PATENT

FOR INVENTION

No. 2249862

DEVICE FOR STRUCTURIZATION OF AN ELECTROMAGNETIC FIELD

Patent Holder(s): ***AIRES Technologies Science & Production (S&P) Association Limited Liability Company (RU)***

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Application No. **2004120428**
Invention priority: **02nd July 2004**
Recorded in the State Register of Inventions of the Russian Federation on ***10th April 2005***
The patent validity will expire on ***02nd July 2024***

Head of Federal Service for Intellectual Property, Patents and Trademarks

(signature) *B.P. Simonov*

(19) RU (11) 2 249 862 (13) C1
(51) MPK[7] G 12 B 17/02

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PATENTS AND TRADEMARKS

(12)

(21), (22) Application: 2004120428/28, 02.07.2004

(24) Effective date of the Patent: 02.07.2004

(45) Published on 10.04.2005, Bulletin No. 10

(56) List of documents cited in the search report: RU 2231137 C1, 20.06.2004; RU 2002129253 A, 20.05.2004; RU 2167678 C1, 27.05.2001; RU 2117497 C1, 20.08.1998; RU 9999 U1, 16.05.1999; WO 01/54221 A1, 26.07.2001; WO 99/25044 A1, 20.05.1999

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RU 2249862 C1

(54) DEVICE FOR STRUCTURIZATION OF AN ELECTROMAGNETIC FIELD

CLAIMS:

1. A device for structurization of an electromagnetic field, containing a substrate whereupon a fractal topology is generated, which structure includes the fractal topology with a level of fractalization M not less than three, formed as follows: into structure of the first level fractalization module the 1+N circles of radius R enter, the centers of each of the N circles being located on the first circle, forming a central-symmetric figure, and the circle of radius 2R, which center coincides with the center of the first circle, envelopes the circles of radius R, and the points of contact of the circle of radius 2R with the circles of radius R are the centers of layout of the first level fractalization modules, which are enveloped with the circle of radius 4R at the construction of the second level module, and a further topology is fractalized in the same way, distinguished that the fractal topology is generated by the slits, which width and depth not less than 0.1 micron.

2. The device for structurization of an electromagnetic field according to claim 1, distinguished that through the points of crossing of the N circles of the first module passes at least one additional circle and in the same points the centers of the circles of radius equal to radius of an additional circle locate and said circles of radius equal to radius of an additional circle are enveloped with the circle of radius equal to two radiuses of an additional circle, and further additional modules of the second, ... n level are generated, where n does not exceed M.

3. The device for structurization of an electromagnetic field according to claim 1, distinguished that the substrate is executed from silicon.

4. The device for structurization of an electromagnetic field according to claim 1, distinguished that the substrate is executed as a layered structure, and the top layer is executed as the semi-transparent mirror covering providing reflection from the underlaying layer.

RU 2249862 C1

5. The device for structurization of an electromagnetic field according to claim 4, distinguished that the substrate is executed from glass, and the semi-transparent layer is executed as the film of nickel which thickness is equal 1 micron.

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(12) DESCRIPTION OF THE INVENTION TO THE PATENT

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(54) DEVICE FOR STRUCTURIZATION OF AN ELECTROMAGNETIC FIELD

(57) Abstract

The invention relates to technical physics and can be used, in particular, in getting thin films with a fractal structure. The device for structurization of an electromagnetic field contains a substrate, whereupon a fractal topology is generated, which structure includes the fractal topology with a level of fractalization M being not less than three. The module of the first level of fractalization comprises 1+N circles of radius R, the center of the N circles each being located on the first circle, forming a central-symmetric figure, and the circle of radius 2R, which center coincides with center of the first circle, envelopes the N circles of radius R, and the points of its contact with threes circles are the centers of layout of the first level fractalization modules, which are enveloped with the circle of radius 4R at the construction of the second level module, and a further topology is fractalized in the same way. The fractal topology formed by the slits, which width and depth are not less than 0,1 microns. Such a solution allows expanding the spatial region of localization of the structurized field. 4 dependent claims, 8 ill.

