AN INEXPENSIVE UTILITY ANTENNA FOR 80 METERS

BY WILLIAM I. ORR,* W6SAI

THE perfect, all-purpose 80 meter antenna would combine low angle radiation for DX work, high angle radiation for local contacts, good bandwidth for low s.w.r. across the band and small size for easy erection on a city lot. When you, kind reader, find such an antenna, please let me know, as I have been looking for such an object for over 15 years.

The requirements remind me of the plaintive request of the small-town band leader, looking for a fill-in musician: "I'm looking for a man who plays clarinet and trombone, doubles on the violin and saxophone, and wears a size forty seven suit!"

W6SAI's need for an all-purpose 80 meter antenna came about because of a series of schedules on s.s.b. and c.w. that ranged up and down the Pacific Coast, inland to Nevada, and across the continent to the Mississippi River. This, combined with a love of chasing DX on 3.5 mc, resulted in the desire for a simple antenna system that would fill the bill under all circumstances. Needless to say, the search is still going on for such an ideal antenna system.

In order to survey the problem, let's look at some of the simple antennas used, and the results achieved. The summary should be of interest to Novices, traffic men and DX'ers alike.

The 80 Meter Dipole

One of the first antennas used for various schedules was the simple 80 meter dipole. Figure 1 shows the s.w.r. plot for a dipole cut to the phone band and illustrates typical results obtained when the antenna was erected about 50 feet in the clear. The dipole was slung between a 70 foot tower and a short mast erected on the building housing the station. According to various plots of antenna height versus impedance available in the Handbooks, the feedpoint of such an antenna should be approximately 50 ohms at resonance. Alas, measurements run on the antenna with an accurate impedance bridge proved that, in this particular instance, the assumption was unfounded. As shown in the graph, the minimum value of s.w.r. at resonance indicated the impedance was about 88 ohms and the operational bandwidth of the dipole (assuming a maximum s.w.r. limit of 2.5:1) was about 330 kc.

This proved to be about par for the course. Moving the dipole about the area and fiddling with the feed system changed the results a bit, but the upshot was that the dipole had an

