often dictate the type of antenna system to be used.

Most readily adapted to these circumstances, as well as the least conspicuous, is ordinary 300 ohm flat twinlead. It follows that a logical antenna choice is the folded dipole or some type of simple beam which can, without undue complications, be matched to 300 ohm line within the confines of an ordinary attic. Have no fear as to the power handling capabilities of the twinlead—matched anywhere within reason, receiving type line will handle the best part of a kilowatt with no sigh of heating. Don't try to use it as a tuned transmission line at high power levels, however. The author attempted this once on 20 meters with a half gallon rig and wound up with several feet of bare copper conductors at neatly spaced intervals along the line.

Folded Dipoles

For sheer simplicity, as well as excellent bandwidth characteristics, the twinlead folded dipole is hard to beat in an indoor installation. The author keeps a set of these available for all bands from 28 mc to 7 mc, those not in use being coiled up in a corner of the attic. Small hooks and eyes, the former attached to the antennas with string and the latter screwed into the peak beam of the attic at strategic points, provide a simple and flexible means of suspension (see fig. 1). The dipoles can be changed in less than five minutes, feedline connections being made with spring clips.

Space does not pose too much of a problem on the higher bands, since the normal attic will just about accommodate a 20 meter dipole. Hanging a full length dipole for 40 meters indoors is something else again, and fig. 2 shows

