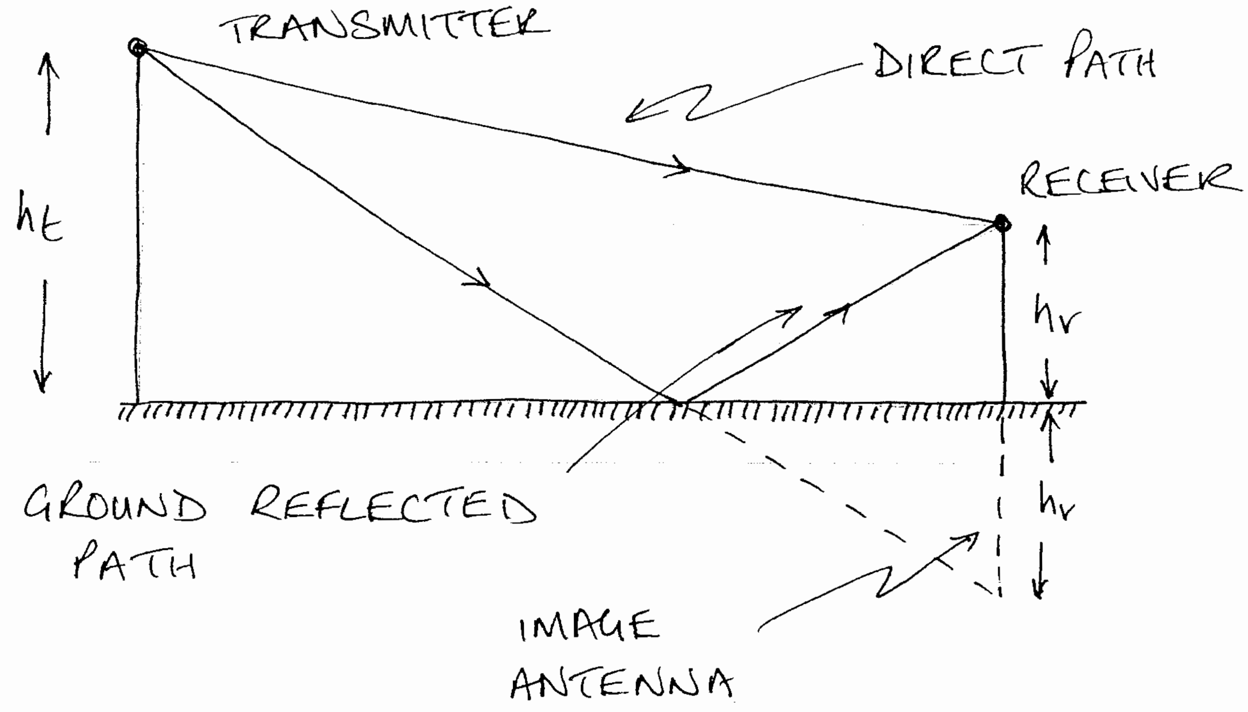
HEIGHT FUNCTION

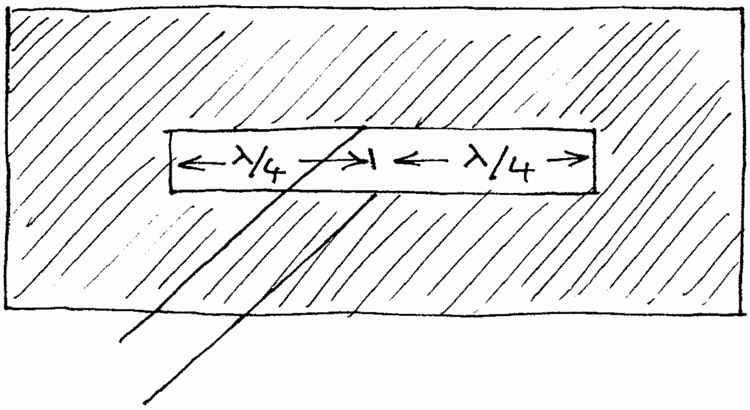
THE HEIGHT ABOVE GROUND OF A VERTICAL OR HORIZONTAL RECEIVING ANTENNA HAS AN EFFECT ON THE RECEIVED SIGNAL FROM A DISTANT TRANSMITTER DUE TO INTERFERENCE BETWEEN THE DIRECT RAY AND THE GROUND REFLECTED RAY