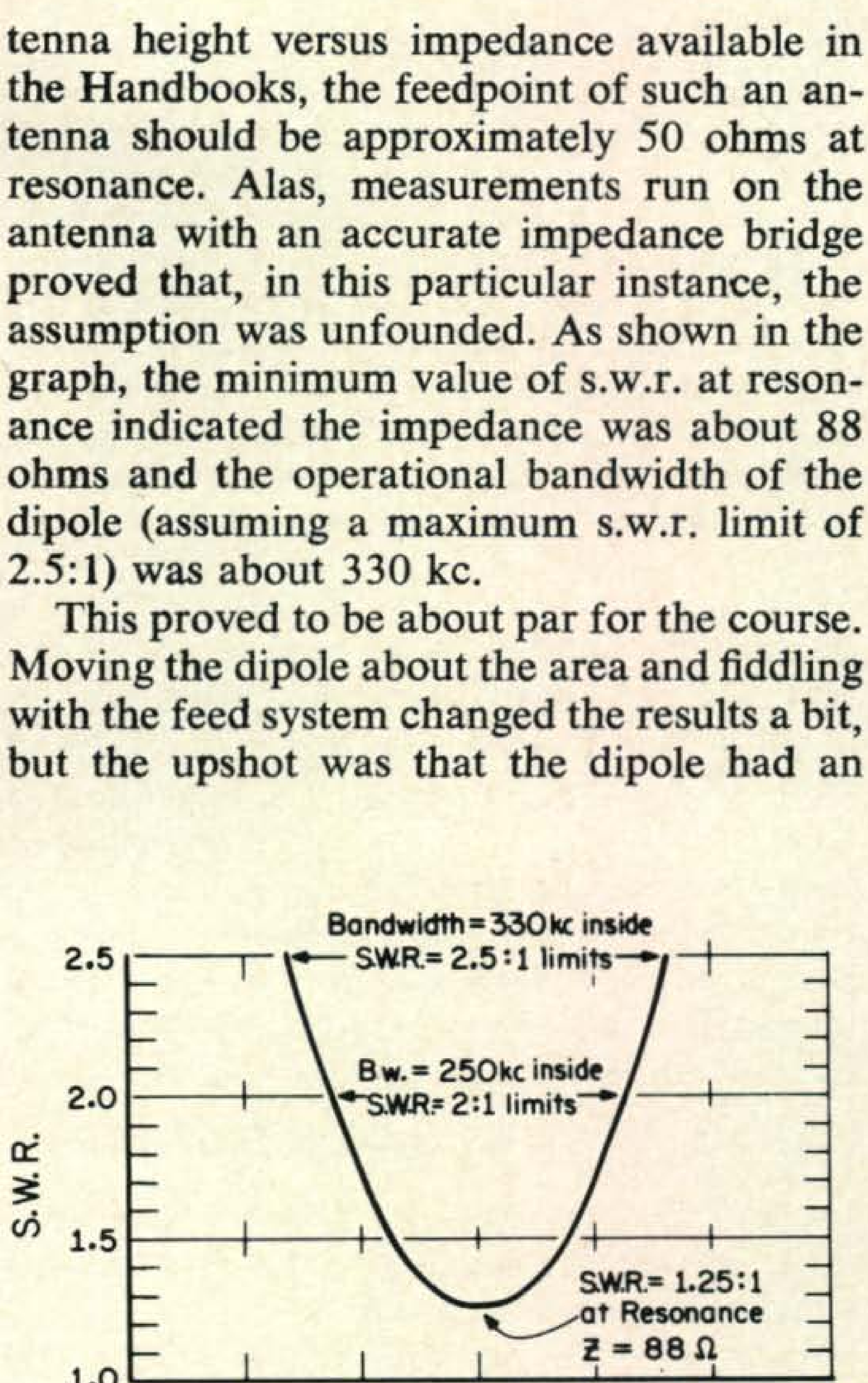

Fig. 1—Typical s.w.r. plot of 80 meter dipole antenna. Because of the low height above ground compared to a half-wavelength, the impedance of an 80 m. dipole varies over a wide range at the feedpoint. In this case, the dipole height was about 50 feet, and the center impedance at resonance measured about 88 ohms. A 72 ohm transmission line (RG-11/U) was used and the operational bandwidth of the antenna is as pictured above. As most pi-network circuits in amateur gear can accept a s.w.r. of about 2:1, or 2.5:1, the useable bandwidth of the antenna is between 250 kc and 330 kc.

*Manager, Amateur Service Department, Eimac Division of Varian, San Carlos, Calif. 94070.

