Nov. 11, 1952 E. B. McMILLAN ET AL 2,617,934

ANTENNA HOUSING

Filed May 2, 1945

FIG. 1

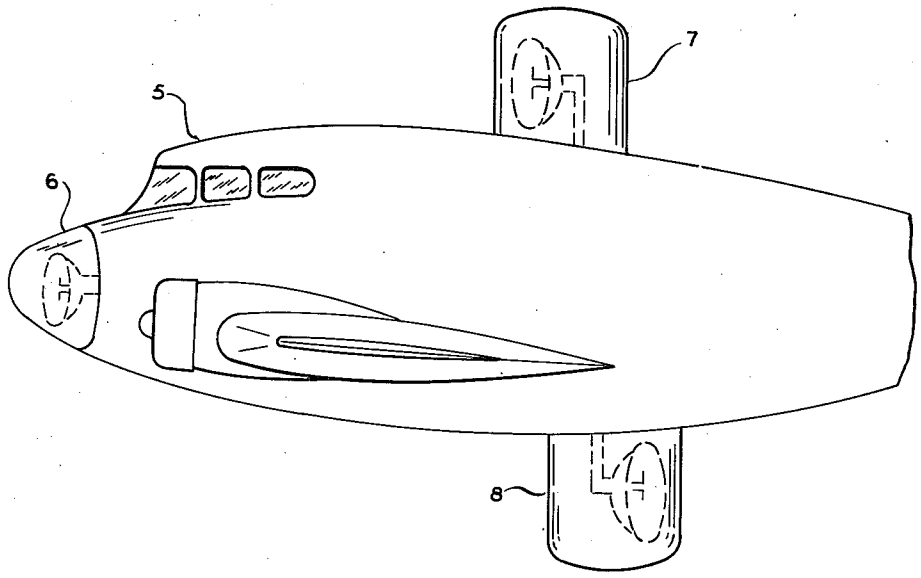
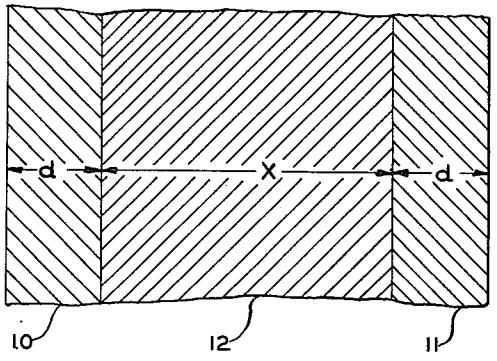


FIG. 2



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ANTENNA HOUSING

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1 Claim. (Cl. 250—33)

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This invention relates in general to antenna housings and more particularly to antenna housings having laminated construction.

In radio communication systems employing carrier frequencies in the ultra high frequency and microwave bands, it is practicable to use antenna housings because of the reduced size of the antenna apparatus. Such housing plays an important part in antenna assemblies because it protects delicate antenna assemblies against inclement weather, blows from solid objects, and strong wind pressures encountered in airborne installations.

A housing, consisting of one layer of plywood, plastic, or other material which is transparent to radio energy, will afford the advantages mentioned above. However, the electromagnetic waves radiated from the antenna within the housing will be reflected at least in part from any surface which separates media of different di-electric constants. This means that, in general, there will be reflection from the housing, since any material of which it may be made will have a dielectric constant appreciably different from that of the surrounding air. Such reflections reduce the amount of electromagnetic energy eventually transmitted through the wall; moreover, these reflections distort the predetermined energy distribution pattern of the antenna.

In many high frequency radio communication systems, it is desired to enclose in a housing a highly directional rotatable antenna. The magnitude and phase of the energy reflected by the housing wall may vary with the position of the antenna because of non-uniform transparency of the housing. A portion of the reflected energy may be absorbed by the antenna and communicated back to the transmitter so that a non-uniform impedance is presented to the radio frequency generator. This may result in a condition of frequency instability.

Therefore, it is one object of the present invention to provide an antenna housing which minimizes undesirable reflections.

Another object is to provide an antenna housing which will have desired transmission characteristics and will also protect antenna assemblies from wind, weather, and accidental blows, and which is lightweight, yet strong.

These and further objects of this invention will be evident to those skilled in the art upon reference to the following specification, claim, and drawings, in which:

Fig. 1 shows several possible antenna installations to which a housing of the type disclosed herein is especially adaptable; and

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Fig. 2 shows a cross-sectional view of the wall construction of such a housing.

Briefly, the invention consists of laminating two dissimilar materials in a "sandwich" fashion, yielding a three-ply sheet with a low density, low dielectric core surrounded by thin skins of high mechanical strength. The materials comprising the sheet may be of a nature which lends itself readily to forming into suitable housing shapes by a molding process.

