



(51) International Patent Classification:

H01Q 17/00 (2006.01) *H01Q* 15/00 (2006.01)
H01Q 1/42 (2006.01) *H05K* 3/46 (2006.01)

(21) International Application Number:

PCT/SE2012/051132

(22) International Filing Date:

23 October 2012 (23.10.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant: SAAB AB [SE/SE]; S-581 88 Linköping (SE).

(72) Inventors: HÖÖK, Anders; Kläddegärdevägen 27, S-430 63 Hindås (SE). STENQUIST, Elisabeth; Konsertvägen 21, S-435 44 Mölnlycke (SE). ISAKSSON, Hanna; Krok-slättsparkgata 69A, S-431 68 Göteborg (SE).

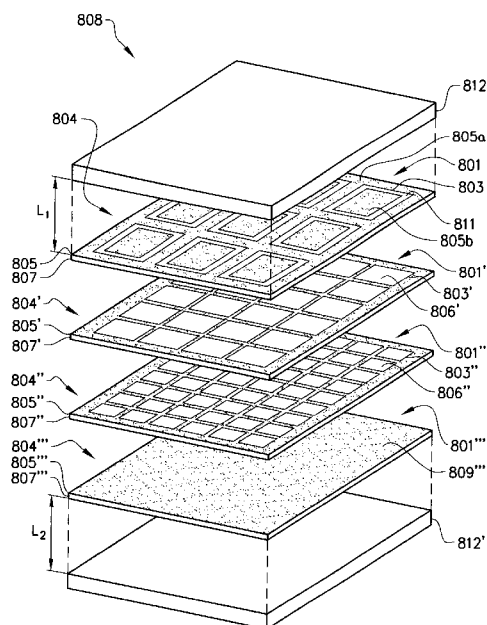
(74) Agent: ZACCO SWEDEN AB; Box 5581, Valhallavägen 117N, S-11485 Stockholm (SE).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: MULTISCALE CIRCUIT-ANALOG ABSORBERS





Declarations under Rule 4.17:

Published:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))* — *with international search report (Art. 21(3))*

Multiscale circuit-analog absorbers

TECHNICAL FIELD

The present invention relates to a circuit-analog absorber structure for the transmission
5 of electromagnetic waves comprising more than one layer, the layers having different transmission characteristics, e.g. due to different resistive properties.

BACKGROUND ART

RCS, Radar Cross Section, is a quantitative measure regarding the detectability of an
10 object. The RCS is a property amongst others dependent on the target's size, shape and the material from which it is fabricated and is a ratio of the reflected and incident EM, Electro Magnetic power densities. As low RCS as possible is desirable for many different applications, both for disguising moving vehicles, as for example for aircrafts, and for disguising permanent structures, as for example for fixed antennas and military
15 facilities. For vehicles used in combat the RCS has implications to survivability and mission capability. In particular, antennas on a vehicle contribute significantly to the overall RCS.

For low RCS applications it is desirable to have surfaces with either the capability to
20 absorb incoming electromagnetic waves or to reflect incoming electromagnetic waves in preferred directions. This can be achieved in many different ways. One way to improve the RCS properties is by optimizing the shape of the object as such. Although shaping is very important, it only redirects the radiation through specular reflection, hence there is still a probability of detection from radars. Another approach is to use
25 dissipative loading, aiming to reduce the scattering from hotspot regions through the application of patches. Dissipative materials are designed to modify the surface impedance so as to absorb the otherwise scattered signal.

Traditionally FSS radomes, Frequency Selective Surface radomes, have been used in order to electromagnetically shield antennas and other structures, in a certain
30 frequency band by reflecting the electromagnetic waves in the directions less sensitive from a possible hostile detection point of view. In the concerned frequency band the surface of the FSS appears as a metal surface, shielding the underlying antenna. At frequencies outside the concerned frequency band the surface is transmissive for electromagnetic waves. These layers are generally coated with metallic patterns, for

example giving the structure the function of low, high or band pass filter. The efficiency of the FSS is highly dependent on the direction to the threat relative to the normal of the radome.

- 5 This concept has some evident drawbacks. Even if the electromagnetic waves are reflected in a preferred direction, there is still a risk that they might be intercepted by hostile radars. Additionally, there are surfaces on aircraft with normals pointing into the concerned directions, thus significantly contributing to the RCS.
- 10 Instead of reflecting the electromagnetic radiation, circuit-analog absorbers, CAA, absorb incident electromagnetic waves. For absorbing surfaces the purpose is simply to let a substantially lower magnitude of EM power density reflect back to the source of the incident waves. Radar absorbing materials are made from resistive and/or magnetic materials, and can be classified as impedance matching or resonant absorbers.
- 15 Impedance matching absorbers are for example pyramidal absorbers, often used for anechoic chambers, tapered loading absorbers and matching layer absorbers. Absorbers such as circuit-analog materials give more design freedom since they provide the possibility to vary the shape parameters of the patterns. The circuit-analog absorbers of today are often constructed by one or more than one resistive layer
- 20 wherein all layers have the same resistive properties, making the absorbing properties easy to calculate and to predict, but also offering limited possibility when it comes to affecting the transmissive properties.

The EM properties of a resistive layer is dependent on the surface resistivity and
25 possible different pattern used, but also on the permittivity and the loss tangents of the materials supporting the resistive layer. For multilayer structures the total EM properties are also dependent on the distance between the layers.

Generally it is desirable to cover wide range of operating frequencies, but for some
30 applications only a narrow range of frequencies needs to be shielded. E.g., the aircrafts of today are generally equipped with a plurality of antennas, and these antennas contribute to the total vehicle RCS over wide frequency bands, while they themselves are functioning in relatively narrow bands. Hence, absorbing materials and structures as described above can advantageously be used to shield these built-in antennas. The

drawback is that, unless sufficient frequency selective absorbers are used, at the same time as absorbing materials are used to lower the RCS, the gain of a shielded antenna is lowered.

5 Thus, there is a need for further improvements.

SUMMARY

The object of the present invention is to provide an inventive method for designing circuit-analog absorber structures for customized transmission of electromagnetic waves where the previously stated problems are avoided, with customized transmission meaning minimized transmission, hence maximized absorption, within at least one frequency band, and maximized transmission, hence minimized absorption, within at least one another frequency band. This object is achieved by the features of the characterizing portion of claim 1, disclosing a circuit-analog absorber structure for the transmission of electromagnetic waves comprising more than one layer, the properties of each layer determining the transmission characteristics of the circuit-analog absorber structure characterised in that a first circuit-analog absorber structure layer, having a first set of transmission characteristics, is different from a second circuit-analog absorber structure layer, having a second set of transmission characteristics different from the first set of transmission characteristics of the first circuit-analog absorber structure layer. Consequently, also the absorption characteristics are different for the first set of transmission characteristics and the second set of transmission characteristics. Accordingly, it is possible to achieve that the quantity of transmission of electromagnetic waves in a first, predetermined frequency range, is higher than the quantity of transmission of electromagnetic waves in a second, predetermined frequency range. By combining different circuit-analog absorber structure layers, which have different transmission characteristics (and absorption characteristics), it is possible to adjust the transmission of electromagnetic waves, and also other properties, of the circuit-analog absorber structure according to what is desirable for a specific application.

The inventive circuit-analog absorber structure comprises a number of circuit-analog absorber structure layers. At least two circuit-analog absorber structure layers are needed in order to be able to affect the transmission characteristics of the circuit-

analog absorber structure, comprising the circuit-analog absorber structure layers, according to the inventive concept. Due to physical restraints the number of circuit-analog absorber structure layers, forming the circuit-analog absorber structure, is limited to four or in some embodiments five. Also, the more layers used the greater will the signal strength losses become. In a preferred embodiment of the inventive multilayer circuit-analog absorber structure it comprises two circuit-analog absorber structure layers or in an even more preferred embodiment it comprises three circuit-analog absorber structure layers.

Further advantages are achieved by implementing one or several of the features of the dependent claims. According to one aspect of the inventive multilayer circuit-analog absorber structure, the first circuit-analog absorber structure layer comprises a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion, forming the first circuit-analog absorber structure layer. A first structural pattern is formed in the first resistive layer portion that is different from a second structural pattern formed in a second resistive layer portion. The second resistive layer portion is arranged on a second carrier layer portion, the second resistive layer portion and the second carrier layer portion together forming a second circuit-analog absorber structure layer. Structural pattern can be used to describe the pattern formed either by a resistive layer portion on a carrier layer portion or a pattern formed in a resistive layer portion by apertures in the resistive layer portion.

The primary function of carrier layer portion of the circuit-analog absorber structure layer is to support the resistive layer portion. But the carrier layer can also contribute with other beneficial properties to the structure, e.g. add physical strength to the structure as such. The carrier layer portion is preferably made of a commercial polymeric material.