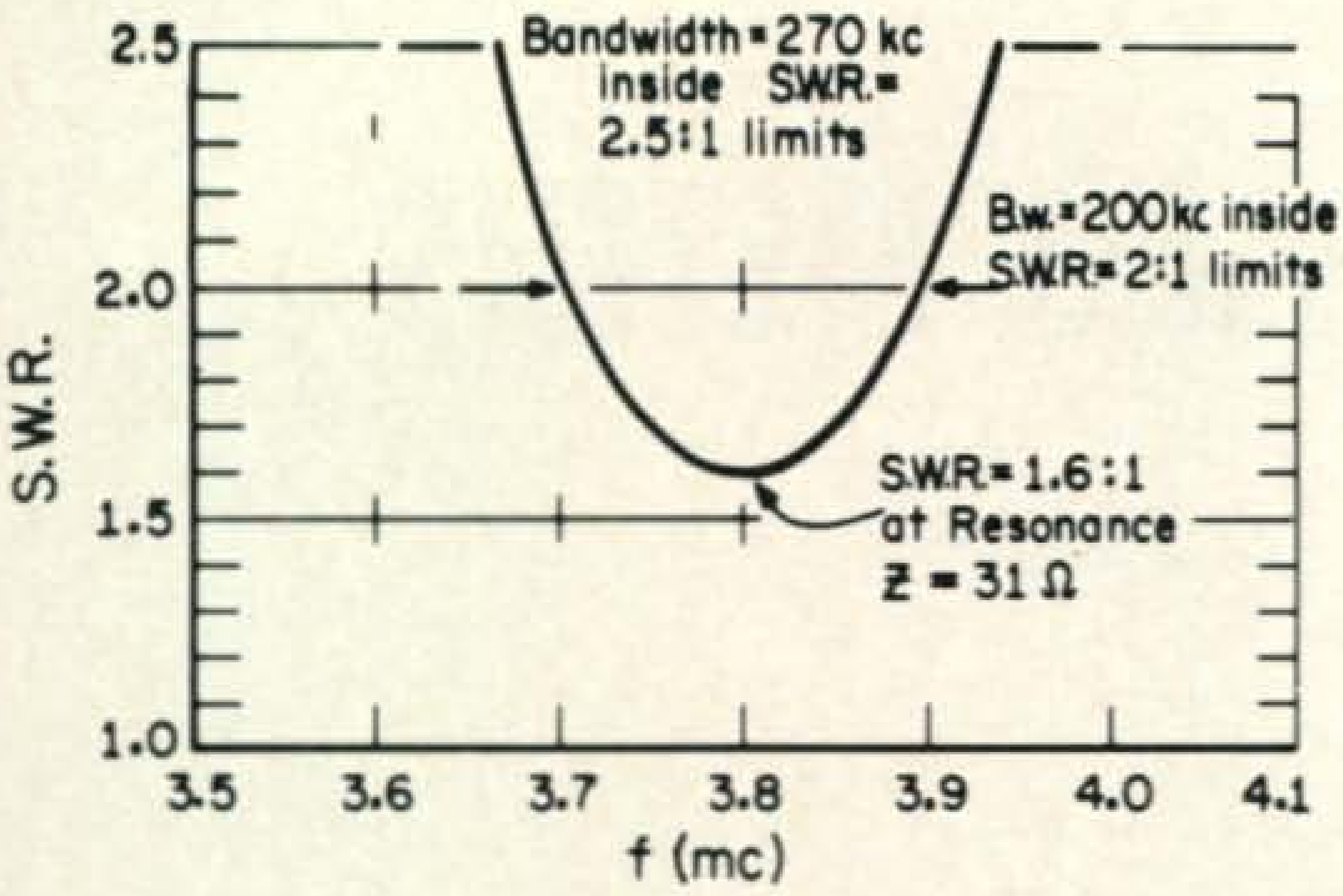

Fig. 2—Typical s.w.r. plot of 80 meter vertical ground plane antenna. This quarter-wave plane was made of light aluminum tubing and had four 66 foot radials at the base, which was about 10 feet above the ground. The feedpoint impedance of the antenna was about 31 ohms at resonance. Operational bandwidth was not as good as that of the dipole shown in fig. 1. Use of an impedance transformation network at the base of the antenna undoubtedly would help matters. Additional radials, of staggered length, might also improve the operational bandwidth.

operational bandwidth at best of about 250 kc to 325 kc, regardless of the positioning or height above ground. The RG-8/U (52 ohm) feedline was removed and the antenna fed with RG-11/U (70 ohm) coaxial line, and the results of fig. 1 were accepted as representative. Adjustment of the height above ground permitted the resonance figure of s.w.r. to be dropped to a value very close to 1:1 but the overall bandwidth of the antenna remained about the same.

Operationally, the dipole worked as expected. Results were poor off the ends and good broadside to the wire. Close-in results were mediocre, with plenty of fading noticeable in the afternoon hours. At night, the dipole performed well at distances 400 to 1200 miles from the station. For short distance (100 to 200 miles) the dipole was *not* outstanding at all.