SINCE THE TWO PATH LENGTHS ARE DIFFERENT, DEPENDING ON THE HEIGHT OF THE RECEIVER ANTENNA, THE RAYS CAN EITHER REINFORCE ONE ANOTHER OR CANCEL EACH OTHER OUT. HENCE THE SIGNAL LEVEL VARIES FROM ZERO TO SOME MAXIMUM AS THE RECEIVE ANTENNA HEIGHT IS VARIED – WE WILL TAKE A BETTER LOOK AT THIS "MULTI-PATH" EFFECT WHEN WE LOOK AT GROUND REFLECTIONS.

SLOT ANTENNAS

A SIMPLE FORM OF SLOT ANTENNA IS A $\lambda/2$ SLOT CUT INTO A METAL SHEET AND FED AS SHOWN BELOW;

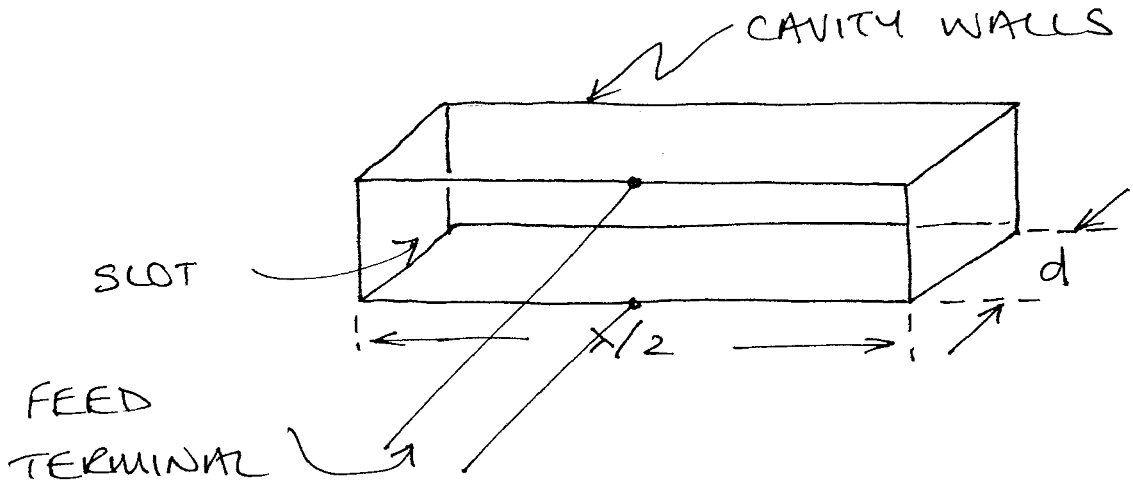


RADIATION OCCURS EQUALLY ON BOTH SIDES OF THE SLOT AS IN A DIPOLE ANTENNA, BUT DIFFERS IN THAT THE CURRENTS ARE NOT CONFINED TO THE EDGE BUT SPREAD OUT OVER THE SHEET, AND IF THE SLOT IS HORIZONTAL THE RADIATION IS VERTICALLY POLARIZED.

THE IMPEDANCE OF THE SLOT ANTENNA VARIES DEPENDING ON THE POSITION OF THE FEED. AT THE CENTRE OF THE SLOT IT IS TYPICALLY 500Ω