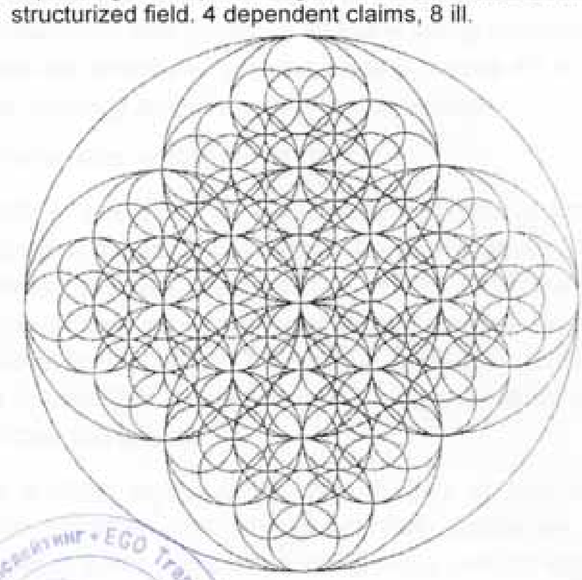

Fig. 1.

RU 2249862 C1

The present invention relates generally to area of technical physics and, more particularly, can be used mainly in areas, where it is necessary to provide influence of structured electromagnetic field on various physical, chemical, and biological processes, for example, getting thin nanodimension films with a fractal structure, protection of biological objects against harmful influence of electromagnetic field of technogenic character, and so on.

Structurization of an electromagnetic field with help of various diffraction gratings is known. Physically speaking, a diffraction grating will transform a flat wave falling on it both into a set of flat waves extending from the grating under certain angles and into infinite superposition of surface waves, playing an essential role only adjacent to the grating.

It is known a device [1] carried out as a periodic structure, consisting of the indefinitely thin and indefinitely long ideally conducting tapes of certain width and certain period which plane makes an angle with the normal to the plane of the grating. In such a grating a mirror resonance occurs on the condition of coincidence of the direction of the wave extending above said grating with the direction of the specularly reflected beam. Also in the slits between the tapes the continuous waveguide waves exist, which interference results in sharp splashes on the dependences of peak factors of divergent shock waves upon frequency and parameters of said grating. The interference of TEM wave and the first waveguide wave in the slits results in a resonant total reflection of energy.

The limitation of the known device from view of practical use is a narrow frequency range of transformation of an electromagnetic field.

The most similar combination of essential features to offered invention has a device [2] comprising a substrate made of dielectric material and/or semiconductor and/or metal whereupon a fractal topology is generated, which structure includes the fractal topology with a level of fractalization M not less than three, formed as follows: into structure of the first level fractalization module the 1+N circles of radius R enter, the center of the N circles each being located on the first circle, forming a central-symmetric figure, and the circle of radius 2R, which center coincides with center of the first circle, envelopes the circles of radius R, the points of contact of circle of radius 2R with circles of radius R being the centers of layout of the first level fractalization modules, which are enveloped with the circle of radius 4R at the construction of the second level module, and a further topology is fractalized in the same way.

Such devices refer to a fractal matrix structurizator (hereinafter referred to as FMS).

In the basis of the known device lays its opportunity to transform an electromagnetic field in three-dimensional spatial system of the interferential maxima and minima located in the space above FMS and having an ordered structure, correlated with fractal graphics structure. It is clearly illustrated, for example, at growing nanodimension films in the presence of one or several known devices [3] in a sputter volume but outside of zone of sputtered material transportation. On the substrate the structures grow aspiring to repeat the topology of the known device. For explanation of this phenomenon was offered to consider said topology as a multielement diffraction grating.

One of the major properties of the multielement gratings is the expansion of area of polarizing susceptibility. With rise of frequency the wavelength becomes comparable with finer details on the period of the grating; therefore the resonant area appears wider at multielement gratings than at single-element gratings. But as the experiment has shown, the known device has not very great spatial area of structurization, it does not exceed several millimeters over optical range.

The purpose of the invention is to provide the device for structurization of an electromagnetic field with greater spatial area of influence that will allow using it for such purposes as structurization of a radiotelephone field, radiations of electron-beam tubes, and so on.

