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A Circularly Polarized Corrugated Flanged Feed Horn— Its Design & Development

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Design and development of a circularly polarized and matched *H*-plane sectoral horn antenna have been reported. By proper trimming of the flange parameters, any desired polarization can be obtained from the horn.

Pioneer workers[1-3] explored certain conditions for producing circular polarization, tilt of polarization, etc. for beams from reflection grating with metallic corrugated walls. The aim of the present study is to design and develop a circularly polarized *H*-plane sectoral horn antenna using corrugated flange technique. These may find practical applications in communication satellite, radar, etc.

Geometry of the flanged horn is shown in Fig. 1. Aluminium is selected for the fabrication of the flanges as it offers good conductivity, low cost and minimum weight. The experiment is conducted with corrugated comb profiles having depths varying from 0.109λ to 0.140λ, and corrugation periods varying from 0.110λ to 0.385λ, where λ is the free space wavelength. The corrugations are inclined at 45° to *E* vector component parallel to the plane of the flange. Depending upon the position of the flange from the aperture (Z), the flange angle (2β) and frequency (f), the desired polarization can be synthesized. This technique can produce a narrow pencil beam from the horn.

Polarization pattern in the *H*-plane of the flanged horn is plotted by rotating a distant linearly polarized antenna. The radiation patterns in the co-polar and cross-polar planes are recorded in the usual manner with flanged horn as the transmitter. The VSWR of the system is also studied using the normal test bench method. These experiments were done inside an anechoic chamber.

The variations of the axial ratio along the on-axis with the position of the flange from the aperture of the horn (Z) are shown in Fig. 2. It is clear that there is a critical position for achieving a circular polarization. Generally, the pattern is elliptically polarized. By measurement of VSWR, it is observed that the matching condition also is improved at this critical position. In this case, at 9.345 GHz the VSWR with and without flanges are 1.32 and 1.53, respectively. The radiation patterns in the co-polar, cross-polar and 45° planes for the above system are presented in Fig. 3.

The on-axis axial ratio of the system is 0.268 dB. Typical radiation pattern having predominant cross-polarization is shown in Fig. 4. Typical radiation patterns monitored by left and right hand helical antenna are shown in Figs 5 and 6. It is interesting to note that when the tilt of corrugation is 45° as shown in Fig. 5 the sense of rotation is left and when the tilt angle

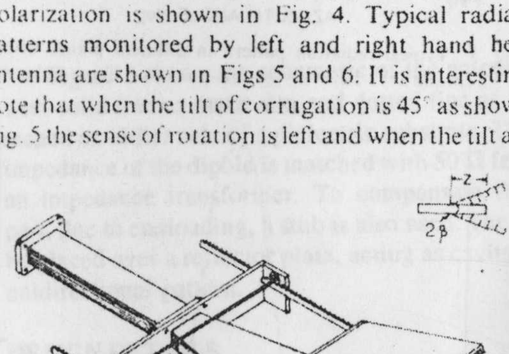

Fig. 1 Geometry of the flanged *H*-plane sectoral horn

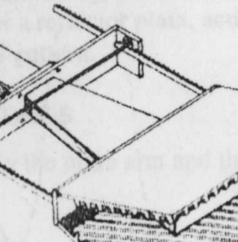

Fig. 2 Variation of axial ratio with the position of the flange from the aperture (Z) (Flanges with corrugation parameters $d = 0.1875\lambda$, $a = 0.156\lambda$, $h = 0.125\lambda$ and flange angle $2\beta = 45°$; horn length $= 23.5$ cm, *H*-plane width $= 10$ cm and flare angle $= 24°$, $\lambda = 3.2$ cm)

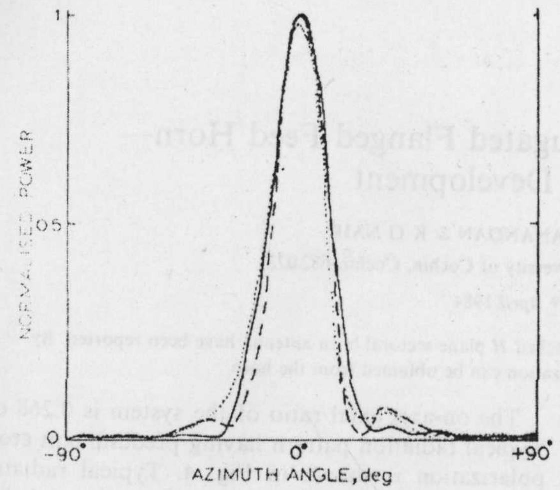

Fig. 3—Typical radiation pattern in different planes with Z = 2.2 cm and λ = 3.2 cm (——, Co-polar; ----, Cross-polar; and ..., 45° plane)

