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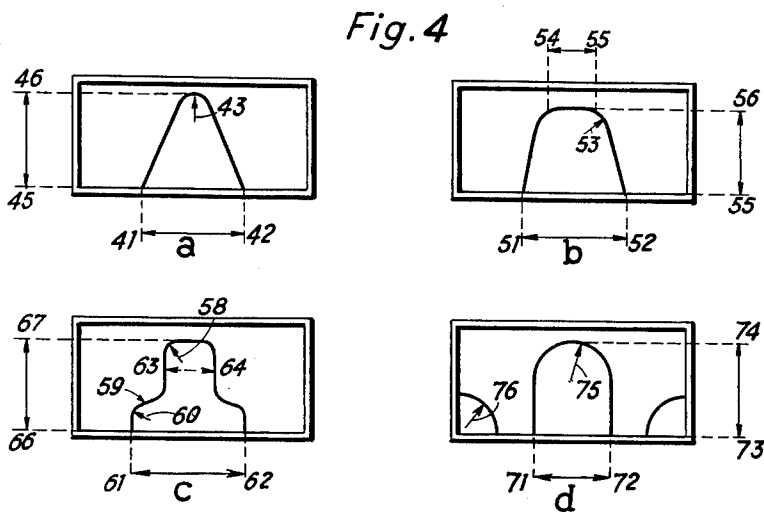
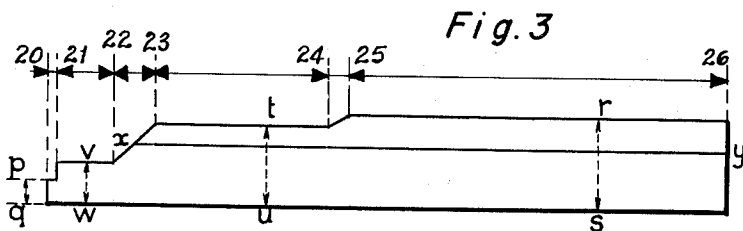
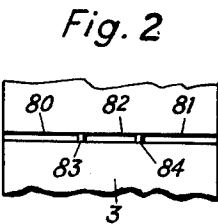
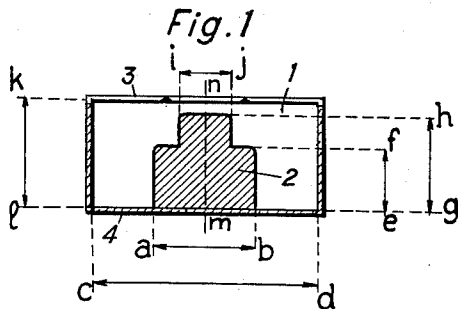
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RADIATING SLOT RIDGED WAVEGUIDES

Filed March 29, 1962

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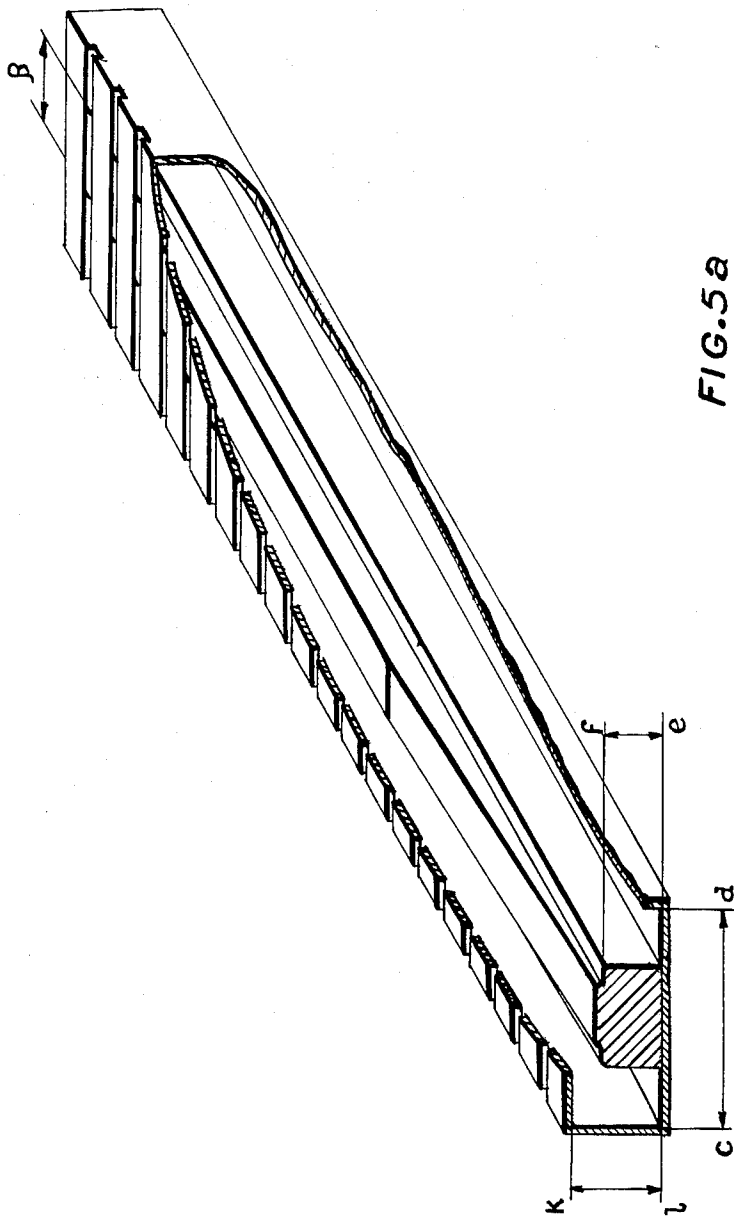
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RADIATING SLOT RIDGED WAVEGUIDES