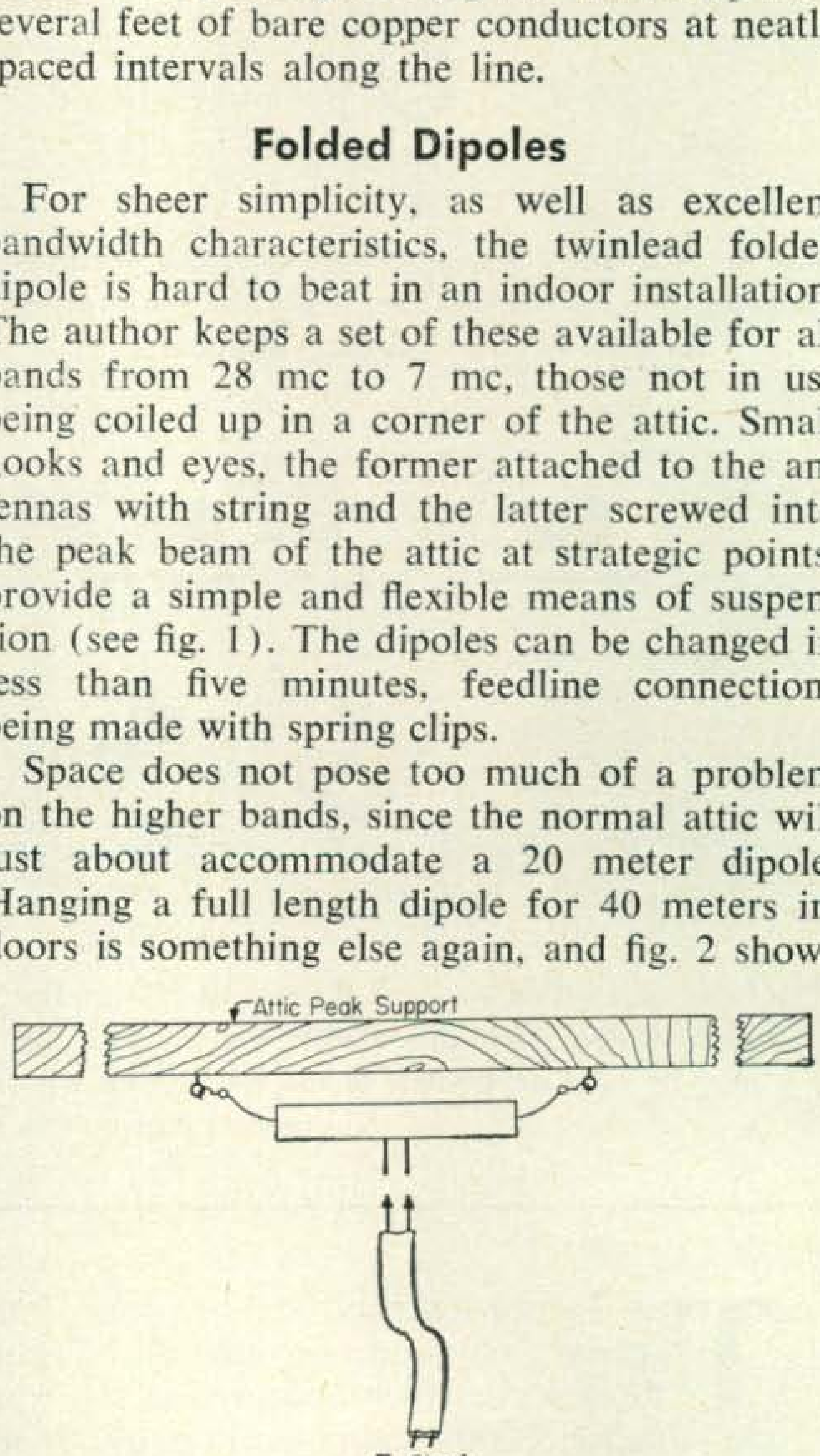

Fig. 1—The half wave dipole is suspended by hooks and eyes and connected to the feedline by spring clips.

the method used at W2LCB. The center half, the part which does most of the radiating, incidentally, runs in a straight line along the peak of the roof. The ends, in turn, run down the sloping roof beams at the extremities of the attic and fold in toward the center again at floor level. More about the radiation pattern from this beast a little later.