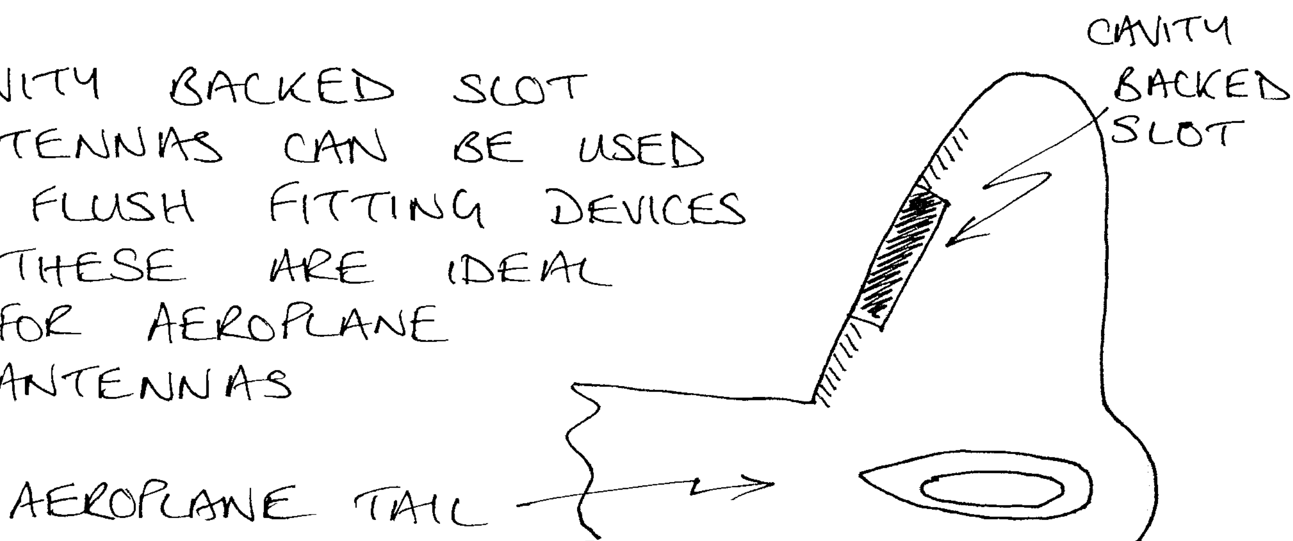
CAVITY BACKED SLOT ANTENNA

IF THE SHEET OF METAL IS MADE LARGE THE $\lambda/2$ SLOT MAY BE BACKED BY A CAVITY TO PRODUCE RADIATION ON ONE SIDE OF THE SHEET ONLY;

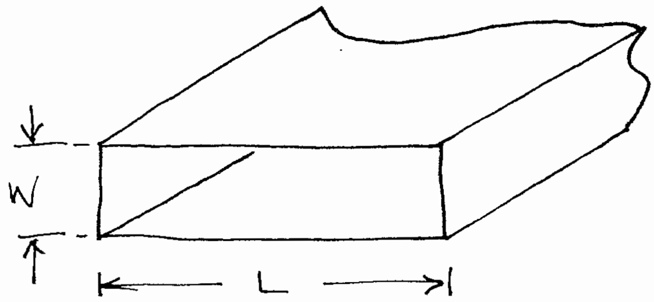


IF THE DEPTH OF THE CAVITY IS MADE TO BE $\lambda/4$ NO SHUNT SUSCEPTANCE APPEARS ACROSS THE SLOT – THE TERMINAL IMPEDANCE IS NON-REACTIVE AND APPROXIMATELY IS TWICE THE VALUE WITHOUT THE BOX ($1k\Omega$)

CAVITY BACKED SLOT ANTENNAS CAN BE USED AS FLUSH FITTING DEVICES – THESE ARE IDEAL FOR AEROPLANE ANTENNAS



RADIATION FROM ONE SIDE OF A SHEET MAY ALSO BE OBTAINED BY A SLOT FED WITH A WAVEGUIDE;