The technical result of the invention is the expansion of spatial area of the structured field localization.

The task in view is solved due to the fact that the offered device for structurization of an electromagnetic field and the known device both contain a substrate whereupon a fractal topology is formed which structure includes the fractal topology with a level of fractalization M not less than three, formed as follows: into structure of the first level fractalization module the 1+N circles of radius R enter, the center of each of the circles being located on the first circle, forming a central-symmetric figure, and the circle of radius 2R, which center coincides with center of the first circle, envelopes the N circles of radius R, the points of contact of circle of radius 2R with circles of radius R being the centers of layout of the first level fractalization modules, which are enveloped with the circle of radius 4R at the construction of the second level module, and a further topology is fractalized in the same way. But in the offered device unlike the known device the fractal topology on the substrate is formed using slits which width and depth are not less than 0,1 microns.

Fractal graphics of FMS represents a diffraction grating of complex design assembled from curvilinear closed elements formed by closed slits on which electromagnetic waves are spread as on a waveguides system. In said slits interference of several not fading electromagnetic waves occurs. Interference both TEM and the first waveguide wave results in resonant full reflection of energy [1] in said slits. Resonant phenomena influence on the interference picture in a far zone and in a near one. This phenomenon can be treated as the expansion of a near zone in area of a far zone. The diffracting element of minimal size and accordingly the wavelength of diffracting radiation will be defined by minimal size of the point of angle formed by the crossing of arcs of the circles. In view of the fact that a mutual contact of arcs occurs under different angles in the widest range of angles and will be defined by geometrical parameters of waveguide slits, as well as their mutual configuration and arrangement, a continuous set of diffracting elements will take place characterized by various geometrical features, starting from a submicron range (as minimal as possible wavelengths of diffraction spectrum lay over optical and ultraviolet ranges). Taking into account that fractal graphics can consider as a continuous set of diffracting elements of different sizes up to the biggest one determined by FMS borders and lying already over millimetric range, the offered device refers to a broadband converter and a structurizator of an electromagnetic field in this range. It should be pointed out, that FMS even with not very dense graphics and the size of the slit in some microns will contain about 400000 diffracting elements located in orderly fashion, which provide various, ordered, intensive diffracting picture.

Comparison of two devices having identical graphics but executed on various technologies, the first with help of said slits and the second with help of the lines, generated on the surface of substrates, shows that the offered device influences on an electromagnetic field much more intensive. Comparison was done on a basis of spatial pictures of distribution of the interference maxima and minima generated by both the known FMS and the offered one under the action of a nonmonochromatic light. Extension of the structured field above the substrate in the first case reached several millimeters, whereas in the second one reached several centimeters.

The minimal width of the slit equal of 0.1 micron is connected with the covered spectrum band of an electromagnetic radiation (0.1 micron – the wavelength in the ultraviolet). But as the experiment has shown, even at width of the slits equal 7 microns the whole spectrum of an optical range is structured. It is possible to explain that the minimally covered wavelength will be defined by not only slit parameters, but also the sizes of the sharpest angle in the offered fractal graphics.

The minimal depth of the slit equal of 0.1 micron is chosen empirically from the general physics reasons, namely the height of the stair as a diffracting element cannot be less than the wavelength of an electromagnetic radiation. At such depth the structured area reaches several centimeters.

The combination of features according to claim 2, characterizes the device in which through the points of crossing of the N circles of the first module at least one additional circle passes and in the said points the centers of the circles of radius equal to radius of said additional circle are located which are enveloped with the circle of radius equal to two radiuses of said additional circle, and further additional modules of the second, ... n level, where n does not exceed M, are generated.

In this case the device is supplemented with one more fractal structure dependent on the first one. Not only the number of the ordered cells, but also the number of their kinds and the variety of their configurations increase, and this ensured that the resonant area essentially extends.

The combination of features according to claim 3, characterizes the device in which the substrate is executed from silicon.

Choice of the substrate material is of great importance only because of consumer properties of material. It is obvious that the more difference in density of the substrate and the environment, the greater will be diffracting structure efficiency. For example, the pair platinum-vacuum will be ideal. But it is important to take into account material availability and its price. Silicon has a reasonable price and can be quite used as the substrate in devices for structurization of a radiotelephone field, radiation of computer, etc.