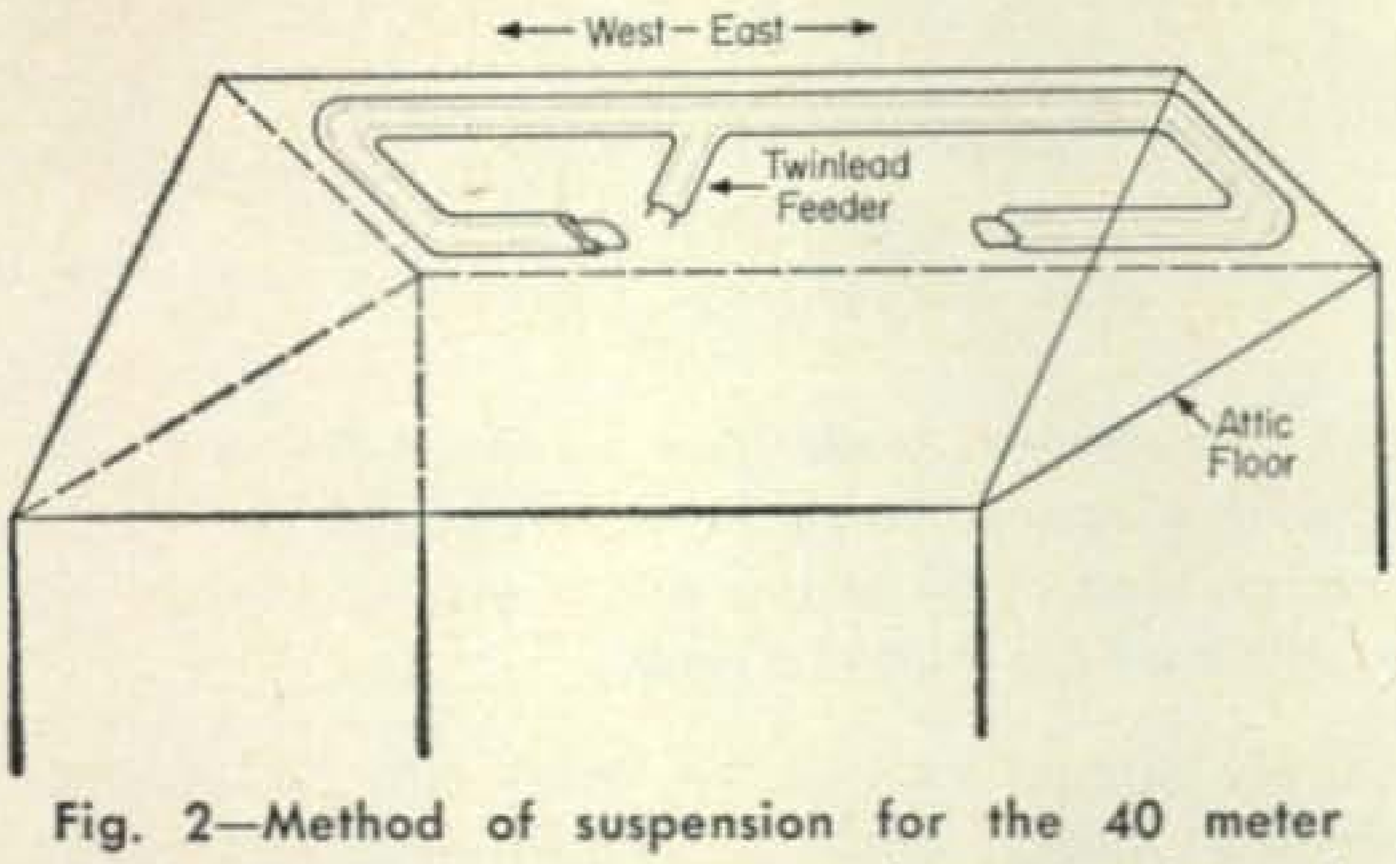

Fig. 2—Method of suspension for the 40 meter dipole. The hooks and eyes (not shown) are located at the ends and bends.

Firing up on 80 meters in cramped quarters is even more difficult, but it is by no means an insurmountable obstacle. Figure 3 illustrates the author's approach to this problem. The antenna, a full length twinlead dipole, starts at ground level at the back of the lot, runs upward at an angle through the attic window, continues on through the house at approximately the same slope, and then drops out of a front window to the base of a small tree near ground level. When not in use, it is untied from the tree and the front half is coiled up at the rear of the attic.

Other Antenna Types

Convenient though it may be, the folded dipole is by no means the only answer to the city dweller's problem. Another antenna which lends itself quite well to indoor use on bands from 14 mc to 28 mc is the old single section 8JK, a bidirectional end-fire array with a pair of driven elements.

Probably the most serious drawback to this antenna is the extremely low impedance at the feed point when wire elements are used. Fortunately, this disadvantage is easily overcome. Reference to the *ARRL Antenna Handbook* will show that if folded dipole elements with one-quarter wavelength spacing are used, and if these are fed with quarter-wave matching sections made of 300 ohm twinlead, the feedpoint impedance will also be 300 ohms (see fig. 4).

