The Umbrella Antenna

By building "out" instead of "up," a very efficient antenna requiring pole heights of only 10 to 20 feet can be built for use on the low frequency bands–40, 80 and 160 meters. No difficult or special construction or materials are required.

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Short vertical antennas for the low-frequency bands are certainly nothing new. Inductively loaded mobile whips are a common form. They take up very little space and perhaps for the mobile situation are the only practicable antenna form. However, considered for usage in a fixed station situation where even a moderate amount of space is available, it appears foolish to accept the limitations of such a form. The limitations of the loaded mobile whip–poor efficiency, very narrow bandwidth and an awkward value of terminal impedance–arise because of the form of loading used. A small loading coil is required because of space limitations and in order to provide even usable efficiency the coil must be of high "Q" with resultant narrow bandwidth.

If the space limitations did not exist, it would be desirable to make the loading coil as large as possible to increase efficiency. Also, it would be desirable to include some form of capacity or "top-hat" loading since the reactive effects of the inductive and capacitive loading will act to maintain antenna resonance over a greater bandwidth. It is rarely possible to do this in a mobile situation but it is possible in a fixed station situation. This article describes a form of antenna which combines a very efficient method of combined inductive and capacitive loading while still requiring very little space compared to any conventional antenna of full-size dimensions.

Umbrella Loading

The basic form of the umbrella antenna is shown in **Fig. 1 (A)**. The vertical mast is relatively short (10 feet on 40 meters, 20 feet on 80 and 160 meters) and the wire web on top introduces inductive loading by

