John J. Schultz W2EEY/1
40 Rossie Street
Mystic CT 06355

The Double Delta is a new and unique design which provides both broad-band and efficient performance on the low-frequency bands for a compact, vertically polarized antenna. The ease of tuning and the simple construction are special features.

THE DOUBLE DELTA ANTENNA

During recent years many forms have been developed for reasonably compact low-frequency antennas that would exhibit better efficiency than base-loaded verticals, be reasonably broad-band, and have a more predictable and controlled radiation pattern than random long-wire antennas. Various antenna forms have achieved some combination of these electrical qualities, but usually their forms were such as to pose many constructional problems. One example would be low-frequency cage-type vertical antennas. The cone shaped cage requires at least 8 to 16 radial wires, and the open end of the cone must be at the apex of the antenna structure and not at the ground end. Also, a good ground radial system is required for efficient operation of such an antenna.

This article, however, describes a new and unique type of compact low-frequency antenna design which combines many of the features of previous designs but yet is very simple to construct and can have a wide range of physical dimensions. No inductive loading is used in the design, it is reasonably broad-band (over two low-frequency bands with reasonable antenna dimensions), it can be fed with any common transmission line, it has an omnidirectional radiation pattern and the efficiency is good (again with reasonable antenna dimensions) without the use of a ground radial system. Although the design can certainly be used for any fixed station operation, its ease of construction and erection makes it particularly applicable to portable operations.

Basic Design

The design of the antenna, nicknamed the

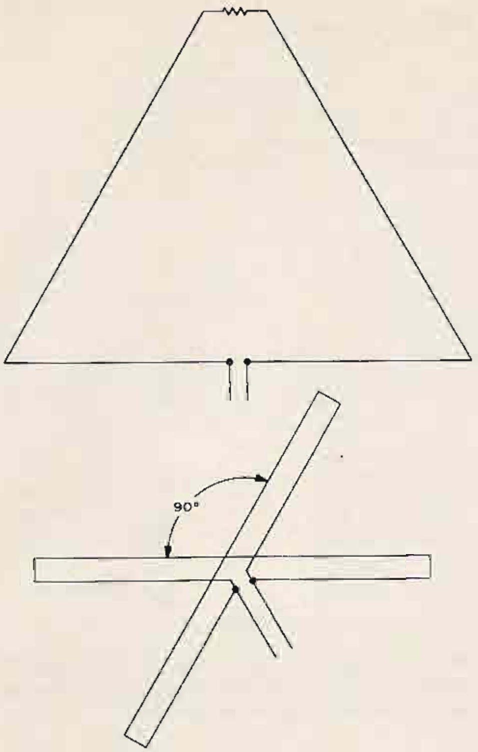

Fig. 1. The Double Delta antenna is basically a combination of a vertical half rhombic design (A), frequently called a delta antenna, and a turnstile antenna (B) made from folded dipole antennas.

Double Delta, was not simply "pulled out of the hat" but is based upon two well established and proven antenna forms. Figure 1 shows these forms. The antenna forms of Fig. 1 (A) may not appear immediately familiar, but it is really just half a terminated rhombic antenna which is vertically oriented, and is frequently referred to as a Delta antenna. It radiates mainly at high radiation angles, and is particularly useful for short-skip work on the lower-frequency bands. In its proper rhombic form and to provide some directivity and gain, the dimensions of the antenna have to be fairly large – at least a 60 ft center height on 40 meters, for instance. However, because the terminating resistor makes the antenna non-resonant, it will accept power over a broad range of frequencies even when its physical dimensions are contracted. The terminating resistor value must only be chosen for given physical dimensions of the antenna. The radiation pattern of the antenna will change as its dimensions are reduced to the point where a small loop configuration is reached. Generally, the vertical plane radiation pattern becomes much broader, and for a given loop or delta size on a given frequency, the horizontal plane radiation may be mainly broadside or in line with the physical plane of the antenna. Such an antenna could be used alone with reduced dimensions, but one real disadvantage would be the radiation pattern change with frequency.

The antenna form of Fig. 1 (B) is that of a conventional turnstile antenna which consists of two half-wave folded dipoles phased so that an omnidirectional horizontal radiation pattern is produced. The necessary phasing is often done with a separate phasing line, but it can also be done by proper interconnection of the dipole feed terminals as shown. When done in this manner, the phasing will remain correct over whatever range the basic dipole antennas can be operated.