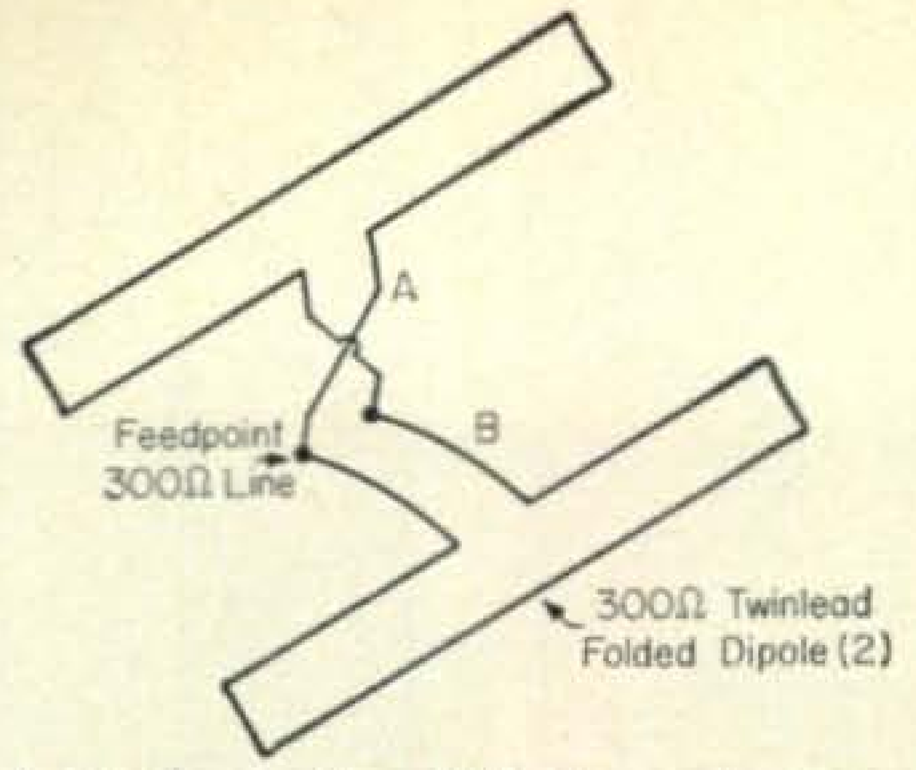

Fig. 4—A single section 8JK (two element endfire) array designed for 300 ohm feedpoint impedance. The dipoles are spaced ¼ wavelength and suspended from beams with hooks and eyes. A and B are ¼ wavelength matching sections made of 300 ohm twinlead and cut according to transmission line formula. Either one may be transposed to give the necessary 180 degree phase shift.

This is just what we need to match our permanently installed twinlead feedline.

In practice, of course, things are not quite that simple. The impedance figures given in the *Antenna Handbook* are for an antenna suspended in the clear and will vary considerably for an array located in close proximity to other objects. By varying the spacing and element lengths a bit, however, it is possible to achieve a very satisfactory match for 300 ohm feedline. The author, in fact, has had quite satisfactory results with arrays of this type simply cut to *Handbook* dimensions and installed without additional matching adjustments.

Three other types of antennas have been tried indoors at W2LCB with varying degrees of success: the two element driven beam commonly known as the "ZL Special"; parasitic arrays of up to three elements; and both full size and top-loaded groundplanes.

The "ZL Special" is very similar in configuration to the 8JK array and, if multiple wire elements or a suitable matching section is employed, can be fed with 300 ohm twinlead. By utilizing the hook and eye suspension system described earlier, the beam can easily be turned around 180 degrees to provide service in either of two directions. Although performance will not compare with that of an outdoor installation, the array will still show some gain and an excellent front-to-back ratio.

Parasitic arrays of the Yagi type can be constructed either from aluminum tubing or from aluminum foil. One fixed Yagi tried by the author on 28 mc consisted of three strips of foil tacked