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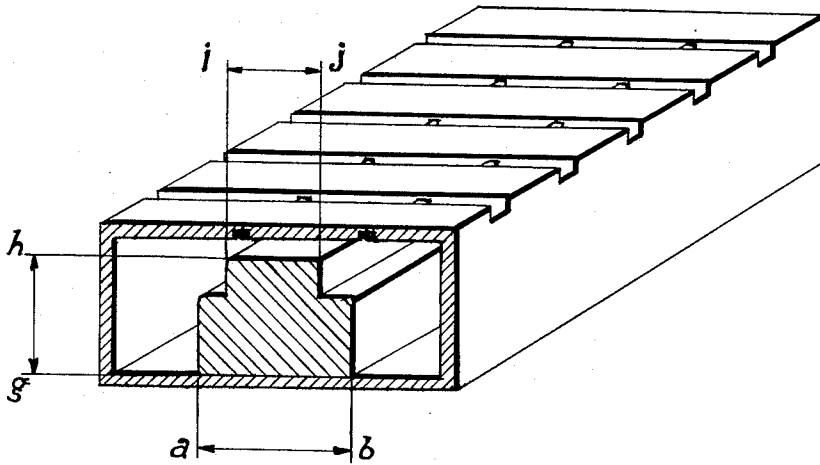


FIG. 5b

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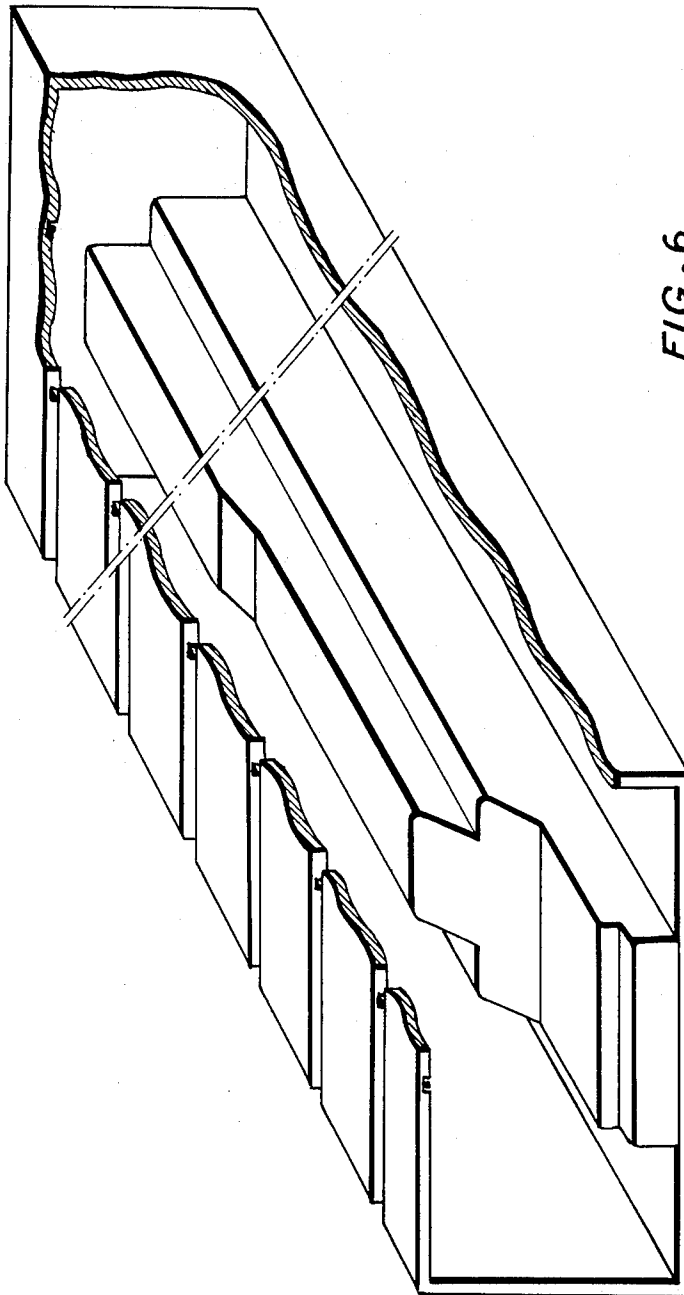
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RADIATING SLOT RIDGED WAVEGUIDES

