Jan. 23, 1962 L. THOUREL 3,018,480

IMPROVEMENTS IN AERIALS OF THE COSECANT-SQUARED TYPE

Filed Dec. 1, 1959

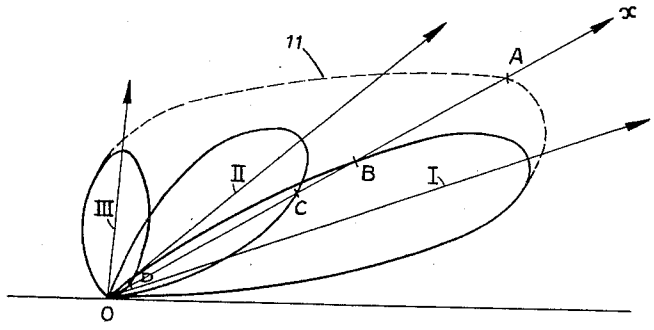


FIG. 1

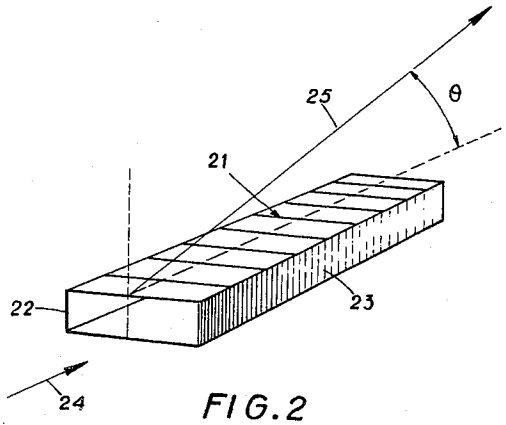


FIG. 2

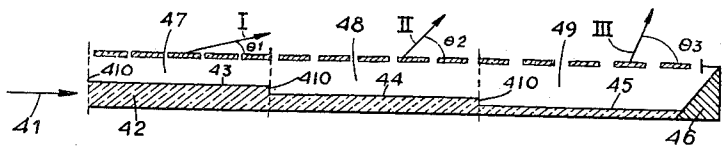


FIG. 3

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IMPROVEMENTS IN AERIALS OF THE COSECANT-SQUARED TYPE

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The present invention relates to directional ultra high frequency aerials. More particularly, it relates to aerials whose radiating pattern is of the cosecant-squared type.

Aerials having this type of radiation pattern are currently associated with high coverage air field approach surveillance radars. However, in so far as airborne radars are concerned, the considerations tied to aerodynamics and to space requirements rapidly become of prime importance.

It is an object of the present invention to remedy the difficulties which generally arise in this respect by providing a flat aerial, capable of being rapidly mounted in an aircraft for association with a radar system which may be, for example, aimed at exploring the underlying ground.

An aerial according to the invention comprises a wave-guide, one of the large sides of which is slotted while the opposite side supports within the guide a dielectric body, the thickness of which changes at intervals.

The radiation pattern of the aerial is adjusted to the desired configuration by adjusting the thickness of the dielectric body, which may form a layer, and the width of the slots.

The invention will be best understood from the following description given by way of example, with reference to the appended drawing, in which:

FIG. 1 is a radiating pattern obtained with an aerial of the invention;

FIG. 2 shows a wave-guide with radiating slots of the known type;

FIG. 3 is an axial cross-sectional view of an aerial according to the invention.

As is well known, the general radiation pattern **11** of an aerial may be obtained by adding elementary patterns I, II, and III as shown in FIG. 1. The field radiated in any direction, such as for example the direction Ox, is given by the vector $\overline{OA}$ and its magnitude is:

$$\overline{OA}=\overline{OB}+\overline{OC}+\overline{OD}$$

$\overline{OB}$, $\overline{OC}$ and $\overline{OD}$ being the respective radiation vectors corresponding to elementary diagrams I, II and III.