The 80 Meter Ground Plane

All in all, eight or ten dipoles were used at various times and locations over the past ten years. In 1956, experiments were started with a series of 80 meter ground plane antennas; some full height; some compact, loaded whip arrangements. The representative groundplane was a 66 foot whip with four 66 foot radials run randomly about the yard. The base of the whip was 10 feet above the ground, and the radials were about the same height, or slightly less. The junction point of radials and feedline was grounded with an eight foot copper strap running to a convenient water pipe. Measured results are shown in fig. 2. At resonance, the antenna impedance ran very close to 31 ohms and the overall bandwidth at the s.w.r. limits of 2.5:1 was about 270 kc. The groundplane was fed with 50 ohm RG-8/U coaxial line.

Operationally, the ground plane was inferior to the dipole out to distances of perhaps 600 miles or so. Greater fading was observed on close-in contacts and reports were several S-points weaker on the ground plane than on the dipole. At distances greater than 600 miles or so, the ground plane appeared better than the dipole, and seemed very effective on DX contacts. Working Europeans on 80 meters separates the men from the boys, as far as antennas go, and the ground plane seemed to do a great job. Interestingly enough, a check of the W6SAI log shows that during the period of 1957-1959 when the ground plane was used extensively, over 99% of the replies to CQ calls on 80 meter c.w. (outside of California) were from stations *east* of Ohio! That speaks well for the DX-ability of the ground plane.

On the other side of the coin, the ground plane was a star performer in picking up random noise and static. QRN that was unnoticed on the dipole was exceedingly annoying on the ground plane and many a good DX contact was obliterated by an electric motor or electric razor, somewhere in the vicinity, that blotted out the weak 80 meter DX signal.

The Utility 80 Meter Antenna

After observing the characteristics of the two antennas over a period of years, it was decided to experiment with a modified antenna system that, hopefully, would combine the better features of both antennas and eliminate some of the worse features. After many rolls of wire were expended, the resulting antenna had the operational characterisics shown in fig. 3. The physical configuration of the antenna is shown in fig. 4.

Basically, the Utility 80 meter antenna is an extended ground plane, with the top portion run in a horizontal position to provide a degree of high angle radiation. Experience has shown that such a bent radiator will tend to "fill in" the radiation nulls observed with both the vertical and the horizontal antennas. To boost the antenna impedance at the feedpoint, it was deliberately made longer than the resonant length, and resonance was established by the inclusion of a series capacitor, much as in the manner used for the popular pre-war "Marconi" antennas, so popular on the dear, defunct [?] 160 meter band.

Operationally, the Utility antenna has done a good job for over two years since it was first erected. The radiation pattern is substantially omnidirectional, and signal reports compare favorably with both the horizontal dipole and the ground plane at various distances. The Utility antenna, for example, is better that the simple ground plane at distances up to 600 miles or so, exhibiting a much stronger signal and less fading. At greater distances, it seems equally as effective as the ground plane. Best of all, the boost in input impedance allows the antenna to cover a substantially greater portion of the 80 meter band than either the dipole or the ground plane. As measured, the 2.5:1 s.w.r. bandwidth of the Utility antenna is about 375 kc and exhibits a s.w.r. of better than 1.1:1 at the chosen resonant frequency.

Constructing the 80 Meter Utility Antenna

The Utility antenna is inexpensive to build and easily erected in a few hours time. In its simplest form, it is a 68 foot wire, 24 feet of which is run vertically, and 44 feet horizontally. The antenna provides both vertical and horizontal radiation in approximately equal amounts and the vertical pattern is a broad "blob". Three 66 foot radials are used, in conjunction with a ground connection. The base of the antenna is placed close to ground level and the radials are run in random directions about 6 inches above the ground. To prevent the radials from becoming a hazard to life and limb, they are run along the base of a fence, along the bottom of a hedge, and along the lower wood siding of the house, at approximately 120° angles to each other.

