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IMPROVING THE INDOOR ANTENNA SYSTEM

The use of thin copper sheeting is featured to construct efficient, broad-band indoor antenna systems of either the single-band or multi-band variety.

Having to work with an indoor antenna system inside an apartment or house is, of course, a major handicap. No indoor antenna system will ever work as well as an outdoor antenna system constructed of the same materials, at the same height, etc. However, rather than take the defeated approach to the indoor antenna problem, it is very worthwhile to examine the possibilities concerning what things can be done better with an indoor antenna system than with an outdoor antenna system. After all, using an indoor antenna system, the materials used are not subject to the same wear or stress requirements as those on an outdoor system, the antenna is usually more accessible to make adjustments, etc.

Keeping these thoughts in mind, I decided to explore a somewhat different technique for the construction of an indoor antenna system. One of the chief factors that is desired to achieve in any antenna system is low-loss. That is, regardless of how good the matching is to an antenna system to transfer power to the system, one still wants to keep the basic Ω loss of the system as low as possible. Such a condition insures at least that each delivered watt of power really radiates and also leads the way to the development of a broad-band or multiple-band antenna system which does not require critical tuning.

Searching around for materials to use for an indoor antenna system, I finally found the ideal material in the form of copper sheeting. Of course, most amateurs would have been using such material if it were as readily available as common household aluminum foil. But, with a little bit of effort, one can find an almost similar form for copper The advantages are numerous as compared to the aluminum foil material various amateurs have used for the indoor construction of loop or dipole antenna systems. The losses of copper are far lower and the copper can be directly soldered with ordinary soldering materials. Unfortunately, one can't walk down to the nearest hardware or grocery store and obtain a roll of thin copper. But, it can be found by searching out the various wholesale metal product outlets. If one gets back far enough in the suppliers' chain, it will be found that the metal is sold on the basis of weight. In my case, hard drawn copper sheeting about 12" wide and 4/1000" thick was found selling at about $2 a pound. The total cost would depend upon the length of sheeting purchased. For a typical 3 band antenna system (described later), the cost was about $10. The 4/1000" material is by no means as

