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SLOTTED WAVEGUIDE ANTENNA ARRAY PROVIDING DUAL FREQUENCY OPERATION

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FIG. 1.

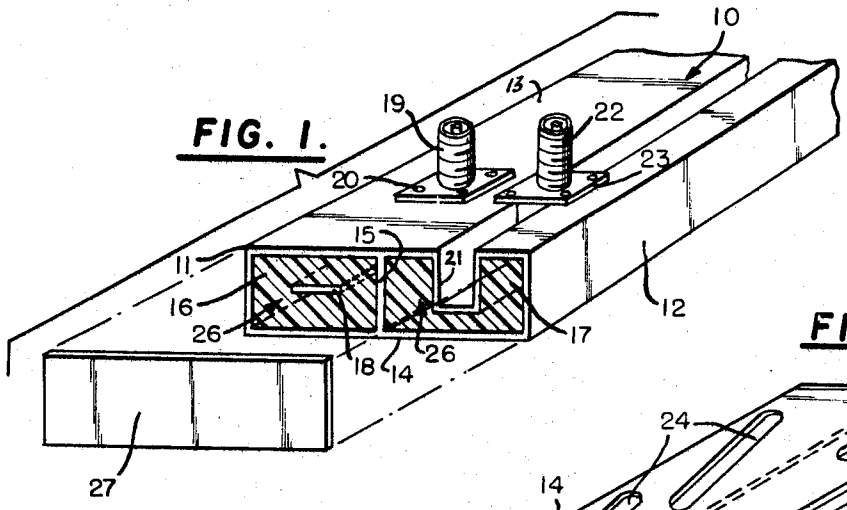


FIG. 2.

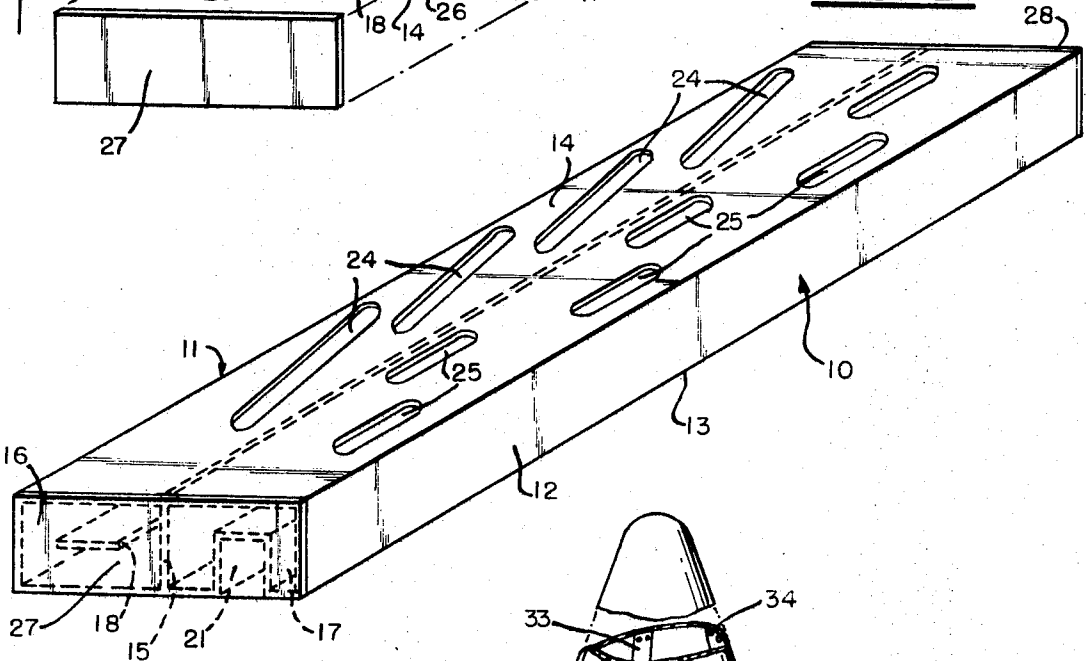
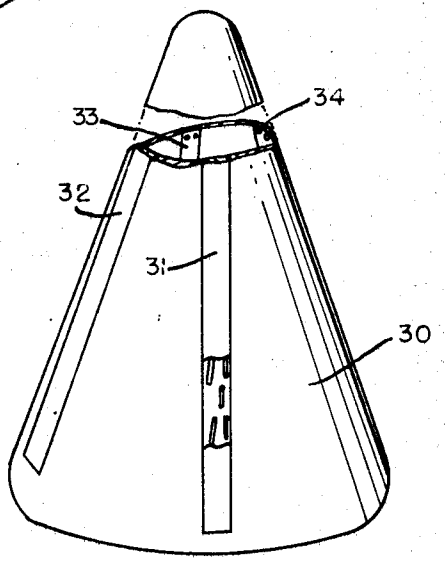


