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Corrugated Flanged Horn Feed for Offset Paraboloidal Reflectors

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A technique for improving the coupling between a feed horn and reflector by using corrugated metallic flanges is presented. Experimental data for flanges of varying parameters are given and theoretical explanation is supplemented.

It has been reported[1] that a plane flanged *H*-plane sectoral horn can improve the matching conditions as well as the beam shape of the antenna. Experimental and theoretical investigations on beam shaping of *H*-plane sectoral horns fitted with corrugated metallic flanges have been published[2]. It is established that corrugated flanges at the optimum position[3] (0 position), can improve the matching condition along with beam sharpening. But the effect of corrugated flanges attached to feed horns of secondary reflector antenna on the impedance condition has not been studied. A major problem in such experimental set-up of flanged horn facing a parabolic reflector is the aperture blocking. To eliminate this, offset paraboloidal reflector is used[4].

Corrugated flanges are made by machining uniform grooves of width d ranging from $\lambda/8$ to $\lambda/2$ on rectangular aluminium sheets of size $20 \times 10 \times 1.2$ cm. The width w of the flange is large compared to the wavelength used. Table 1 gives the various parameters of the flanges. The geometry of the flanged horn and offset paraboloid is shown in Fig. 1. The offset paraboloid has a focal length of 1 m and F/D ratio 0.5, where D is the diameter of the actual parabola of which the offset is a part. It may be noted that the line joining the vertex of the parabolic antenna and the centre of its *aperture is not collinear with the axis of the parabola in* offset systems. The diameters in the horizontal and vertical planes are nearly 1 m each. The reflector surface has an accuracy of the order of $\pm\lambda/30$. An *H*-plane sectoral horn is used as the primary radiator. It is so mounted in front of the reflector that the aperture of the horn is in the focal plane of the reflector. The offset angle subtended by the horn at the aperture is nearly 60° (β). The flange is mounted perpendicular to the E-vector and it can be made to slide back and forth along the length of the horn. An X-band Gunn oscillator is used as the source of microwaves having wavelength 3.35 cm. A standard pyramidal horn is used as the receiver and is kept at a distance greater than $(D_1^2 + D_2^2)/2$ to ensure plane electromagnetic waves, where D_1 and D_2 are the largest dimensions of the receiving and transmitting antennas, respectively. The received power is measured by a microwave power meter. The reflection coefficient is measured using a slotted line carriage.

Fig. 2 shows the variation of on-axis power density and reflection coefficient from the normal reflection coefficient. It is found that the on-axis power density P_0 and reflection coefficient τ are highly influenced by the distance (Z) of the flange from the aperture of the horn, number of corrugations (n), the included angle (2α), etc. The effect is predominant in the case of corrugated flanges. When the reflection coefficient is minimum, the on-axis power density is found to be maximum and vice versa. With this set-up, a reduction in reflection coefficient of the order 4.9 dB with respect to the normal reflection coefficient (i.e., with horn only as the feed) is obtained, and in this case the on-axis power density is increased by 8.59 times from the normal

Table 1—Flange Parameters

No. of corrugations n	Corrugation width cm
0 (Plane)	—
6	1.66
8	1.25
11	0.90
14	0.714
19	0.526

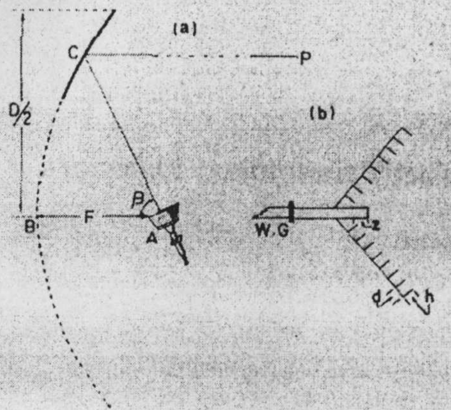

Fig. 1—Geometry of a corrugated flange fitted on an *H*-plane sectoral horn: (a) Offset parabolic reflector with feed horn (A is the focus, B the vertex of the actual paraboloid and C the centre of aperture of the offset paraboloid used); and (b) Primary feed horn with the flanges

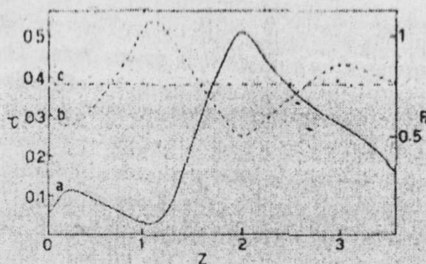

Fig. 2—Curves showing the variation of on-axis power density P_0 and reflection coefficient (τ) from normal reflection coefficient as a function of distance (Z) of the flange from the aperture of the horn [(a) power ——; (b) voltage reflection co-efficient -----; (c) normal reflection co-efficient —·—·—; $n=6$ and $2\alpha=45°$]

power. Table 2 shows these results. Fig. 2 shows the variation of τ and P_0 with respect to Z for different parameters of the flanges. The results can be qualitatively explained as follows. When the flange is at the '0' position the whole energy incident on the reflector is radiated along the axis, since the primary source from the focus gives rise to a pencil beam of very small beam width. But when the flanges are moved to the minimum[3] (M) position the beam is broadened or

Table 2—Variation of τ and P_0 from the Normal when the Flange is at the Optimum Position

Variation from normal (dB) at 45° position for		Variation from normal (dB) at 60° position for		Variation from normal (dB) at 90° position for	
τ	P_0	τ	P_0	τ	P_0
−4.25	4.47	−3.04	−1.59	−2.2	−1.59
−4.1	−1.13	−4.9	9.3	−1.4	9.05
−0.93	5.3	−1.57	11.46	−1.15	4.47
−3.5	6.95	−4.01	6.9	−1.28	6.12
−2.62	5.6	−1.89	6.2	−2.57	9.9
−4.82	6.3	−1.42	7.7	−1.24	8.06

split and it will have an apparent effect of tilting of incidence and hence a random reflection.

Table 2 clearly shows the variation of τ and P_0 from the normal value of reflection coefficient and power density when the horn without flange is used. The results presented in Table 2 clearly show that the corrugated flanges fitted on feed horns are more *effective in improving the performance of secondary* reflectors than plane flanges. The impedance conditions are improved with better on-axis flow of energy. The experimental results reveal that flanges having corrugation width of the order $\lambda/2$ are nearly *ideal. Thus the corrugated flanges on feed horn may act* as 'antenna trimmers' for fine adjustment of different parameters.

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