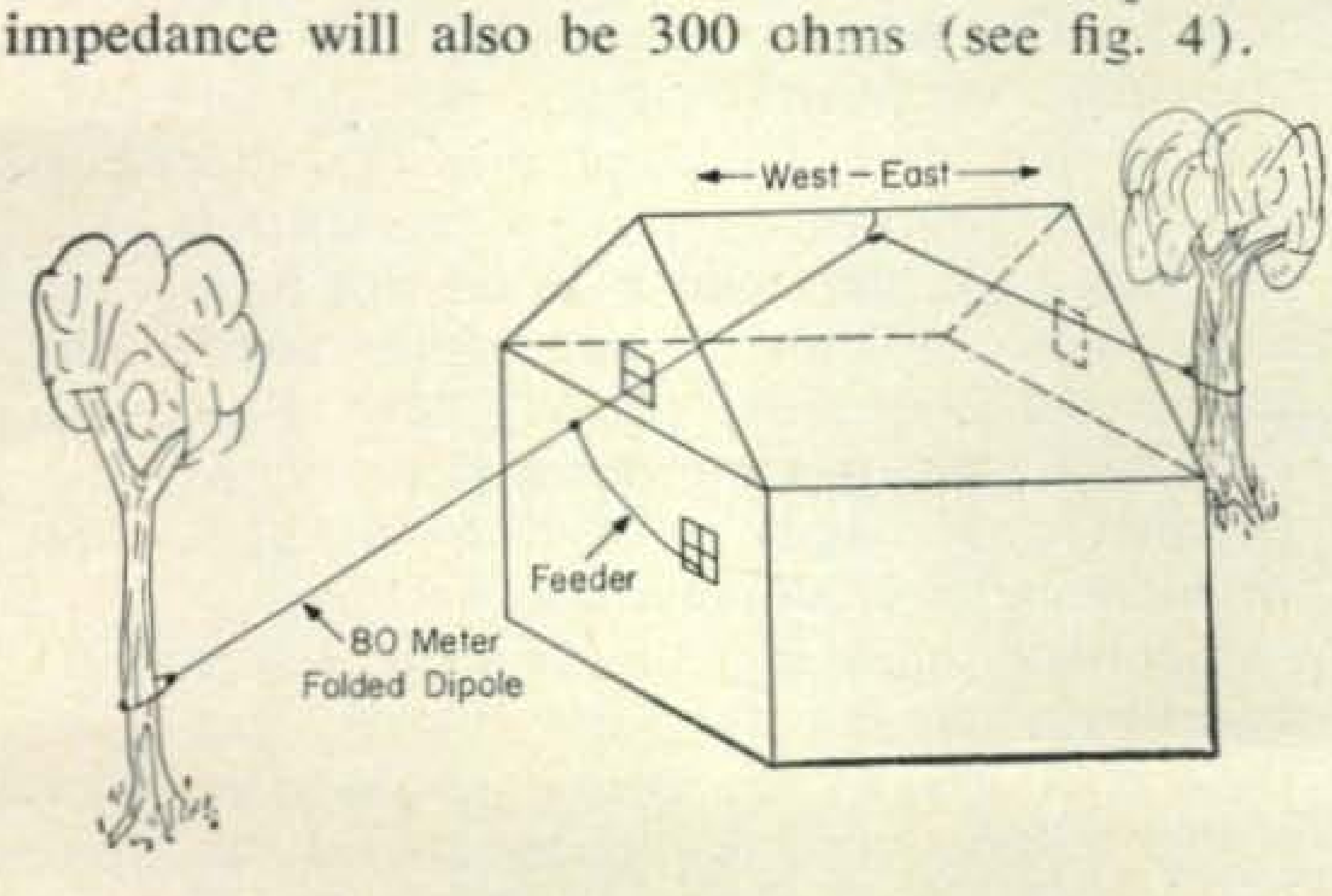

Fig. 3—A method of hanging an 80 meter folded dipole. The antenna enters the back attic window, runs to the peak and drops out the front attic window to the ground. The antenna is supported by hook and eye at the peak and the feedline is taken off just before the antenna enters the rear attic window.

