Microwave Memos
Memo 17

The Crosseyed Waveguide Array

Carl E. Baum
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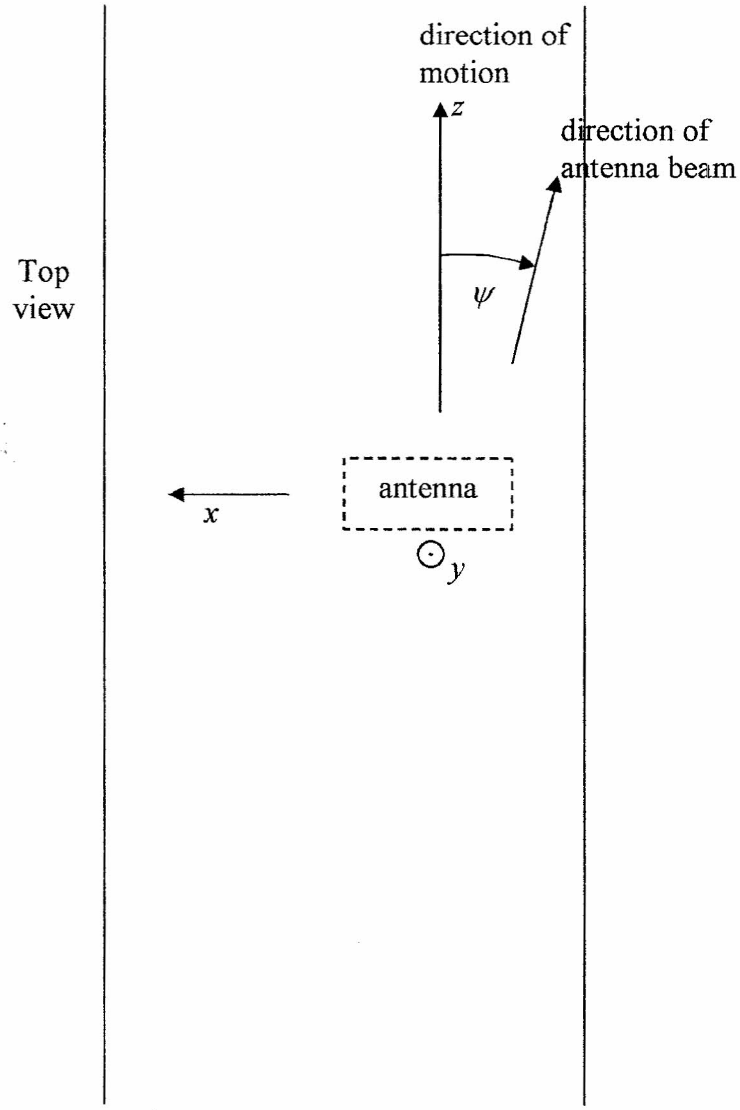
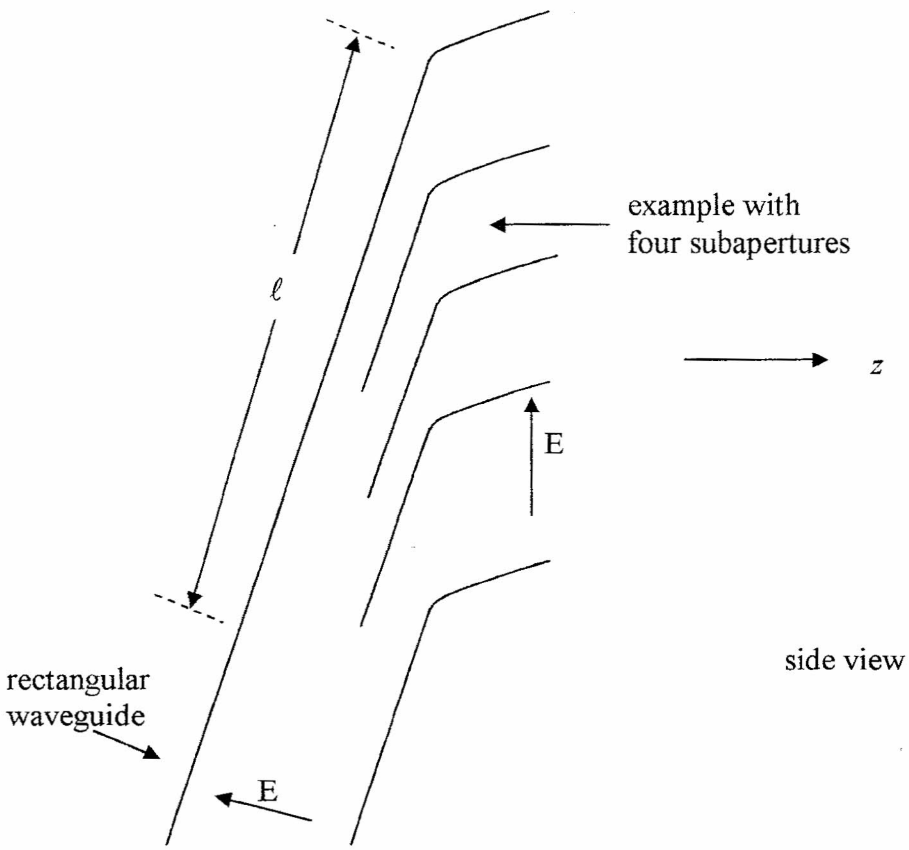
The problem is to give an antenna pattern (moderately high poer) to sweep both sides of a corridor (road) from a moving vehicle.



