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71 Applicant: **THE MARCONI COMPANY LIMITED**  
Marconi House New Street  
Chelmsford Essex CM1 1PL(GB)

72 Inventor: **Suckling, Harold Frederick**  
Bonaire South View Road  
Danbury Nr. Chelmsford Essex(GB)

74 Representative: **Tolfree, Roger**  
The Marconi Company Limited Marconi House New  
Street  
Chelmsford, CM1 1PL(GB)

54 A waveguide and a method of making the same.

57 When machining waveguides a problem exists because of the flexing of the machining tool, this leading to inaccuracies in the waveguide. This is especially pronounced for narrow waveguides designed for high frequency operation since the tool has had to be of correspondingly narrow diameter. In Figure 2 a number of waveguides having a narrow dimension W are formed by interdigitated projections (6, 6A) on two pieces of material 1 and 2. These interdigitated projections are produced by machining relatively wide parallel grooves in the two pieces of material and this can be done using a relatively large diameter tool which is not appreciably subject to flexing during operation. The result is relatively accurate, narrow waveguides of high surface finish unobtainable using conventional techniques.

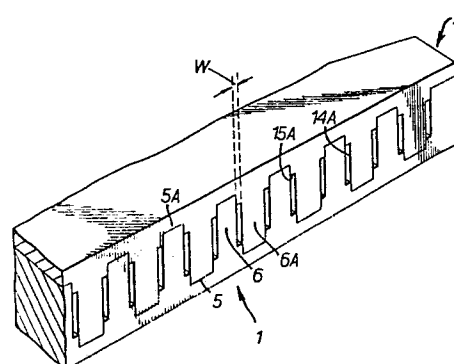


FIG.2.

0040005

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PATENT SPECIFICATION

INVENTOR:- Harold Frederick SUCKLING,  
Bonaire,  
South View Road,  
Danbury,  
Nr. Chelmsford, Essex.

TITLE:- A Waveguide and a method of making  
the same.

APPLICANTS:- The Marconi Company Limited,  
Marconi House,  
New Street,  
Chelmsford,  
Essex.

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AGENT:- Roger K. Tolfree

A WAVEGUIDE AND A METHOD OF MAKING THE SAME

This invention relates to waveguides. It arose in the design and manufacture of a squintless antenna having a plurality of waveguides leading to an array of  
5 radiating apertures. A squintless antenna is an antenna in which radiation is fed to an array of radiating positions in such a way that it arrives at each of those positions at the same phase.

Squintless antenna for operation in the L and S band  
10 of frequencies, have been made in the past by machining grooves in two sheets or plates of conductive material. These sheets are then fitted together, one on top of the other, so that each groove in one sheet co-operates with a corresponding groove in the other sheet to form one of  
15 the waveguides. A problem has arisen in machining the grooves since it is necessary that their dimensions be defined within small tolerances.

The inventor has found that this problem is accentuated when the antenna is designed to operate at  
20 high frequencies, e.g. in the J band. This is because the waveguides need to be correspondingly narrower. They therefore need to be machined using an end mill or other tool of relatively small diameter. The small diameter means that the tool is liable to flex in operation and  
25 this leads to inaccuracies in the surfaces of the grooves. It is not just the diameter of the tool which is relevant but the relationship between the diameter and the length, the minimum possible length of the tool being dictated by the depth of the groove required. As an  
30 example, rectangular waveguides for J band operation might typically be one millimeter wide and ten millimeters deep. Using the conventional technique described above this would mean machining grooves one millimeter wide and five millimeters deep.

This invention provides a method of making a waveguide in which a groove having a base and two sides is formed in one piece of material, a projection is formed on another piece of material and the projection is then fitted into the groove so as to form the waveguide between a side of the projection and a side of the groove.

The invention also provides apparatus comprising a waveguide formed between a side of a groove having a base and two sides in one piece of material and a side of a projection having an end face and two sides on another piece of material, the projection fitting in the groove.

One way in which the invention may be performed will now be described with reference to the accompanying drawings in which:-

Figure 1 is an exploded perspective view of a  
5 squintless antenna constructed in accordance with the invention; and

Figure 2 is a perspective view of the antenna shown in Figure 1 viewed from the direction indicated by arrow A on Figure 1.