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RADIATING SLOT RIDGED WAVEGUIDES

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858,340, Patent 183,503

7 Claims. (Cl. 343—771)

The present invention relates to improved radiating slot waveguides, the inside of which comprises a ridge, extending longitudinally of the guide.

As is known, such guides present, over those wherein the phase velocity is modified by means of a dielectric material partially filling the waveguide, the advantages of reduced cost price, easier manufacture, reduced sensitivity to temperature variations, and larger band-width.

However, known slotted waveguides with rectangular cross-section ridges present some disadvantages. As is known, in such guides the phase velocity is, for a given width of the ridge, a decreasing function of the height of the same and, for a given height of the ridge, the phase velocity is a function of the width of the ridge and passes through a minimum for a width approximately equal to half the width of the waveguide.

Therefore, if it is desired to reduce substantially the phase velocity in a slotted waveguide, so as to obtain a radiating pattern, the axis of which forms a small angle, say for example of 10° , with the longitudinal axis of the guide, it will be necessary to use a ridge having a substantial width, for example, equal to half the width of the guide and such a height that the radiation of the slots is strongly perturbed. Actually, in this case, the increasing of the field in the space between the ridge and the upper wall, where the slots are provided, results in an enhanced radiation of the slots which are the nearest to the source, at the expense of the field radiated by the other slots.

It is an object of the invention to avoid this drawback.

The invention provides a slotted waveguide comprising a ridge the portions of which, facing the slots, have a height which is substantially less than the maximum height of the ridge.

According to a modification, the maximum height of the ridge cross-section varies along the waveguide, in order to provide a desired radiation pattern.

The invention will be best understood from the following description and appended drawings, wherein:

FIG. 1 is a cross-section of any one of the portions of a slotted waveguide according to the invention comprising a shouldered ridge;

FIG. 2 is a detail showing the arrangement of the radiating slots in the waveguide of FIG. 1;

FIG. 3 is a lateral view of a ridge adapted to produce a cosecant-squared radiation pattern;

FIGS. 4, 4a to 4d show end views of ridged waveguide sections according to the invention;

FIGS. 5a and 5b are perspective views of parts of the ridged wave guide according to the invention; and

FIG. 6 is a perspective view of the complete ridged slotted wave guide according to the invention, the wave guide being shown partly broken away for the sake of clarity.

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In FIG. 1, there has been illustrated a cross-section of a ridged waveguide 1 having two rows of radiating slots in the upper wall. This view may be any cross-section of the ridge along the guide, except for the input end which will be described later; dimensions ab and ij are constant along the guide, while heights ef and gh vary along it, this figure showing only the general shape of said cross-sections. Guide 1 is formed with a ridge 2 supported by wall 4. In accordance with the invention, ridge 2 has two shoulders with rounded outer edges.

Guide 1 is, by way of example, a standard waveguide for the 3 cm.-band. For a better understanding of the figure, the waveguide is drawn on a double scale.

In FIG. 2, which shows a portion of the upper wall 3, two radiating slots 80 and 81 are limited by two lead wires 83 and 84, extending across a comparatively wide slot, say about 0.8 mm. for $\lambda=3$ cm., λ being the operating wave length, in free space, in accordance with a known practice.

