160, 75, and 40 Meter Inverted Dipole Delta Loop

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Presented here is a description of an efficient, full-size 160-meter antenna that fits in the same space as an inverted V, 75-meter dipole, with the capability of functioning as a full-wave triangle loop on 75 or 80 meters, as well as two full waves on 40 meters.

NOW THAT THE sunspot cycle is rapidly declining to a minimum, nocturnal activity on 10, 15, and 20 meters is curtailed proportionately and daytime activity on 10 meters is sporadic at best. Many amateurs are migrating back to the lower-frequency bands through necessity, if not by choice. Because of the sad state of 40 meters at night, with high-power broadcast stations every few kilohertz, the band that bears the burden of activity is 75 meters. Another amateur band that could shoulder some of the increased activity, but doesn't to any great extent, is 160 meters. Several factors are responsible for this:

1) Most amateur equipment covers 80 through 10 meters only.

2) Antenna size and efficiency becomes a major stumbling block.

3) High atmospheric noise levels prevail in the tropical latitudes.

Factor 1 is easy to solve. One can modify existing equipment or resort to home construction. Factor 3 is not a major one to most U.S. amateurs. Item 2 poses the major problem since many residential lots cannot accommodate a conventional full-size 160-meter antenna. Generally, a full-size 75-meter doublet or inverted V is possible. This article presents a practical solution for the operator who wants a full-size 160-meter antenna which occupies no more space than a 75-meter inverted V. No complicated counterpoises, antenna tuners, or open-wire feed lines are needed. As a bonus, efficient operation on 75/80 and 40 meters is possible. Only one 50- or 75-ohm feed line is used.

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Antenna Development

For a number of years the author listened to 160 meters with envy while marveling at the uncrowded conditions existing in that relatively narrow allocation. In the prime evening hours of the winter months, it was not unusual to listen to uninterrupted QSOs between East Coast and Midwest stations that were running only 25 or 50 watts. These stations had one thing in common – *a good antenna.*

A full-size doublet on 1800 kHz is approximately 260-feet long and will not fit on a typical suburban lot (unless you build your home on an old railroad right-of-way!). An 80-meter folded dipole has a total of 260 feet of wire, yet fits in 130 feet of space. It can be erected on even less property if it is an inverted V as shown in Fig. 1A. If the long second wire of the inverted-V folded dipole were dropped to horizontal, and the ends or top of the inverted V were adjusted to take up slack, a triangle would be formed as in Fig. 1B.

The height was adjusted to accommodate the same ground dimensions as the dipole of Fig. 1A;

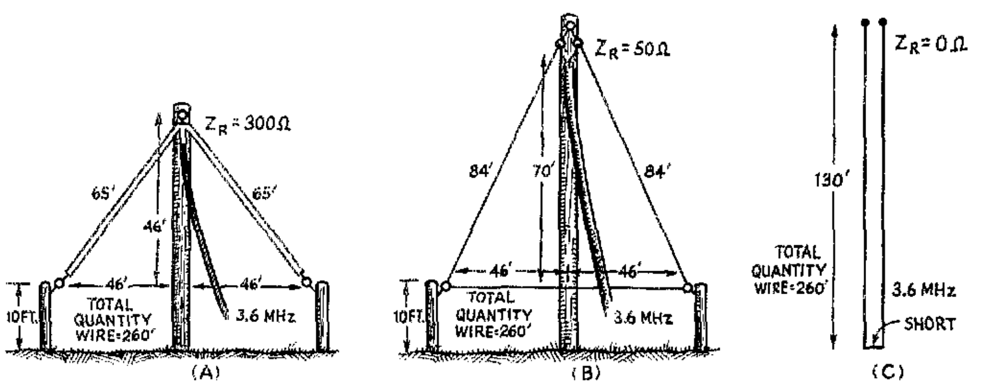

Fig. 1 – (A) A folded dipole for 75 meters, (B) a triangle with dimensions for a full-wave loop on 80 meters, (C) a quarter-wave section of transmission line.

