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(54) Electromagnetically-transparent structure.

(57) An electromagnetically-transparent structure, which is weather-, moisture-, and gas-resistant, for enclosing and protecting a radio antenna including a layer of laminate, comprising adhered layers of polytetrafluoroethylene (PTFE) membrane (2), thermoplastic polymer (3), a second layer of PTFE membrane (2), and a backing fabric (4) comprising woven fibres of PTFE.

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ELECTROMAGNETICALLY-TRANSPARENT STRUCTURE

The present invention relates to a structure for covering and protecting a radio antenna such as a radar antenna, against weather and moisture, while remaining electromagnetically transparent.

Large radio antennas, such as radar installations and radio telescopes, often need a covering structure of some kind to protect them from the weather, i.e. sunlight, wind, and moisture and which will preferably be gas-tight; this covering structure is referred to as a radome. One type of radome is an inflatable radome. In this case, a gas-tight balloon shrouds the antenna. A blower inflates the balloon and spaces the structure away from the antenna so that the antenna may move or rotate freely. A popular form of such covering is the geodesic dome or metal space frame radome, which is formed from many metal (or other structural material) geometric shaped segments, such as triangles and others, which are covered with an appropriate radio frequency transmitting membrane, then affixed to each other to form a part-spherical dome surrounding the radar antenna, which rotates or moves inside the radome. Positive gas pressure is not required inside the metal space frame radome, but may be useful at times, for example, to dislodge snow from the outside of the dome, or to aid in controlling the environment within the dome. Another type of installation has solid segmented covering doors over the radio antenna which open to allow the antenna to function through the opening.

On each side of the opening is affixed a semi-circular track, up which is drawn each edge of a large, nearly electromagnetically transparent sheet of protective membrane to cover the antenna while in use. Other forms of antennas can also be suitably covered by such membranes held above or affixed around them in various ways to keep out moisture and the effects of weather.

While useful in varying degrees, the various forms and compositions of membrane hitherto known in the art, such as polytetrafluoroethylene fibre-glass laminates, have not solved all of the problems associated with use of this type of covering for protecting radio antennas.

According to the present invention there is provided an electromagnetically-transparent structure, which is weather, moisture, and gas-resistant, for enclosing and protecting a radio antenna including a layer of laminate, comprising adhered layers of polytetrafluoroethylene (PTFE) membrane, thermoplastic polymer, a second layer of PTFE membrane, and a backing fabric, comprising woven fibres of PTFE. The preferred membranes and fibres are of porous PTFE and preferably of porous expanded PTFE (EPTFE) prepared as described in U.S. Patents 3,953,566; 4,096,227; 4,187,390; 4,110,392; 4,025,679; 3,962,153, and 4,482,516.

The invention will now be particularly described, by way of example, with reference to the accompanying drawings in which:-

Figure 1 is a cross-section of a preferred laminate according to the invention;

Figure 2 is a broken-away view of a space frame radome covering and protecting a rotating radio antenna, and

Figure 3 shows a radio telescope housing, where shutter and doors are drawn aside and a covering sheet of composite membrane is being drawn over the antenna.

Figure 1 illustrates a laminate 1 according to the invention in cross-section showing various layers. The outer layer 2 is of polytetrafluoroethylene (PTFE), preferably porous PTFE, and most preferably EPTFE.

EPTFE is the porous expanded PTFE membrane material made by stretching PTFE in the manner described in the U.S. patents listed above. EPTFE has superior dielectric constant and loss tangent characteristics thus aiding electromagnetic transmission. The outer layer 2 is bonded by means of a thermoplastic polymer layer 3 to a second layer 2 of EPTFE which has previously been adhered or bonded to a textile backing layer 4 comprising woven fibres of PTFE. Here again, the preferred form of PTFE is EPTFE.