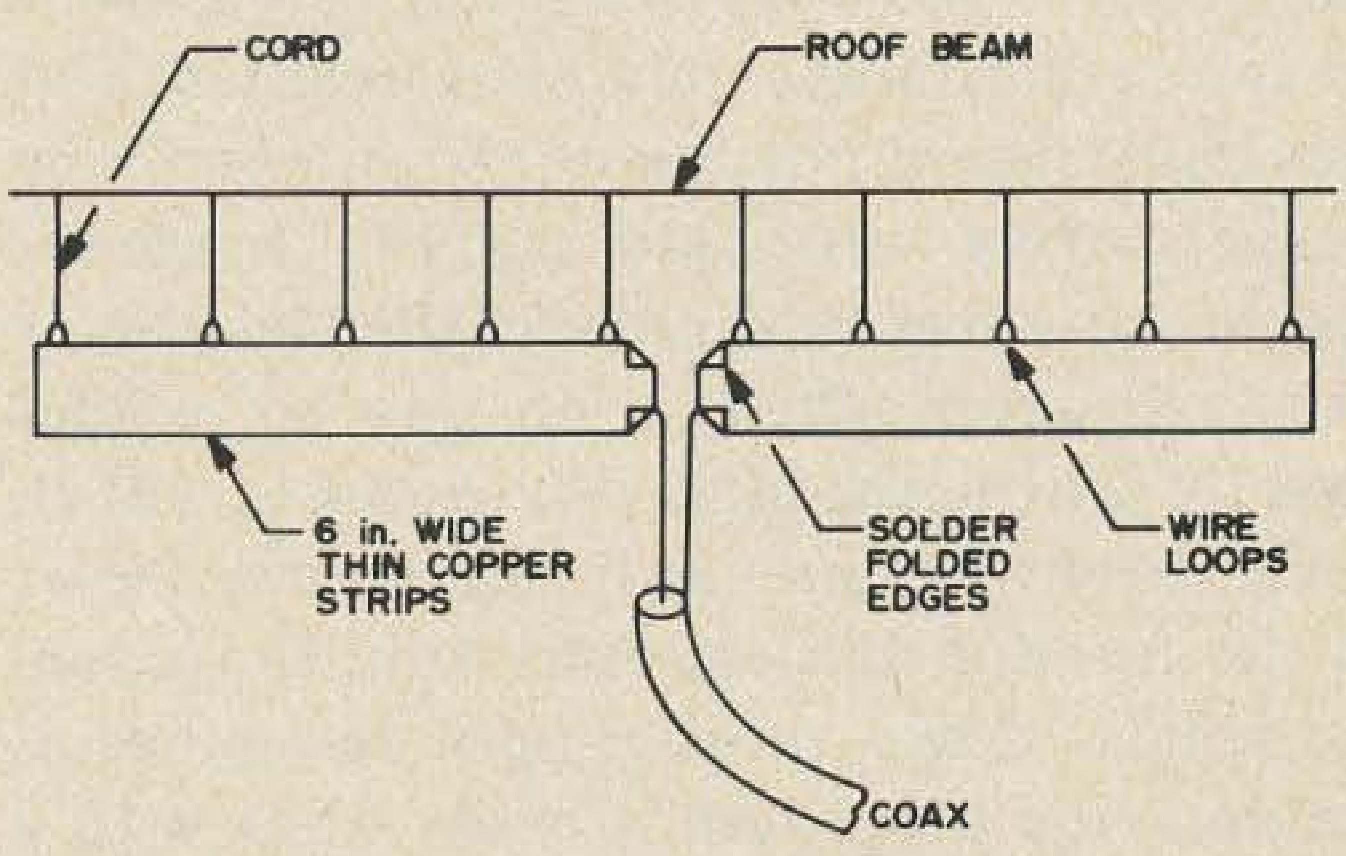

Fig. 1. Basic dipole constructed from thin copper strips.

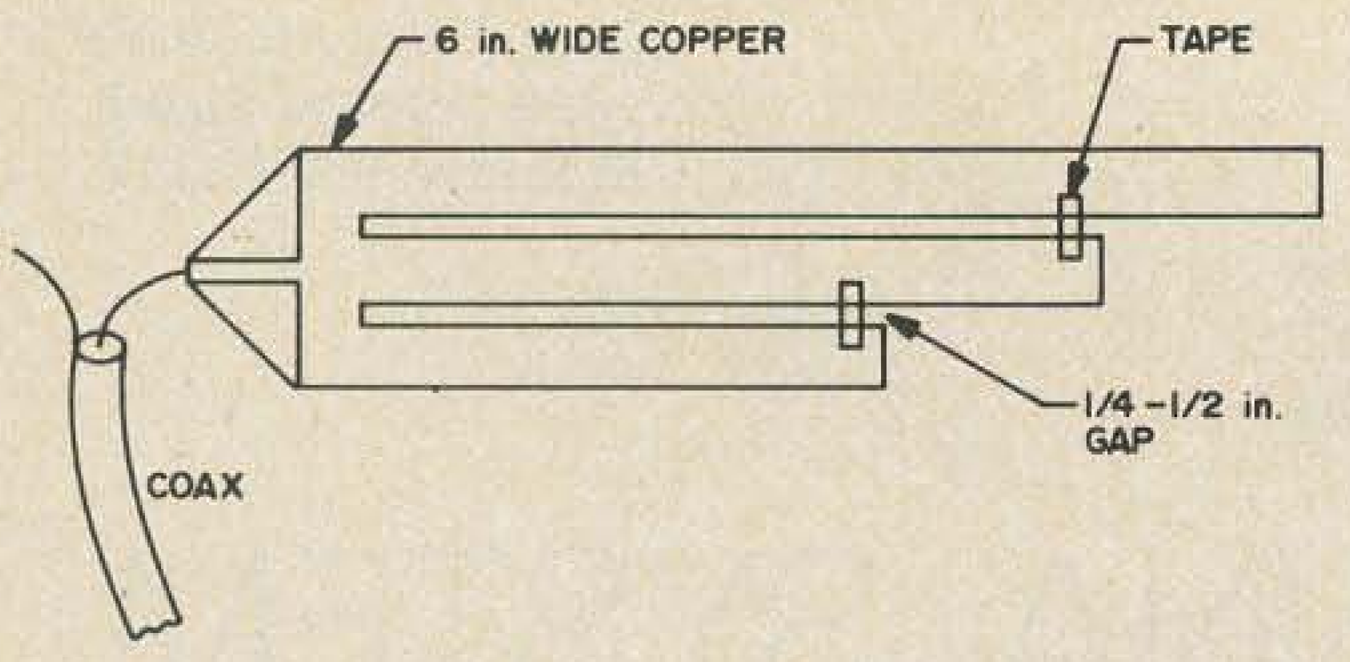

Fig. 2. One half of a tri-band dipole.

fragile as it sounds when one considers that regular foil is still only a fraction of this thickness. One may ask, why fuss to obtain such copper sheeting or foil when, if copper is so desirable, copper tubing is readily available from plumbing supply houses. The advantage of the sheeting is that one obtains far greater surface area for less cost with the sheeting and it is far easier to handle and form in different antenna shapes.