Slot 82 which is bound by wires limiting slots 80 and 81 has in this case a length smaller than $\lambda/4$, so that it does not radiate. Should slot 82 be longer, it may be subdivided into several non radiating slots by means of other wires. The length of the non radiating central portion is at least equal to the length ij in FIG. 1.

FIG. 3 is an axial lateral view of a ridge adapted to be used in a guide of the type illustrated in FIG. 1, having two rows of radiating slots, as shown in FIG. 2, in order to obtain a cosecant-squared radiation pattern with a frequency comprised in the 8,600 to 9,600 mc./s. band. In FIG. 3, the vertical dimensions are, for convenience, on a double scale, whereas the horizontal dimensions are reduced to $1/2$. FIG. 3 corresponds to a lateral view of the ridge of FIG. 1. The cross-section shown in the latter figure being along line $r-s$ in FIG. 3 if hg is made equal to rs .

The cross-section along line $t-u$ of FIG. 3 is the same if that dimension gh is reduced to dimension tu .

The cross-section along line vw is derived from that of FIG. 1 by suppressing the upper ridge portion of width ij and reducing dimension of ef to vw .

A transition is made between the two portions of the ridge of heights rs and tu and another transition exists between the two portions of the ridge of heights tu and vw . The end portion of the ridge shown in FIG. 3, the height of which is pq , is a $\lambda/4$ -step matching i.e. a step of length $\lambda/4$ and impedance $Z=Z1.Z2$ where $Z2$ is the impedance of the ridged slotted wave guide and $Z1$ the impedance of a feeding line (which may be, for example, an ordinary non slotted wave guide). Line xy corresponds to the shoulders, which are seen in FIG. 1.

The actual dimensions in millimeters are as follows:

In FIG. 1: $ab=10$; $cd=22.86$; $ef=6$; $gh=9$; $ij=5$; $kl=10.16$; the curvature radius of the rounded edges is 0.5.

In FIG. 3: $20-21=11$; $21-22=55$; $22-23=40$; $23-24=168$; $24-25=20$; $25-26=370$; $pq=2.3$; $vw=4$; $tu=8$; $rs=hg=9$.

The waveguide illustrated makes it possible to obtain, in the portions thereof where the height of the ridge is equal to rs , a phase velocity corresponding to a mean radiation angle inclined at an angle of 10° to the axis of the waveguide without noticeably affecting the radiation pattern of the slot assembly.

As shown by experience and confirmed by theory, a ridge of the type shown results in a phase velocity which is only slightly less than that which would be obtained in the same guide with the same slots and a ridge whose basis would have the same width ab , but which could have the same height hg all along its width (FIG. 1). This velocity is nearer to that obtained with the ridge of base ab and height gh than to that corresponding to a ridge of base ab and height ef .

In addition, the delay line effect which anyhow appears between the upper face of the ridge, the width of which is ij , and the upper wall of the guide, is further increased on account of the fact that the portion of the upper wall 3 facing the upper side of the ridge is provided with non radiating slots. The system described, while usable with any type of radiating slots, is of particular interest with radiating slots which are separated from each other by a non radiating slot.

The type of ridge shown in FIG. 1 provides, moreover, a better power handling capacity than would be the case with a rectangular cross-section ridge, even with rounded edges. This additional advantage prevails even if the radiating slots are not arranged opposite the shouldered portions of the ridge.

The embodiment illustrated in FIG. 3 is, however, not the only one which is satisfactory for two-row radiating slot waveguides. By way of example, FIGS. 4a through c illustrates other usable transversal ridge profiles, FIG. 4d showing an example of a more complex ridge.

The dimensions in millimeters of the ridges shown in FIG. 4 are as follows:

FIG. 4a; 41—42=10, 45—46=9.5, curvature radius 43=1.

FIG. 4b; 51—52=10, 54—55=5, 55—56=8.5, curvature radius 53=2.

FIG. 4c; 61—62=12, 63—64=5, 66—67=9, curvature radius 59, 59 and 60=2.

FIG. 4d; 71—72=8, 73—74=9, curvature radius 75 and 76=4.

The transversal dimensions of the guide shown in FIGS. 4a to 4d, are the same as those of the guide shown in FIG. 1.

As already stated for the ridge shown in FIG. 1, the ridges shown in FIG. 4 are suitable to be used with two row radiating slot waveguides.

FIG. 5a is a perspective view, with a part thereof cut away, of a portion of the ridged slotted guide according to FIGS. 1, 2 and 3, and FIG. 5b is an enlarged perspective view of a portion of FIG. 5a. In these figures, as in FIG. 1, the heights ef , gh vary along the ridge.

