

NATIONAL RADIO ASTRONOMY OBSERVATORY  
SOCORRO, NEW MEXICO  
VERY LARGE ARRAY PROJECT

VLA ELECTRONICS MEMORANDUM NO. 152

MEMO ON  $TE_{on}$  MODE FILTER DEVELOPED BY MARCONI RESEARCH LABORATORIES

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SUMMARY

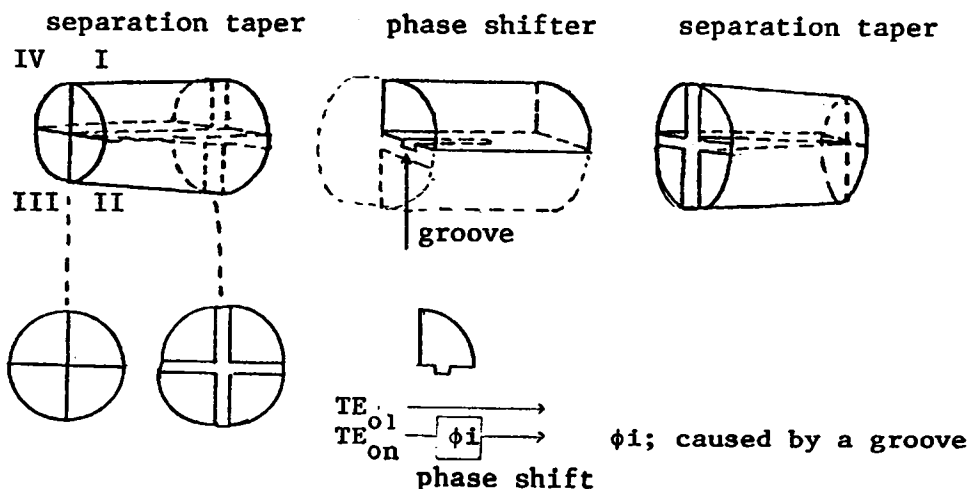
In September, 1976, they informed us of their working on  $TE_{on}$  mode filters in Marconi Research Laboratories. During my trip to IEE Conference in London last month, I had a chance to hear about their present development situation from them. According to their explanations, they studied some theoretical analysis and they are building the first one with no electrical data confirmed.

This is the report saying in more detail about their  $TE_{on}$  mode filter.

I. PRINCIPLE OF FILTERS

The basic principle of this filter is the same as that of the one developed in Japan. (IEEE MTT Vol. 24, No. 1, January, 1976) A circular waveguide is divided into two or more segment waveguides by conductive septums that contain the center line of the cylinder. In those segment waveguides, different phase velocity of  $TE_{on}$  mode are given leaving minimum effects to  $TE_{01}$  mode. At the backward edge of septums, segment waveguides are combined into a circular waveguide again and  $TE_{on}$  mode waves from different segment waveguides cancel each other and most of the power can be converted into other unsymmetrical modes while  $TE_{01}$  mode waves combine with small loss.

The configuration of the filter is shown below.



The length of groove is different in each segment waveguide and gives different phase shifts.

The TE<sub>on</sub> mode loss can be expressed as follows.

$$A_{(on)} = \frac{1}{P} \sqrt{\sum_{i=1}^P \cos \phi_i}$$

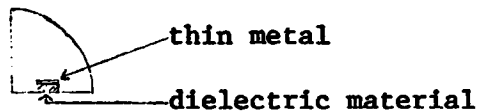
P; number of segment waveguides equally divided from a circular waveguide, (P=4 in the above figure).

By increasing the number P, it is possible to make small value from A<sub>02</sub>, A<sub>03</sub> (means large loss) in broadband frequency range.

## II. DESIGN

The electro-magnetic field of segment waveguides with a groove on its flat surface is calculated by transverse-resonance technique or mesh-network method. From them phase shift (cut-off frequency shift) caused by the groove is calculated on TE<sub>01</sub> and TE<sub>on</sub> modes with different values for groove dimensions. Optimum values are found and the required length is determined by generalized calculations with different P and  $\phi_i$ .

Instead of grooves, perturbation is also considered to give similar phase shift. It makes it unnecessary to have separation taper and makes the configuration more simple.



## III. FEATURES

In Japanese mode filter, a circular waveguide is divided into

two semicircular waveguides ( $P=2$  in the preceding figure) and phase shift is caused by diameter change.

In this proposal, a circular waveguide is divided into many segments to obtain broadband  $TE_{on}$  ( $n \geq s$ ) mode attenuation response. Another remarkable feature is its phase shift mechanism by grooves.

#### IV. DEVELOPMENT STATUS

Calculation has been done on different models of filters with promising results on  $TE_{02}$  and  $TE_{03}$  mode attenuation. The prototype filter is under fabrication and any data has not been obtained.

No consideration has been made on  $TE_{01}$ - $TE_{on}$  mode conversion in a filter itself. (This is important in  $TE_{on}$  mode filters.)

The length is expected to be 500-600 mm.

#### V. COMMENTS (by M. Ogai)

The development status seems to be far away from actual use. It seems to take one year at least before it is commercially available.

One of the features is a large attenuation response in expanded frequency band but it is associated with 0.5 dB insertion loss and 500-600 mm length. These facts decrease its merits.

The needs for such a mode filter is not clear. Only in special cases, it might be required. British Post Office has no idea to use it in their waveguide system at this moment.

#### VI. OTHER INFORMATION

1. Marconi don't supply any corner waveguide nor gas components to British Post Office.
2. Marconi made some studied on helical coupler and filed a patent on it about five years ago.

Note: This information was given during the discussion with Mr. B. K. Watson on November 19 in Chelmsford, England