A basic structural element of a circuit-analog absorber structure layer represents a minimal recurring shape that is formed in the resistive layer portion. One recurring shape constitutes a unit cell. Together the basic structural elements form a structural pattern. Hence, the structural pattern comprises a number of unit cells, the number of unit cells depending on the size of the recurring shape. The resistive layer may comprise any kind of substance with electromagnetic properties. Basic structural

element can be used to describe the recurring pattern formed either by a resistive layer portion on a carrier layer portion or a pattern formed in a resistive layer portion by apertures in the resistive layer portion.

- 5 The basic structural element formed in a resistive layer affects the electromagnetic properties of the layer. Consequently, the structural pattern, formed in the resistive layer of a circuit-analog absorber layer, is one of the properties that determine the transmission characteristics of the circuit-analog absorber structure.
- 10 One way of expressing and/or to categorize the basic structural elements or the structural pattern is by using the periodicity of the pattern. Consequently, the property of periodicity affects the transmission characteristics of the circuit-analog absorber structure. The periodicity is determined by three parameters; d_1 , d_2 and α , wherein d_1 represents the distance between the central points of two adjacent unit cells in a first
- 15 direction and d_2 represents the distance between the central points of two adjacent unit cells in a second direction, the second direction being inclined relative the first direction and where α represents the angle between d_1 and d_2 . Consequently, the central point of the unit cell is also the central point of the basic structural element. d_1 , d_2 and α determine the size of the unit cell, thus the size of the basic structural element. For
- 20 example; $d_1 = d_2$ and $\alpha = 90^\circ$ gives a quadratic pattern, $d_1 \neq d_2$ but $\alpha = 90^\circ$ gives a rectangular pattern, $d_1 = d_2$ and $\alpha = 60^\circ$ gives a rhombic pattern or a pattern consisting of equilateral hexagons.

According to a further advantageous aspect of the inventive multilayer circuit-analog

25 absorber structure, at least one of said first or second circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, wherein the resistive layer portion is arranged on the carrier layer portion. Parallel or near parallel apertures are formed in the resistive layer portion, extending in one direction forming resistive layer strips. The apertures separating the resistive layer strips isolates the

30 strips from each other so that they are not electrically connected to each other. This is one of the most advantageous configurations of the resistive layer portions. Striped resistive layers may, in some applications, have polarization discriminating influence on incident electromagnetic waves.

According to yet one aspect of the inventive multilayer circuit-analog absorber structure, at least one of said first or second circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, wherein the resistive layer portion is arranged on the carrier layer portion. Further on, parallel or near parallel
5 apertures are formed in the resistive layer portion extending in a first direction, and other parallel or near parallel apertures are formed in the same resistive layer portion extending in a second direction, the second direction being different from the first direction. The formed apertures in the resistive layer portion isolate the remaining resistive layer portion elements from each other. This is another of the most
10 advantageous configurations of the resistive layer portions.

According to one other aspect of the inventive multilayer circuit-analog absorber structure, at least one of said first or second circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, the resistive layer portion
15 being arranged on the carrier layer portion, wherein the resistive layer portion is homogenously covering said carrier layer. This is yet another of the most advantageous configurations of the resistive layer portions.

According to another aspect of the inventive multilayer circuit-analog absorber
20 structure, the first and the second circuit-analog absorber structure layers comprise a carrier layer portion and a resistive layer portion each. The resistive layer portions are arranged on the carrier layer portions, wherein the first circuit-analog absorber structure layer may comprise a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion. Additionally, the
25 first resistive layer portion comprises a first basic structural element characterized by the parameters $d_{1,1}$, $d_{2,1}$ and α_1 . The second circuit-analog absorber structure layer may comprise a second carrier layer portion and a second resistive layer portion, the second resistive layer portion being arranged on the second carrier layer portion, wherein the second resistive layer portion comprises a second basic structural element
30 characterized by the parameters $d_{1,2}$, $d_{2,2}$ and α_2 . According to this aspect of the invention $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 is different from $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 , or in order to clarify, either $d_{1,1}$ is different from $d_{1,2}$ and/or $d_{2,1}$ is different from $d_{2,2}$ and/or α_1 is different from α_2 . By ensuring that at least one of the corresponding parameters, $d_{1,1}$ versus $d_{1,2}$, $d_{2,1}$ versus $d_{2,2}$ and/or α_1 versus α_2 , are different for two circuit-analog

absorber structure layers, the transmission characteristics of the circuit-analog absorber can be affected as intended. This is one of the most advantageous approaches in order to affect the transmission characteristics of a circuit-analog absorber structure in a structured manner.

5

According to yet another aspect of the inventive multilayer circuit-analog absorber structure, at least one of said first or second circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, the resistive layer portion being arranged on the carrier layer portion, wherein an irregular pattern is formed in the

10

resistive layer portion. An irregularly shaped resistive layer portion can be the most advantageous configuration for some applications. For doubly curved surfaces, such as for example is used in nose radomes for aircrafts, irregularly shaped patterns are necessary in order to obtain substantially uniform transmission properties over the surface. However, irregularly shaped patterns may also be used in other applications.

15

The suitable irregular pattern for a certain application, e.g. based on the curvature of the surface, desirable transmission characteristics etc., can be calculated by using mathematical methods.

According to one preferred aspect of an inventive multilayer circuit-analog absorber structure, the circuit-analog absorber structure comprises a third circuit-analog absorber structure layer, the third circuit-analog absorber structure layer having a different set of transmission characteristics from at least one of said first and second circuit-analog absorber structure layers. Adding a third circuit-analog absorber structure layer adds additional degrees of freedom when designing the circuit-analog absorber structure.

20

25

According to one aspect of the inventive multilayer circuit-analog absorber structure, the circuit-analog absorber structure comprises a third circuit-analog absorber structure layer, wherein said first circuit-analog absorber structure layer comprises a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion, forming the first circuit-analog absorber structure layer, wherein a first structural element is formed in the first resistive layer portion. The first structural pattern is different from either a second structural pattern, formed in a second resistive layer portion, wherein the second resistive layer portion is

30

arranged on a second carrier layer portion, the second resistive layer portion and the second carrier layer portion together forming a second circuit-analog absorber structure layer, and/or a third structural pattern formed in the third resistive layer portion, wherein the third resistive layer portion is arranged on a third carrier layer portion, the third resistive layer portion and the third carrier layer portion together forming a third circuit-analog absorber structure layer. Using different structural pattern, comprising different basic structural elements, for at least two of the three resistive layer portions of the three circuit-analog absorber structure layers, is one of the most advantageous approaches to design a for the specific purpose appropriate circuit-analog absorber structure.

According to another aspect of the invention, said first, second and third circuit-analog absorber structure layers may comprise a carrier layer portion and a resistive layer portion each, where the resistive layer portions are arranged on the carrier layer portions. Further on, the first circuit-analog absorber structure layer may comprise a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion, wherein the first resistive layer portion comprises a first basic structural element characterized by the parameters $d_{1,1}$, $d_{2,1}$ and α_1 . The second and the third circuit-analog absorber structure layers are arranged accordingly, thus the second circuit-analog absorber structure layer may comprise a second carrier layer portion and a second resistive layer portion, the second resistive layer portion being arranged on the second carrier layer portion, wherein the second resistive layer portion comprises a second basic structural element characterized by the parameters $d_{1,2}$, $d_{2,2}$ and α_2 , wherein $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 is different from $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 , and the third circuit-analog absorber structure layer may comprise a third carrier layer portion and a third resistive layer portion, the third resistive layer portion being arranged on the third carrier layer portion, wherein the third resistive layer portion comprises a third basic structural element characterized by the parameters $d_{1,3}$, $d_{2,3}$ and α_3 . According to this aspect of the invention $d_{1,3}$ and/or $d_{2,3}$ and/or α_3 is different from or equal to $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 , and is different from or equal to $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 . Consequently, within at least one of the three groups of corresponding parameter, the corresponding parameters being $d_{1,1}$, $d_{1,2}$ and $d_{1,3}$ or $d_{2,1}$, $d_{2,2}$ and $d_{2,3}$ or α_1 , α_2 and α_3 , two parameters differ from each other. This is one of the most advantageous approaches in order to affect the transmission characteristics of a

circuit-analog absorber structure, comprising three circuit-analog absorber structure layers, in a structured manner.

According to yet another aspect of the invention, a multilayer circuit-analog absorber structure may comprise at least one of said first, second or third circuit-analog absorber structure layers, wherein the layers comprise a carrier layer portion and a resistive layer portion each, the resistive layer portion being arranged on the carrier layer portion, wherein an irregular pattern may be formed in at least one of the first, second or third resistive layer portions. An irregularly shaped resistive layer portion can be the most advantageous configuration for some applications. As stated above, for doubly curved surfaces, such as for example is used in nose radomes for aircrafts, irregularly shaped patterns are necessary in order to obtain substantially uniform transmission properties over the surface. However, irregularly shaped patterns may also be used in other applications. The suitable irregular pattern for a certain application, e.g. based on the curvature of the surface, desirable transmission characteristics etc., can be calculated by using mathematical methods.