TABLE I

Switch Position	Calculated Freq. (kHz)	Measured Freq. (kHz)	Impedance	SWR 50-ohm Feed	SWR 70-ohm Feed
Open	1800	1825	50	1:1	1.4:1
80 Meters (without added dipoles)	3600	3700	100	2:1	1.4:1
80 Meters (with dipoles added)	3600 & 3900	3700 & 3900	50	1:1	1.4:1
40 Meters (with loading coil)		7250 (or any desired)	50	1:1	1.4:1

however, the example shown requires an 80-foot mast. As indicated in Table I, the radiation resistance of the triangle has lowered to the 50- or 100-ohm region. If it were possible to keep raising the top of the triangle, pulling in the sides, the end result would be an 80-meter, half-wave, two-wire transmission line with the end opposite the feed point shorted, as shown in Fig. 1C. The feed point of the half-wave transmission line would have an impedance of zero ohms. This fact should be kept in mind, since it illustrates how the 80-meter impedance of the antenna may be adjusted by those who are fortunate enough to have a sufficiently high mast.

Figure 1B illustrates a full-wave triangle antenna for 80 meters. On 160 meters, however, it will be a half-wave triangle (total length of wire) having an extremely high impedance at the feed point. By simply opening the base wire at the center, the configuration becomes a 160-meter half-wave inverted-V dipole with the ends folded back toward the center mast. The antenna may be resonant at a slightly higher frequency than its calculated half-wave resonance. Operation on 160 or 80 meters can be accomplished by either opening or shorting the center point of the base of the triangle with a switch.

Since the author does not have an 80-foot mast, the base ends of the triangle had to be pulled out to take up the slack. As shown in Fig. 2, the dimensions of the actual antenna approaches a more realistic value for many installations. The problem with lowering the height and pulling out the ends is that the impedance on 75 meters increases, mostly because of the antenna geometry, *approaching* that of a folded dipole again. With the dimensions shown in Fig. 2, the impedance on 80 meters is approximately 150 ohms. Two additional

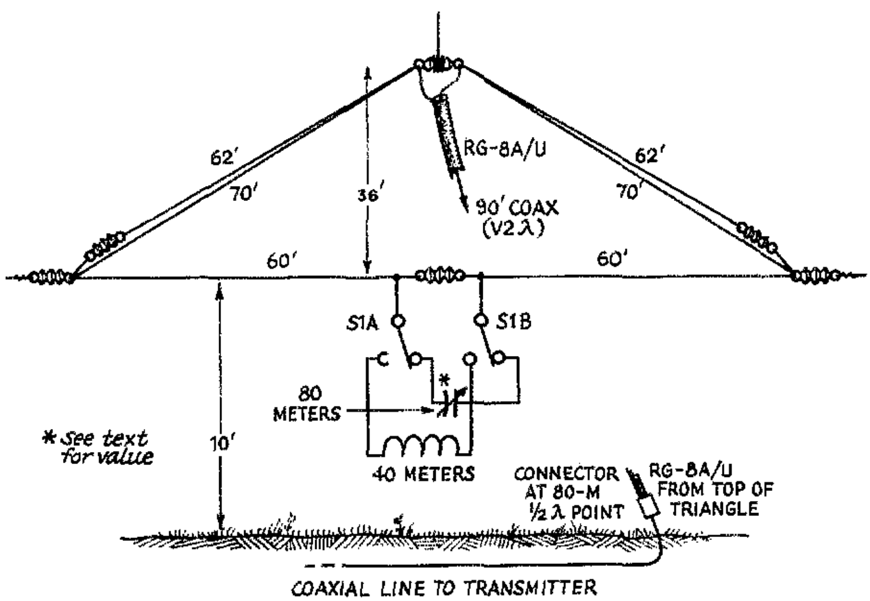

Fig. 2 — Suitable dimensions and switching arrangement for the three-band antenna. S1 is a dpdt knife switch. The switch is left in the open position for 160-meter operation.

wires were added at the feed point to form a half-wave inverted V for 75 meters. The dipole elements illustrated in Fig. 2 resonate at 3900 kHz. A bonus feature of the triangle loop is it operates as a 2 wavelength resonance, with a 50-ohm impedance, at 7400 kHz. By adding a small loading coil to the center of the base wire, the resonance can be centered in the 40-meter band. To accommodate all three bands a dpdt knife switch can be mounted on the mast at the center of the horizontal wire. With the switch open, the 160-meter inverted V is active. With the switch in the 75-meter position, the full-wave triangle and the 75-meter dipole elements are active. With the switch set for 40 meters, the loading coil is activated. The inductor for 40 meters should be about 20 turns of No. 12 or No. 14 bus wire, 2-1/2 inches in diameter, 7 turns per inch, with taps and a clip lead for adjustment. Approximately 10 turns are needed to obtain resonance at the high end of 40 meters.