FIG. 3.



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SLOTTED WAVEGUIDE ANTENNA ARRAY PROVIDING DUAL FREQUENCY OPERATION

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U.S. Cl. 343—771 8 Claims

ABSTRACT OF THE DISCLOSURE

An improved slotted waveguide antenna capable of operating in two frequency bands. The antenna structure comprises a one-piece metal extrusion providing separate antenna sections arranged so as to achieve good isolation between signals in the two bands.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an improved slotted waveguide antenna capable of operating in two frequency bands e.g. the "L" and "S" bands; and is more particularly concerned with an antenna of the type described wherein the antenna structure comprises a one-piece metal extrusion having a configuration providing separate antenna sections operable in two different frequency bands but so arranged as to achieve good isolation between signals in said two bands notwithstanding the fact that common portions of the same extrusion are used in both antenna sections.

Various forms of waveguide antenna configurations are presently known adapted to operate in different frequency bands. The actual band in which any given antenna may operate is determined by its size and configuration. When it has been desired to provide an antenna array capable of operation in more than a single band, it has been the practice heretofore to select individual antenna constructions corresponding in configuration respectively to the particular frequencies to be received or transmitted, and then to assemble these different waveguide antennas in an appropriate array which provides necessary isolation between the different sections of the array. An array of these known types is normally relatively large in size; and this size consideration often renders the array impractical for certain uses e.g. on the surface of conventional missile bodies. Suggestions have been made heretofore dealing with possible techniques for making such arrays more compact, but these prior suggestions have never considered it practicable to provide a waveguide antenna utilizing a one-piece extrusion for operation in plural bands. In this respect, it has been believed heretofore that such a one-piece structure would necessarily produce undesired interference between the sections of the structure intended for operation at different frequencies, and moreover, it has been considered that any such composite structure would necessarily be so costly and complex as to render it impractical for actual use.

The present invention, recognizing these considerations, is concerned with a dual frequency waveguide antenna comprising an extrusion of unique configuration providing, in a single compact structure, separate waveguide antenna sections operating in different frequency bands, which also provide sufficient isolation between said different frequencies of operation to allow very satisfactory performance of the structure in most radar systems. In this respect, moreover, the present invention is adapted to provide the foregoing operational characteristics in a structure which can be fabricated at relatively low cost.

It is accordingly an object of the present invention to provide an improved dual frequency waveguide antenna.

Another object of the present invention resides in the provision of a dual frequency waveguide antenna comprising a single metal extrusion defining separate antenna sections operable respectively in different frequency bands.

A further object of the present invention resides in the provision of a metallic extrusion having different antenna sections associated with dissimilar slot orientations in a common wall of said extrusion for providing isolation between different frequencies of operation.

Another object of the present invention resides in the provision of a one-piece extrusion capable of being fabricated at relatively lost cost, and capable of operation as a dual-frequency antenna.

A still further object of the present invention resides in the provision of an improved dual-frequency antenna having far greater compactness than has been the case heretofore, rendering the antenna usable in environments wherein dual-frequency antennas have been considered impractical heretofore e.g. on missile bodies.