Since the circuit-analog absorber structure layer comprises both a resistive layer portion and a carrier layer portion, in the apertures of the resistive layer portion, which can be present in many different configurations as is obvious from the examples stated above, only the carrier layer portion is present. This applies to all examples of the inventive concept.

According to one aspect of the invention the circuit-analog absorber structure comprises at least two circuit-analog absorber structure layers, wherein at least one dielectric layer is arranged parallel to, but separated from, and at least on one side of the circuit-analog absorber structure. Consequently, also more than one dielectric layer can be arranged on one or both sides. Using a dielectric layer, or two dielectric layers, preferably being made of low loss material, is advantageous e.g. in order to increase the structural strength of the circuit-analog absorber structure, but depending on the properties of the dielectric layer/layers also other advantageous properties can be added to the structure. The dielectric layer can e.g. be made of pre-cured fibre composites.

According to another aspect of the invention, the circuit-analog absorber structure comprises at least either two circuit-analog absorber structure layers and/or one circuit-analog absorber structure layer and one dielectric outer layer, wherein the layers are separated by a filling material, preferably being a honeycomb material, a foam material or a syntactic material. The filling materials are used to fill the gap between the respective layers, but can also add valuable properties to the circuit-analog absorber structure. The filling materials can be either anisotropic, like for a honeycomb material, or isotropic, as for foam materials or syntactic materials. The filling materials can e.g. have impact on the physical strength of the circuit-analog absorber structure and on the total overall resistive properties. Also the distance between the different layers, hence the thickness of the structure as such, can influence the electromagnetic properties of the structure and can be chosen accordingly. Also other properties can be affected.

According to one aspect of the invention the properties of the circuit-analog absorber structure is selected to give maximized transmission of electromagnetic waves in the L-band and maximized absorption of electromagnetic waves at frequencies above the L-band. The L band is, according to the microwave frequency bands as disclosed below, defined as the frequency band between 1 and 2 GHz. The microwave frequency bands are generally defined as:

20

Microwave frequency bands: L band 1 to 2 GHz

S band 2 to 4 GHz

C band 4 to 8 GHz

X band 8 to 12 GHz

25 Ku band 12-18 GHz

K band 18 to 26,5 GHz

Ka band 26,5 to 40 GHz

Minor deviations regarding the frequency interval for respective band may occur in prior art, relevant literature etc. The invention should not be considered to be limited according to the microwave frequency bands stated above. The L band frequency interval comprises several of the sensor functions where maximized transmission is desirable according to the invention.

30

According to another aspect of the invention the properties of the circuit-analog absorber structure is selected to give maximized transmission of electromagnetic waves at lower frequencies than 3,3 GHz and maximized absorption of electromagnetic waves at frequencies above 3,3 GHz. The stated frequency interval comprises some of the sensor functions where maximized transmission is desirable according to the invention.

According to yet another aspect of the invention the properties of the circuit-analog absorber structure is selected to give maximized transmission of electromagnetic waves between 2-6 GHz and maximized absorption of electromagnetic waves at frequencies above 6 GHz. The stated frequency interval comprises some of the sensor functions where maximized transmission is desirable according to the invention.

According to a different aspect of the invention the invention further comprises a radome, wherein the radome comprises the inventive multilayer circuit-analog absorber structure according to any previously described aspect of the invention.

According to another different aspect of the invention the invention comprises an aircraft comprising the radome, wherein the radome comprises the inventive multilayer circuit-analog absorber structure according to any of previously described aspect of the invention. According to this aspect of the invention the radome can for example constitute at least a part of the surface of the aircraft body.

According to yet another different aspect of the invention the invention comprises a ship comprising the radome, wherein the radome comprises the inventive a multilayer circuit-analog absorber structure according to any previously described aspect of the invention. According to this aspect of the invention the radome can for example constitute at least a part of the surface of the ship.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in detail with reference to the figures, wherein:

- 5 Fig. 1 schematically shows one example of a circuit-analog absorber structure layer according to the invention from above,
Fig. 2 schematically shows one other example of a circuit-analog absorber structure layer according to the invention from above,
Fig. 3 schematically shows yet another example of a multilayer circuit-analog
10 absorber structure according to the invention from above,
Fig. 4 schematically shows another example of a circuit-analog absorber structure layer from above according to the invention from above, being a specific embodiment of the example shown in fig. 3,
Fig. 6 schematically shows an example of a multilayer circuit-analog absorber
15 structure according to the invention,
Fig. 7 schematically shows another example of a multilayer circuit-analog absorber structure according to the invention, and
Fig. 8 schematically shows yet another example of a multilayer circuit-analog absorber structure according to the invention.

20

It should be noted that the following description of the examples is for illustrative purposes only and should not be interpreted as limiting.

25 DETAILED DESCRIPTION

In the following only one embodiment of the invention per figure is shown and described, simply for illustration of one mode of carrying out the invention.

30 As will be realised, the invention is capable of modification in various obvious respects, e.g. in regards of choice of material, all without departing from the scope of the appended claims. Accordingly, the figures and the description thereto are to be regarded as illustrative in nature, and not restrictive. All figures are schematically illustrated.

The following examples of the present invention relate, in general, to the field of circuit-analog absorber structures, comprising circuit-analog absorber structure layers, wherein the shaded portions represent the resistive layer portions of the circuit-analog absorber structure layers and the white portions represents apertures, formed in the resistive layer portions, of the circuit-analog absorber structure layers, wherein the carrier layer portion is visible between the resistive layer portions/in the apertures formed between the resistive layer portions.

Fig. 1 schematically shows a top view of an example of a circuit-analog absorber structure layer 101 according to the invention. The dashed lines indicate the unit cells 102, and as further can be seen is the parameters d_1 , d_2 and α indicated in fig. 1, wherein d_1 represents the distance between the central points of two adjacent unit cells 102 in a first direction, d_2 represents the distance between the central points of two adjacent unit cells 102 in a second direction and α represents the angle between d_1 and d_2 , the angle being $\alpha = 90^\circ$ in fig. 1 and $d_1 = d_2$. In fig. 1 is an example of a basic structural element 103, thus the basic structural elements 103 together forming the structural pattern 104 of the circuit-analog structure layer 101, located in each unit cell 102. According to the example of the invention shown in fig. 1 is the basic structural element 103 a square with sides of equal lengths, and an angle of 90° between two adjacent sides.

In fig. 1 is the basic structural element 103 formed of resistive layer portion 105, separated by apertures 106 in the resistive layer portion 105, but the basic structural element may also be in form of apertures formed in the resistive layer portion, hence, the inverse to what is shown in fig. 1. This applies to all examples shown in fig. 1 to 8.

The resistive layer portions 105 according to fig. 1 are electrically isolated from each other.

This is just one example of a suitable basic structural element that can be centrally located in each unit cell, and also just one example of how the unit cell can be designed by varying the parameters d_1 , d_2 and α , according to the invention.

Fig. 2 schematically shows a top view of another example of a circuit-analog absorber structure layer 201 according to the invention, where the shaded portions represent the resistive layer portions 205, 205', 205'' and the white portions represents apertures 206, where the apertures 206 are formed in the resistive layer portions 205, 205', 205'', wherein the carrier layer portion 207 is visible between the resistive layer portions 205, 205', 205'' /in the apertures 206 formed between the resistive layer portions 205, 205', 205''. The resistive layer portions 205, 205', 205'' are electrically isolated from each other. The dashed lines indicate the unit cells 202. As further can be seen is the parameters d_1 , d_2 and α indicated in fig. 2, wherein d_1 represents the distance between the central points of two adjacent unit cells 202 in a first direction, d_2 represents the distance between the central points of two adjacent unit cells 202 in a second direction and α represents the angle between d_1 and d_2 , the angle being $\alpha = 90^\circ$ in fig. 2 and $d_1 < d_2$. In fig. 2 is one example of a basic structural element 203, thus the basic structural element 203 together forming the structural pattern 204 of the circuit-analog structure layer 201, located in each unit cell 202. According to the example of the invention shown in fig. 2 is the basic structural element 203 a square with different length of the sides, and an angle of 90° between two adjacent sides.

This is just one example of a suitable basic structural element that can be centrally located in each unit cell, and also just one example of how the unit cell can be designed by varying the parameters d_1 , d_2 and α , according to the invention. The example of the inventive circuit-analog absorber structure of fig. 1 can be seen as a specific case of the inventive concept shown in fig. 2, where $\alpha = 90^\circ$ and $d_1 = d_2$.

