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CAVITY LOADED SLOT ANTENNA

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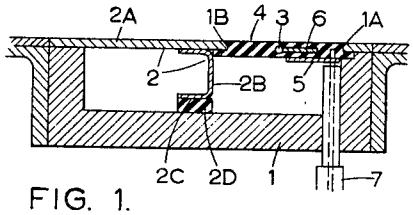


FIG. 1.

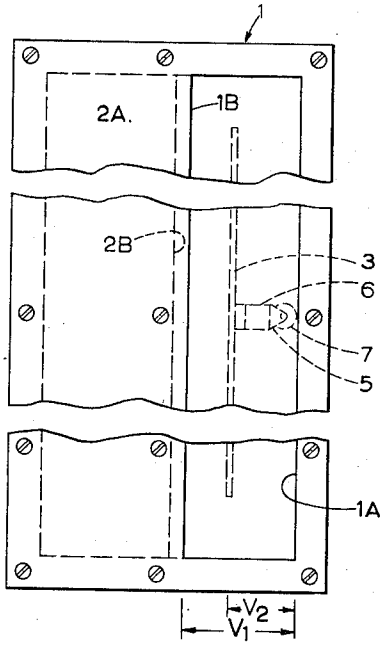


FIG. 2.

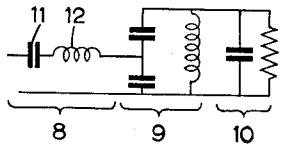


FIG. 3.

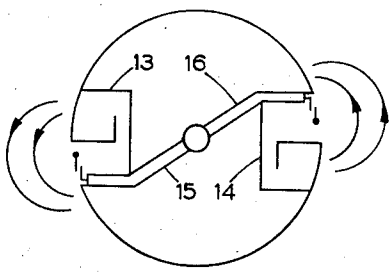


FIG. 4.

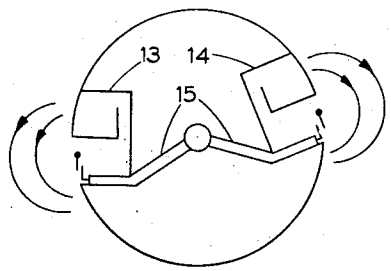


FIG. 5.

Inventor
F. J. H. Charman
By Glascock Downing & Seebold
Attys.

United States Patent Office

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CAVITY LOADED SLOT ANTENNA

Frederick John Henry Charman, Lightwater, Surrey, England, assignor to Electric & Musical Industries Limited, Hayes, England, a company of Great Britain

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9 Claims. (Cl. 343—767)

This invention relates to aerials.

The problem is sometimes encountered of providing an aerial on a vehicle or mast structure where the space available for the aerial is small and the aerial must not extend outside the surfaces of the vehicle. The natural approach to the solution of such a problem is to employ a slot aerial but even for such an aerial there may be insufficient internal space to provide the quarter-wave resonant cavity necessary to obstruct radiation into the interior of the vehicle.

The object of the present invention is to reduce the difficulty indicated and at the same time to provide an aerial with broad band characteristics.

According to the present invention there is provided a slot aerial comprising a slot formed in the wall of a resonant cavity, the cavity having a dimension smaller than required for resonance at a desired frequency and capacitive loading means being provided in the cavity to tune the cavity to resonance at said desired frequency. The capacitive loading is preferably provided by means of a longitudinal baffle and it reduces the effective phase velocity for energy in the cavity, so that tuning of the cavity to resonance in the desired frequency band can be achieved by choosing the capacitive loading required to give the appropriate phase velocity.

In order that the invention may be clearly understood and readily carried into effect, the invention will be described with reference to the accompanying drawings, in which:

FIGURE 1 is a cross sectional view of a slot aerial according to the invention,

FIGURE 2 is a fragmentary plan view of the aerial,

FIGURE 3 is the equivalent circuit of the aerial shown in FIGURES 1 and 2, and

FIGURES 4 and 5 illustrate diagrammatically slot aerials according to the invention mounted on a mast structure.

The aerial shown in FIGURES 1 and 2 of the drawing is formed by means of a cavity in a part of the outer casing 1 of a vehicle. The cavity in this example is about four inches wide, one inch deep and eighteen inches long. The cavity behaves as a waveguide and is formed as a folded cavity by virtue of a baffle 2, so that the cavity is tuned to resonance in a desired frequency band. The baffle 2 comprises a plate 2A extending longitudinally from one end of the cavity to the other and extending laterally from one side approximately half way to the other side. It comprises furthermore a web 2B extending from the plate 2A nearly to the bottom of the cavity where the web 2B is provided with a flange 2C spaced from the bottom of the cavity by di-electrical material 2D. In some cases the di-electric material 2D may be dispensed with. By virtue of the baffle 2, the cavity has the form of a cavity folded about a longitudinal axis and the baffle provides capacitive loading sufficient to bring the cavity to resonance at a desired frequency in the working band, the length of the cavity (the vertical dimension of FIGURE 2) being only a fraction of that which would be required for quarter wave resonance at that frequency with the phase velocity which would prevail in the absence of the capacitive loading. The cavity is represented in the drawing as conforming to a rectangular prism, but it may in fact be curved to conform to the surface of the vehicle on which it is provided. For example it may be curved about an axis normal to the plane of the web 2A, the part 1 being for example of ring formation. The slot which forms the radiating element of the aerial is bounded by the edge 1A of the cavity and by the edge 1B of the baffle and it extends the full length of the cavity to give the maximum conductance load on the cavity. The shunt resistance of a half-wave slot radiating into half-space is 1,000 ohms. The slot shown, nearly $3\lambda/4$ long, provides a load of about 500 ohms and some capacitive load which is taken into account in resonating the cavity. However the working characteristic impedance of the cavity is lower than this value, and the bandwidth of the aerial would be too restricted for many applications. In order to increase the bandwidth, a linear conductor or rod 3 is disposed within the slot, its position being adjusted so that it "taps" into the electric field across the slot and provides a transformer with turns ratio V_2/V_1 as indicated. The linear conductor 3 behaves as a transmission line in series with the feed which is provided by a coaxial line 7, and the length of the conductor 3 is adjusted to provide inductive reactance. Series capacitance is added at the feed point of the arrangement, for example by conductive films 5 and 6 the former of which is deposited on the under surface of a di-electric window 4 which closes the slot and is connected to the inner conductor of the aerial feed line 7, and the latter of which is embedded in the di-electric window 4 and connected to the conductor 3. The equivalent circuit of the aerial is shown in FIGURE 3 and as can be seen it represents a half section constant-k band pass filter comprising a series resonant circuit 8, a parallel resonant circuit 9 and an admittance 10. The capacity 11 of the series resonant circuit is introduced mainly by the conductive films 5 and 6 and the inductance 12 is provided mainly by the conductor 3. The parallel resonant circuit 9 is provided mainly by the cavity and the series and parallel resonant circuits are in effect coupled by tapping the series resonant circuit to an intermediate point in the capacitive arm of the parallel resonant circuit, the tapping point being determined by the position of the conductor 3 in the slot. The admittance 10 is provided by the slot, the reactive component of this admittance being, as aforesaid, taken into account in tuning the cavity.