The combination of features according to claim 4, characterizes the device in which the substrate is executed as a layered structure, and the top layer is executed as the semi-transparent mirror covering, providing reflection from the underlying layer.

The combination of features according to claim 5, characterizes the device in which the substrate is executed from glass and the semi-transparent layer is executed as the film of nickel with thickness equal 1 micron.

The semi-transparent mirror covering introduces an additional element of structurization. Each beam getting on the covering will be reflected twice (fig. 4): first time from the external surface, second time, penetrating into the covering with refraction from the border of the unit «a covering – a subsequent layer». Thus different ranges of wavelengths will be reflected from each structure element. The reflected bunches of different wavelengths from a great number of elements will interfere.

The invention is explained by drawings, where:
Figures 1-2 are examples of embodiments of topology of the device;
Figure 3 is a topology of the module of the first level of fractalization;
Figure 4 is a scheme of the rays path in the device made as a layered structure;
Figures 5-8 are photos of the structured electromagnetic field generated by devices with various characteristics.

Referring to Figure 1, an elementary kind of graphics carried out on a substrate is shown. Referring to Figure 3, construction of the first level fractalization module at N=4 is shown. On the circle of radius R the centers of four circles with the same radius are located, and they are covered with the circle of radius 2R. Thus construction of the first level fractalization module is completed. In the same Figure 3 construction of the second fractal topology module derivative from the first one is shown. The circle of radius R_d passes through the points of crossings of circles 1_1-4_1 of radius R, and in the same points the centers of the circles with radius R_d are located.

of contact of the circle of radius 2R with the circles of radius R are the centers of layout of the first level fractalization modules, which are enveloped with the circle of radius 4R at the construction of the second level module, and a further topology is fractalized in the same way, distinguished that the fractal topology is generated by the slits, which width and depth not less than 0.1 micron.

2. The device for structurization of an electromagnetic field according to claim 1, distinguished that through the points of crossing of the N circles of the first module passes at least one additional circle and in the same points the centers of the circles of radius equal to radius of an additional circle locate and said circles of radius equal to radius of an additional circle are enveloped with the circle of radius equal to two radiuses of an additional circle, and further additional modules of the second, ... n level are generated, where n does not exceed M.

3. The device for structurization of an electromagnetic field according to claim 1, distinguished that the substrate is executed from silicon.

4. The device for structurization of an electromagnetic field according to claim 1, distinguished that the substrate is executed as a layered structure, and the top layer is executed as the semi-transparent mirror covering providing reflection from the underlaying layer.

5. The device for structurization of an electromagnetic field according to claim 4, distinguished that the substrate is executed from glass, and the semi-transparent layer is executed as the film of nickel which thickness is equal 1 micron.

Construction of the first level fractalization module is completed with construction of the circle of radius 2Rd. This variant of the embodiment is described in Claim 2. At the construction of the second level fractalization module, on the circle of radius equal 2R the centers of the first level modules are located, covered with the circle of radius 4R. A further construction proceeds in the same way. Referring to Figure 2, appearance of the device which topology corresponds to claim 2 is shown.

Technologically the structures can be realized as follows: on the cleared substrate a resist layer either negative or positive is brought. In the resist layer the required image of graphics is formed by method of contact seal, or with help of multiplication and then the resist layer is subjected to action of developer resulting in removal of the not reacted layer of the resist. Then the resist layer is cured. Using the positive resist layer, a film is coated on it proof to aggressive environment used at dry etching or to only ionic etching. Usually it is a metallic film. The additional requirement to said film is to keep film thickness smaller than resist layer thickness. Then the resist layer is subjected to the lift off technology, during which the resist layer is removed together with the metallic film brought on it, and on the substrate the metallic film remains with generated fractal structure with opened sites of the substrate for dry etching. The following stage is dry etching. Correlation between depth and width of the slits can run up to 6-10.