Fig. 3 schematically shows a top view of yet another example of a circuit-analog absorber structure layer 301 according to the invention, where the shaded portions represent three different examples of configurations the basic structural element 303, 303', 303'' in the resistive layer portions 205 may have. The dashed lines indicate the unit cells 302 according to the inventive example. As can be seen is the parameters d_1 , d_2 and α indicated in fig. 3, wherein d_1 represents the distance between the central points of two adjacent unit cells 302 in a first direction, d_2 represents the distance between the central points of two adjacent unit cells in a second direction and α represents the angle between d_1 and d_2 . According to the example in disclosed in fig. 3 is $d_1 < d_2$ and $\alpha < 90^\circ$. The specific configuration of d_1 , d_2 and α shown in fig. 3 results

in hexagonally shaped unit cells 302. Additionally, in fig. 3 is further an example of a circular basic structural element 303, an example of a hexagon shaped basic structural element 303' and an example of a cross shaped basic structural element 303'', centrally located within the hexagonally shaped unit cells 302, disclosed. This is three
5 examples of different basic structural elements 303, 303', 303'' that can be used to design the structural pattern, but also other shapes are possible.

However, it is important to point out that different basic structural elements are not mixed in one structural pattern.

10

This is just one example of a suitable unit cell can be designed according to the invention.

Fig. 4 schematically shows a top view of another example of a circuit-analog absorber structure layer 401 according to the invention, where the shaded portions represent the resistive layer portions 405 and the white portions represents apertures 406, formed in the resistive layer portions 405, wherein the carrier layer portion 407 is visible between the resistive layer portions 405/in the apertures 406 formed between the resistive layer portions 405. The resistive layer portions 405 are electrically isolated from each other.

15

The dashed lines indicate the unit cells 402. As further can be seen is the parameters d_1 , d_2 and α indicated in fig. 4, wherein d_1 represents the distance between the central points of two adjacent unit cells 402 in a first direction, d_2 represents the distance between the central points of two adjacent unit cells 402 in a second direction and α represents the angle between d_1 and d_2 . According to the example in disclosed in fig. 4 is $d_1 < d_2$ and $\alpha < 90^\circ$. The example of the invention shown in fig. 4 is a specific embodiment of the set of parameters, $d_1 < d_2$ and $\alpha < 90^\circ$, shown in fig. 3. In fig. 4 is an example of a basic structural element 403, thus the basic structural elements 403 together forming the structural pattern 404 of the circuit-analog structure layer 401, located in each unit cell 402. According to the example of the invention shown in fig. 4 is the basic structural element 403 a square with sides of equal lengths, but an angle of $\alpha < 90^\circ$.

20

25

30

Fig. 5 shows an example of an inventive circuit-analog absorber structure 508 comprising three circuit-analog absorber structure layers 501, 501', 501''. Each of the

circuit-analog absorber structure layers 501, 501', 501'' comprises a top resistive layer portion 505, 505', 505'' and a bottom carrier layer portion 507, 507', 507'', wherein the structural pattern 504, 504', 504'' of each circuit-analog absorber structure layer 501, 501', 501'' is formed in the top resistive layer portion 505, 505', 505''. According to the example disclosed in fig. 5;

the uppermost circuit-analog absorber structure layer 501 comprises a homogeneously covering resistive layer portion 509, wherein the entire top resistive layer portion 505 is electrically conductive ,

the in the middle positioned circuit-analog absorber structure layer 501' comprises a striped structural pattern 504', wherein the resistive layer portion stripes 510 are separated by apertures 506' and are electrically isolated from each other, and

the bottom circuit-analog absorber structure layer 501'' comprises a homogeneously covering resistive layer portion 509'', wherein the entire top resistive layer portion 505'', of the bottom circuit-analog absorber structure 501'', is electrically conductive.

The striped in the middle positioned circuit-analog absorber structure 501' can be seen as a specific embodiment of the example of the invention as disclosed in fig. 1 or 2 wherein $d_2 \gg d_1$, and the resistive layer portions extend all the way to the edge of the circuit-analog absorber structure.

Striped or homogeneously covering resistive layer portions are just two examples of suitable structural patterns according to the invention.

Fig. 6 shows another example of an inventive circuit-analog absorber structure 608 comprising three circuit-analog absorber structure layers 601, 601', 601''. Each of the circuit-analog absorber structure layers 601, 601', 601'' comprises a top resistive layer portion 605, 605', 605'' and a bottom carrier layer portion 607, 607', 607'', wherein the structural pattern 604, 604', 604'' of each circuit-analog absorber structure layer 601, 601', 601'' is formed in the top resistive layer portion 605, 605', 605''. According to the example disclosed in fig. 6;

in the uppermost resistive layer portion 605 of the uppermost circuit-analog absorber structure layer 601 is a structural pattern formed 604, wherein three times three unit cells 602 are indicated by dashed lines, wherein an aperture 606 in the form of a Jerusalem Cross is centrally located in each unit cell 602, wherein the Jerusalem

Cross shaped apertures 606 is the basic structural element 603 for the example of the invention disclosed in fig. 6 and wherein the resistive layer portions 605 formed around the cross shaped apertures 606 is electrically conductive,

in the resistive layer portion 605' of the in the middle positioned circuit-analog absorber structure layer 601' is a structural pattern 604' formed, wherein two times two unit cells 602' are indicated by dashed lines, wherein an aperture 606' in the form of a Jerusalem Cross is centrally located in each unit cell 602, wherein the Jerusalem Cross shaped apertures 606' is the basic structural element 603' for the example of the invention disclosed in fig. 6 and wherein the resistive layer portions 605' formed around the Jerusalem Cross shaped apertures 606' is electrically conductive, wherein the Jerusalem Cross shaped apertures 606 of the uppermost circuit-analog absorber structure layer 601 have the same shape of the basic structural element 603 as the cross shaped apertures 606' of the in the middle located circuit-analog absorber structure layer 601', but where the size of the basic structural elements 603, 603' is different from each other, hence d_2 and d_1 are different for the two circuit-analog absorber structure layers 601, 601' (however, α is the same for the two circuit-analog absorber structure layers 601, 601'), and

in the resistive layer portion 605'' of the bottom circuit-analog absorber structure layer 601'' is the resistive layer portion shaped as a Jerusalem Cross 605'', hence except for that d_2 and d_1 are different for all three circuit-analog absorber structures layers 601, 601', 601'', the basic structural elements 603, 603' of the upper two circuit-analog absorber structures layers 601, 601' is the inverse to the basic structural element 603'' of the bottom circuit-analog absorber structure layer 601''. The aperture 606'' surrounding the Jerusalem Cross shaped resistive layer portion 605'' of the bottom circuit-analog absorber structure layer 601'' is uncovered carrier layer portion 607''.

Fig. 7 shows another example of an inventive circuit-analog absorber structure 708 comprising four circuit-analog absorber structure layers 701, 701', 701'', 701'''. Each of the circuit-analog absorber structure layers 701, 701', 701'', 701''' comprises a top resistive layer portion 705, 705', 705'', 705''' and a bottom carrier layer portion 707, 707', 707'', 707''', wherein the structural pattern 704, 704', 704'', 704''' of each circuit-analog absorber structure layer 701, 701', 701'', 701''' is formed in the top resistive layer portion 705, 705', 705'', 705'''. According to the example disclosed in fig. 7;

the uppermost circuit-analog absorber structure layer 701 comprises three times three basic structural elements 703, the basic structural elements 703 in this specific example of the invention comprising square shaped frame aperture 711 with sides of substantially the same length and of a certain width, wherein the resistive layer portion surrounding the frame apertures 705a are electrically connected and the resistive layer portions within each frame aperture 705b are electrically isolated,

the upper of the two middle circuit-analog absorber structure layers 701' comprises six times nine basic structural elements 703', wherein the basic structural elements 703' comprises square shaped apertures 706' formed in the resistive layer portion 705', wherein the resistive layer portion 705' surrounding the apertures 706' are electrically connected, wherein the number of basic structural elements 703' in a first direction and the number of basic structural elements 703' in a second direction, the second direction being perpendicular to the first direction, also can be any other number than six times nine according to the upper of the two middle circuit-analog absorber structure layers 701' disclosed in fig. 7,

the lower of the two middle positioned circuit-analog absorber structure layers 701'' comprises a striped structural pattern 704'', wherein the resistive layer portion stripes 710'' are separated by apertures 706'' and are electrically isolated from each other, and the bottom circuit-analog absorber structure layer 701''' comprises a homogenously covering resistive layer portion 709''', wherein the entire top resistive layer portion 705''', of the bottom circuit-analog absorber structure 701''', is electrically conductive.

This is just one example disclosing a number of circuit-analog absorber structure layers with suitable structural patterns, comprising basic structural elements that can be used according to the invention.