Figure 2 shows how the basic two foregoing antenna ideas are combined to form the Double Delta antenna. As can be seen, it

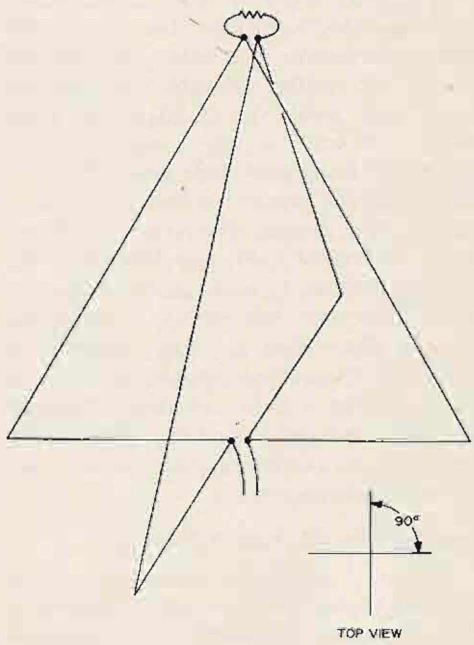

Fig. 2. The Double Delta consists of two Delta antennas placed at right angles to each other and phased in a manner similar to a turnstile antenna.

consists of two single Delta antennas oriented and phased like the dipole antennas in a turnstile configuration. Although the radiation pattern of the single Delta antenna will change with frequency (depending upon dimensions), the turnstile type phasing makes the Double Delta retain an essentially omnidirectional radiation pattern. The use of two Delta antennas further broadens the frequency bandwidth of the overall antenna system. Although a separate terminating resistor could be used in each Delta, the use of a single resistor was found to be sufficient.

No specific dimensions, even in terms of wavelength, was mentioned in the foregoing discussion because, in fact, no hard and fast dimensions can be given. The following section of this article describes a Double Delta antenna which I constructed for use on 80 and 40 meters, but the dimensions shown are by no means the only possible ones. Although studies could not be made of a large variety of antenna dimensions, it would appear that good efficiency will be achieved as long as the total *lineal* length of each Delta element (sides plus bottom section) is made about ¼ wave on the lowest frequency band to be used. The antenna will work with shorter dimensions, but the efficiency will suffer. Probably an absolute lower limit would be to make the lineal length 1/8 wave at the lowest operating frequency. Even with these restrictions, the antenna height required is only a fraction of that of other designs. The ratio of total base length to height (not side length) at the center should not be made greater than a 1:1 ratio. This great latitude in choosing the antenna dimensions is partly possible because the terminating resistor can be "tailored" to suit a given impedance transmission line, and one is not dependent solely upon the antenna configuration to establish the feed point impedance.

Practical "Double Delta" Example

Figure 3 shows the dimensions of one "Double Delta" design which I tried for 80 and 40 meter operation. The total lineal length of each Delta was made about ¼ wave on 80 meters. The base length to height ratio was chosen such that the height was about

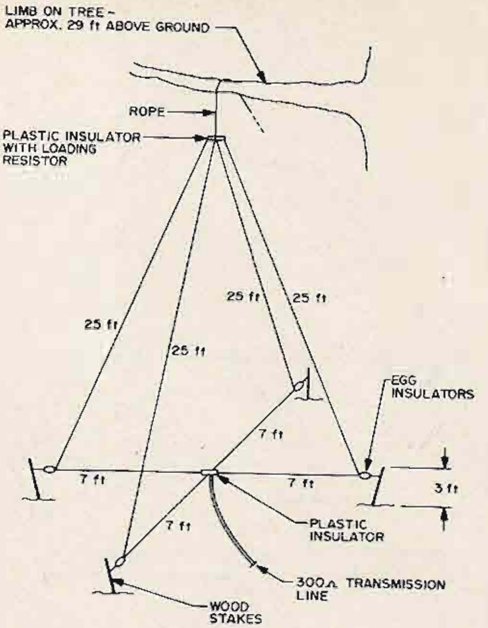

Fig. 3. Dimensions of a Double Delta antenna which was tested. Coaxial transmission line can also be used as explained in the test.

27 ft in order to allow simple erection of the antenna via a rope support around a high tree trunk.