A Practical Antenna

One of the simplest but most effective indoor antennas which one can construct if space is available in an attic is an ordinary dipole. In my case, one dipole antenna which was constructed is shown in Fig. 1. The 12' wide copper sheeting was cut with a pair of heavy shears to two strips of 6" width and each strip used as the arm of a dipole. Little loops of wire were soldered to the top edge of each sheet at intervals and these loops used to attach plastic cord which in turn was used to suspend the antenna from a roof beam, at about a 12" spacing from the beam. At the center of the antenna, the copper strip was folded together towards the center where the coaxial feedline was attached. The folded over edge of the strips was soldered along each edge to the body of the copper strip. This was done to insure absolutely minimum resistance at this high current portion of the antenna. The copper strips were first cut to "formula" length for a regular dipole on the band being used. However, there is no way to predict exactly how much longer the antenna will be than required. One has to use an swr meter in the feedline and carefully trim the antenna length down until proper resonance is found. This procedure is easily done with a pair of shears, trimming the copper stripping down equally at both ends of the dipole until a 1:1, or as close as possible to 1:1, swr ratio is achieved in the center of the band for which the antenna is cut. This procedure requires patience but it is absolutely essential. One of the greatest faults made with indoor antenna systems of the self-resonant type is that many operators forget that the capacitance of the building structure surrounding the antenna completely changes its resonant frequency. The antenna must be cut for resonance where it is mounted or one will end up blaming the indoor location for poor performance results which are not really justified.

A Multi-Band Antenna

The use of the copper stripping to construct an indoor antenna really demonstrates its versatility when constructing a multiband parallel dipole type of antenna system. The multi-band type of antenna about to be described can really be made for any combinations of bands, although the space available in most indoor situations will allow it to be constructed for only 20, 15 and 10 meters or some two band combinations of these bands. The basic multi-band antenna is constructed for the lowest frequency band to be used the same as the antenna shown in Fig. 1 and tuned up for operation on this band. Then each side of the basic dipole is cut using shears to form either two or three strips out of each dipole side as shown in Fig. 2. Try to cut the copper so there is about a 1/4" gap between the strips. Now, if the basic dipole were cut for 20 meters, the center strip would be cut back equally on each side of the dipole until the antenna resonated properly on 15 meters. Then the

