An experimental investigation of the effect of flange angle on radiation patterns of V-slot waveguide antenna

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Results of exhaustive study of the effect of metallic flanges on *H*-plane radiation characteristics of V-slot waveguide antenna are presented. It has been established that the beam can be sharpened or broadened by varying the flange angle. The adjustment of the flange angle and flange width would further improve the radiation pattern, yielding optimum efficiency from the flanged system.

1 Introduction

Many researchers have studied the flange technique for modifying the radiation characteristics of electromagnetic horn antennas[1-5]. The effect of metallic flanges on radiation patterns of V-slot waveguide antenna (V-SWGA) and variation of return loss with number of slot pairs are already presented[6]. But the effect of flange angle on radiation patterns of V-SWGA for different flange widths has not been studied in detail. In the present investigation, these aspects are taken for the detailed study.

2 Nature of V-slot waveguide

The electric field lines across the V-slot over a rectangular waveguide in TE_{10} mode are shown in Fig. 1. The components of the field lines along x- and z-direction are E_{1x}, E_{1z}, E_{2x}, E_{2z}. Here the field components in x-direction are 180° out of phase, while field lines in z-direction are in phase. These in-phase field components constitute the polarization in z-direction.

In the case of second V-slot, since it is separated at a distance of $\lambda_g/2$ from the first V-slot, the x-components of the electric fields are in opposite direction, while z-components of the electric field are in the same direction for both the V-slots. Thus the polarization of these two slots are combined together in z-direction.

3 Experimental measurements

The antenna system consists of a rectangular waveguide with array of V-slots on broader wall of it. The length of each arm is $\lambda_o/2$ and separation between V-slots is $\lambda_g/2$. Metallic flanges designed and fabricated so as to conveniently vary the flange parameters, like the width and angle (Fig. 2), are used to study their effects on radiation pattern. One end of the waveguide is connected to a dummy load and the other end is attached to the receiving system. Measurements were taken with the antenna system under test in receiving mode. Figure 3 shows the radiation patterns for V-SWGA with and without flanges.

4 Results and discussion

4.1 Variation of axial power density with flange angle

Flanges on V-SWGA has improved the axial power density considerably. The on-axis power density is measured for a particular flange with different included angle (2β). The on-axis power density (P_o) varies to a maximum value and falls steadily. Table 1 shows the variation of on-axis power density (P_o) for different SWGA at different included angle of various flange widths.

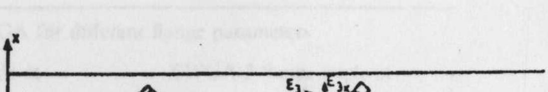

Fig. 1—Electric field variations across the V-slot

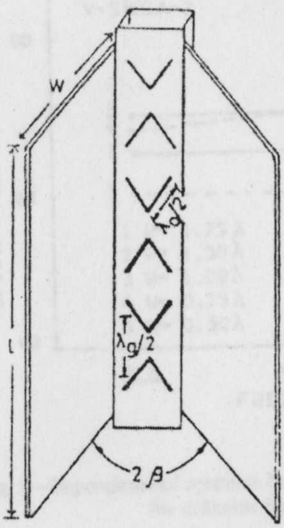

Fig. 2—Schematic diagram of V-slot antenna with flanges (W = width of the flange, l = length of flange, 2β = included angle of the flange, $\lambda_o/2$ = length of the arm of V-slot, $\lambda_g/2$ = separation between two V-slots)

4.2 Dependence of axial power density on the width of the flange

The on-axis power density varies with the width of the flange. The maximum on-axis power density is obtained at A_o, the optimum angle. The optimum flange angle, A_o, is mainly depending on the width of the flange and the operating frequency. It is clear from Fig. 4 that P_o increases considerably with the increase in flange width.

4.3 Dependence of optimum flange angle on flange width

For a particular SWGA operating at a designed frequency, the optimum flange angle (A_o) will go on varying for different widths of flanges. Figure 5 shows the variation of A_0 with different flange widths and for different frequencies. It is found that when the flange widths are 1 λ and 1.75 λ, the optimum flange angle A_0 is virtually independent of the frequency.