An aerial according to the invention comprises a slotted wave-guide **23**, such as that shown in FIG. 2; the slots **21** are cut in one of the large walls **22** of guide **23**. They are spaced apart from one another, for example by a quarter of a wavelength. When ultra high frequency energy is fed to the guide of FIG. 2 from one of its ends, for example end **24**, it radiates in a direction **25** making an angle θ with the plane of the slots.

As is well known, this angle is defined by the equation

$$\cos\theta=\frac{\lambda}{\lambda_g}$$

where λ and λ_g are the lengths in the air and in the wave guide respectively of the operating wave.

According to the invention, wave guide **23** comprises a dielectric body. For example the bottom of wave guide **23** is covered with a layer of dielectric material **42**, such as Teflon or a ceramic material, as shown in section in FIG. 3. The guide is thus divided in a plurality of wave-guide sections, **47**, **48** and **49**, the thickness of the dielectric layer **43**, **44** and **45** being different in each section and decreasing from the input end **41** of the guide to the opposite end. Energy is fed to the guide at the input end **41**, the opposite end being coupled to a matched load **46**. The described structure results in the wave length λ_g varying from one guide section to the adjacent one, angle θ varying accordingly and being smaller as the wavelength in the guide is greater, i.e. the dielectric layer thicker.

The system of FIG. 3 makes it possible to obtain a radiation pattern of the type shown in FIG. 1. By adjusting the respective amounts of dielectric material **43**, **44** and **45**, guide sections **47**, **48** and **49** can be caused to radiate along the radiation patterns I, II and III respectively, the axes of these patterns being inclined to the upper surface of the guide by angle θ_1, θ_2 and θ_3 respectively.

In addition, the radiating pattern can be further adjusted by providing guide sections **47**, **48** and **49** with slots having different widths which may, for example, increase from one section to the other in the order named. As well known, the radiation coefficient, by a slot having a given length, i.e. the ratio of the energy radiated by said slot to the energy propagating in the guide, is substantially proportional to the width of the slot, consequently, the width of the successive slots is a parameter for adjusting the radiation pattern.

It will be understood that the invention is not limited to the embodiment described which has been given only by way of example. Thus, a different number of wave guide sections could be used and the dielectric body need not form a continuous layer covering the bottom of the guide but may have any other shape or position.

What is claimed is:

1. An aerial comprising a wave-guide having two large and two small sides and two ends and including a plurality of guide portions of the same cross section, one of said large sides having equally spaced slots; and respective dielectric bodies having respective constant cross-sections in said guide portions, the volume of said bodies decreasing from one end of said guide to the other.

2. An aerial comprising a wave-guide having two large and two small sides and two ends including a plurality of guide portions of the same cross section, one of said large sides having equally spaced radiating slots; respective dielectric layers in said portions, said layers covering the other large side and the thickness of said layers decreasing from one end of said guide to the other.

3. An aerial comprising a wave-guide having two large and two small sides and two ends and including a plurality of guide portions of the same cross section, one of said large sides having equally spaced radiating slots; respective dielectric layers in said portions, said layers covering the other large side and the thickness of said layers decreasing from one end of said guide to the other and being constant in each of said guide portions.

4. An aerial comprising a wave-guide having two large and two small sides and two ends and including a plurality of guide portions of the same cross section; equally

spaced radiating slots in one of the large sides; the width of said slots increasing from one end of said guide to the other; respective dielectric bodies in said portions, the volume of said bodies decreasing from said one end of said guide to said other end.

5. An aerial comprising a wave guide having two large and two small sides and two ends and including a plurality of guide portions, one of said large sides having equally spaced radiating slots; respective dielectric layers in said portions, said layers covering the other large side and the thickness of said layers decreasing from one end of said guide to the other and the width of said slots increasing from one end to said other end and being constant in each of said guide portions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,405,242	Southworth	Aug. 6, 1946
2,433,368	Johnson et al.	Dec. 30, 1947
2,447,549	Willoughby	Aug. 24, 1948
2,822,542	Butterfield	Feb. 4, 1958

FOREIGN PATENTS

902,510	Germany	Jan. 25, 1954
1,014,722	France	June 18, 1952