The experiments confirming the structurization of an electromagnetic field were carried out with use of the nonmonochromatic light source. The following photos show the results of experiments with the following structures:

Figure 5. R_0 is equal 2.5 mm, N=4, width of the slits L is equal 2.5 microns, depth of the slits H is equal 2 microns, the material of the substrate is glass. The structured field runs from the substrate to 2 cm.

Figure 6. Graphic topology is the same as in the previous case. L=7 microns, H=7 microns. The material of the substrate is silicon. The structured field runs from the substrate to 4 cm.

Figure 7. Graphic topology is the same as in the previous case. L=7 microns, H=0.1 micron. The material of the substrate is glass and the evaporated film of nickel with thickness equal 0.1 micron. The structured field runs from the substrate to 4 cm.

Figure 8. Geometrical structure is the same. L=7 microns, H=3.5 microns. The material of the substrate is silicon and the evaporated film of nickel with thickness equal 0.1 micron. The structured field runs from the substrate to 4 sm.

The experiments show that the offered device provides much more spatial distribution of the structured field from the substrate than the same parameter of the known device.

References

1. V.P. Shestopalov, et al. Multiple Slit Diffraction. – Kharkov, Kharkov University Publishing House, 1993, p. 287.
2. Patent RU No. 2231137.
3. Patent RU No. 2212375.

What we claim is:

1. A device for structurization of an electromagnetic field, containing a substrate whereupon a fractal topology is generated, which structure includes the fractal topology with a level of fractalization M not less than three, formed as follows: into structure of the first level fractalization module the 1+N circles of radius R enter, the centers of each of the N circles being located on the first circle, forming a central-symmetric figure, and the circle of radius 2R, which center coincides with the center of the first circle, envelopes the N circles of radius R, and the points