Layer 3 of thermoplastic polymer is preferably a fluorinated ethylene-propylene co-polymer (FEP), but other fluorinated thermoplastic polymers might be used where their PTFE-adhesive properties, radar wavelength transparency, and gas-resistant properties are suitable for use in the particular laminate being prepared. Other non-fluorinated thermoplastic polymers may be used for layer 3 where they meet the criteria of sufficient adhesiveness, electromagnetic transmission characteristics, and gas-proofness or gas-resistance to be adequately functional and useful. Useful thermoplastic polymers may include perfluoroalkoxytetrafluoroethylene polymers, ethylene-tetrafluorofluoroethylene copolymers, copolymers of vinylidene fluoride and hexafluoropropylene, polychlorotrifluoroethylene, copolymer of hexafluoropropylene and tetrafluoroethylene, polyethylene and polypropylene. Layer 4 is a woven textile backing fabric for the laminate where the fibres are PTFE, preferably porous PTFE, and most preferably EPTFE. Layer 4 provides strength properties to the laminate, and additional layers of this material may be added where an increase in laminate

strength is needed and desired.

The woven PTFE or EPTFE fabric is coated with commercially available PTFE dispersion or thermoplastic polymer dispersion to about three to ten percent by weight dispersed PTFE add-on and laminated to an EPTFE film under hot pinch-roll conditions under pressure. Another EPTFE membrane is adhered to FEP film under heat and pressure. The FEP side of this second laminate is then laminated to the EPTFE side of the first laminate by hot pressure rolling to form a four-layer laminate, such as that depicted in cross-section in Figure 1. Additional pairs of layers 2 and 3 may be laminated to the EPTFE face of the laminate in like manner, if desired, to change the electromagnetic transmission characteristics or gas resistance.

Some variation among the fluorinated thermoplastics available for layer 3 may be utilized as well to adjust the electromagnetic transmission characteristics and frequency demand. The laminate provides significant gas-resistance or gas-proof properties associated with the thermopolastic layer or layers so as to be useful for positive pressure type structures in which gas pressure within the dome or shelter holds the covering away from the rotating or moving parts of the antenna housed therein.

Figure 2 shows a large metal space frame radome for sheltering and enclosing a radio antenna 5. The segments 6 of the dome have been made by covering geometric shaped frames, usually of metal or other stiff construction materials such as metal or plastic tubing or shaped bar stock, with laminate of this invention. Segements 6 are then assembled into a radome as shown. Other methods for making such a frame, not involving geometric segments, can be made to serve as well and other methods for covering the domes with the laminate 1 of the invention may be used.

Figure 3 depicts a different type of housing or shelter for a radio antenna 9, in which the entire housing revolves, a roof shutter 7 and doors 8 roll out of the way of antenna 9, and a large sheltering sheet 11 of composite membrane of the invention is drawn up track 10 to which it is attached at each end to protect the antenna while it is in use. Sheet 11 of Figure 3 and the covering 6 of each segment of the geodesic dome of Figure 2 each embody one form of the present invention.

The laminates are inert to and unaffected by the elements, including sunlight, ozone, temperature extremes, wind, rain, and snow, and are inert, hydrophobic and gas-resistant. They are very thin and strong, have excellent colour reflectance and electromagnetic transmission, low dielectric constant, and low loss tanget. The laminates when used in radomes reduce maintenance costs, provide lower cost structural enclosures, allow more accurate measurements, and provide for increased viewing time, do not need to be painted or otherwise maintained as do other materials, and have low adhesion and excellent release for snow and ice which might form on the surface of the radome.

Claims

1. An electromagnetically-transparent structure, which is weather, moisture, and gas-resistant, for enclosing and protecting a radio antenna including a layer of laminate, characterised in that it comprises adhered layers of polytetrafluoroethylene (PTFE) membrane, thermoplastic polymer, a second layer of PTFE membrane, and a backing fabric comprising woven fibres of PTFE.

2. A structure according to claim 1, characterised in that the first and second layers of PTFE are porous.

3. A structure according to claim 2, characterised in that the first and second layers of PTFE are porous expanded PTFE (EPTFE).