The invention will now be described in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of a dual-frequency antenna constructed in accordance with the present invention;

FIG. 2 is a view similar to FIG. 1 showing the reverse side of the antenna of FIG. 1; and

FIG. 3 is an illustrative representation of a typical missile body utilizing dual-frequency antennas of the types contemplated by the present invention.

Referring initially to FIGS. 1 and 2, the dual-frequency slotted waveguide antenna of the present invention comprises a one-piece double channel extrusion **10** formed, e.g., of aluminum. The extrusion **10** includes a pair of sidewalls **11** and **12**, and a pair of lateral boundary walls **13** and **14** extending between sidewalls **11** and **12**. The extrusion further includes an interior wall **15** integral with extending between the lateral boundary walls **13** and **14** and dividing the one-piece aluminum extrusion into two waveguide sections designated **16** and **17**.

Waveguide section **16** is substantially rectangular in cross section and is bounded by sidewall **11** and interior wall **15** of the extrusion **10** as well as by portions of the lateral walls **13** and **14**. A rod **18** of rectangular cross section extends through the center of waveguide section **16** whereby said section **16** constitutes a coaxial transmission line adapted to propagate energy in the TEM coaxial mode. Section **16** of the extrusion may be fed from a 50 ohm coaxial line connected to a coupling **19**

mounted by any appropriate means, e.g., fitting **20**, on lateral wall **13** of the extrusion.

In the region of waveguide section **17**, lateral wall **13** is shaped to provide a rectangular indentation **21** extending toward a portion of lateral wall **14** and acting as a loading ridge formed as a unitary portion of the overall extrusion. Waveguide section **17** accordingly acts as a single ridge waveguide, and may also be fed from a 50 ohm coaxial line whose impedance is matched to the ridge waveguide, said line being connected to a further coupling **22** also mounted on lateral wall **13** of the extrusion **10** by means such as a fitting **23**.

By reason of the configuration of extrusion **10**, two waveguide sections **16** and **17** are provided for operation in two different bands. These two sections are associated with a common lateral wall **14**; and this lateral wall is appropriately slotted to effect appropriate coupling between the waveguide sections and space. More particularly, lateral wall **14** is provided with a plurality of inclined slots **24** extending in generally parallel relation to one another but at an angle to the longitudinal axis of waveguide section **16** for coupling electromagnetic energy propagating in waveguide **16** to space. The same wall **14**, in the region of waveguide **17**, is provided with a plurality of longitudinal (shunt) radiating slots **25** extending in directions generally parallel to one another and parallel to the longitudinal axis of the waveguide **17**. The resultant array of slots **25**, associated with the ridge waveguide **17**, operates to propagate energy in the TE_{10} mode.

In a preferred embodiment of the invention each of the waveguide sections **16** and **17** is filled with dielectric foam **26** to improve the rigidity of the overall structure. Moreover, the opposing ends of the dual-frequency waveguide antenna formed by extrusion **10** are preferably closed by a pair of aluminum plates **27** and **28**.

In accordance with one embodiment of the invention the one-piece double channel extrusion **10** is dimensioned to provide sidewalls **11** and **12** having a height of 0.6 inch, and the lateral walls **13** and **14** have an overall width of 2.4 inches. With these dimensions, the rectangular coaxial waveguide section **16** operates in the "L"-band, and the ridge waveguide section **17** operates in the "S"-band. The complete antenna assembly, designed for simultaneous operation in these two different frequency ranges, has the feature of compactness and small volume, and is, overall, far smaller in size than a pair of standard size slotted waveguide antennas operable in the "L" and "S" bands. Notwithstanding the design compactness and close proximity of each array, and notwithstanding the fact that the radiating slots **24** and **25** are formed in the same wall **14** of the extrusion **10**, good isolation is obtained between the two arrays by reason of the dissimilar slot orientation of the slots **24** and **25** respectively. The overall efficiency of the structure is good, as is its electrical performance (gain and sidelobe characteristics) over a very reasonable band width. The dimensional tolerances of the double channel extruded guide are very satisfactory, and its fabrication cost is far less than that of standard single channel guides.

