

**INVESTIGATIONS ON A PLANAR HELIX
SLOW-WAVE STRUCTURE**
with particular reference to
TRAVELLING-WAVE TUBE APPLICATIONS

By
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CERTIFICATE

This is to certify that the thesis presented by Devi Chadha for the award of the degree of Doctor of Philosophy of the Indian Institute of Technology, Delhi, is a bonafide record of research work carried out by her over the last three years under our supervision.

The candidate has fulfilled the requirements of all the regulations relating to the degree. The results obtained in the thesis have not been submitted in part or in full to any other university or institute for the award of a degree or diploma.

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Abstract

The 'planar helix', consisting of a pair of unidirectionally conducting (UC) screens, each conducting in a different direction, has electromagnetic guiding properties similar to those of a circular helix. The helix of circular cross-section has been a very successful slow-wave structure in the travelling-wave tube application because of its simple construction, large bandwidth and high characteristic impedance. In view of this, an attempt has been made in the present work to study the behaviour of planar helix as a slow-wave structure in travelling-wave tubes. The planar helix is expected to have advantages over the circular helix of easier fabrication and lower cost, the advantages pertaining to the planar structures.

First of all, a detailed field analysis has been carried out to study the dispersion characteristics of the planar helix in the presence of an electron beam. The characteristic equation reveals the presence of three modes, with one increasing mode, which would result in gain in a travelling-wave tube. Gain calculated for a few cases is comparable to that in a circular helix travelling-wave tube. Important circuit parameters, such as interaction impedance and space-charge parameter, which characterize a travelling-wave tube, have been calculated for the proposed

structure, both for a hollow beam and for a solid beam case. The values of these parameters also confirm potential of the planar helix as a slow-wave structure in travelling-wave tube application.

In practice, the helix is supported on dielectric rods held inside a metal tube. In view of this, a study has also been included on the analysis of a general configuration in which the UC screens constituting the planar helix are printed on dielectric substrates and the shielding metal plates are also present. The dispersion characteristics indicate a reduction in phase velocity and an increase in bandwidth due to both, the dielectric and the metal shield. The interaction impedance calculated for different special cases derived from the general configuration also shows a reduction. It is found that the interaction impedance deterioration is less severe as compared to that in the case of circular helix. In this respect, a better performance is expected from the planar helix than from other printed-circuit slow-wave structures too. This should prove significant in the practical utilization of the planar helix in the travelling-wave tube applications.

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