4. A structure according to claim 3, characterised in that the backing fabric is EPTFE.

5. A structure according to claim 4, characterised in that the thermoplastic polymer is a fluorinated ethylene- propylene co-polymer (FEP).

6. A structure according to claim 5, characterised in that the thermoplastic polymer is perfluoroalkoxytetrafluoroethylene (FPA), an ethylenetetrafluoroethylene copolymer, a copolymer of vinylidene fluoride and chlorotrifluoroethylene, a copolymer of vinylidene fluoride and hexafluoropropylene, polychlorotrifluoroethylene, a copolymer of hexafluoropropylene and tetrafluoroethylene, polyethylene, or polypropylene.

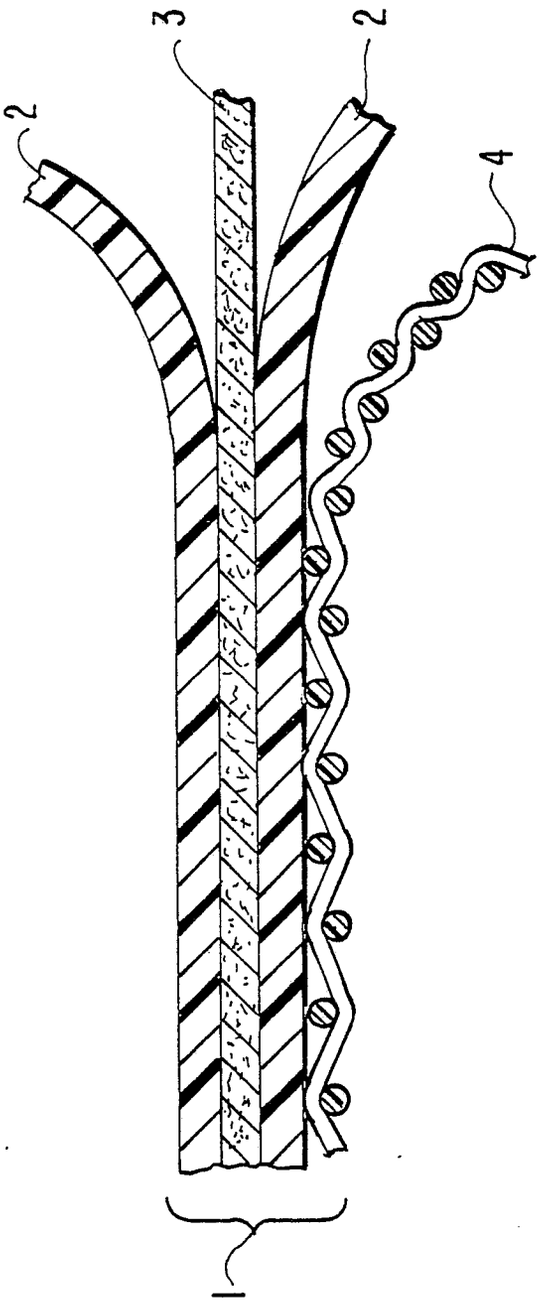


FIG. 1.

FIG. 2.