It must be emphasized that the radials are not counterpoise wires, or substitutes for the actual ground. They form half the antenna and, although they theoretically are not supposed to radiate, no doubt they do and, in addition are "hot" with r.f. at the ends. For safety's sake, therefore, the radials should be made of insulated wire, carefully taped at the ends to prevent inquisitive children from getting r.f. burns when the transmitter is in operation. It is a matter of mild conjecture as

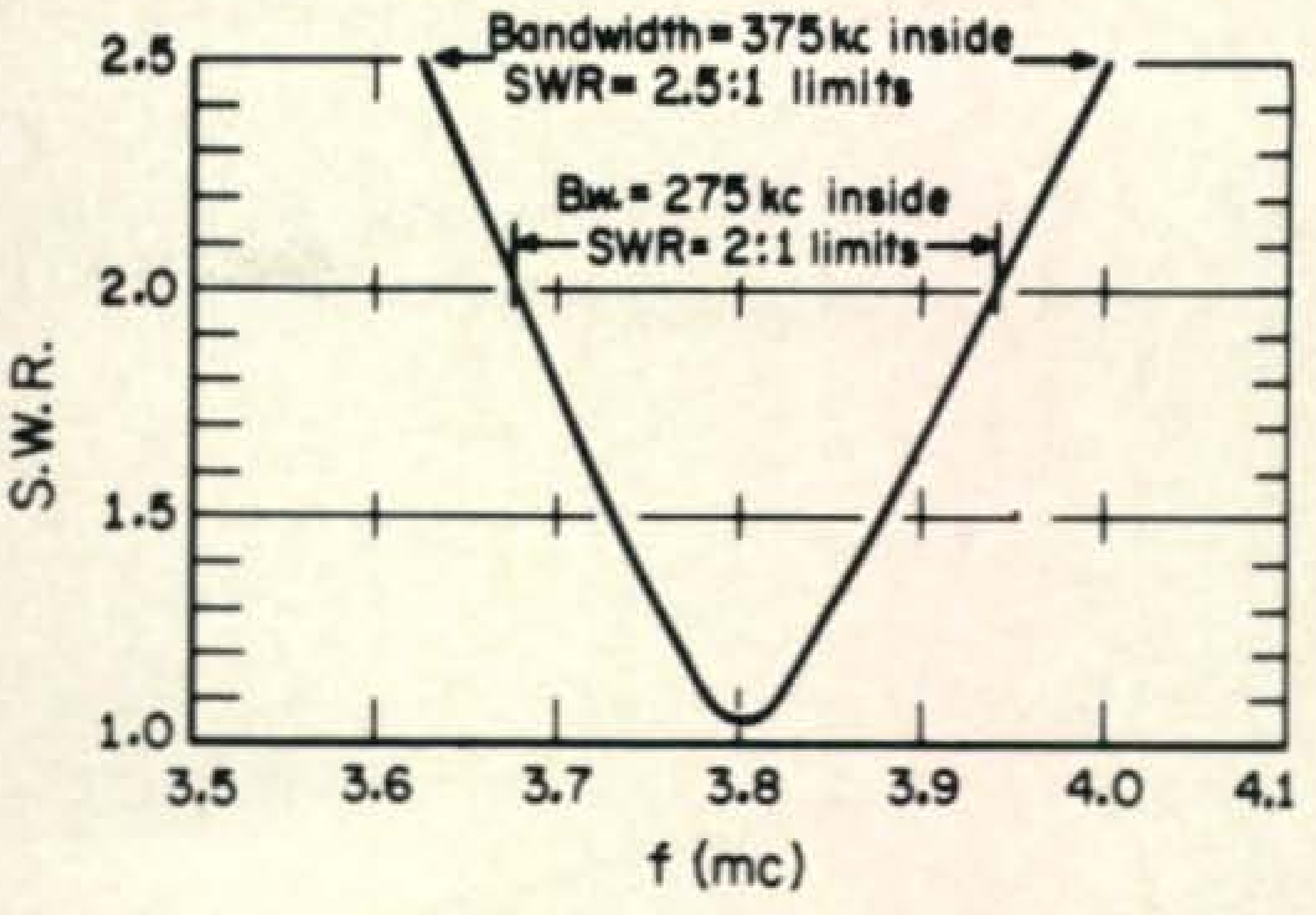

Fig. 3—Typical s.w.r. plot of 80 meter Utility Antenna. The quasi-vertical antenna system of fig. 4 provided this plot of operational bandwidth. The overlength, series-tuned antenna provided a good impedance match at resonance to a 52 ohm (RG-8/U) transmission line, and improved bandwidth as compared to the antennas of figs. 1 and 2.

to the degree that the radials contribute to the antenna pattern. Not much, probably, as they are very close to the ground, but the reader should not assume that they are not a portion of the antenna radiating system, as they are.

The antenna ground connection is important as it established reference ground for the whole radiating system. It need not be perfect, but it must be there. In this case, the ground connection consisted of two four-foot pipes driven vertically into the soil at the junction of the radials. The pipes are jumpered together and connected to the radials and the outer braid of the coaxial transmission line.

The horizontal section of the antenna should be reasonably in the clear and should not run parallel to electric or utility wires, if possible. The first time this antenna was erected, it caused much distress to the XYL, who found that the dining room lights flickered every time the OM came on the air! Moving the flat-top portion of the antenna at an acute angle to the house wiring cured this annoying problem.

Adjusting the Utility Antenna

The dimension of the antenna are proportioned so that the antenna exhibits a typical 50 ohm load to the feed system at the resonant frequency of the antenna, as illustrated in fig. 3. To resonate the antenna, a variable capacitor is placed in series with the antenna and a two turn link coil that is slipped over a grid dip oscillator (point X). The oscil-