Fig. 8 shows another example of an inventive circuit-analog absorber structure 808 comprising four circuit-analog absorber structure layers 801, 801', 801'', 801''' and additionally to that two dielectric layers 812, 812'. One dielectric layer 812 is positioned on top of the circuit-analog absorber structure layers 808 and one 812' below. Each of the circuit-analog absorber structure layers 801, 801', 801'', 801''' comprises a top resistive layer portion 805, 805', 805'', 805''' and a bottom carrier layer portion 807, 807', 807'', 807''', wherein the structural pattern 804, 804', 804'', 804''' of each circuit-

analog absorber structure layer 801, 801', 801'', 801''' is formed in the top resistive layer portion 805, 805', 805'', 805'''. According to the example disclosed in fig. 8;

the uppermost circuit-analog absorber structure layer 801 comprises three times three basic structural elements 803, the basic structural elements 803 in this specific example of the invention comprising square shaped frame aperture 811 with sides of substantially the same length and the of a certain width, wherein the resistive layer portion surrounding the frame apertures 805a are electrically connected and the resistive layer portions within each frame aperture 805b are electrically isolated,

the upper of the two middle circuit-analog absorber structure layers 801' comprises four times six basic structural elements 803', wherein the basic structural elements 803' comprises square shaped apertures 806' formed in the resistive layer portion 805', wherein the resistive layer portion 805' surrounding the apertures 806' are electrically connected,

the lower of the two middle circuit-analog absorber structure layers 801'' comprises six times nine basic structural elements 803'', wherein the basic structural elements 803'' comprises square shaped apertures 806'' formed in the resistive layer portion 805'', wherein the resistive layer portion 805'' surrounding the apertures 806'' are electrically connected, and

the bottom circuit-analog absorber structure layer 801''' comprises a homogenously covering resistive layer portion 809''', wherein the entire top resistive layer portion 805''', of the bottom circuit-analog absorber structure 801''', is electrically conductive.

The space between a dielectric layer and the adjacent circuit-analog absorber structure L_1 , L_2 , the size of the space dependent on the distance between the dielectric layer and the adjacent circuit-analog absorber structure, can be filled with a filling material, preferably being a honeycomb material, a foam material or a syntactic material. The dielectric layers can e.g. add mechanical strength to the structure as such. The example of the invention according to fig. 8 discloses two dielectric layers 812, 812', but it is also possible to just use one dielectric layer, positioned on any side of the circuit-analog absorber structure, but preferably on the side facing away from the antenna, hence the outside. The dielectric layers 812, 812' can be of different thicknesses.

This is just one example disclosing a number of circuit-analog absorber structure layers with suitable structural patterns, comprising basic structural elements that can be used according to the invention.

- 5 The structural pattern, formed in the resistive layer portion of any circuit-analog absorber structure layer can also be irregularly shaped.

10 In the following claims the previously described figures are used for clarification. For readability reasons are, for most of the claims, only references to one of the above described figures per claim made. Reference signs mentioned in the claims should not be seen as limiting the extent of the matter protected by the claims, and their sole function is to make claims easier to understand.

CLAIMS

- 1) A circuit-analog absorber structure (508) for transmission of electromagnetic waves comprising more than one layer (501, 501', 501''), the properties of each layer (501, 501', 501'') determining the transmission characteristics of the circuit-analog absorber structure (508)

characterised in that

a first circuit-analog absorber structure layer (501), having a first set of transmission characteristics, is different from

a second circuit-analog absorber structure layer (501'), having a second set of transmission characteristics different from the first set of transmission characteristics of the first circuit-analog absorber structure layer (501),

wherein the quantity of transmission of electromagnetic waves in a first, predetermined frequency range, is higher than the quantity of transmission of electromagnetic waves in a second, predetermined frequency range.

- 2) A multilayer circuit-analog absorber structure (508) according to claim 1, wherein said first circuit-analog absorber structure layer (501) comprises a first carrier layer portion (507) and a first resistive layer portion (505), the first resistive layer portion (505) being arranged on the first carrier layer portion (507), forming the first circuit-analog absorber structure layer (501), wherein a first structural pattern (504) is formed in the first resistive layer portion (505) that is different from a second structural pattern (504') formed in a second resistive layer portion (505'), wherein the second resistive layer portion (505') is arranged on a second carrier layer portion (507'), the second resistive layer portion (505') and the second carrier layer portion (507') together forming a second circuit-analog absorber structure layer (501').

- 3) A multilayer circuit-analog absorber structure (508) according to any of claim 1 or 2, wherein at least one of said first or second circuit-analog absorber structure layers (501, 501') comprises a carrier layer portion (507, 507') and a resistive layer portion

(505, 505'), the resistive layer portion (505, 505') being arranged on the carrier layer portion (507, 507'), wherein parallel or near parallel apertures (506') are formed in the resistive layer portion (505'), extending in one direction.

5

- 4) A multilayer circuit-analog absorber structure according to any of claim 1 to 3, wherein

at least one of said first or second circuit-analog absorber structure layers (201) comprises a carrier layer portion (207) and a resistive layer portion (205), the resistive layer portion (205) being arranged on the carrier layer portion (207, wherein

10

parallel or near parallel apertures (206) are formed in the resistive layer portion (205) extending in a first direction, and other parallel or near parallel apertures (206) are formed in the same resistive layer portion (205) extending in a second direction, the second direction being different from the first direction.

15

- 5) A multilayer circuit-analog absorber structure (508) according to any of claim 1 to 4, wherein

at least one of said first or second circuit-analog absorber structure layers (501, 501') comprises a carrier layer portion (507, 507') and a resistive layer portion (505, 505'), the resistive layer portion (505, 505') being arranged on the carrier layer portion (507, 507'), wherein the resistive layer portion (505) is homogenously covering said carrier layer (507).

20

- 6) A multilayer circuit-analog absorber structure according to any of claim 1 to 4, wherein

the first and the second circuit-analog absorber structure layers comprise a carrier layer portion and a resistive layer portion each, the resistive layer portions being arranged on the carrier layer portions, wherein

30

the first circuit-analog absorber structure layer may comprise a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion, wherein

the first resistive layer portion comprises a first basic structural element characterized by the parameters $d_{1,1}$, $d_{2,1}$ and α_1 , and wherein

the second circuit-analog absorber structure layer may comprise a second carrier layer portion and a second resistive layer portion, the second resistive layer portion being arranged on the second carrier layer portion, wherein the second resistive layer portion comprises a second basic structural element characterized by the parameters $d_{1,2}$, $d_{2,2}$ and α_2 , wherein
5 $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 are different from $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 , respectively.

7) A multilayer circuit-analog absorber structure according to any of claim 1 or 2, wherein

10 at least one of said first or second circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, the resistive layer portion being arranged on the carrier layer portion, wherein an irregular pattern is formed in the resistive layer portion.

15 8) A multilayer circuit-analog absorber structure (508) according to any of the proceeding claims, wherein the circuit-analog absorber structure (508) further comprises a third circuit-analog absorber structure layer (501''), the third circuit-analog absorber structure layer (501'') having a different set of transmission characteristics from at least one of said first and second circuit-analog absorber structure layers (501, 501').

9) A multilayer circuit-analog absorber structure (608) according to claim 8, wherein said first circuit-analog absorber structure layer (601) comprises a first carrier layer portion (607) and a first resistive layer portion (605), the first resistive layer portion (605) being arranged on the first carrier layer portion (607), forming the first circuit-analog absorber structure layer (601), wherein a first structural (604) pattern is formed in the first resistive layer portion (605) that is different from either

25 a second structural pattern (604') formed in a second resistive layer portion (605'), wherein

30 the second resistive layer portion (605') is arranged on a second carrier layer portion (607'), the second resistive layer portion (605') and the second carrier layer portion (607') together forming a second circuit-analog absorber structure layer (601'), and/or

a third structural pattern (604'') formed in a third resistive layer portion (605''), wherein

the third resistive layer portion (605'') is arranged on a third carrier layer portion (607''), the third resistive layer portion (605'') and the third carrier layer portion (607'') together forming a third circuit-analog absorber structure layer (601'').

- 10) A multilayer circuit-analog absorber structure according to claim 8 or 9, wherein said first, second and third circuit-analog absorber structure layers may comprise a carrier layer portion and a resistive layer portion each, the resistive layer portions being arranged on the carrier layer portions, wherein
- the first circuit-analog absorber structure layer may comprise a first carrier layer portion and a first resistive layer portion, the first resistive layer portion being arranged on the first carrier layer portion, wherein
- the first resistive layer portion comprises a first basic structural element characterized by the parameters $d_{1,1}$, $d_{2,1}$ and α_1 , and wherein
- the second circuit-analog absorber structure layer may comprise a second carrier layer portion and a second resistive layer portion, the second resistive layer portion being arranged on the second carrier layer portion, wherein
- the second resistive layer portion comprises a second basic structural element characterized by the parameters $d_{1,2}$, $d_{2,2}$ and α_2 , wherein
- $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 is different from $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 , and wherein
- the third circuit-analog absorber structure layer may comprise a third carrier layer portion and a third resistive layer portion, the third resistive layer portion being arranged on the third carrier layer portion, wherein the third resistive layer portion comprises a third basic structural element characterized by the parameters $d_{1,3}$, $d_{2,3}$ and α_3 , and wherein
- $d_{1,3}$ and/or $d_{2,3}$ and/or α_3 is different from or equal to $d_{1,1}$ and/or $d_{2,1}$ and/or α_1 , and is different from or equal to $d_{1,2}$ and/or $d_{2,2}$ and/or α_2 respectively.