Referring now to Fig. 1, three possible types of housings adapted to airborne systems are shown. An airplane 5, carrying an ultra high frequency radio communication system, may have the antenna for the system mounted in the nose of the plane, in which case the housing 6 will be a continuation of the outer skin of the plane. An antenna may also be mounted in a turret-like housing 7 on the upper side of the plane, or alternatively, as at 8, on the under side. These turrets may be retractable if it is so desired. It is to be emphasized that these three alternatives do not exhaust the possible uses of antenna housings but are presented only as examples.

In Fig. 2, a section of housing wall is shown. It consists of two skins 10 and 11 of the same thickness d and di-electric constants α, and a core 12 having a dielectric constant β, and a thickness x.

Double wall housings are well known in the art, having been developed to reduce the objectionable reflections described hereinabove. These double wall housings generally consist of two skins separated by spacers placed at intervals around the housing. A major difficulty with this type of structure is the non-uniform wall thickness, this variable wall thickness affecting the transmission of extremely high frequencies or microwaves through a housing. The wall tolerance is a function of wavelength; the shorter the wavelength, the closer the tolerance. Also, the wall thickness tolerance is a function of skin thickness, tolerance and skin thickness varying inversely. It can be seen that the application of external forces to such a housing may flex the outer skin, altering the skin spacing with adverse effect. Alternatively, if the skin is made thick enough to be rigid, the tolerances allowable are too great to allow ease of manufacture.

The sandwich type housing has the advantages of the simple double wall type without its disadvantages. The core can be manufactured to accurate thicknesses, and very thin, mechanically strong skins can be bonded thereto. The use of a sandwich composition for mechanical strength is not novel. However, heretofore such con-

$$X=\frac{\lambda}{\sqrt{\beta}}\left[\frac{N}{2}-\left(\frac{1}{2\pi}\right)\tan^{-1}\frac{2\sqrt{\alpha\beta}(\alpha-1)\sin\left(4\pi\frac{d\sqrt{\alpha}}{\lambda}\right)}{(\beta-\alpha)(\alpha+1)+(\beta+\alpha)(\alpha-1)\cos\left(4\pi\frac{d\sqrt{\alpha}}{\lambda}\right)}\right]$$

struction has not been made according to optimum electrical properties,

A principal factor in minimizing reflections is the core thickness. It has been found, that for a normally incident electromagnetic wave, it is possible to obtain the optimum core thickness in terms of the other variables of the sandwich, using the expression:

$$X=\frac{\lambda}{\sqrt{\beta}}\left[\frac{N}{2}-\left(\frac{1}{2\pi}\right)\tan^{-1}\frac{2\sqrt{\alpha\beta}(\alpha-1)\sin\left(4\pi\frac{d\sqrt{\alpha}}{\lambda}\right)}{(\beta-\alpha)(\alpha+1)+(\beta+\alpha)(\alpha-1)\cos\left(4\pi\frac{d\sqrt{\alpha}}{\lambda}\right)}\right]$$

where

X=optimum thickness of core 12

λ=free-space wavelength of electromagnetic energy

N=any integer

α=dielectric constant of skins 10 and 11

β=dielectric constant of core 12

d=thickness of skins 10 and 11

A housing constructed according to this relation will exhibit electrical characteristics markedly improved over previous types of housings, and advantages of mechanical strength and ease of manufacture as elaborated hereinbefore. It will, of course, be understood that slight departures from optimum values may be tolerated without substantial loss of the values of the invention.

What is claimed is:

An antenna housing having a wall construction comprising two skins of predetermined thickness spaced apart by a core also of predetermined thickness, said skins being substantially identical in composition and thickness, said skins and said core being of material transparent to radiant electromagnetic energy, said wall being proportioned substantially according to the following relationship:

where

X=thickness of said core

λ=free-space wavelength of electromagnetic energy

N=any integer

α=dielectric constant of said skins

β=dielectric constant of said core, and

d=thickness of said skins

whereby energy reflections from said skins and said core will combine in a subtractive manner when radiant energy is propagated in a direction normal to said housing wall, thus to provide satisfactory transmission characteristics through said housing.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,557,049	Hammond, Jr.	Oct. 13, 1925
2,202,380	Hollman	May 28, 1940
2,223,224	Newhouse	Nov. 26, 1940
2,304,540	Cassen	Dec. 8, 1942
2,376,653	Boyer	May 2, 1945
2,405,992	Bruce	Aug. 20, 1946
2,407,911	Tonks	Sept. 17, 1946
2,413,085	Tiley	Dec. 24, 1946
2,415,352	Iams	Feb. 4, 1947
2,417,052	Benioff	Mar. 11, 1947