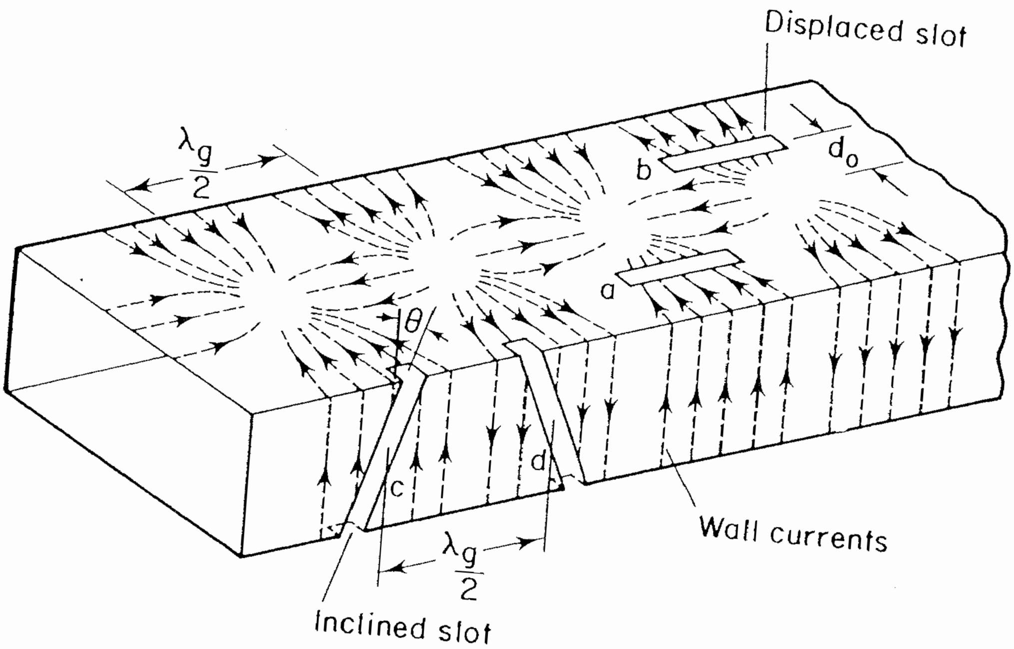


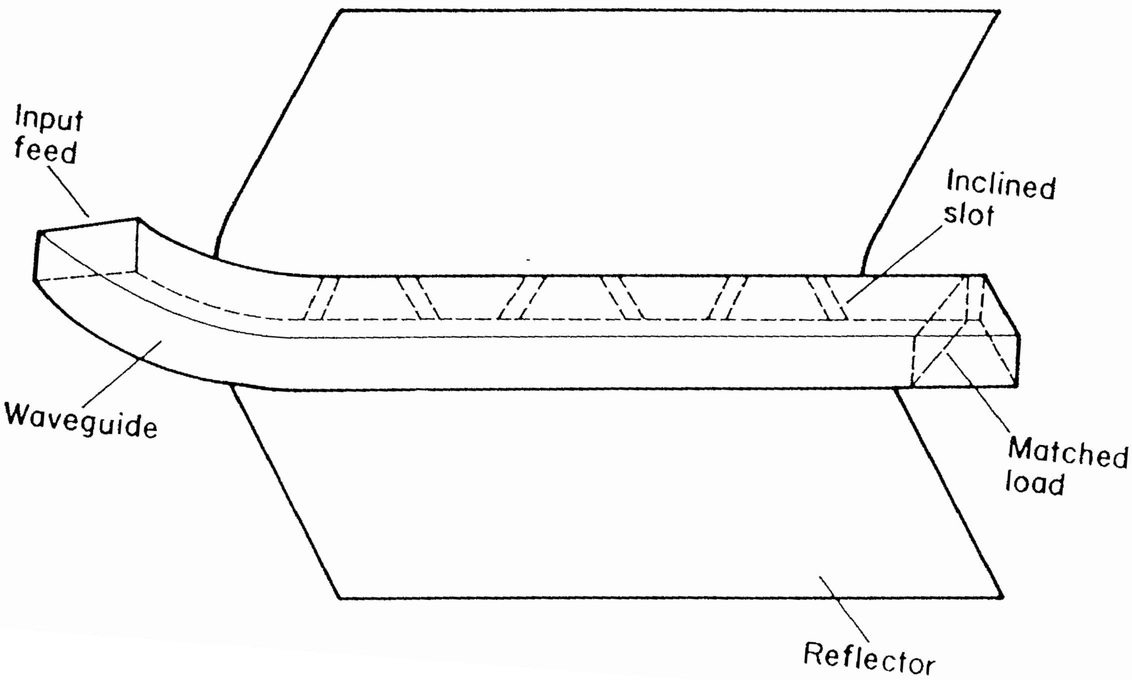
THE WIDTH OF THE GUIDE L MUST BE GREATER THAN $\lambda/2$ TO TRANSMIT ENERGY, BUT SHOULD BE LESS THAN λ TO SUPRESS HIGHER ORDER MODES. THE OPEN SLOT APPEARS AS AN ABRUPT JUNCTION SO IT GENERATES A MISMATCH. THIS IS MINIMIZED IF $L/W < 3$