4.4 Effect of half-power beam width

It is found that for a particular SWGA and optimum flange angle, the half-power beam width (HPBW) decreases considerably by changing the

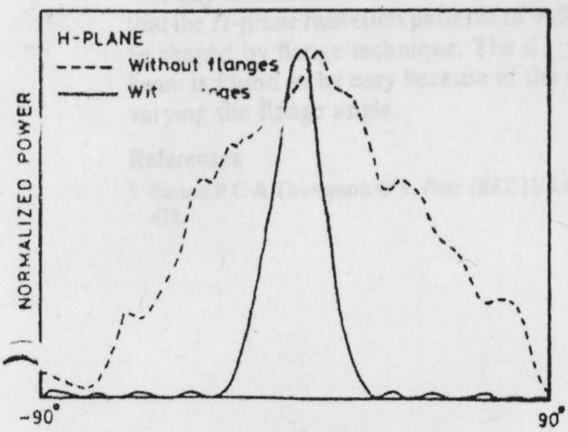

Fig. 3 Typical radiation patterns of V-slot waveguide antenna with and without flanges (f = 9.50 GHz)

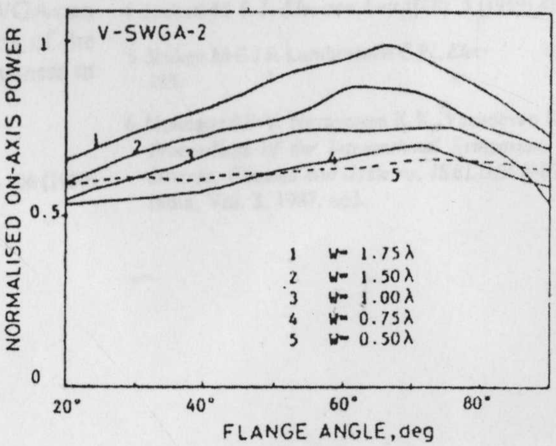

Fig. 4—Variation of on-axis power with flange angle for flanges of different widths (f = 9.50 GHz)

Table 1—Variation of on-axis power density (P_o) of V-SWGA for different flange parameters

Flange width	SWGA-1 flange angle at			SWGA-2 flange angle at			SWGA-3 flange angle at		
	30°	60°	90°	30°	60°	90°	30°	60°	90°
1.75 λ	7.0	7.9	6.0	10.0	12.8	10.0	19.7	26.0	20.6
1.50 λ	6.5	7.5	6.1	9.2	11.7	9.5	20.8	23.0	17.2
1.00 λ	5.7	6.6	5.8	8.0	10.0	8.8	16.7	19.4	16.7
0.75 λ	6.0	6.9	6.2	7.4	9.0	7.7	15.9	19.2	18.2
0.50 λ	3.5	3.6	3.4	8.3	8.7	8.5	13.9	16.8	16.0

Note: SWGA-1 3 pairs of 70° V-slot; SWGA-2: 5 pairs of 90° V-slot; SWGA-3: 5 pairs of 120° V-slot

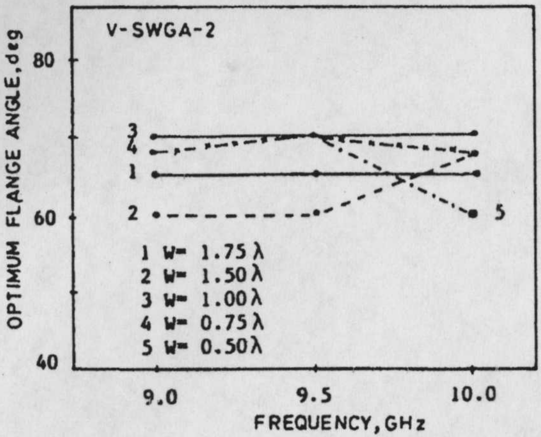

Fig. 5—Dependence of optimum flange angle A_o on flange width for different frequencies

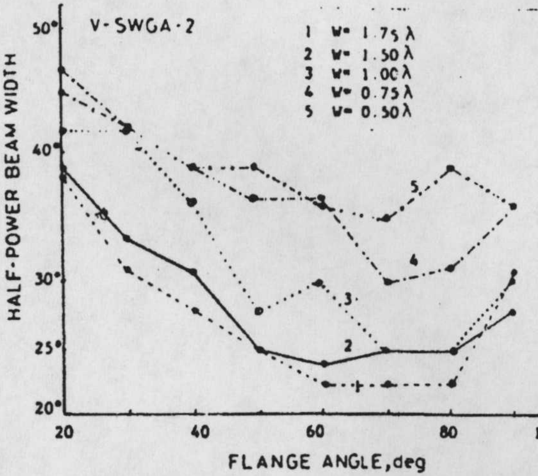

Fig. 6—Variation of half-power beam width against the variati of flange angle for different flange widths

width of the flange. Figure 6 shows the variation of HPBW with flange angle for different flange widths.

5 Conclusion

It may be concluded from the above measurements that the *H*-plane radiation patterns of V-SWGA can be shaped by flange technique. The sh[illegible]ing of the beam is found to be easy because of the easiness in varying the flange angle.

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