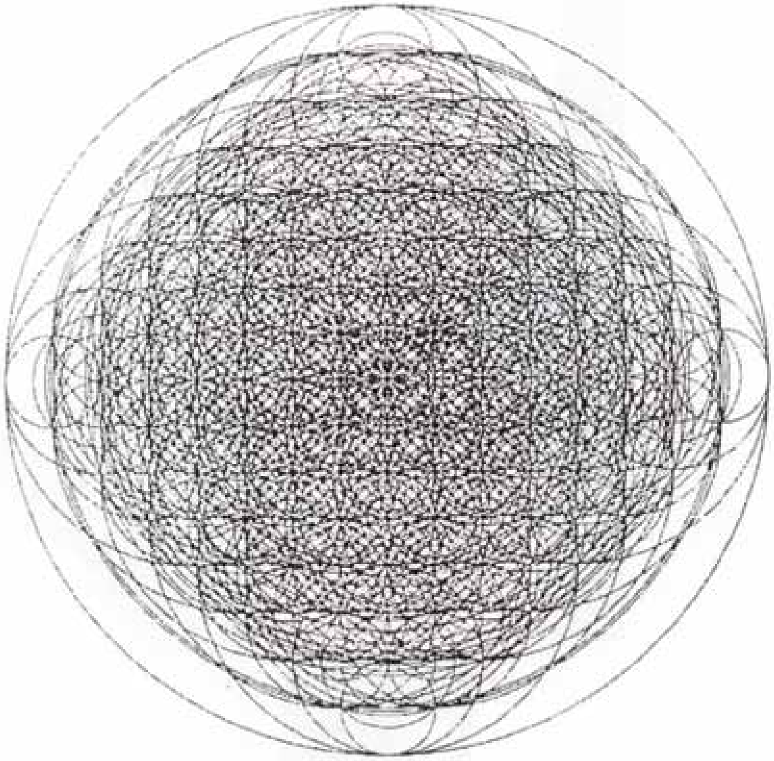

Fig. 2

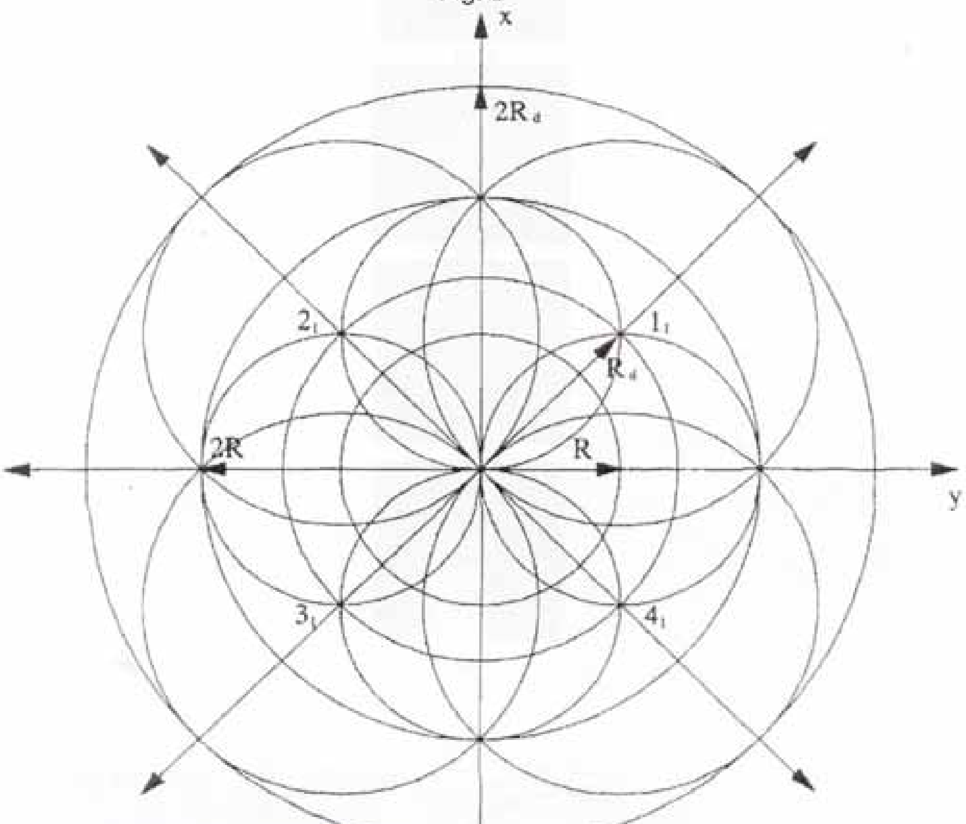

Fig. 3

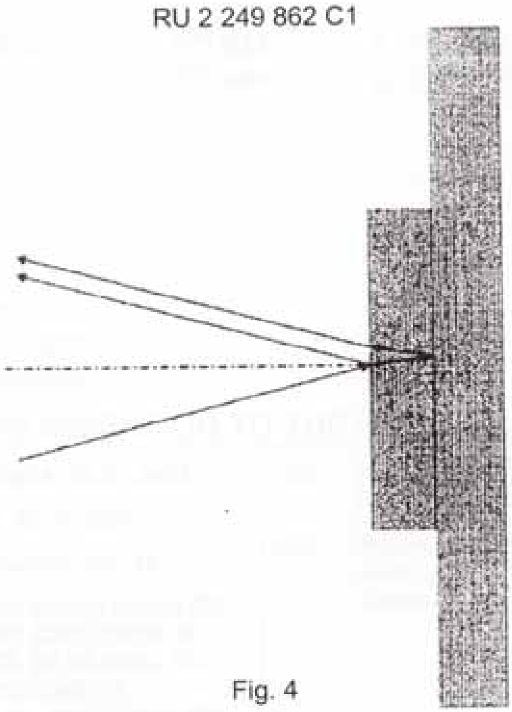

Fig. 4

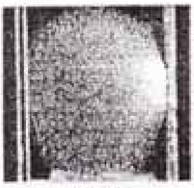

Fig. 5

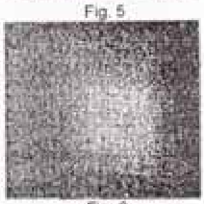

Fig. 6

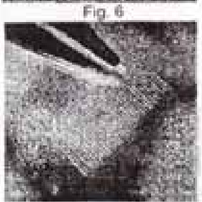

Fig. 7

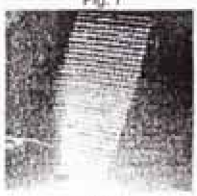

Fig. 8