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ON THE COMPLETE CALCULATION OF THE EQUIANGULAR SPIRALANTENNA

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To get a deeper insight into the exact radiation mechanism of the equiangular spiralantenna, a rigorous solution is required for the total radiation field, including the extreme near field.

As there are no publications available on this special problem, a new method is presented to overcome this lack.[1]

The method given is not only restricted to spiral antennas but holds in general for any thin wire antennas of arbitrary geometry.

The basic principle of handling curved antennas, for example the equiangular spiral antenna, is to break up the geometrical structure into 2 K straight polygonial segments.

If their axial dimension l is chosen sufficiently small in comparison with the radius of curvature each segment may be defined by an associated cylindrical coordinate system.

Assuming thin wire segments the current distribution is considered only to have an axial component. The overall vector potential then arises by superposing the contributions of all segments weighted by a function $g_k(z)$ due to their geometrical orientation.

The resulting electric and magnetic fields can well be handled by common differential operations and easily performed in cylindrical coordinates associated with each segment.

Now by increasing the number 2 K of segments to infinite the differential length decreases to zero and the polygon converges against the true spiral structure. In the same way the calculated radiation field becomes that required for the equiangular spiral antenna.

As a fundamental assumption for this calculation the current distribution must be known exactly or determined to fit the boundary conditions.

A rigorous solution to be looked for demands for a current source function $I(z')$ to vanish at the open ends of the antenna arms. In addition the resulting tangential component of the electric field has to be zero at the antenna surface.

To achieve this a method[2] is used which represents the unknown current source function as a series of unattenuated travelling waves with unknown coefficients $\underline{B}_{n'}$.

Dealing with center fed symmetrical antennas the current source function reduces to

$$I(z') = \sum_{n'=1,3...} \underline{B}_{n'} \cdot \cos(n' \frac{\pi}{2L} z') \qquad (1)$$

and causes a vektor potential as

$$\underline{A} = \frac{\mu}{4\pi} \sum_{k=-K}^{K} g_k \sum_{n=1,3...} \underline{B}_{n'} \int_0^L \cos(n' \frac{\pi}{2L} z') \frac{e^{-j\beta_0 r'}}{r'} dz' \qquad (2)$$

The results of calculating the corresponding field distributions due to each term of the travelling wave representation are given.

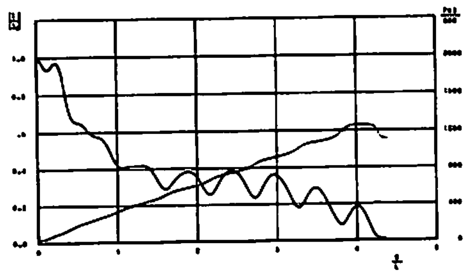
To fit the boundary condition at the feed gap the electric tangential field component obtained from (2) at the antenna surface must holf for the presumed one given at the fee gap.

Identity may be achieved by representing both field distributions as Fourier series and enforce the unknowns to be equal.

This procedure then leads to an infinite inhomogenious system of linear algebraic equations for the current coefficients $\underline{B}_{n'}$. They can be determined gradually by solving for a sufficient number of the first equations.

With the aid of the $\underline{B}_{n'}$, the radiation field is known completely which in this case also holds strictly for the near field to be looked for.

Expressions are given for all electrical characteristics of interest. Further results of digital computations are presented for conical equiangular spiral antennas and are found to be in good agreement with experimental data.



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