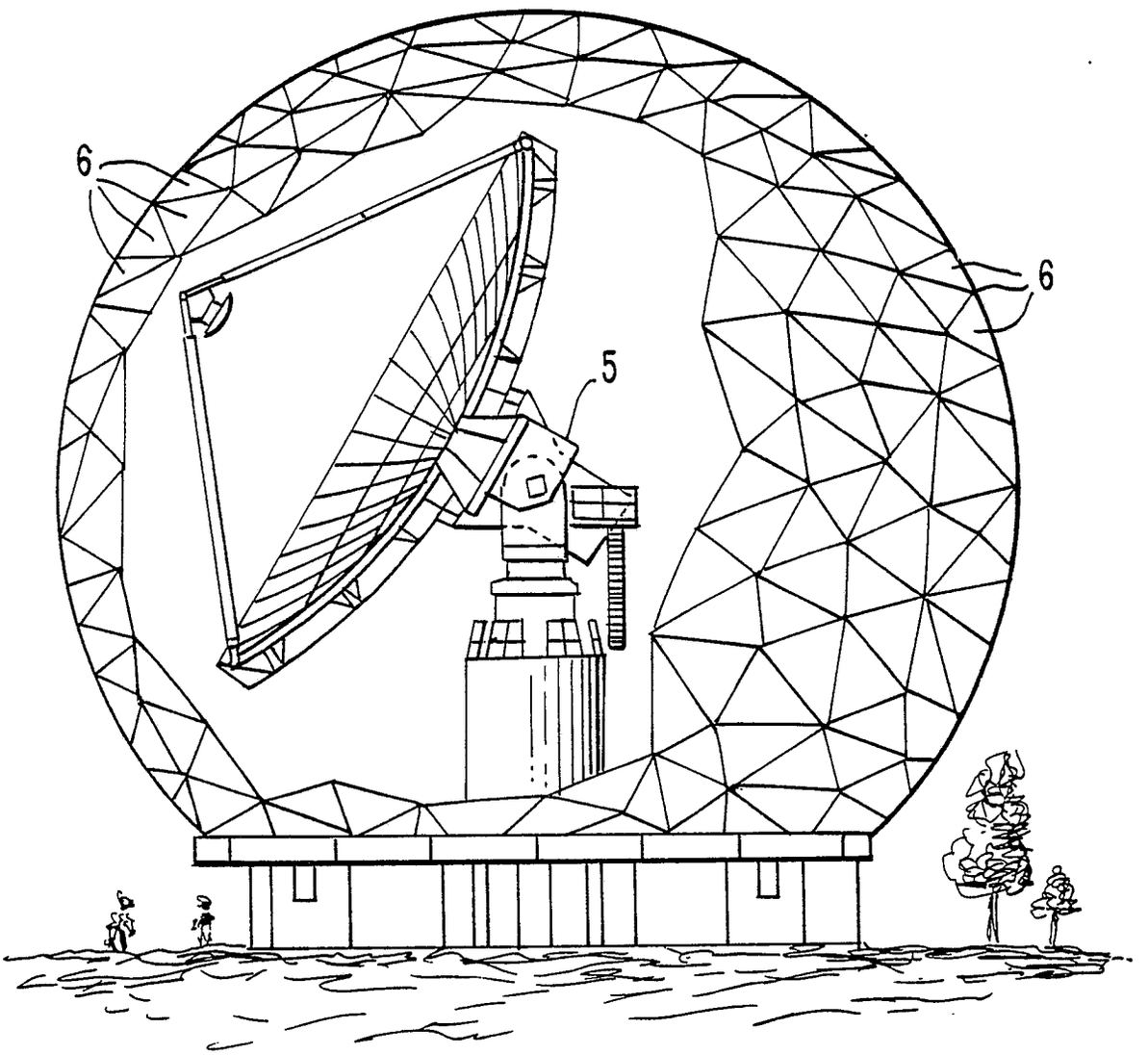
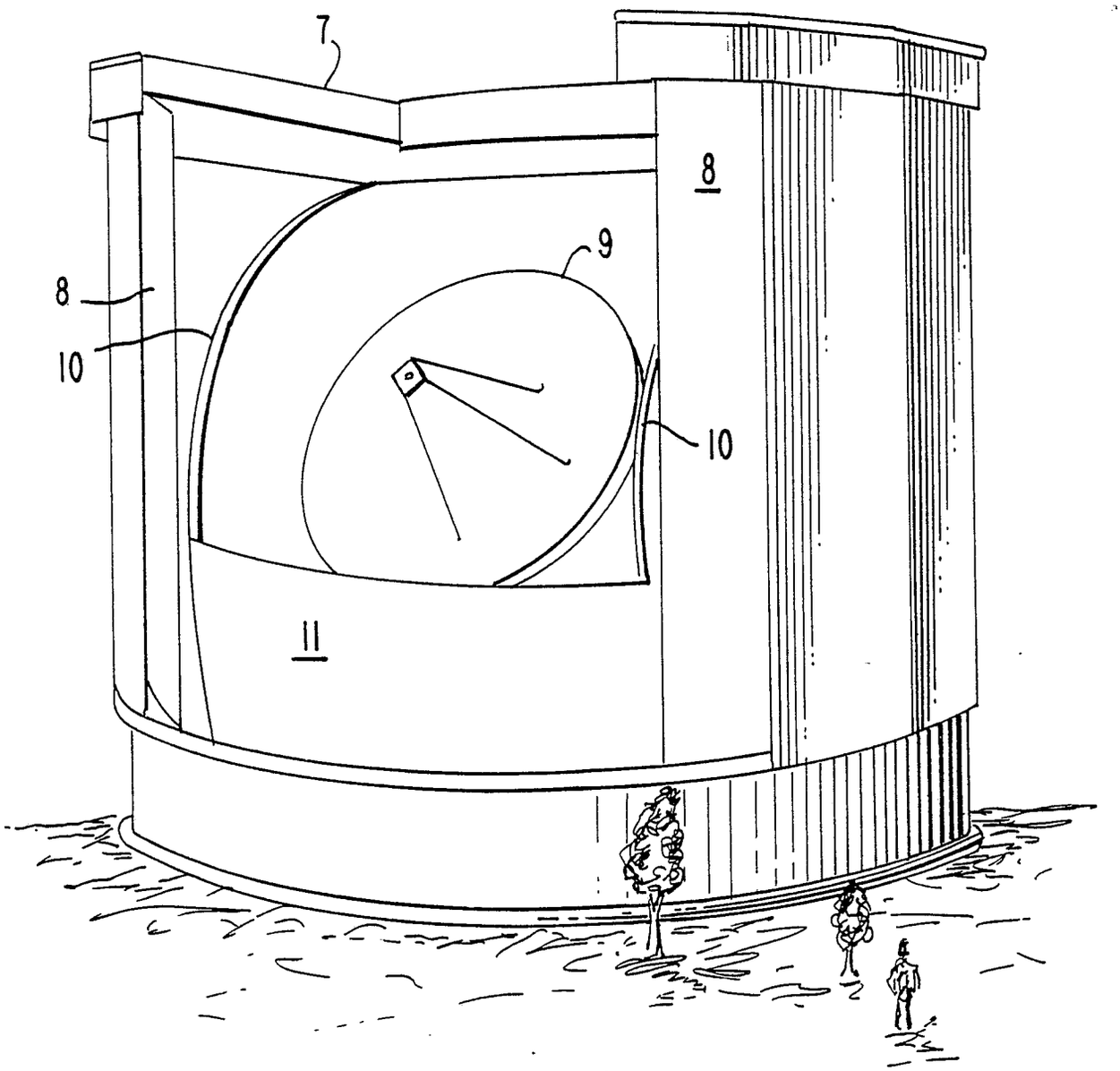


FIG. 3.



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EUROPEAN SEARCH REPORT

Application Number

EP 88 30 6093

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	US-A-4 615 933 (G. TRAUT) * figure 1; abstract *	1,2	H 01 Q 1/42
Y	DE-A-3 421 196 (DORNIER) * claim 8; page 5, lines 16,17 *	1,2	
D,A	US-A-3 953 566 (R.W. GORE) * figure 1; column 2, lines 7-16 *	3	
D,A	US-A-4 025 679 (T.E. DENNY) * figure 2; abstract; column 3, lines 34-39 *	4	
A	EP-A-0 158 116 (DORNIER) * page 2, lines 14-18 *	5	
A	EP-A-0 155 599 (DORNIER) * claims 2,7-9 *		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4) H 01 Q 1/42

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	10-11-1988	BREUSING J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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