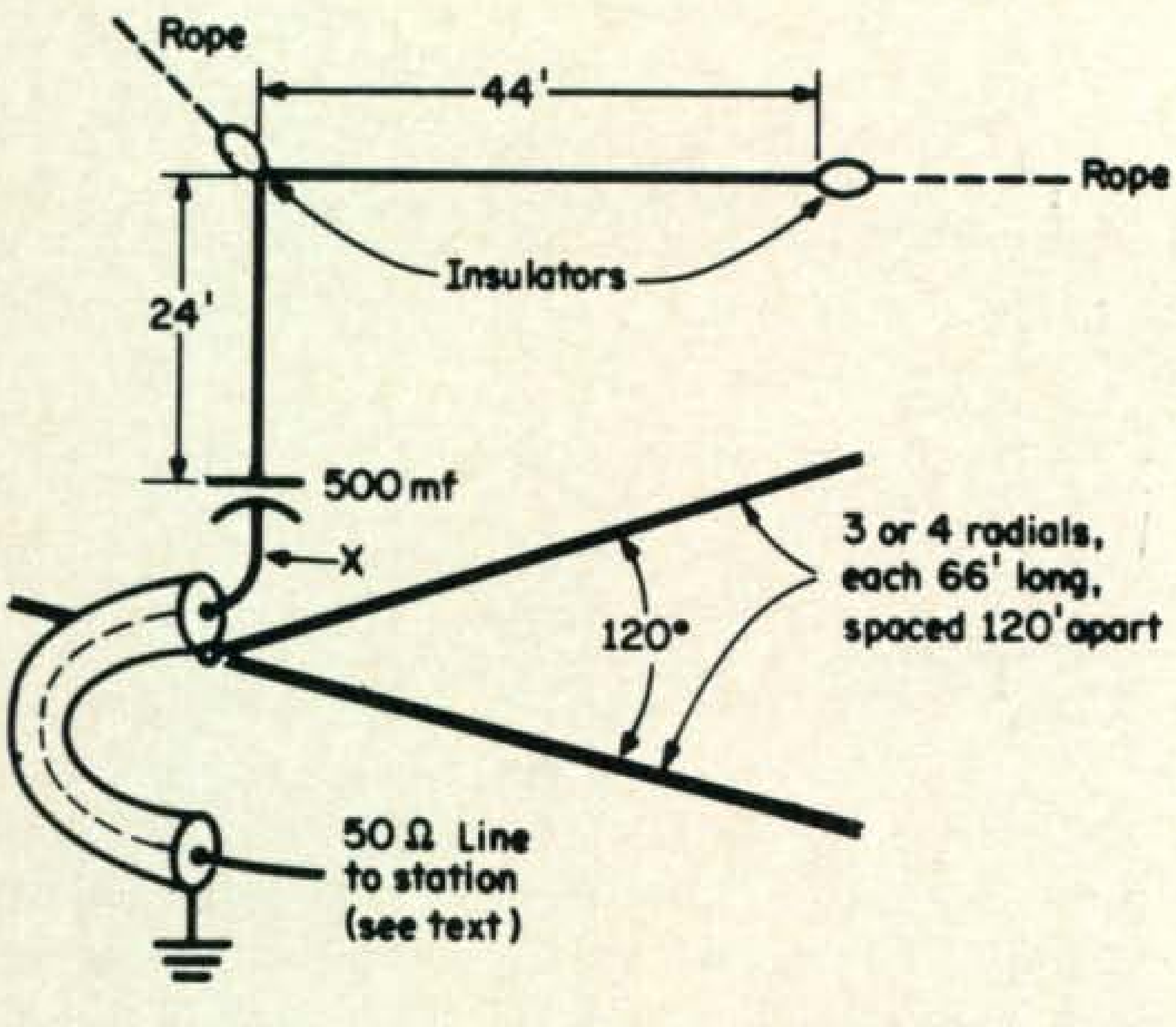

Fig. 4—The simple Utility Antenna for 80 meters. This up-to-date version of the old Marconi antenna provides both horizontal and vertical radiation, plus a 50 ohm feedpoint termination. For adjustment, the antenna is broken at point X and a two turn coil inserted between the series capacitor and ground. (The feedline is unused in this test). The series capacitor is adjusted for grid dip resonance indication at the chosen operating frequency. Three or four 66 foot radials are used, strung a few feet above the ground. A ground connection is also required at the base of the antenna system. The 24 foot leg is vertical, and the 44 foot section is horizontal, forming an inverted L-section, as shown. Radials should be made of insulated wire, and should not touch the ground.

lator is set to the desired center frequency of operation, in this case, 3.8 mc. The series capacitor (made up of paralleled sections of a broadcast tuning capacitor) is adjusted until an indication of resonance is found on the oscillator. The variable capacitor may be temporarily clipped in the circuit, with the stator sections attached to the antenna and the rotor (frame) attached to the pickup loop and ground. When resonance is found, coupling between the loop and the grid dip oscillator is loosened until a very sharp resonance dip is noted. The capacitor may then be removed from the circuit and measured on a bridge or capacitance meter. For the antenna shown, a capacitance of 500 mmf was required to establish resonance at 3.8 mc. More capacitance will be required for a lower resonant frequency, and less for a higher one. Once the value has been determined, a fixed transmitting-type mica capacitor may be substituted for the variable test unit.

The base impedance of the antenna at resonance is established by antenna length. If the s.w.r. value at resonance is judged to be unusually high, the antenna length may be varied a few inches at a time, one way or the other to bring the impedance close to 50 ohms. Conversely, the resonant frequency of the system may be varied back and forth by adjustment of the test capacitor, and a plot of frequency vs. s.w.r. run for the antenna length in use. Observation of the plot will then disclose whether the antenna should be shortened or lengthened to hit the "target" center frequency.