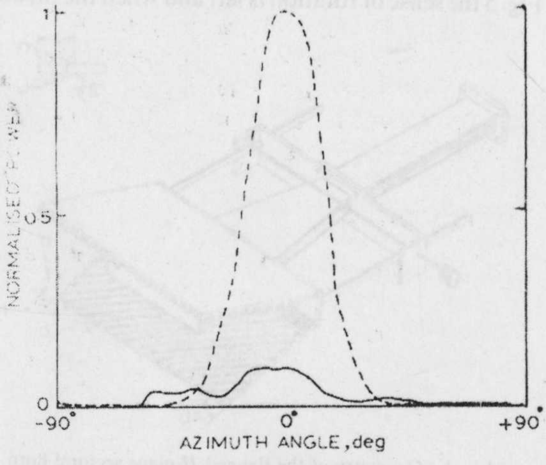

Fig. 4—Typical radiation pattern having predominant cross-polarization for Z = 4.5 cm and λ = 3.2 cm (——, Co-polar; and ---, Cross-polar)

is 135° (Fig. 6) it is circularly polarized in the right-hand sense.

The experimental results can be physically explained as follows. The incident plane polarized wave originated from the horn is inclined at 45° to the corrugation. This wave on the groove surface can be resolved into *TE* and *TM* components[1]. The tips of the corrugation will act as secondary radiators for the *TE* components and are totally reflected from the top of the corrugation. The other component is reflected from the bottom of the corrugations. At a particular value of Z, these two components and radiation from the horn may produce two equal and orthogonal components with phase quadrature which results in circular polarization. Here, it is observed that for a particular depth we can produce circular polarization at different wavelengths by proper adjustment of the other flange parameters.

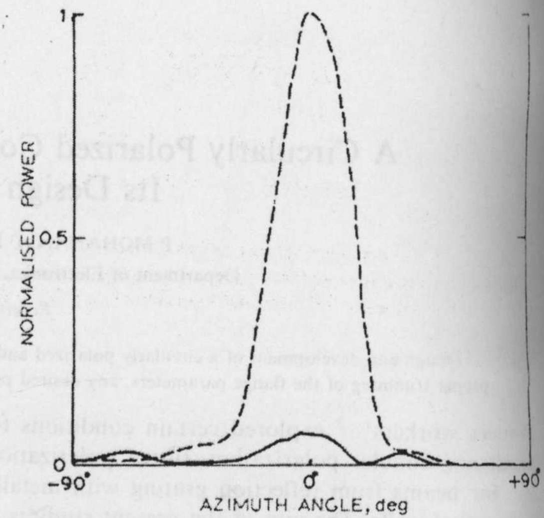

Fig. 5—Radiation pattern monitored by the helical antennas when the tilt of corrugation was 45° (——, Right-hand helical antenna; and ---, left-hand helical antenna)

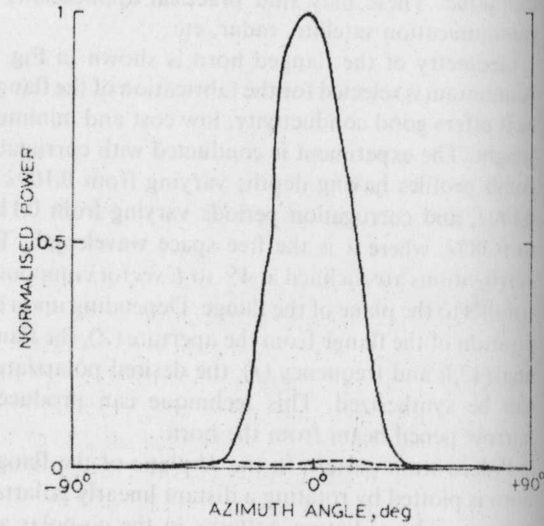

Fig 6—Same as Fig. 5 but for 135° tilt

From the experiment, the optimum periodicity for fairly good circular polarization is in the range $\lambda/8$-$\lambda/4$. The main advantage of this type of antenna is that adjustment could be done readily to produce any desired polarization.

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