ARRAYS OF SLOTS

DISPENSING WITH THE FLAT SHEET ALTOGETHER AN ARRAY OF SLOTS MAY BE CUT INTO THE WAVEGUIDE TO PRODUCE A DIRECTIONAL RADIATION PATTERN

IF THE SLOT IS CUT NORMAL TO THE NARROW WALL NO CURRENT LINES ARE CUT - WHICH RESULTS IN NO RADIATION. ADJACENT SLOTS ARE OPPOSITELY INCLINED TO PRODUCE CO-PHASED RADIATORS


Displaced slot
λg/2
b
d0
a
θ
c
d
Wall currents
λg/2
Inclined slot


Input feed
Inclined slot
Waveguide
Matched load
Reflector

HORN ANTENNAS

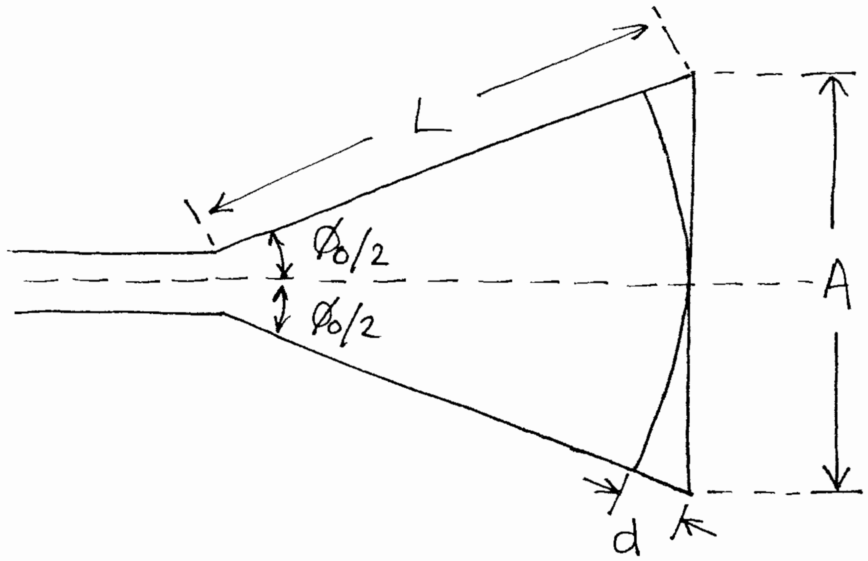
THE HORN ANTENNA IS BASICALLY JUST A FLARED SECTION OF WAVEGUIDE.

THE TRANSITION FROM WAVEGUIDE TO AIR IS SOMETIMES GIVEN AN EXPONENTIAL TAPER ESPECIALLY AT VERY HIGH FREQUENCIES, IN ORDER TO MINIMIZE REFLECTIONS OF THE GUIDED WAVE (SLOWLY MATCH THE GUIDE IMPEDANCE TO FREE SPACE IMPEDANCE). HOWEVER, HORNS WITH STRAIGHT FLARES ARE MORE COMMON BECAUSE THEY ARE EASIER TO CONSTRUCT.

WE HAVE ALREADY DISCUSSED APERTURE DISTRIBUTIONS; TO OBTAIN A DISTRIBUTION THAT IS AS UNIFORM AS POSSIBLE WE REQUIRE A VERY LONG HORN WITH A SMALL FLARE ANGLE. FROM A PRACTICAL STAND POINT THE HORN SHOULD BE AS SHORT AS POSSIBLE. AS WE HAVE SAID, ALTHOUGH A UNIFORM DISTRIBUTION GIVES MAXIMUM DIRECTIVITY, IT ALSO HAS THE <u>LARGEST SIDELOBES</u>

AN <u>OPTIMUM</u> HORN IS A COMPROMISE BETWEEN MINIMUM BEAMWIDTH, LOW SIDE LOBES AND EXCESSIVE LENGTH.