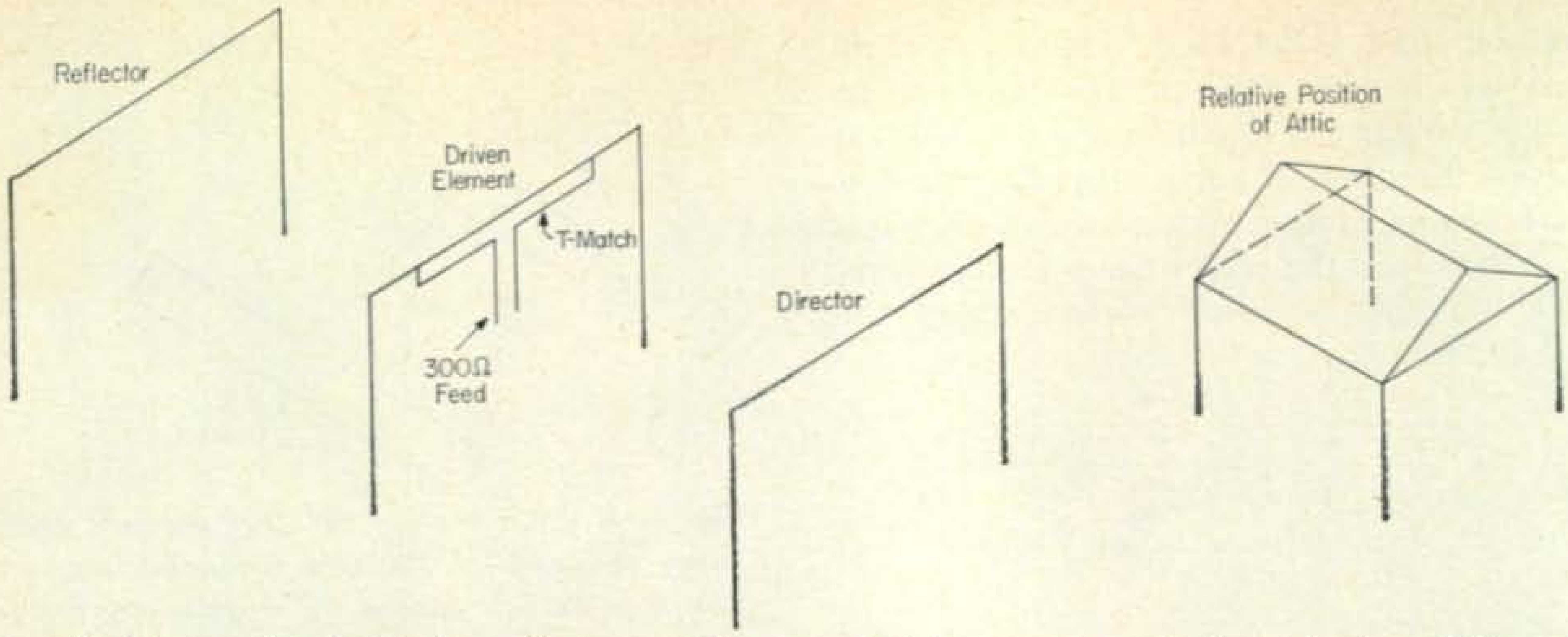

Fig. 5—Construction details for a 3 element 28 mc yagi with elements made from aluminum foil and fastened to the beam with thumb tacks. The element spacing is approximately 0.15 wavelength. The T match is made from two short pieces of aluminum tubing insulated at the center with a wooden dowel and supported from the driven element with a pair of short clip leads.

to the beams with thumbtacks (see fig. 5). The elements of this particular antenna ran across the attic rather than lengthwise, which necessitated dropping the ends of all three straight down for several feet. It still produced a fair signal in the part of the world at which it was aimed.

An attic 8 feet high from floor to roof peak, and of any normal length, will take a full size ground plane on 28 mc. Radials are simply strung out along the floor and the vertical radiator suspended from the peak. Again the primary problem is low feed point impedance, and if 300 ohm transmission line is to be used, some form of matching device will be required. The *ARRL Antenna Handbook* suggests several methods of feeding these antennas.

If the attic is 30 feet or so long and at least 8 feet high, a less effective but still workable groundplane can be constructed for 20 meter use (see fig. 6). Radials are again strung along the floor, but the vertical section, instead of running straight up, has its top portion folded back and forth along the center beam of the roof. Although this proved to be a generally poor performer, the low radiation angle characteristic of the groundplane was definitely noticeable on both transmitting and receiving.

