343-754 CROSS REFERENCE SEARCH ROOM

June 24, 1958 E. B. McMILLAN 2,840,811
DIELECTRIC BODIES FOR TRANSMISSION OF ELECTROMAGNETIC WAVES
Filed May 17, 1954 2 Sheets-Sheet 1

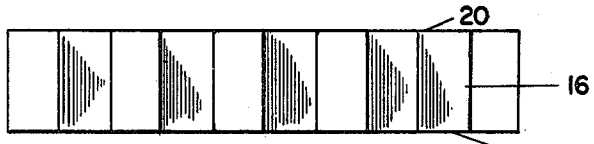


FIG. 1A

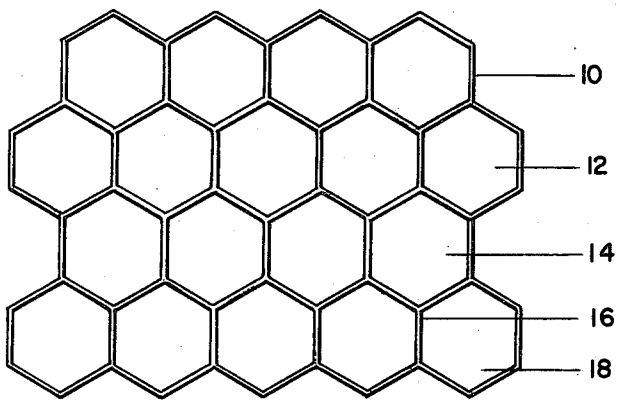


FIG. 1B

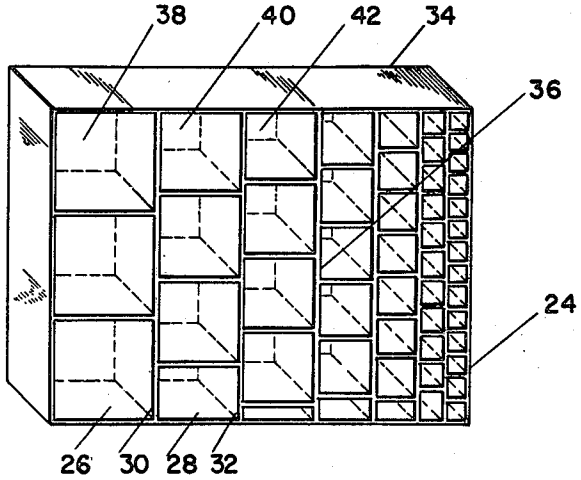


FIG. 2

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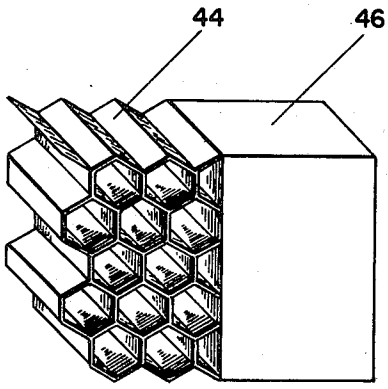


FIG. 3

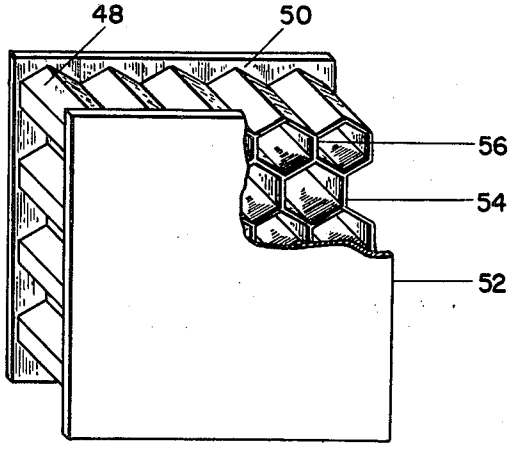


FIG. 4

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2,840,811

DIELECTRIC BODIES FOR TRANSMISSION OF ELECTROMAGNETIC WAVES

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Application May 17, 1954, Serial No. 430,388

4 Claims. (Cl. 343—18)

This invention relates to dielectric bodies for transmission of electromagnetic waves and particularly to a new type of dielectric body which may provide both high strength and light weight.