- 11) A multilayer circuit-analog absorber structure according to any of claim 8 or 9, wherein
- at least one of said first, second or third circuit-analog absorber structure layers comprises a carrier layer portion and a resistive layer portion, the resistive layer portion being arranged on the carrier layer, wherein

an irregular pattern is formed in the resistive layer portion.

- 12) A multilayer circuit-analog absorber structure (808) according to any of claim 1 to 11, wherein the circuit-analog absorber structure (808) comprises at least two circuit-analog absorber structure layers (801, 801', 801'', 801'''), and wherein at least one dielectric layer (812, 812') is arranged parallel to, but separated from, and at least on one side of the circuit-analog absorber structure (808).
- 13) A multilayer circuit-analog absorber structure (808) according to any of claim 1 to 12, wherein at least two of the layers (801, 801', 801'', 801''') of the circuit-analog absorber structure (508, 608, 708, 808), being either two circuit-analog absorber structure layers (801, 801', 801'', 801''') and/or one circuit-analog absorber structure layer (801, 801', 801'', 801''') and one dielectric outer layer (812, 812'), are separated by a filling material, preferably being a honeycomb material, a foam material or a syntactic material.
- 14) A multilayer circuit-analog absorber structure (508, 608, 708, 808) according to any of the proceeding claims, wherein the properties of the circuit-analog absorber structure (508, 608, 708, 808) is selected to give maximized transmission of electromagnetic waves in the L-band and maximized absorption of electromagnetic waves at frequencies above the L-band.
- 15) A multilayer circuit-analog absorber structure (508, 608, 708, 808) according to any of claim 1 to 13, wherein the properties of the circuit-analog absorber structure (508, 608, 708, 808) is selected to give maximized transmission of electromagnetic waves at lower frequencies than 3,3 GHz and maximized absorption of electromagnetic waves at frequencies above 3,3 GHz.
- 16) A multilayer circuit-analog absorber structure (508, 608, 708, 808) according to any of the claim 1 to 13, wherein the properties of the circuit-analog absorber structure (508, 608, 708, 808) is selected to give maximized transmission of electromagnetic waves between 2-6 GHz and maximized transmission of electromagnetic waves at frequencies above 6 GHz.

- 17) A radome comprising said circuit-analog absorber structure (508, 608, 708, 808) according to any of the proceeding claims.
- 18) An aircraft comprising a multilayer circuit-analog absorber structure (508, 608,
5 708, 808) according to any of the proceeding claims.
- 19) A ship comprising a multilayer circuit-analog absorber structure (508, 608, 708, 808) according to any of claim 1 to 17.