10 Referring firstly to Figure 1, the antenna is formed from first, second and third pieces of conductive material, e.g., brass or aluminium. The first piece 1 of material is machined with a number of grooves 4 of various  
15 different lengths and extending generally parallel to each other as shown. Each groove 4 has, at its base, a portion of reduced width forming a slot 5. These slots 5 may be machined before or after machining of the rest of the grooves 4 using a tool of narrower diameter. Alternatively, a specially shaped tool having a narrower  
20 diameter at its free end could be used. Between each pair of adjacent grooves 4 a flange 6 is defined. It will be noted that the grooves 4 are not straight. Each has a bend 7 and a bend 8.

The second piece 2 of material has features 4A, 5A, 6A,  
25 7A and 8A corresponding to 4, 5, 6, 7 and 8. The flanges 6A form projections which fit snugly into the slots 5.

The parts 1 and 2 have respective rebates 9 and 9A and these co-operate with the third piece 3 of material as will now be explained.

30 The piece 3 of material is machined so as to form a channel 10 which tapers from a relatively deep end 11 to a relatively shallow end 12. Rebates 13 form lips 14 which fit into the rebates 9 and 9A of the respective parts 1 and 2. When the parts 1, 2 and 3 are assembled,

as shown in Figure 2, the taper of the channel 10 serves to distribute microwave energy introduced through the end 11 of the channel 10 evenly into each of the waveguides formed by the parts 1 and 2.

5        Referring now to Figure 2, this shows the parts 1 and 2 fitted together and it can be seen that each side of each projection 6A co-operates with an adjacent side of a flange 6 to form a waveguide of width W. This width W is much smaller than the diameter of the tool needed to  
10 machine the various grooves and slots which have been referred to previously. It is thus possible by employing the invention to produce narrow waveguides of great accuracy and high surface finish.

15        It will be apparent that the invention is applicable to non-squintless feeds and to other type of apparatus besides the squintless feed illustrated. It could for example be employed in the manufacture of diverging and/or tapered waveguides as might be used in an organ-  
20 pipe scanner.

CLAIMS:

1. A method of making a waveguide in which a groove having a base and two sides is formed in one piece of material, and a projection having an end face and two  
5 sides is formed on another piece of material, characterised in that the projection is then fitted into the groove so as to form the waveguide between a side of the projection and a side of the groove.
2. A method according to claim 1 in which two waveguides  
10 are formed on opposite sides of the projection between the projection and corresponding sides of the groove.
3. A method according to claim 1 or 2 in which said one piece of material has a plurality of grooves and the other piece of material has a plurality of projections,  
15 each projection fitting in a corresponding groove to form a plurality of waveguides.
4. A method according to claim 3 in which a main waveguide is formed by securing to the said two pieces of material, a third piece of material forming a channel  
20 which communicates with each of the said plurality of waveguides.
5. A method according to claim 4 of making an antenna having a plurality of radiating apertures in which each of said plurality of waveguides has an open end,  
25 opposite to an end communicating with the channel, each said open end constituting one of said radiating apertures.
6. A method according to claim 5 of making a squintless antenna.
7. A method according to any preceding claim in which the  
30 waveguide or each waveguide is for operation at J band.
8. Apparatus comprising a waveguide characterised in that the waveguide is formed between a side of a groove having a base and two sides in one piece of material and  
35 a surface of a projection having an end face and two sides on another piece of material, the projection fitting in

the groove.

9. Apparatus according to claim 8 in which two waveguides are formed on respective opposite sides of the projection, between the projection and corresponding  
5 sides of the groove.

10. Apparatus according to claim 8 or 9 in which said one piece of material has a plurality of grooves and the other piece of material has a plurality of projections, each projection fitting in a corresponding groove to form  
10 a plurality of waveguides.

11. Apparatus according to claim 10 comprising a main waveguide formed by a third piece of material defining a channel which communicates with each of said plurality of waveguides.