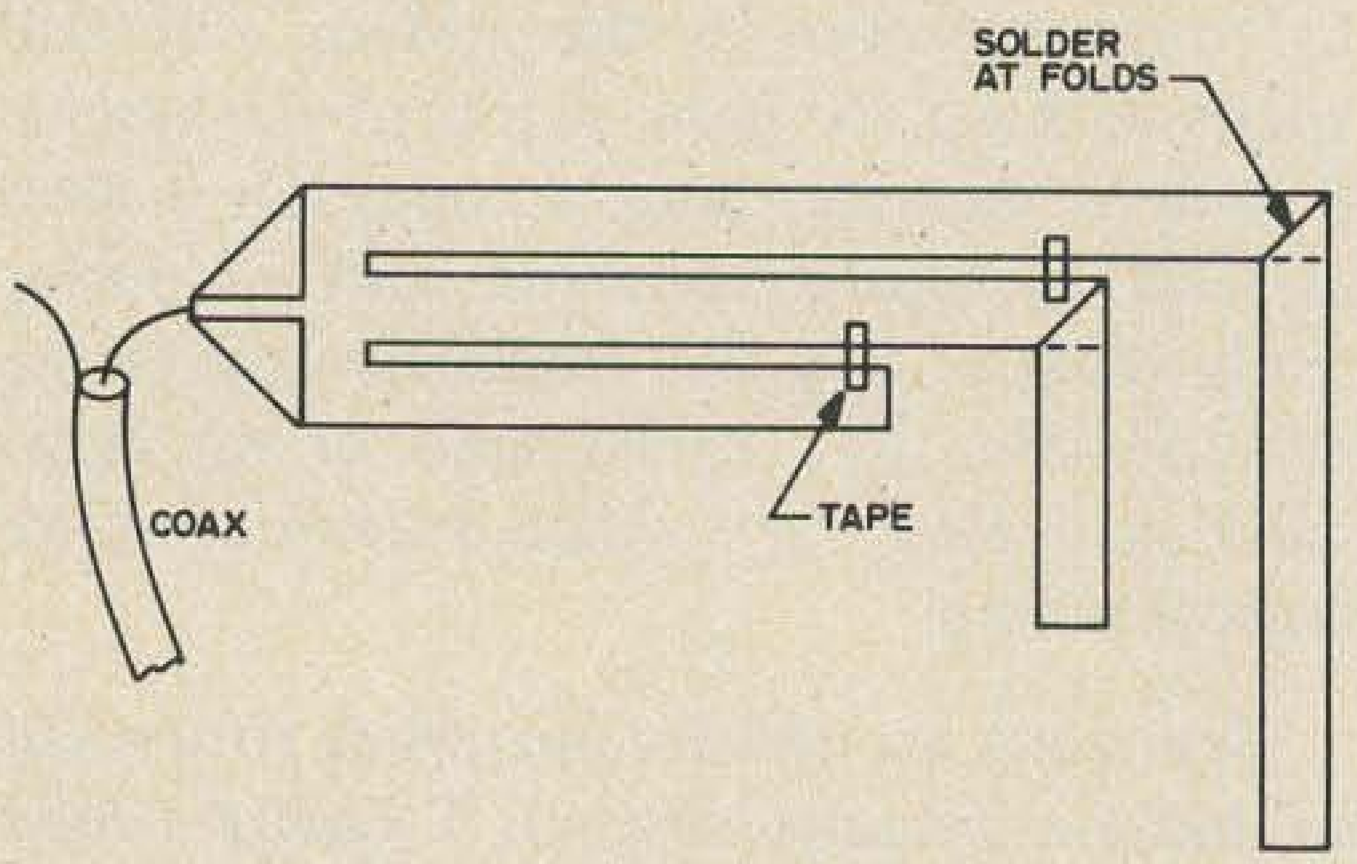

Fig. 3. A space-saving version of the multi-band dipole element of Figure 2.

bottom strip would be cut away equally on both sides of the antenna until the antenna resonated properly on 10 meters. Little pieces of tape placed periodically between the strips will be more than adequate for physical support. The large area surface of the antenna is such that trimming of the strips to form dipoles on each band does not appreciably affect the resonance on any one band. However, one should recheck the resonance on each band. Corrections, if necessary, are easily done by soldering on a few inches of copper stripping cut off during the tuning process on each end of the dipole strip. Solder on these correction strips vertically on the end of each dipole strip.

The same procedure can be used to construct almost any form of dual or tri-band antenna when there is sufficient space to run a dipole on the lowest frequency band being used.

Variations

The ease with which the copper stripping can be bent and, particularly, soldered makes it possible to vary the construction of an indoor antenna to suit almost any situation. For instance, as shown in Fig. 3, if not enough space is available to run out a full length dipole, the dipole strips can be bent to hang vertically at the end of the antenna to make up the necessary length. Inductively loaded or trap antennas are also easily constructed by soldering the necessary components between sections of the copper stripping. A 80-10 meter loop antenna can be formed as shown in Fig. 4 by constructing as large a loop in the attic as space will permit to be hung and using a trans-match type of tuner to resonate the system. Don't hang such a loop horizontally unless it is relatively small and operation is desired only on the 80 or 40 meter bands. The reason for this is that the dominant radiation from a loop will either be broadside to the plane of the loop or along the plane of the loop or a combination thereof depending on the relationship of the loop size in wavelengths to the frequency being used. A horizontally placed loop operated on the higher frequency bands might well operate in a mode such that the dominant radiation is wasted because it is straight up and down.