1/5

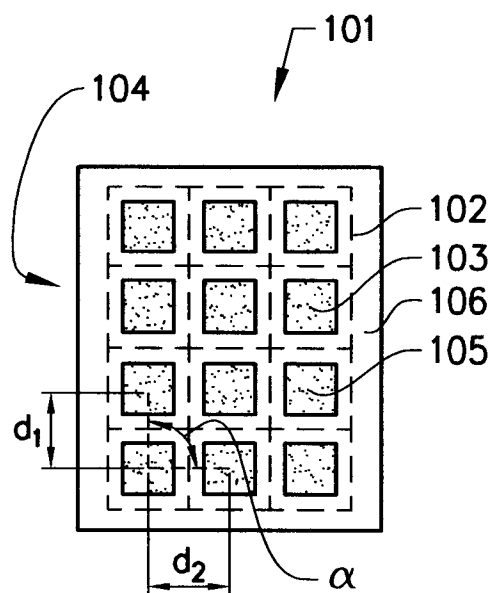


FIG. 1

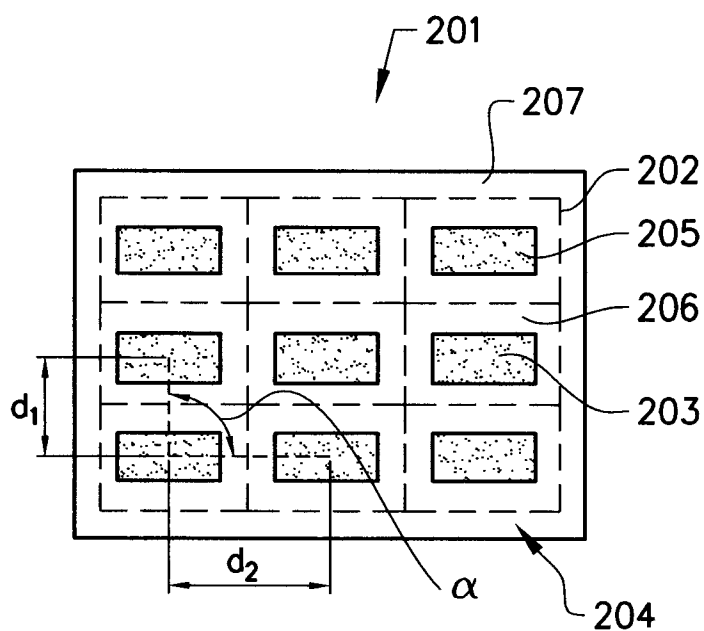


FIG. 2

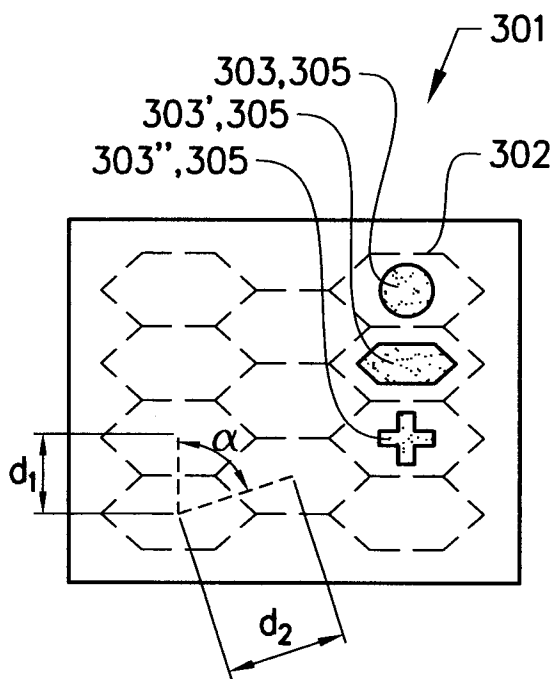


FIG. 3

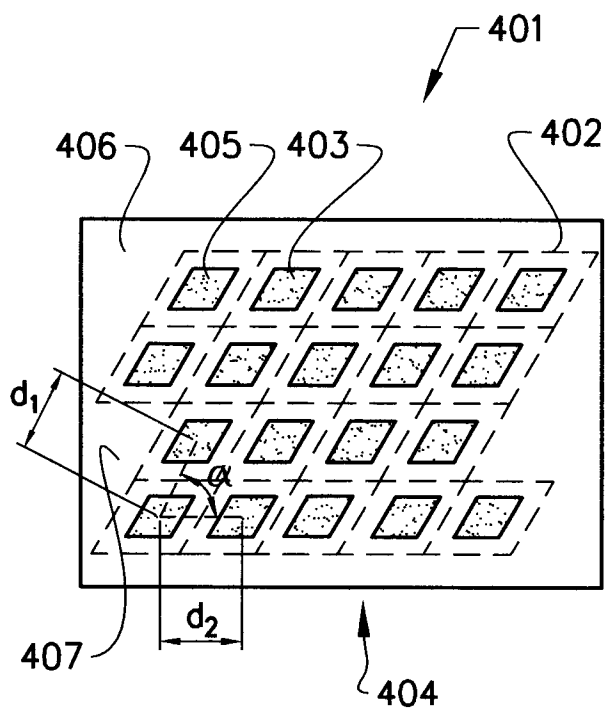


FIG. 4

2012 -10- 2 3

2/5

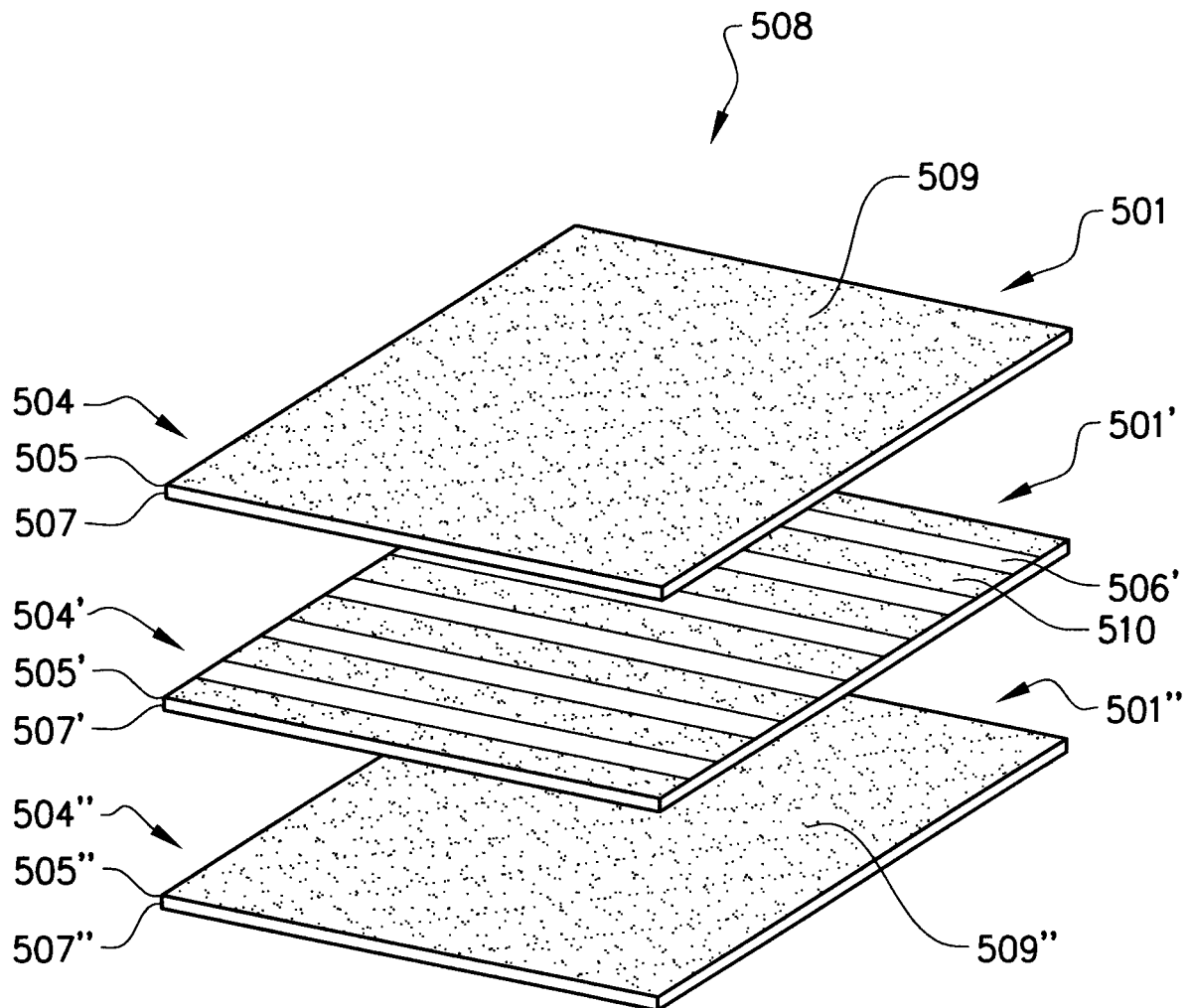


FIG. 5

3/5

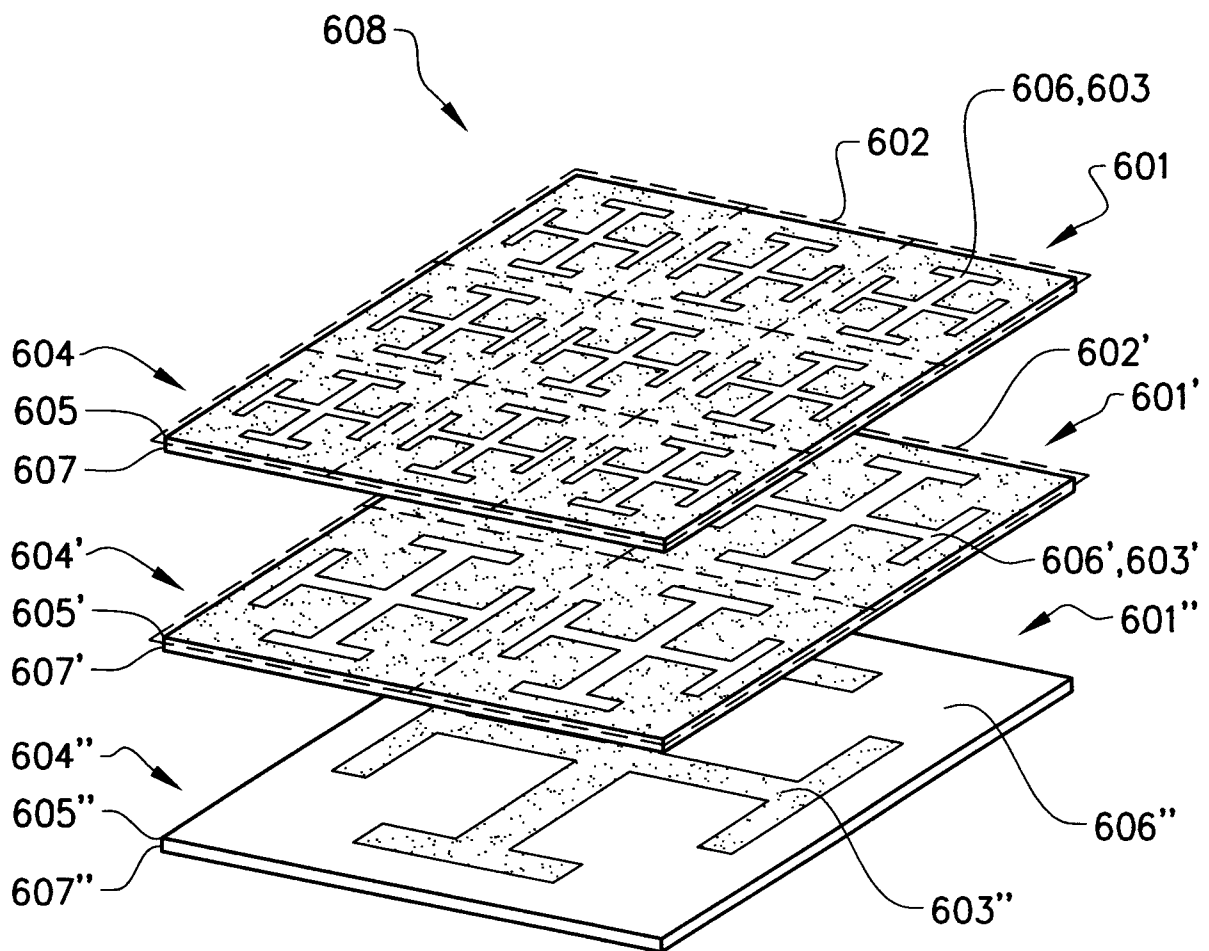


FIG. 6

4/5

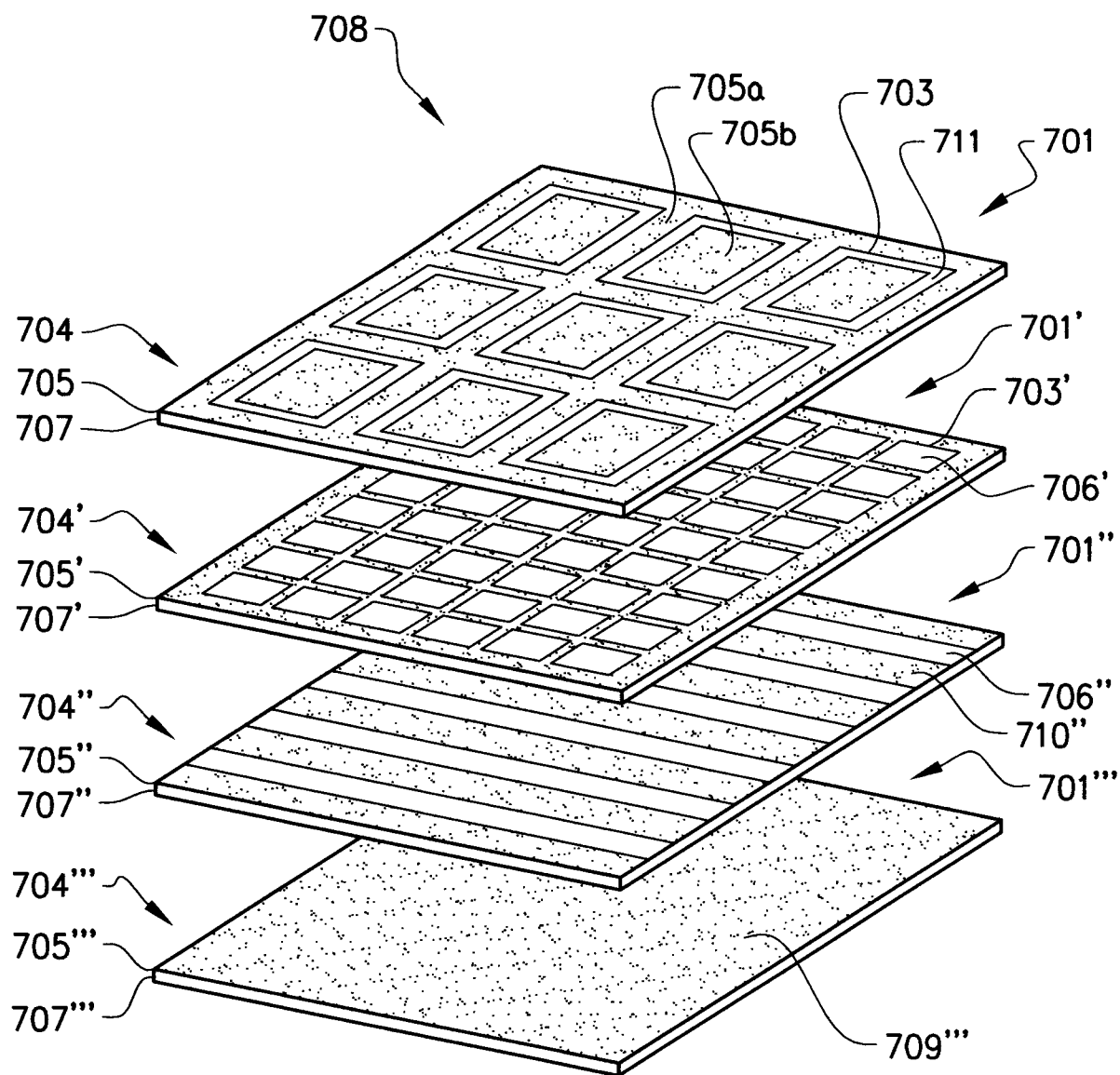


FIG. 7

5/5

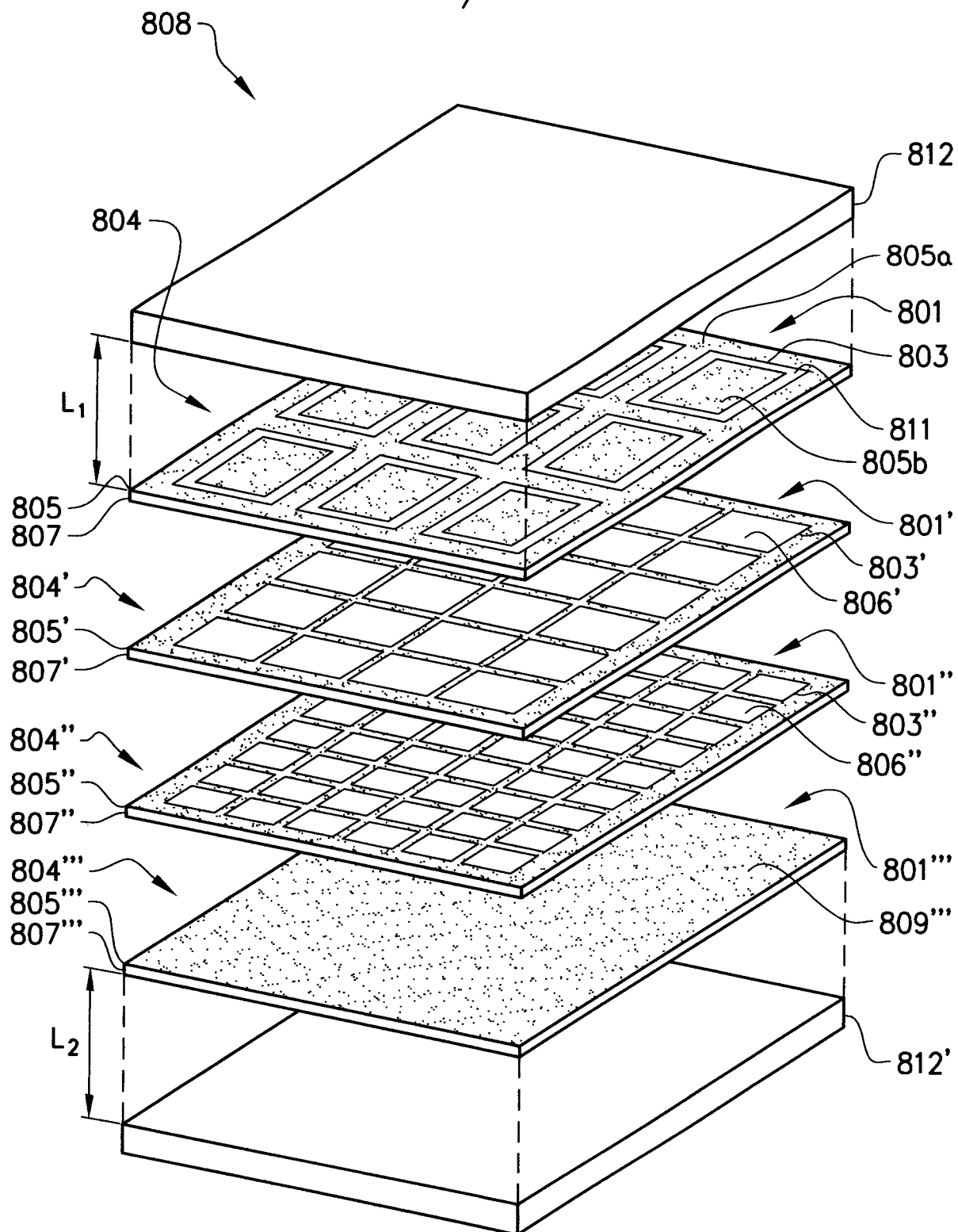


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2012/051132

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Motevasselian, A., Jonsson, B. L. G. "Design of a wideband rasorber with a polarisation-sensitive transparent window" In: IET Microwaves, Antennas and Propagation, Vol. 6, Issue 7, 16 May 2012, pp 747-755, ISSN 17518725; page 748, paragraph [0002]; page 750, paragraph [0005] - page 752, paragraph [0007]; figures 1,5-7 --	1-19
X	US 6538596 B1 (GILBERT ROLAND A), 25 March 2003 (2003-03-25); column 3, line 55 - column 3, line 64; column 5, line 18 - column 5, line 32; figure 3	1, 2, 8, 9
A	--	3-7, 10-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

13-09-2013

Date of mailing of the international search report

16-09-2013

Name and mailing address of the ISA/SE

Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer

Jonas Holmqvist

Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

 International application No.
 PCT/SE2012/051132