THE BASIC HORN DESIGN PARAMETERS ARE SHOWN BELOW;



A - APERTURE
ϕ_0 - FLARE ANGLE
L - LENGTH OF HORN
d - PATH LENGTH VARIATION OVER APERTURE

FOR A CONSTANT LENGTH L THE DIRECTIVITY OF THE HORN INCREASES (BEAMWIDTH DECREASES) AS THE APERTURE A AND FLARE ANGLE ϕ_0 ARE INCREASED. MAXIMUM DIRECTIVITY OCCURS FOR THE LARGEST FLARE ANGLE FOR WHICH d DOES NOT EXCEED A CERTAIN VALUE d_0.

FOR OPTIMUM HORN DESIGN WE CAN BE SHOWN THAT;

$$d_0 = \frac{L}{\cos(\phi_0/2)} - L \quad , \quad L = \frac{d_0 \cos(\phi_0/2)}{1 - \cos(\phi_0/2)}$$

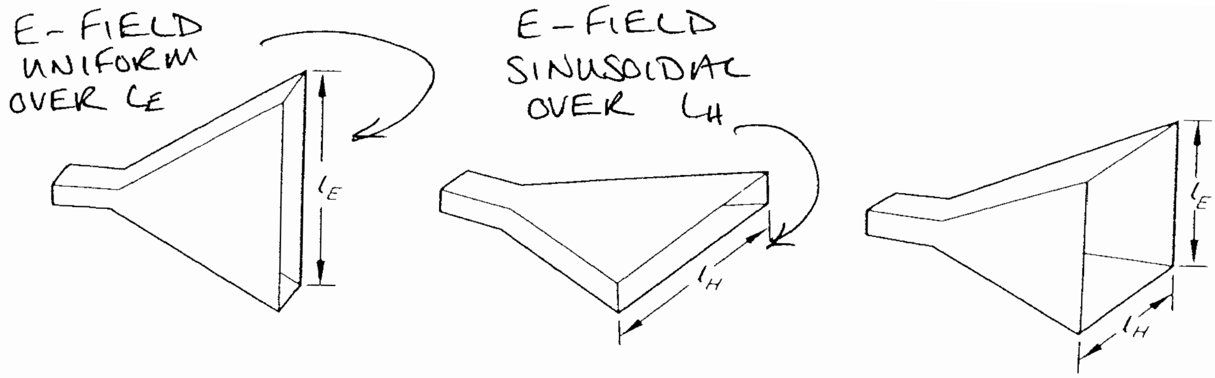
$$\phi_0 = 2 \arccos\left[\frac{L}{L+d_0}\right] \qquad 0.1\lambda \lesssim d_0 \lesssim 0.4\lambda$$

IT CAN BE SHOWN THAT THE GAINS AND BEAMWIDTHS FOR OPTIMUM HORNS ARE;

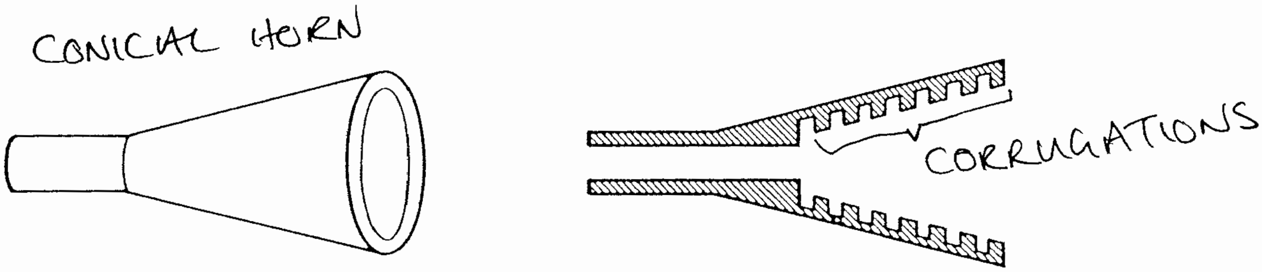
	E-PLANE HORN	H-PLANE HORN	PYRAMIDAL HORN
GAIN	$10A/\lambda^2$	$10A/\lambda^2$	$7.5A/\lambda^2$
BEAMWIDTH (RADIANS)	$0.94\lambda/L_E$	$1.36\lambda/L_H$	$1.0\lambda/L_H$