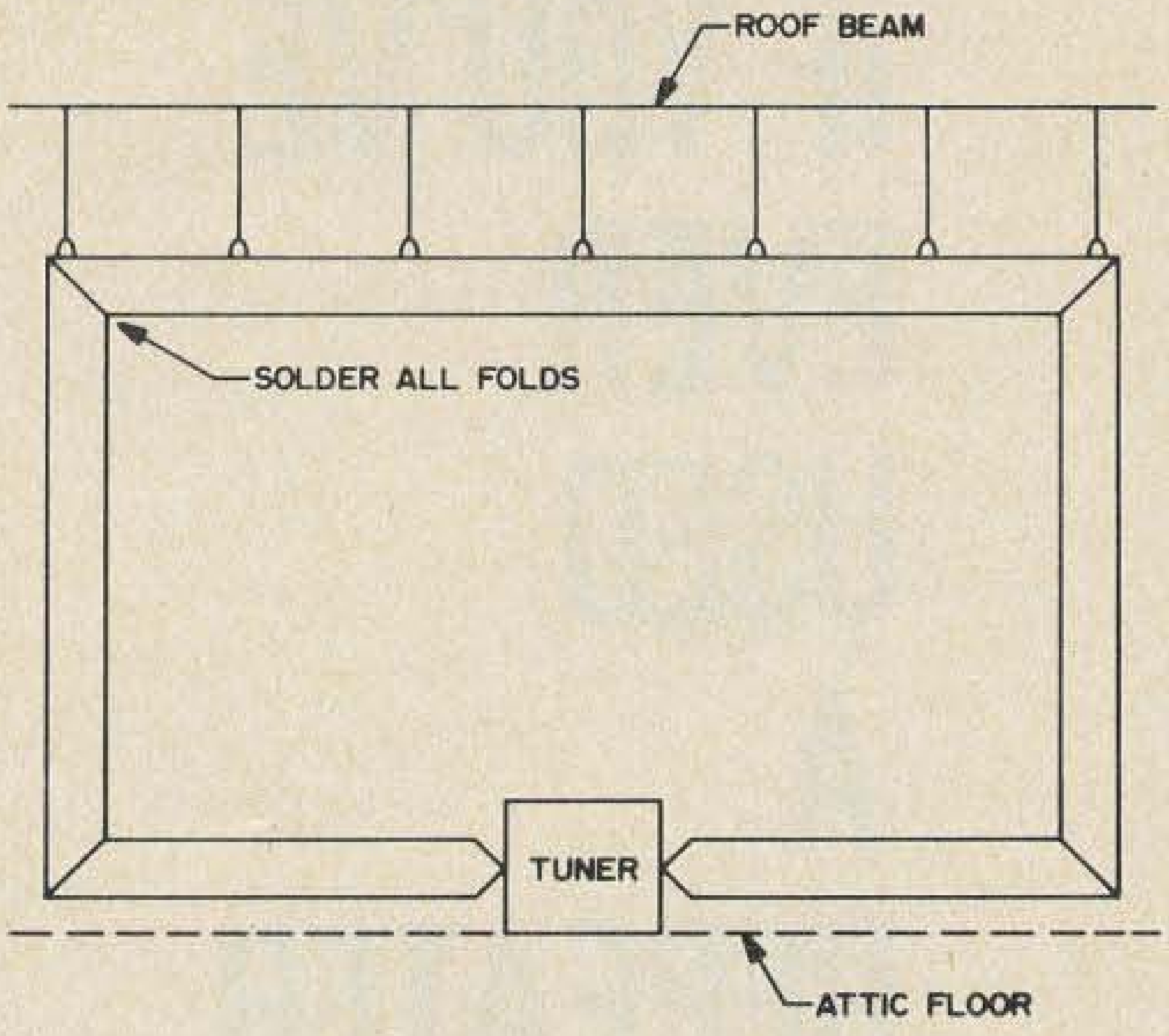

Fig. 4. A multi-band loop for suspension in an attic.

Baluns

The use of a balun for an indoor antenna system is highly recommended. There are usually enough problems with rf fields with indoor installations because of the close proximity of the station equipment and the antenna that it doesn't pay to aggravate it by additional "rf on the feedline" problems. Inexpensive home brew or kit-type toroid baluns can be used since no weather protection is necessary. I used a kit-type toroid balun placed directly between the dipole elements at the center. The toroid winding ends were soldered directly to the copper stripping which formed the dipole and to the coax feedline.

Conclusions

The usage of indoor antennas is also often associated with lower power operation so that one suffers a double handicap. The use of copper stripping as described goes just about as far as one can economically go in keeping antenna losses low. So, if one can match whatever power is available correctly to the antenna, at least one source of loss can be minimized.

A word of caution when handling copper stripping, especially the hard-drawn type. With normal care, there is absolutely no problem handling the material. However, the edges when cut with shears can become like knife blades. Keep the kids away or tape the edges.

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