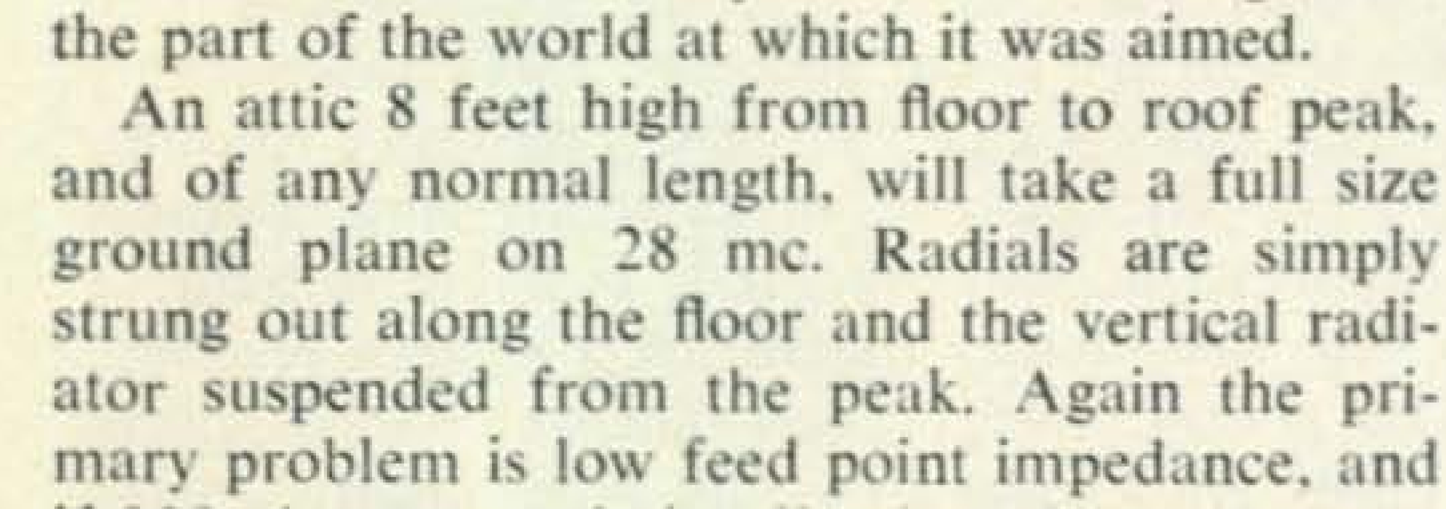

Fig. 6—A shortened groundplane for 20 meters with top half (approximately) of the radiator folded back and forth along the peak of the roof. This method is not recommended unless the distance from floor to peak is at least 8 feet. Radials (A) are made of aluminum foil or heavy wire laid along the attic floor. The feedpoint impedance is low so a matching device for 300 ohm line is needed.

Dimensions

The antenna systems described in this article have all been tried at W2LCB and have produced many satisfactory contacts. Since they are merely suggestions as to what can be accomplished under adverse conditions, and since optimum lengths and element spacing will vary from one situation to another, no actual dimensions have been shown. It is suggested that the individual experimenter simply start with *Handbook* dimensions and then resort to cut and try tactics until element resonance and optimum feedline match are obtained. An s.w.r. bridge and antennascope will facilitate the operation considerably.

Shortcomings

The old proverb that nobody ever gets anything for nothing in this world certainly holds true in the case of these lashups. They will get the crowded city dweller on the air all right and will give him some excellent contacts, but they have inherent shortcomings which must be accepted as part of the package.

Radiation Patterns

One of the major problems is that of predicting radiation patterns, since these can assume very peculiar configurations indeed when antennas are bent or suspended in close proximity to other objects. The 40 meter dipole described in this article is an excellent example of the case at point.

The center half of this antenna runs almost due east and west (the direction of the author's house), and it would appear logical to assume that maximum radiation would take place on a north-south axis. This is exactly what it does *not* do. The antenna does its best job by far in Australia, northern Europe, and southern Africa, in that order. It also produces excellent late afternoon (our time) reports in Australia via the long path, no mean trick on this band with any dipole radiator. Furthermore, just to increase the confusion, shifting the folded end sections to the opposite down slope of the attic beams changes signal strength by a full S-point or more in some directions.

Generally speaking, life is a bit less complicated with antennas for bands above 7 mc, since these can usually be strung up indoors in a straight line. As a result, maximum radiation does tend to occur at right angles to the axis of the antenna, and the pattern is fairly predictable. Even the 80 meter dipole illustrated in fig. 3 is reasonably faithful to the laws of nature, giving maximum signal in the direction of the long downslope and an angle of radiation considerably lower than that of a simple horizontal dipole. In support of the latter observation, it has consistently dumped an excellent signal into New Zealand on this band while producing only mediocre results in Western North America.