Operational Results

But the antenna is not that critical in adjustment! A bit of juggling of the series capacitor value can move the resonant frequency several hundred kc, an ample amount to swing the antenna plot from one end of the band to the other. In fact, the antenna shown has been operated at 3.5 mc with a measured s.w.r. of 5.5:1 (wow) with no ill results to the transmitter. True, it refused to load at first, but the length of the coaxial transmission line running from the antenna to the transmitter was changed a bit, in small increments, until satisfactory loading was established. This expediency did not alter the s.w.r. on the line in the least, it merely presented a more acceptable value of reactance at the transmitter—a value that fell within the operational limits of the pi-network coupler in the equipment. This length of line was retained, since it did not affect operation of the antenna at the other end of the band in the region of 3.65-4.0 mc.

Thus, by prudently trimming the transmission line, the antenna provided a satisfactory match to the transmitter over the entire 80 meter band, regardless of the fact that a rather high degree of s.w.r. existed on the line below 3.65 mc. The art of juggling transmission line length is not universally known, but it is a good stunt, and effective. The user should not, however, think he is improving the s.w.r. on his antenna system by this stunt. To the contrary, the s.w.r. remains as before; the impedance presented to the transmitter under high values of s.w.r. is merely more acceptable. In each case, the experimenter will have to determine the proper line length for his particular antenna system that will permit adequate transmitter loading at high values of transmission line

[*Continued on page 84*]

XT2AA–To WA5REU.
YN1GLB–c/o WA5GFS.
YTØM–Via YU1BCD.
ZA2RPS–c/o DL7FT.
ZB2A–To WB9BWU.
ZD3D–c/o WA9UVE.
ZD8JK–Via WA3FNK.
ZD9BN–To GB2SM.
ZF1GC–C.w. QSO's on July 7, 1970 only, c/o W4VPD.
ZF1ML–Via K9QFZ.
3V8AL–To W4WHF.
3V8ZK–c/o F5ZK.
4N2LO, 4N2KO, 4N2ML–Via YU2NEG.
4S7AB–To W2CTN.
4Z4AI–c/o WA2KWP, 17 Orchard Rd., Middlesex, N.J. 08846.
5VZWT–Via W4SPX.
5W1AF–To KH6GLU, 95213 Waimeli Place, Waipio, Hawaii 96786.
5X5MP–c/o LA8ML.
5Z4JS–Via 5N2AAJ.
7Q7AA–To W2CTN.
8R1DY–c/o WB4QNP.
9E3USA–Via VE3IG.
9F3USA–To VE3IG.
9X3WJ–c/o W1MIJ.
9Y4US–Via K8NSA.
9Y4VE–To VE3GCO.

73, John, K4IIF.

80 M Antenna [*from page 30*]

s.w.r. At W6SAI, various lengths of RG-8/U are always at hand, complete with fittings, that can be spliced into a transmission line in a few seconds, when operation is contemplated near regions of high s.w.r. indication.

As for operational results, the little Utility antenna has been in use for nearly two years and has proven its worth. The radiation pattern seems nearly omnidirectional, and good signal strength reports are consistently received out to 1200 miles or so. In short, the antenna compares favorably with the best characteristics of both the ground plane and the center fed dipole.

Old Timers will scoff that this antenna is little more than a jazzed up version of the old Marconi antenna. Perhaps so, but it is more subtle than it looks. Not only does it provide a good impedance match to a 50 ohm transmission line, but it also affords good bandwidth and a practical radiation pattern usable for both short-haul and long distance contacts. In short, it "plays clarinet and trombone, doubles on the violin and saxophone, and wears a size forty-seven suit". ■

Mail Order [*from page 54*]

requesting that I be allowed to communicate with anyone! Guess what came in the mail today. Two lovely clear photostats!

Now, some sixteen months after I placed