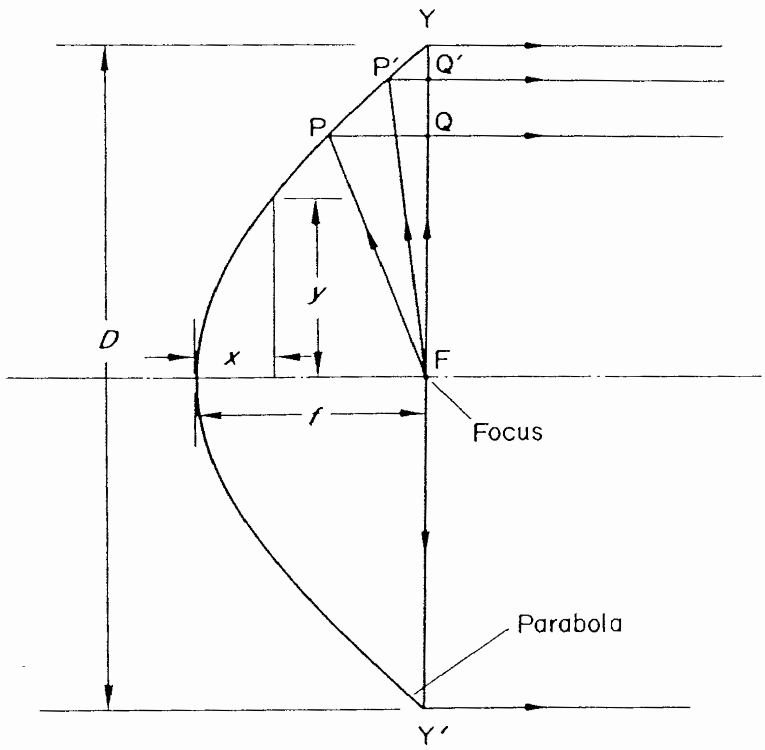
HORNS THAT HAVE SMOOTH INNER SURFACES CAN HAVE PROBLEMS WITH UNEQUAL BEAMWIDTHS AND HIGH SIDELOBE LEVELS IN BOTH ORTHOGONAL PLANES.

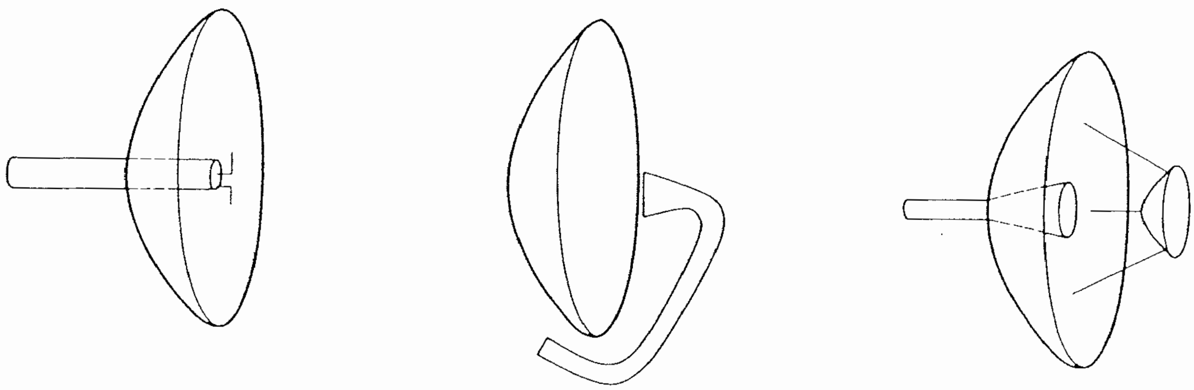
FOR CONICAL HORNS, ADDING CIRCULAR CORRUGATION $\lambda/4$ DEEP PRODUCES REACTIVE SURFACES WHICH HELP PRODUCE A CIRCULARLY SYMMETRIC RADIATION PATTERN. CORRUGATED HORNS HAVE VERY LOW CROSS POLARIZATION RADIATION CHARACTERISTICS - IMPORTANT FOR USE IN FEEDS FOR DUAL-POLARIZATION TRANSMISSION SYSTEMS



E-Plane　　H-Plane　　Pyramidal







Dipole feed　　Horn feed　　Cassegrain feed