For a fan beam, narrow with respect to the vertical (so as not to waste μwave power), consider first a single waveguide array. A high power version of this is discussed in C. E. Baum, "High-Power Scanning Waveguide Array", Sensor and Simulation Note 459, July 2001. For present purposes perhaps some of the high-power features can be relaxed. Perhaps SF_6 or even air would be strong enough to hold the high fields.

Assume that a vertical polarization is desired.

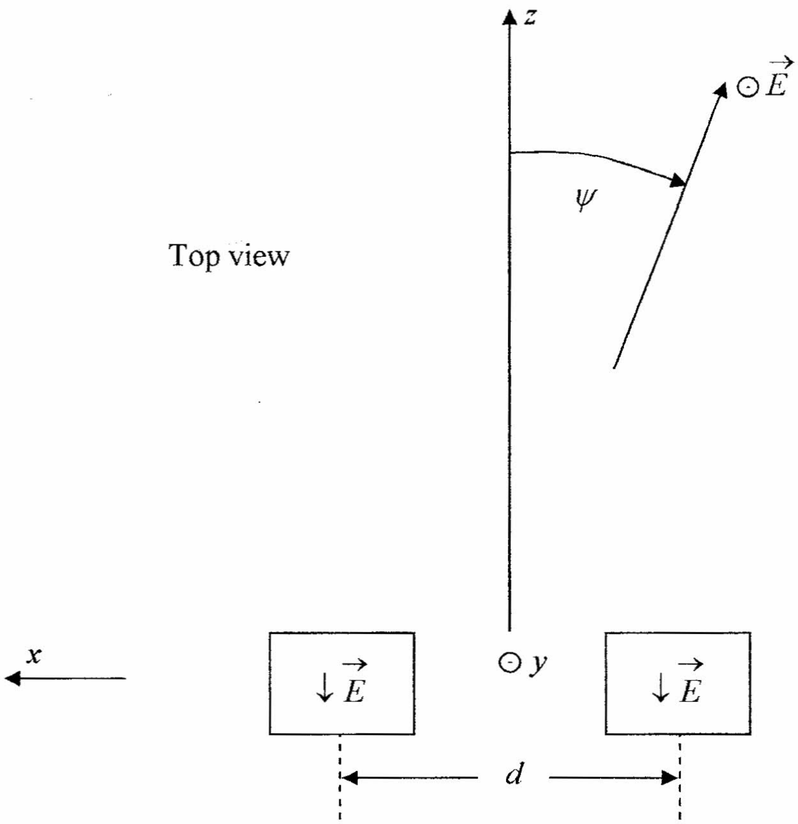


This is also being called a split waveguide array. As ℓ and the number of subapertures is made larger the angular spread in the vertical direction is made smaller and the gain is thereby larger.

In the side-to-side direction the beam is quite wide (a fan beam), going to zero at $\psi = \pm\pi/2$ (90°). The gain can be estimated as N times the low gain of a single dipole radiating into a half space, where N is the number of subapertures.

Note that the waveguide is not necessarily vertical. This depends on the guide wavelength and spacing of the subapertures to maximize the power parallel to the ground.

Now consider two such arrays, side by side, driven in opposite phases. This is easily achieved by an appropriate power divider from one waveguide into two.



Note along x = 0 (the y z plane), by symmetry we have a null.

Now let $d \sin(\psi_0) = \lambda / 2$
(λ = free space wavelength)

In the two directions ψ_0 we have maxima in the pattern. The field is doubled for twice the input power, or an extra factor of 2 in gain, or 2N times the single-element gain.

For example:

$$f = 1 GHz \quad , \quad \lambda \simeq 0.3\, m$$

Then we have

$$\psi_0 = \pi/6 \left(30^\circ\right), \quad d = \lambda = 0.3\, m$$

$$\psi_0 = \pi/12 \left(15^\circ\right), \quad d \simeq 0.58\, m$$