FIG. 6 shows in perspective the whole of the slotted ridged guide including, from the input of the guide to the output; the $\lambda/4$ step matching, the rectangular ridged portion, the two shouldered ridged portions, and the transition portions between the rectangular and the first shouldered portion and between the two shouldered portions. In order to avoid confusing dotted lines, the figure is drawn with the assumption that the guide is partly broken away. Also, only some of the slots are shown in FIG. 5a. As in FIG. 3, different scales are used for the vertical and longitudinal dimensions. Again, for the sake of clarity, conventional dotted lines showing hidden edges have been omitted in FIG. 5a, 5b and 6.

All the above examples relate to standard waveguides used in the X-band; it is however to be understood that the invention is also applicable to the guides used in other frequency bands.

In the case of waveguides having a single row of radiating slots, the transversal profile of the ridge must present a recess opposite the slots.

Other things being equal, a smaller phase velocity will be obtained by providing a radiating slot in the central portion of a transversal slot having two non radiating lateral portions.

The slotted waveguides according to the invention present the following advantage over conventional ridge waveguides:

(a) A wide range of phase-velocities may be obtained; in particular the radiation pattern may be directed along angles, for example down to 10° , with small inclination to the longitudinal axis of the guide.

(b) The gradual variation of the longitudinal profile of the ridge makes it possible to obtain a wide range of phase-velocities, and thus allows an easy modulation of the radiation diagram in the longitudinal plane of the guide.

(c) The power handling capacity is better than with conventional ridge waveguides.

Of course, the invention is not limited to the embodiments shown which were given only by way of example.

What is claimed is:

1. A waveguide portion comprising: a first and a second opposite sidewall, said first sidewall having one row of radiating slots; said second sidewall having a ridge whose height in front of said row in any cross-section along said portion is less than its maximum height in said cross-section.

2. A waveguide, at least one longitudinal portion of which comprises: a first and a second opposite sidewall, said first sidewall having at least one row of radiating slots, said row being parallel to the longitudinal dimension of said first sidewall; said second sidewall being a ridged sidewall and the height of said ridged sidewall in front of said row being, in any cross-section of said portion, less than its maximum height in said cross-section.

3. A waveguide portion comprising: a first and a second opposite sidewall, said first sidewall having a longitudinal central part, two rows of radiating slots in said first sidewall, said rows being parallel to the longitudinal dimension of said first sidewall and being respectively located on the two sides of said central part; said second sidewall having a ridge, the height of which in front of said two rows, in any cross-section of said portion, being less than its height in front of said central part in said cross-section.

4. A waveguide portion comprising: a first and a second opposite sidewall; at least one row of radiating slots and at least one row of non-radiating slots in said first sidewall, said row being parallel to the longitudinal dimension of said first sidewall; said second sidewall being a ridged sidewall, the height of said ridged sidewall being, in front of said row of non-radiating slots, in any cross-section, greater than its height in front of said row of radiating slots in said cross-section.

5. A waveguide portion comprising: a first and a second opposite sidewall, said first sidewall having a longitudinal center part; a first row of non radiating slots in said first sidewall, said row extending along said center part; a second and a third row of radiating slots, said second and third rows being parallel to said first row and located on each side thereof; said second sidewall having a ridge the height of which, in front of said first row in any cross-section along said portion, is greater than its height in front of said second and third rows.

6. A waveguide comprising a plurality of longitudinal portions, each of which comprises: a first and a second opposite sidewall; at least one row of radiating slots in said first sidewall, said row being parallel to the longitudinal dimension of said first sidewall; said second sidewall being a ridged sidewall, the height of which in front of said row being, in any cross-section along said portion, less than its maximum height in said cross-section; the maximal height of said ridged sidewall in each of said longitudinal portion being constant, the respective maximal heights being different in said longitudinal portions.

7. A waveguide portion comprising: a first and a second opposite sidewall, said first sidewall having a longitudinal central part; two rows of radiating slots in said first sidewall, said rows being parallel to the longitudinal dimension of said first sidewall and being located in the

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two sides of said central part respectively; said second side-wall having a ridge, the total width of which is approximately half the width of said guide, said ridge comprising a central longitudinal part in front of said central part of said first sidewall, and two lateral longitudinal parts, said central part of said ridge having a first substantially constant height, and said two lateral parts a second substantially constant height differing from said first constant height.

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