The antenna was constructed of ordinary stranded antenna wire with egg insulators attached to wooden stakes, driven in the ground, used to place the two Delta triangles at right angles to each other. Special plexiglass insulators were fabricated to join the wires at the apex of the antenna and at the base where the transmission line is joined to the antenna. Probably many other schemes can be used for these insulators, but the plexiglass types are simple and inexpensive to fabricate. Details of the construction of these insulators is shown in Fig. 4. The upper insulator joins the individual Delta elements in a criss-cross fashion with the non-inductive type terminating resistor mounted on one side of the plexiglass insulator and connected by jumper wires to the Delta elements. A hole was drilled in the center of the insulator and ¼ in. nylon rope knotted underneath the insulator for use as a support line. The bottom insulator is basically the same as the upper insulator, except that the jumper wires for the Delta elements

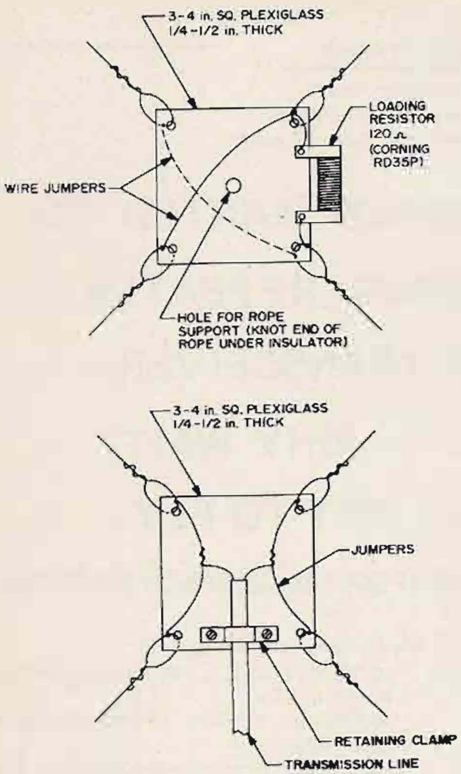

Fig. 4. Details of the upper (A) and lower (B) plastic insulators for the antenna of Fig. 3.

are wired directly from edge to edge. The transmission line used is soldered to the jumper wires and the cable held in place on the insulator by means of a metal or plastic clamp.

Although a 300Ω transmission line was used, any common impedance transmission line, including coaxial types, can be used by properly choosing the value of the terminating resistor. Using 1 or 2 watt carbon composition resistors as test resistors, the value of the terminating resistor can be found which produces the lowest transmission line swr over the desired operating range. Only a few watts of tranmitter power output should be used for these tests (enough power to properly set the swr meter) and then a 25–75 watt resistor substituted for operation at full transmitter power. The wattage rating of the terminating resistor depends upon the dimensions of the antenna, but a safe approach would be to choose a resistor with a wattage rating equal to at least ¼ of the power input of the transmitter used. The 25 watt resistor used with the antenna shown showed no signs of overload when used with a 150 watt transmitter on SSB.

Performance Results

Swr measurements made on the antenna of Fig. 3 showed an swr of less than 2:1 across both the 80 and 40 meter bands. It probably would be possible to further reduce the swr on any one band by more careful selection of the terminating resistor. The total bandwidth of the antenna was not determined, since only 80 and 40 meter operation was of interest. However, there is a good possibility that when properly configured the antenna can be used as a tri-band affair. The only possible disadvantage to such operation is that as the Delta elements become larger in terms of wavelength, one may approach the original vertical half rhombic design with its very high radiation angle.

Comparison tests of the Double Delta design against a base loaded 23 ft vertical made of tubing consistently showed the Double Delta to produce stronger signals on the order of ½ to 2 "S." units.

Summary

The Double Delta shows good promise of being a very useful and simple antenna for use on the low-frequency bands. No claim is made that the optimum dimensions for the antenna have been determined, but the results achieved certainly indicate the validity of the basic design.

Many variations on the basic design suggest themselves, especially if one were interested only in single-band operation. for instance, going back to Fig. 1 (A), one could use a variable capacitor to resonate the antenna "loop style" on a particular frequency. the Double Delta of Fig. 2 could then be constructed with a resonating capacitor in each Delta. This would increase the antenna efficiency by eliminating the dissipation loss in the terminting resistor. However, one would have to accept the feed point impedance thus produced and use a matching network, if necessary, at the feed terminals to couple to a transmission line.

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