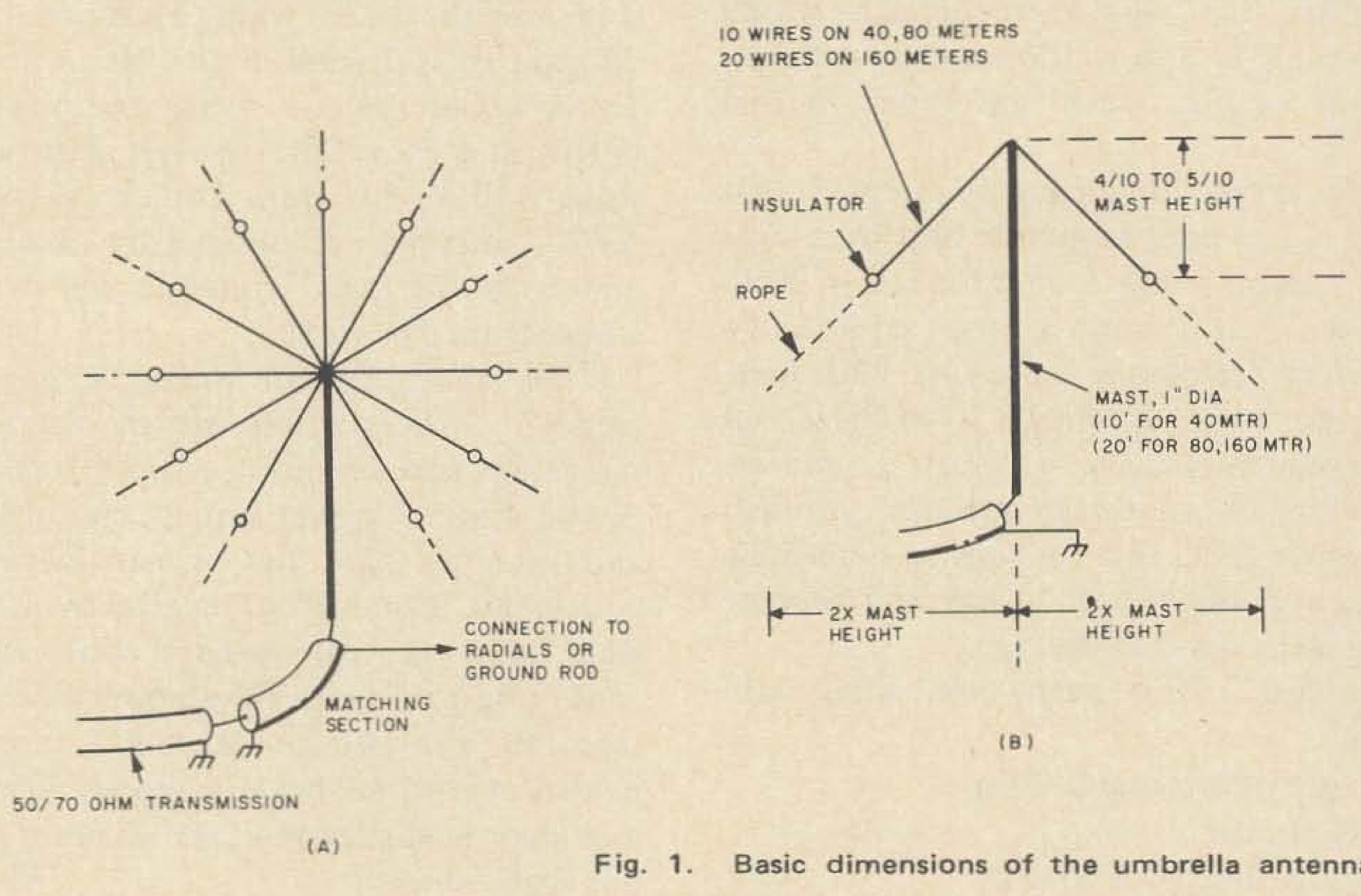

Fig. 1. Basic dimensions of the umbrella antenna.

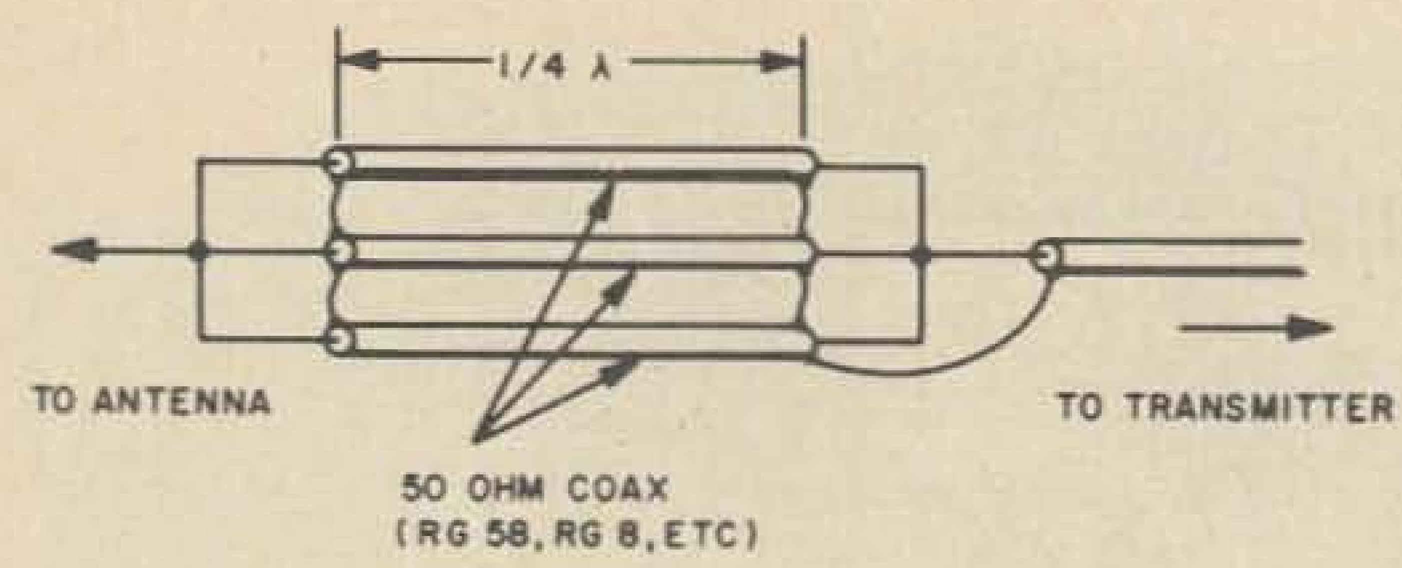

Fig. 2. Transmission line matching transformer for use between base of umbrella antenna and 50/70 ohm coax line.

linearly extending the length of the mast and capacitive loading due to the capacity effect between individual web wire and between the wires and the mast. A side view of the antenna is shown in **Fig. 1 (B)**. The dimensions shown were not randomly chosen as one might at first imagine. They are a compromise between a number of factors. If the web wires are brought closer to the mast, the effect of the loading is reduced. If the web wires are made more horizontal, the ground area required increases (however, the loading effect is increased and if the antenna is mounted on a structure such that a large area is available, this approach may be used.) The vertical projection of the web should be held to within ½ the height of the mast. Making the web wires longer will increase the loading effect but the radiation pattern will change such that high angle radiation results and the antenna does not perform as the equivalent of a full-length quarter wave vertical. If one does not object to the high angle radiation or, in fact, prefers it for short-medium distance work on the lower-frequency bands, the web wires can be made as long as desired.