Dielectric walls for transmission of electromagnetic waves have in general been in the form of dielectric sheets or laminates selected as to material and formed as to shape to provide transmission of electromagnetic waves with minimum or controlled distortion. Such bodies have been too heavy or too weak for certain uses. Efforts to provide a light weight dielectric sheet have produced a foamed resin sheet carrying metallic particles dispersed through it. Such dielectric sheets have often been unsatisfactory where great precision is required because of inherent difficulty in securing and maintaining an even distribution of metallic particles during the process of expanding the resin. That is, portions of the resin expand more than others or in a different manner so that the distribution of metallic particles carried by the resin becomes uneven. Additionally, the dielectric constants of sheets may vary and there is no available means for adjusting the dielectric constant of the foamed sheet to bring it to a desired value.

It is an object of the present invention to provide a new dielectric body providing a high degree of uniformity and capable of being adjusted to a predetermined dielectric constant.

It is a further object to provide a new dielectric body having a high strength in combination with light weight.

According to the present invention there is created a dielectric body operating as a continuous dielectric in which a dielectric effect comparable to that of a continuous dielectric wall is secured through the provision of a multitude of regularly positioned walls disposed at a high angle to a wave receiving surface of the body. The dielectric walls carry metallic particles substantially uniformly distributed in electrically insulated relation and provide a very high dielectric constant along the walls in the direction of propagation of the waves.

Figure 1*a* is an orthogonal view of the edge of a dielectric body constructed in accordance with the present invention;

Figure 1*b* is an orthogonal view of the face of the dielectric body of Figure 1*a*;

Figure 2 is an isometric view of another dielectric body constructed in accordance with my invention;

Figure 3 is an isometric view of the dielectric body of Figures 1*a* and 1*b* abutting a solid dielectric slab;

Figure 4 is an isometric view with a cut-away section showing the dielectric body of Figures 1*a* and 1*b* sandwiched between two dielectric walls.

Example 1

In Figures 1*a* and 1*b* is illustrated a dielectric body constructed in accordance with the present invention. A regular cellular supporting structure **10** composed of repeating cells, such as **12** and **14**, of substantially uniform size and configuration and of dielectric material provides

walls typified by **16** and **18** defining hexagonal prisms normal to the wave receiving faces **20** and **22**. The cells, such as **12** and **14**, have an area taken in a plane parallel to the wave receiving faces **20** and **22** of a size less than cut-off for the electromagnetic waves to be transmitted. Thus wave guide action is avoided. A high dielectric constant along the walls of cells, such as **12** and **14**, is provided by metallic particles which the walls support substantially uniformly distributed in electrically insulated relation in sufficient concentration for the purpose. Since cells, such as **12** and **14**, are disposed at a high angle away from the wave receiving faces **20** and **22**, the dielectric body artifically possesses electrically uniform behaviour in depth. Since it is easy to control the distribution of metallic particles on such faces, a high degree of uniformity can be maintained in securing a predetermined dielectric constant. While the body simulates a solid continuous homogeneous dielectric, its weight can be much less as the cells may be filled with a lighter material or even air. In addition, as the cellular supporting dielectric structure **10** may be very strong, a combination of high strength and low weight can be obtained. Since the dielectric body of Figures 1*a* and 1*b* simulates a continuous dielectric, it may be employed in mixed dielectric constructions to blend with reduced electrical discontinuity with solid dielectric pieces placed against its surfaces and edges.

The cells, such as **12** and **14**, defined prisms whose depth was 0.270 inch and whose cross-sections parallel to the wave receiving faces were equilateral hexagons having a width of 0.144 inch on each side. The walls, typified by **16** and **18**, were 0.015 inch thick and comprised a strip of fiber glass fabric rigidified by a cured phenolic resin and covered on both sides with a 0.0045 inch thick cured coating of the following mixture:

Polyester-styrene resin 100 weight parts
Benzoyl peroxide catalyst 4.5 weight parts
Extra fine aluminum lining powder 25 weight parts

The concentration of uniformly distributed electrically insulated metallic particles in this coating imparted to the walls typified by **16** and **18** a sufficiently high dielectric constant so that the measured dielectric constant of the dielectric body in its entirety was 5.32 at 5000 mc. It possessed the following mechanical strength properties normal to its wave receiving faces **20** and **22**:

Ultimate compressive strength, p. s. i. 609
Ultimate shear strength, p. s. i. 445
Ultimate shear modulus, p. s. i. 21,800
Tensile strength, p. s. i. 488

Its density was only 7.75 pounds per cubic foot.