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Kazemzadeh, A., Karlsson, A. "Multilayered Wideband Absorbers for Oblique Angle of Incidence" In: IEEE Transactions on Antennas and Propagation, Vol. 58, No. 11, November 2010, pp. 3637-3646, ISSN 0018-926X; whole document; figures 2,10,11 --	5, 8-10, 12, 13
A	US 5576710 A (BRODERICK JOHN F ET AL), 19 November 1996 (1996-11-19); column 12, line 15 - column 12, line 56; figures 5,10 --	8-10
A	US 5214432 A (KASEVICH RAYMOND S ET AL), 25 May 1993 (1993-05-25); figures 2,31-33 --	7, 11
A	Costa, F., Monorchio, A. "A Frequency Selective Radome With Wideband Absorbing Properties" In: IEEE Transactions on Antennas and Propagation, Vol. 60, No. 6, June 2012, pp. 2740-2747, ISSN 0018-926X; whole document; figures 1,2 --	1-19
A	Yildirim, E., Aydin Civi, O. "Design of a Wideband Radar Absorbing Structure" In: Proceedings of the 5th European Conference on Antennas and Propagation, Rome, Italy, April 2011, pp. 1324-1327, ISBN 978-888202074-3; whole document --	1-19
A	WO 2007080368 A1 (UNIV SHEFFIELD ET AL), 19 July 2007 (2007-07-19); whole document --	1-19
A	US 20100290503 A1 (RUMPF JR RAYMOND CHARLES ET AL), 18 November 2010 (2010-11-18); whole document -- -----	1-19

Continuation of: second sheet

International Patent Classification (IPC)

H01Q 17/00 (2006.01)

H01Q 1/42 (2006.01)

H01Q 15/00 (2006.01)

H05K 3/46 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2012/051132

US	6538596 B1	25/03/2003	NONE		
US	5576710 A	19/11/1996	NONE		
US	5214432 A	25/05/1993	US	5223849 A	29/06/1993
WO	2007080368 A1	19/07/2007	NONE		
US	20100290503 A1	18/11/2010	NONE		