Directly related to the problem of predicting indoor patterns is the problem of controlling them. The answer is: you don't control them; you take what you get and make the best of it. If your 15 meter attic dipole follows a straight east-west axis, you had better develop a liking for north-south contacts (unless, that is, you are able to rotate the house). But so what? This doesn't mean that you can't have some fine contacts in these two directions, nor does it mean that you won't get good reports. Even the unpredictable, in fact, may work to your ultimate advantage, as it has in the case of the above-mentioned 40 meter dipole.

Coupling to Nearby Objects

Coupling to nearby objects is another hazard of indoor antenna farming, and it is one which may prove either a curse or a blessing. An excellent example of the former may be seen in the relatively poor performance associated with 10 and 20 meter operation at this QTH. Reports from all directions on these bands, even the favored directions, indicate that the signal is simply being absorbed before it leaves the vicinity of the antenna. The villains are not too hard to pinpoint: a metal ridgepole along the peak of the house, and metal gutter pipes along the eaves on each side. All three of these are approximately 32 feet long, a nice convenient half-wave on 20 meters. Need we say more?

Coupling to house wiring can produce some truly spectacular effects, and they are not necessarily detrimental. The wiring at W2LCB, for example, is definitely part of the overall radiating system on 40 meters, although exactly what role any particular portion of it plays would be almost impossible to ascertain.

One of the outward manifestations of the phenomenon is that amplifier plate current and s.w.r. readings both change noticeably when certain combinations of lights are switched on in the house. Fortunately, the change is not great enough to require any retuning, not does it appear to have any appreciable effect upon the received signal at the other end of the line.

A bit more awe inspiring to the layman is the lighting of house lights which can take place under these circumstances, particularly when fairly high power is involved. A pair of three-bulb living room clusters at this QTH flared so brilliantly before corrective action was taken that keying the transmitter at night created an illusion from the street that the house was afire. To save potential wear and tear on the local fire department, offending lamps or lamp clusters were bypassed with 0.1 mf, 600 volt capacitors. These solved the visible part of the problem very nicely (at least in this house).

TVI and BCI

Although the prospects of TV and b.c. interference might be viewed with some alarm, especially under the circumstances described above, these problems may well prove to be insignificant. In eleven years of operation with the various antenna systems described here, the author has experienced only two cases of TVI with his 600 watt low frequency rig. One of these occurred in a certain 1950 model TV receiver which, from the standpoint of susceptibility to interference, is generally conceded to have been the worst offender ever produced in this country. The station was operating at the time on 40 meter c.w. The other was also a clear-cut fundamental overload situation resulting from operation on 11 meter phone. Both were cleared up completely by installing the cheapest and simplest type of unshielded high-pass filters at the receiver antenna terminals.

The best single precaution to take against TVI is to make certain that harmonic energy reaching the antenna is kept to an absolute minimum. A tiny trace of harmonic in a TV channel, which might cause no trouble at all when using a transmitting antenna well up in the clear, might prove devastating when radiated practically at ground level from an indoor antenna or from nearby house wiring. Good transmitter design and thorough output filtering with low-pass filter and/or antenna coupler are the secrets to success. A bit of discretion in the choice of operating hours and mode of operation will also go a long way toward maintaining peace in the home neighborhood. C.w. and s.s.b., needless to say, are likely to cause far less uproar than a.m.

Give it a Try

If this article were composed in the best science fiction style, we would conclude by describing an all-band, super-power-booster, pre-shrunk miniature beam which could be concealed in a clothes closet and still outperform a five element Yagi on a 100 foot tower. Unfortunately, there is no such ready cure-all for the city dweller's problems. The goal instead has been to stimulate thinking and to demonstrate that with a little ingenuity the crowded city ham can still enjoy his hobby. The examples shown here are by no means the only possibilities—any radiating device which will fit into the confines of the attic or the operating shack itself is worth a try (and this includes the bedsprings).

If your curiosity has been aroused, pick up a copy of any antenna handbook, take a closer look at your supposedly impossible QTH, and let your imagination run wild. *You can get on the air!* Furthermore, once you have cultivated your indoor antenna farm, you will get some much-needed exercise galloping up and down the attic stairs as you flit from band to band. ■