Example 2

In Figure 2 is illustrated another dielectric body constructed in accordance with the present invention. A regular cellular supporting structure **24** composed of repeating cells, such as **26** and **28**, of uniformly varying size and configuration and of dielectric material provided walls typified by **30** and **32** defining rectangular prisms normal to the wave receiving faces **34** and **36**. The cells, such as **26** and **28**, had an area taken in a plane parallel to the wave receiving faces **34** and **36** of a size less than cut-off for the electromagnetic waves to be transmitted. Thus wave guide action did not take place. The cell walls **30** and **32** were constructed with the material of the cell walls **16** and **18** of Figures 1*a* and 1*b* and coated in the same way with a concentration of uniformly distributed electrically insulated metallic particles, but were filled with polyethylene. In the cellular supporting structure **24** comprising adjacent columns such as **38**, **40** and **42** of successively smaller prisms, the

dielectric constant of the dielectric body was increased in the direction in which the cell size was decreased. Thus this dielectric body of uniform thickness effectively simulated a dielectric wedge capable of shifting the path of propagation of microwaves toward the direction of decreasing cell size.

Example 3

In Figure 3 is illustrated in isometric view the dielectric body **44** of Figures 1*a* and 1*b* abutting a solid dielectric slab **46** having the same dielectric constant and thickness. In the prior art a dielectric wall comprising a low density body contiguous at its edge with a solid dielectric slab would have caused diffraction and phase front distortion in an electromagnetic wave entering its wave receiving face. This has made it difficult to construct practical reinforced or jointed dielectric walls for the transmission of electromagnetic waves. However, when the low density body and the solid slab are designed in accordance with our invention so as to have the same dielectric constant as well as the same thickness, diffraction and phase front distortion are substantially reduced.

Example 4

In Figure 4 is illustrated in isometric view a cut-away section showing the dielectric body **48** of Figures 1*a* and 1*b* sandwiched between two dielectric walls **50** and **52** having substantially the same dielectric constant as the body and being placed contiguous with its wave receiving faces **54** and **56**. The assembly behaved effectively as a single dielectrically homogeneous panel to electromagnetic waves received through its faces. From an electrical viewpoint it was immaterial whether the walls **50** and **52** were thicker and the dielectric body **48** was thinner, as long as the total thickness remained the same. This provided greater independence of structural design variables from electrical design variables than had been found in the prior art.

For the purpose of describing my invention, certain specific embodiments and materials have been illustrated, but it is to be understood that the invention is not to be limited thereto, since it is evident that such other embodiments and materials are contemplated as are within the spirit and scope of the invention.

What I claim is:

1. A dielectric body for transmission of electromagnetic waves, comprising a substantially regular supporting structure of dielectric material in the form of a plurality of regularly positioned walls disposed at a high angle toward the wave receiving face of said body, and metallic particles supported by said walls substantially uniformly distributed in electrically insulated relation along said walls, the effective size of spaces defined by said walls being below the cut-off wavelengths of electromagnetic waves to be transmitted.

2. A dielectric body for transmission of electromagnetic waves, comprising a substantially regular cellular supporting structure of dielectric material providing walls extending at a high angle to the wave receiving face of said body, and metallic particles supported by said cellular structure substantially uniformly distributed in electrically insulated relation along the walls of said cellular structure, the effective size of cells of said cellular supporting structure being below the cut-off wavelengths of electromagnetic waves to be transmitted.

3. A dielectric body for transmission of electromagnetic waves, comprising a substantially regular cellular structure of dielectric material composed of repeating cells of substantially uniform size and configuration providing walls extending at a high angle to a wave receiving face of said body, and metallic particles supported by said cellular structure substantially uniformly distributed in electrically insulated relation in sufficient concentration to provide a high dielectric constant along the walls of said cellular structure, the effective size of said cells being below the cut-off wavelengths of electromagnetic waves to be transmitted.

4. A dielectric body for transmission of electromagnetic waves as defined in claim 3 in which the walls of said cellular structure define prisms substantially normal to the wave receiving face of said body, the effective size of said cells being below the cut-off wavelength of electromagnetic waves to be transmitted.

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