Due to the compactness of the one-piece extrusion dual-frequency waveguide antenna described above, the structure of the present invention can be placed on the surface of conventional missile bodies with relative ease, where the considerably larger size of a pair of conventional slotted waveguide antennas would render their use impractical. A dual-frequency antenna system constructed in accordance with the present invention and mounted on the surface of a typical missile body is illustrated in FIG. 3. A conical missile structure is illustrated at **30**; and a plurality of dual-frequency antennas **31–34** inclusive are mounted as illustrated at various spaced locations about missile structure **30** to provide substantially omnidirectional coverage.

It will be readily understood by skilled persons that the foregoing embodiments are only exemplary and that many

variations are possible within the scope of the invention as defined in the appended claims. It may be noted that each antenna or waveguide section can be terminated with a waveguide-to-coaxial adapter connected to a matched resistive load; such a device would absorb the energy incident on it, thus reducing the reflected energy directed toward the source. It may also be noted that the use of foam dielectric in each waveguide channel eliminates the need for an electromagnetic window or cover that is normally placed over the slotted wall to provide a pressure barrier and to keep out moisture and foreign matter.

Having thus described my invention, I claim:

1. A dual frequency waveguide antenna comprising an elongated one piece hollow metallic extrusion of rectangular cross-section having an integral interior wall extending in the direction of elongation of said extrusion and dividing said one-piece extrusion into first and second waveguide sections, said first and second waveguide sections being disposed in side-by-side relation to one another on opposite sides of said interior wall and having a common boundary wall constituting a lateral wall of said extrusion extending transverse to said interior wall, first and second means for separately feeding said first and second waveguide sections with energy in different frequency bands respectively, and a plurality of slots in said common boundary wall for coupling energy propagating in said first and second waveguide sections to space, said plurality of slots comprising a first array of radiating slots formed in said common boundary wall adjacent said first waveguide section and spaced from one side of said integral interior wall, said plurality of slots further comprising a secondary array of radiating slots formed in said common boundary wall adjacent said second waveguide section and spaced from the other side of said integral interior wall, the orientation of slots forming said first array being different from the orientation of slots forming said second array to effect isolation between energy in said different frequency bands.

2. The antenna of claim **1** wherein said extrusion defines a further common boundary wall extending across said first and second waveguide section transverse to said interior wall and positioned in opposing relation to said first-mentioned common boundary wall, said further common boundary wall defining an elongated rectangular depression adjacent one of said waveguide sections extending in one dimension in the direction of elongation of said elongated extrusion and extending, in another dimension, in a direction generally parallel to said interior wall and toward a portion of said first-mentioned common wall bounding said one of said sections, said elongated depression acting as a loading ridge whereby said one of said waveguide sections operates as a ridge waveguide.

3. The antenna of claim **2** wherein the other of said waveguide sections includes an elongated rod centrally disposed therein and extending in the direction of elongation of said extrusion, whereby said other waveguide section operates as a rectangular coaxial transmission line.

4. The antenna of claim **3** wherein said extrusion, common boundary walls, interior wall, rectangular depression, and slots are so dimensioned that said one waveguide section propagates energy in the "S" band and in the TE_{10} mode, and said other waveguide section propagates energy in the "L" band and in the TEM mode.

5. The antenna of claim **1** wherein said extrusion comprises a hollow aluminum structure, the opposing ends of said hollow structure being closed respectively by a pair of metallic plates.

6. The antenna of claim **1** wherein said first array of slots comprises a plurality of slots extending substantially parallel to one another and at an angle to the direction of elongation of said extrusion, said second array of slots comprising a further plurality of slots extending substantially parallel to one another and substantially parallel to the direction of elongation of said extrusion.

7. The antenna of claim 1 including a conical missile structure, said metallic extrusion being mounted in a side wall of said conical structure.

8. The antenna of claim 1 wherein each of said waveguide sections is filled with dielectric foam.

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