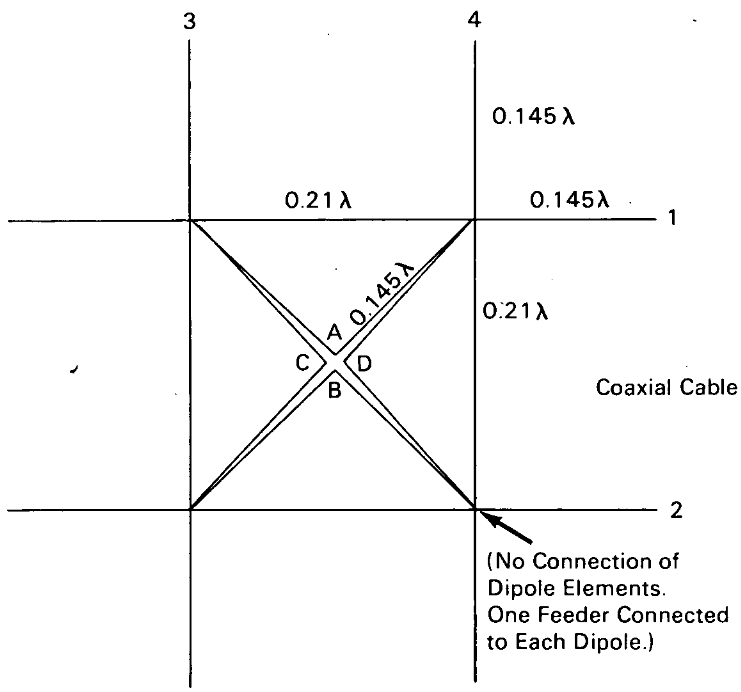
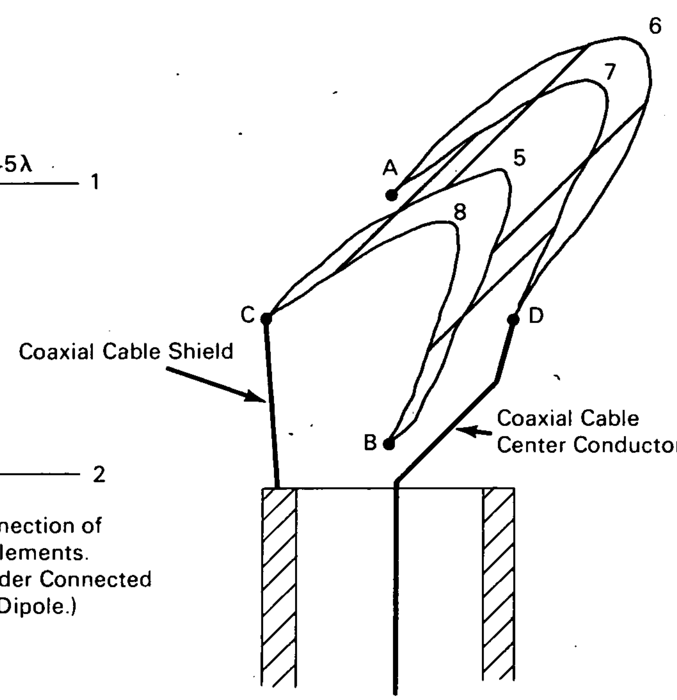
NASA TECH BRIEF

Improved Modified Turnstile Antenna



HALF-WAVE DIPOLE ELEMENTS



EXPLODED VIEW OF FEED AND PHASING SYSTEM

This improved antenna design embodies the principles of turnstiling, broadbanding, and delta dipole matching for its operation. It combines the best features, with none of the limitations, of the conventional turnstile, modified (pretuned) turnstile, and super turnstile (broadband) antennas. The conventional turnstile and modified turnstile are comparatively narrow-band antennas, are difficult to match, and in some cases require complicated feed systems. The super turnstile (a more-broadband antenna) has a complicated feed system and is susceptible to damage from sleet in frigid zones. Its numerous connections are subject to failure from mechanical stress. Additionally, super turnstiles cannot be used in highly directional arrays. When, as required, two super turnstiles are used to develop circular polarization, they take up quite a large volume and are not aerodynamically suitable for aircraft.

As shown in the illustration, two pairs of delta matched dipoles are fed in phase quadrature to develop circular polarization. The antenna is broadbanded by making the sum of the lengths of two pairs

(continued overleaf)

of dipole feeders and the dipole segments cut off by the feeders equal to one wavelength, thereby making use of four half-wave dipoles and two full-wave slots. The delta match also contributes to the antenna's broad bandwidth characteristics. The four dipole elements are dc-insulated from one another, even though they appear to intersect in the illustration. Since the dipoles are fed in pairs, feeders from A and B are connected to dipoles 3 and 4 and feeders from C and D are connected to dipoles 1 and 2. The phasing lines are connected from A and B to C and D. Wires 5 and 6 are in one phasing line, and 7 and 8 are in the second one. The use of more than one phasing line does not appreciably change the VSWR and widens the frequency range in which circularity can be obtained. The transmission lines used to put the dipole currents in proper phase are quarter-wavelengths of balanced lines. In a fully tested engineering model, 300-ohm TV-type twinlead proved to be very successful. The propagation factor of the line used must be taken into account in measuring resonant lengths. The resonant frequencies of the two lines are those for which a high degree of circular polarization can be realized. These two frequencies should not differ by more than 25%.

The engineering model of the improved turnstile antenna was tested with the dipoles and slots resonant at 330 MHz and with phasing lines resonant at 320 MHz and 360 MHz. The VSWR was less than 2:1 across the entire range of frequencies from 225 MHz to 380 MHz. Thus this antenna covered a frequency range of 1.7 to 1 for a VSWR of less than 2:1 without the use of special matching devices. The antenna transmission line was an approximately 50-ohm coaxial feedline. The gain of this antenna over an isotropic source was the same as or slightly more than that of a conventional turnstile. Gain measurements, taken with the model at 300 MHz, show that circular polarization is obtained over a 1.3 to 1 frequency range. Here circular polarization is defined for an axial ratio of less than 3 dB. In the plane of the antenna, radiation is omnidirectional and linearly polarized. The radiation patterns are the same as those of a conventional turnstile.

The antenna could be utilized in a highly directive array by mounting a driven element (constructed with half-wave dipoles as in the illustration) on a horizontal boom, with a parasitic reflector and a number of parasitic directors all properly spaced. Such an array can be constructed very simply at moderate cost. Broadband modified turnstile elements spaced a full wavelength apart, fed in parallel and mounted on a vertical mast in either the vertical or horizontal plane, would provide excellent results for communications where omnidirectional coverage in the horizontal plane is desired. Still another application would be in printed circuit board mounted arrays. Stripline arrays could be connected directly to a receiver front end or, because of its low impedance, to a transmitter output circuit. Since the use of coaxial feedline at UHF and SHF is prohibitive in many cases, this antenna would fill a definite need in stripline technology.

This antenna array also has the advantage of being entirely at dc ground potential, thus minimizing damage by lightning and static discharge. In frigid zones, sleet- and snow-melting equipment can be built into the antenna elements themselves rather easily. These advantages would make the antenna particularly useful in commercial broadcast applications.

Note:

Requests for further information may be directed to:

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Manned Spacecraft Center, Code BM7
Houston, Texas 77058
Reference: TSP70-10482

Patent status:

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