The number of wires in the web will influence the resonant frequency as well as the feed point impedance of the antenna. Six is the minimum which should be used and probably 10 or 12 is a reasonable number considering loading and constructional complexity. Increased loading effect will take place up to at least 20 wires.

The feed point impedance is not as high as one is used to with a purely inductively loaded antenna. Because of the effect of the capacity loading, the feed point impedance when a good ground connection is used will vary between 5 and 8 ohms. Any one of the conventional methods used to match a low impedance load—such as the driver element on a multi-element parasitic beam—to a coaxial cable may be used and so they will not be shown here. One slightly different method to match the antenna by means of a quarter-wave transmission line transformer is shown in **Fig. 2**. Three lengths of coaxial cable are paralleled to form the required simulated low impedance transformer section.

Construction

The main vertical section of the antenna was made from a standard 10 foot aluminum TV mast. The mast was mounted to a ground stake by two standoff insulators (Birnbach No. 448 pillars with tube clamps at each end). A home-brew standoff can be easily fabricated from a block of wood or polystyrene and cutting a hole at both ends for insertion of two adjustable hose clamps. Since the base is at a low voltage point, the quality of the insulator used is not critical.

The ten wires comprising the top web were fastened to the mast by means of an ordinary ground lug. Hook-up wire was used to construct the web although it is suggested that stronger wire be used—common TV guy wire would be an excellent choice, for example, for rugged installation.

As with any antenna being worked against ground—be it full-size or a loaded type—the quality of the ground plane has an important effect upon antenna performance. In moist soil a ground rod driven several feet into the ground may suffice but otherwise a cluster of 10 to 12 radials buried several inches and extending at least to the point where the extension of the web wires touches ground is very desirable.

The author's antenna was constructed following the outline dimensions given in **Fig. 1 (B)** to resonate on 40 meters. After installation and testing it was found that resonance was very slightly below 40 meters. The situation was corrected by placing the ground terminal for the web wires slightly closer to the mast. This was done experimentally while checking the transmission line SWR. There are several variables involved in determining the exact resonance of the antenna and either one can vary the angle of the web wires to "fine-tune" the antenna or these wires can be firmly placed on either a small inductor or capacitor used at the base of the antenna for final adjustment.

Summary

Antenna efficiency is at best a difficult thing to measure or estimate even under the most ideal conditions on low-frequency bands. Compared to full-size quarter-wave verticals, the best estimate is that the umbrella antenna is from 60 to 70% as efficient. This is certainly a far cry from the usual loaded mobile whip which has efficiencies of 2-5% (100 watts transmitter output, 2 to 5 watts actually radiated).

The bandwidth depends upon the band for which it is constructed. On 40 meters when resonance is adjusted for 7150 kc, the antenna will satisfactorily cover both the CW and phone band edges with an SWR of from 2:1 to 2.5:1. On 80 meters either the entire phone band can be covered or the CW portion; the bandwidth is about 250 kc overall. No tests were made on 160 meters but the coverage should be in the order of 75 to 90 kc which is certainly adequate for most uses on that band.

If the antenna is constructed for 40 meters, a double resonance will be found to occur on 21 mc—the same as for any monopole or dipole operated on odd multiple harmonic frequencies. The antenna should be quite efficient on 3rd harmonic operation but the problem is one of the resultant radiation pattern. The pattern appears to produce mostly high-angle radiation which, of course, is useless for DX purposes. Nonetheless the antenna may still be useful as an auxiliary antenna on this band.

The umbrella antenna appears at first glance to be a rather simple and elemental type of loaded antenna. Actually, it is not when one considers its advantages in terms of preserving a low radiation angle and achieving quite good efficiency—all within reasonable dimensions. This form of antenna may not allow an apartment dweller to put out a booming signal on 80 meters but it should certainly permit someone with a moderate amount of space to considerably improve his signal on any low-frequency band as compared to using a whip or randomly placed and tuned length of wire.

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