Table I presents measurements made with the 260-foot triangle antenna shown in Fig. 2. Since the antenna is fed at the top, measurements were made at the end of a 90-foot RG-8A/u feed line which represents a half wavelength at 3.6 MHz and two half waves at 7.2 MHz. With this arrangement, the antenna feed-point impedance will be repeated at the far end of the feed line. On 160 meters, the line is flat and the resonant frequency is easy to determine. If the additional dipole elements are not desired on 75 meters, the antenna could be fed with 70-ohm coax.

Bottom Feed

A major advantage of the antenna configuration shown in Fig. 2 is the convenient access to the center of the triangle base for making adjustments. If it is desired to feed the triangle at the center of the base, some method would have to be devised to open and close the triangle at the top. An automatic passive switch at the top of the triangle can be fashioned from half-wave and quarter-wave transformers. A 90-foot piece of coax cable (1/4 wavelength long at 160 meters) shorted at the far end will present a very high impedance between the two elements of the antenna at the apex. The triangle then will look like a dipole on 160 meters. The same length of coax at 80 meters is a one-half wavelength shorted transmission line with the short being reflected to the apex of the triangle. On 80 meters the triangle will look like a continuous loop. Two half waves shorted provides a similar function for the 40-meter triangle. The same switch arrangement can be retained at the center of the triangle base where the feed line attaches for switching in either the capacitor or inductor.

Beam Arrangements

The possibility of erecting two triangle antennas, appropriately spaced and parallel to each other has been considered. By tuning one of the triangles higher (or lower) than the band in use, a director (or reflector) is formed, thereby providing a beam pattern.

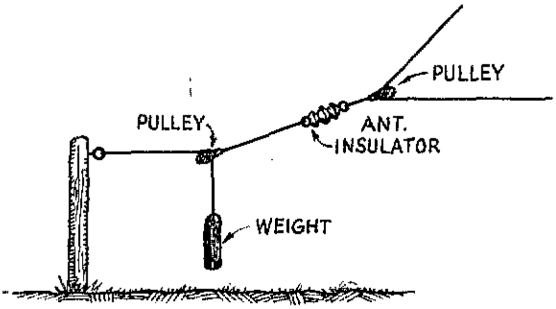

Fig. 3 — Pulley and counterweight arrangement to allow easy adjustment of the triangle size.

Construction

The antenna builder should consider a rope-and-pulley arrangement both at the top and at the ends of the triangle in order to adjust the height-to-base ratio to make impedance adjustments. The counterweight arrangement shown in Fig. 3 will keep tension on the base and top wires.

Soft-drawn solid enameled or stranded No. 12- to 16-gauge copper wire is recommended in preference to Copperweld, which is quite stiff. The author's installation uses 16-gauge stranded, teflon-insulated wire purchased from a surplus dealer. A mast is the preferred center support, however, a tall tree will suffice. A bow, arrow, and light monofilament fishline can be used to shoot a pull line over a high limb.

Operation

Results with the antenna have been most gratifying. Cw contacts as far as 400 miles were made using a 5-watt, 160-meter VFO for a transmitter. A-m contacts using a 5-watt transmitter were made as far as 300 miles in the 1825- to 1850-kHz segment. Performance on 75 meters has been consistently equal to that with any dipole antenna previously used over a 20-year period. Performance on 40 meters, at night, was a pleasant surprise. The 2-wavelength triangular loop seems to exhibit gain over a dipole, with low-angle radiation in the broadside direction. A number of QSOs have been made with W6 and W7 stations from New Jersey. For the suburban antenna experimenter and "top-band" enthusiasts, the three-band inverted dipole/delta loop seems a natural step for solving the problem of space and efficiency on the lower-frequency bands. QST