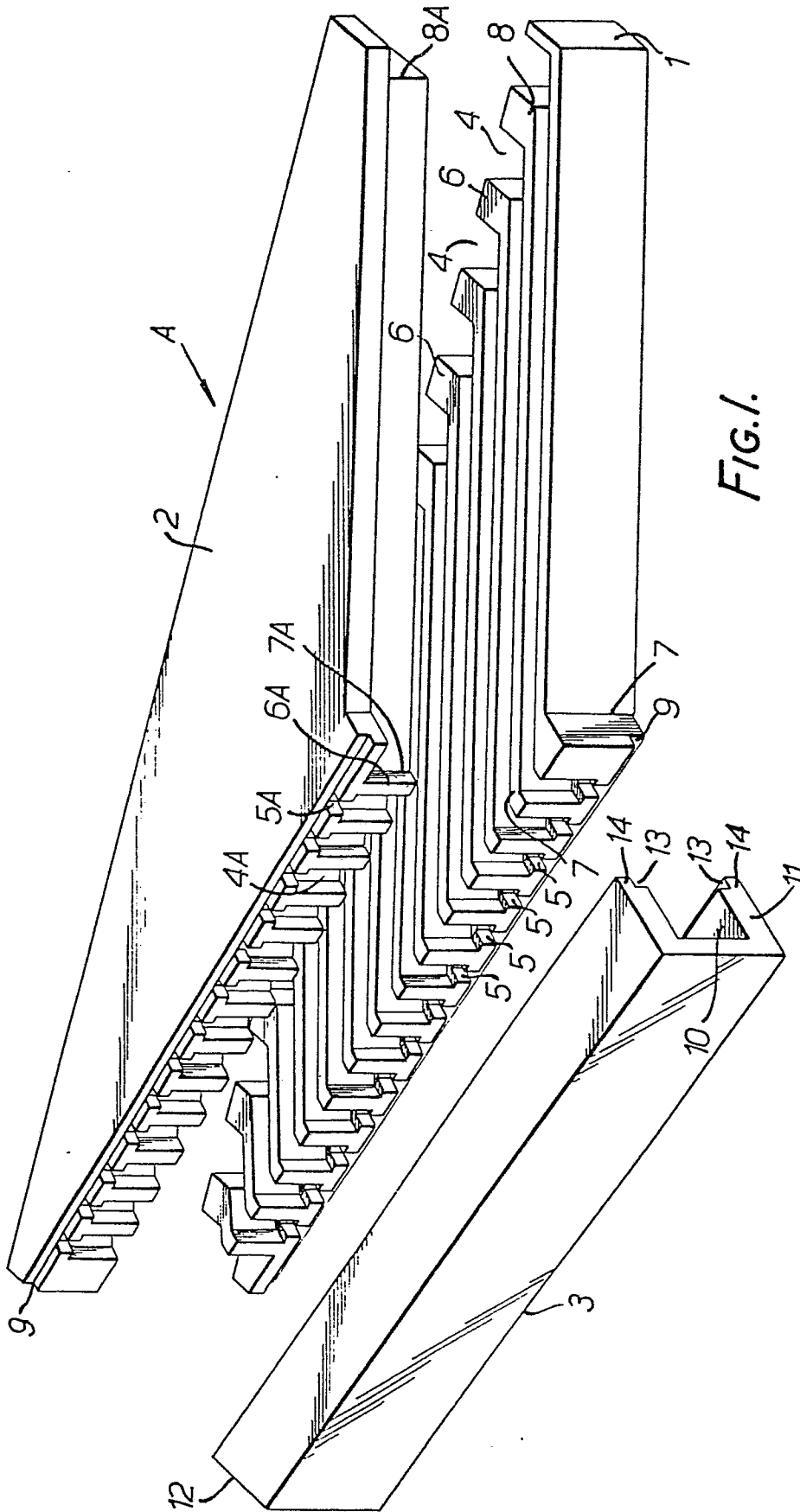
12. Apparatus according to claim 11 in the form of an antenna having a plurality of radiating apertures, each of said plurality of waveguides having an open end opposite to an end communicating with the channel, and each said open end constituting one of said radiating  
20 apertures.

13. A squintless antenna constructed in accordance with claim 12.

14. A waveguide for J band operation and constructed in accordance with any of claims 8 to 13.

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FIG. 1.