A principal advantage of the present invention is that it reduces the volume required for the cavity and it allows the use of a slot which is considerably longer than half-wave length, thus allowing for heavy radiation loading and increased bandwidth.

In some cases a small variable capacitance, not shown, may be provided between the flange 2C and the bottom of the cavity for the purpose of practical adjustment of the resonant frequency. Moreover more than one aerial such as shown in the drawing may be provided on a single vehicle. For example two such aerials may be provided opposite each other and formed around the circumference of a cylinder, being for example built into a ring which is part of the structure of the vehicle.

The invention is not confined to the provision of aerials on vehicles but may be applied to aerials used for U.H.F. and V.H.F. broadcasting. In such applications, the invention is particularly advantageous where it is desired to provide aerials on masts of relatively small diameter, the slots being vertical when horizontal polarization is required and being circumferential when vertical polarization is required. FIGURES 4 and 5 illustrate the provision of two aerials 13 and 14 in accordance with the invention on opposite sides of the mast, the mast being represented in horizontal section and the slots being vertical for horizontal polarization. The aerials are each constructed substantially as illustrated in FIGURES 1

and 2. In the example shown in FIGURE 4 the two aerials **13** and **14** are arranged to radiate in phase whereas in the example shown in FIGURE 5 the two aerials **13** and **14** are arranged to radiate in antiphase, the antiphase radiation being achieved simply by turning one aerial upsidedown with reference to the other. In both cases feeder lines **15** and **16** of equal lengths are provided from a common feed point **17** to the two aerials.

What I claim is:

1. A slot aerial comprising a resonant cavity having two substantially parallel oblong walls, a slot formed in one of said oblong walls, said slot extending longitudinally along the oblong wall and being disposed nearer to one of the long edges of said wall than the other, the cavity being provided with a baffle connected to and projecting from said first mentioned oblong wall towards the parallel wall and being formed with a flange parallel to but insulated from said parallel wall, said baffle extending longitudinally from one end of the cavity to the other and being such as to have the effect of folding the cavity about a longitudinal axis, and said flange providing capacitive loading means to tune the cavity to resonance at a desired frequency, the cavity having a dimension which in the absence of said loading is smaller than required for resonance at said desired frequency.

2. A slot aerial according to claim 1 comprising means for supplying energy to said slot, said means including a capacitive reactance connecting in series with a conductor disposed in the slot, said conductor being substantially parallel to the longitudinal edge of the slot and being dimensioned and positioned to provide inductance which forms with said capacitive reactance a series resonant circuit coupled to the cavity to increase the bandwidth of the aerial.

3. An aerial array comprising a plurality of slot aerials each according to claim 1, one aerial being turned upside-down with respect to another so as to radiate in anti-phase with respect to said other aerial.

4. A slot aerial according to claim 1, said loading means comprising a longitudinal baffle extending parallel to the slot and between the slot and said other edge, and said baffle being conductively attached to said oblong wall, and means being provided for injecting energy to be radiated into the cavity at the slot.

5. A slot aerial comprising a slot formed in the wall of a resonant cavity, the cavity having a dimension smaller than required for resonance at a desired frequency and being provided with capacitive loading means to tune the cavity to resonance at said desired frequency and comprising means having capacitive reactance connected to a conductor disposed in the slot for applying energy to the slot, said conductor being dimensioned and positioned to provide inductance which forms with said capacitive reactance a series resonant circuit coupled to the cavity to increase the band width of the aerial.

6. A slot aerial according to claim 5, wherein said capacitive loading means comprises a longitudinal baffle.

7. A slot aerial according to claim 5 wherein the slot extends substantially the whole length of the cavity.

8. A slot aerial according to claim 6, wherein said baffle extends longitudinally from one end of the cavity to the other and is such as to have the effect of folding the cavity about a longitudinal axis.

9. An aerial array comprising a plurality of slot aerials each according to claim 8, one aerial being turned upside-down with respect to another so as to radiate in anti-phase with respect to said other aerial.

References Cited in the file of this patent

UNITED STATES PATENTS

2,414,266	Lindenblad	Jan. 14, 1947
2,642,529	Frankel	June 16, 1953
2,684,444	Fales	July 20, 1954
2,942,263	Baldwin	June 21, 1960