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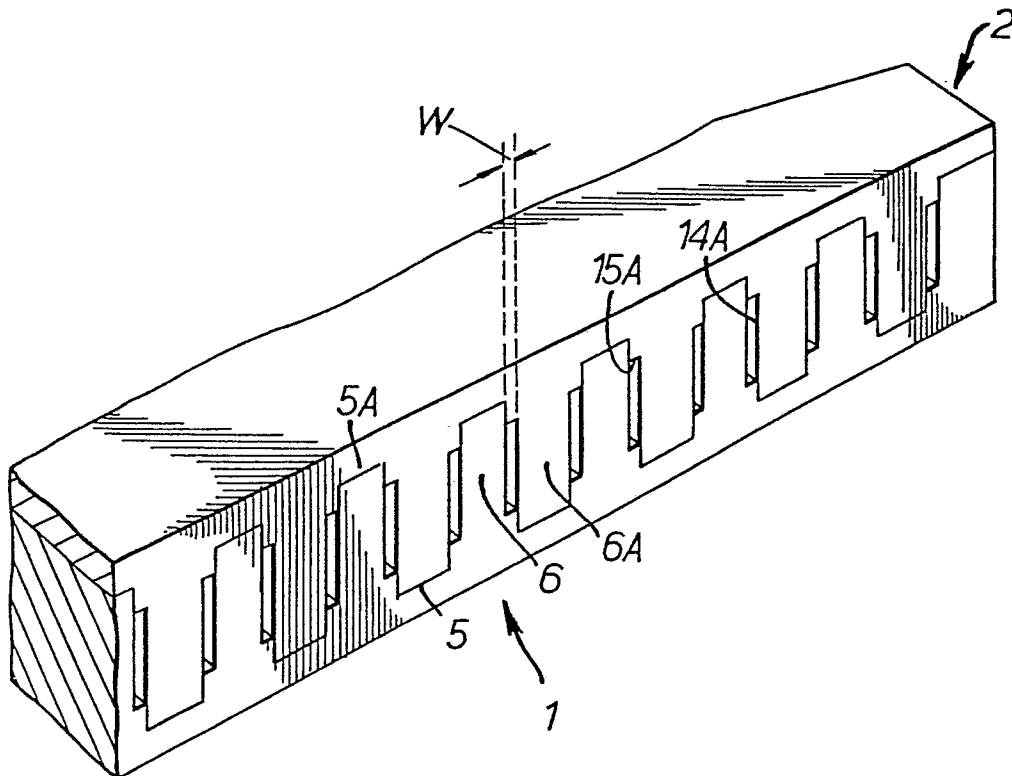


FIG.2.



European Patent  
Office

# EUROPEAN SEARCH REPORT

0040005

Application number

EP 81 30 1701

| DOCUMENTS CONSIDERED TO BE RELEVANT                        |                                                                                     |                   | CLASSIFICATION OF THE APPLICATION (Int. Cl.')                                                                                                                                                                                                                              |
|------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Category                                                   | Citation of document with indication, where appropriate, of relevant passages       | Relevant to claim |                                                                                                                                                                                                                                                                            |
|                                                            | <u>US - A - 4 041 350</u> (H. SHITARA et al.)<br>* Column 1, lines 11-39; figures * | 1-3               | H 01 P 11/00                                                                                                                                                                                                                                                               |
|                                                            | --                                                                                  |                   |                                                                                                                                                                                                                                                                            |
| A                                                          | <u>GB - A - 2 005 923</u> (CIT-ALCATEL)<br>* Figures 2-5 *                          | 1,8               |                                                                                                                                                                                                                                                                            |
|                                                            | --                                                                                  |                   |                                                                                                                                                                                                                                                                            |
| A                                                          | <u>US - A - 2 770 780</u> (R. WARNECKE et al.)<br>* Figures 2-5 *                   | 1                 |                                                                                                                                                                                                                                                                            |
|                                                            | ----                                                                                |                   |                                                                                                                                                                                                                                                                            |
|                                                            |                                                                                     |                   | TECHNICAL FIELDS SEARCHED (Int. Cl.')                                                                                                                                                                                                                                      |
|                                                            |                                                                                     |                   | H 01 P 11/00                                                                                                                                                                                                                                                               |
|                                                            |                                                                                     |                   | CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                                                                                |
|                                                            |                                                                                     |                   | X: particularly relevant<br>A: technological background<br>O: non-written disclosure<br>P: intermediate document<br>T: theory or principle underlying the invention<br>E: conflicting application<br>D: document cited in the application<br>L: citation for other reasons |
|                                                            |                                                                                     |                   | & member of the same patent family.<br>corresponding document                                                                                                                                                                                                              |
| The present search report has been drawn up for all claims |                                                                                     |                   |                                                                                                                                                                                                                                                                            |
| Place of search                                            | Date of completion of the search                                                    | Examiner          |                                                                                                                                                                                                                                                                            |
| The Hague                                                  | 30-07-1981                                                                          | LAUGEL            |                                                                                                                                                                                                                                                                            |