Millimeter Wave Nonthermal Therapeutic Device Based on Parallel-Strip Technology

SAINSUS Iurie, RAILEAN Sergiu, ROTARU Anatol,
CONEV Alexei, RUSSEV Iurie, POSTORONCA Sveatoslav, SCERBII Denis
Institute of Electronic Engineering and Nanotechnologies "D. Ghitsu"
Academy of Sciences of Moldova, Academiei str. 3/3, Chisinau, MD–2028 Republic of Moldova

Abstract - **This paper describes the therapeutic device developed at the Institute of Electronic Engineering and Nanotechnologies "D. Ghitsu" (IIEN). The device is based on the parallel-strip technology. This technology is effective for the designing, testing, and subsequent manufacturing of low intensity microwave generators to use in medicine, veterinary medicine, microbiology, etc.**
The proposed device differs from those developed and used previously by the fact that it combines a number of known and new methods for elaboration, which prove this device with new properties.
We do not use a waveguide (metal mechanical device) in the generator-module as the basic working environment of the active elements (generators), instead, we use a plate with parallel stripes. The plate with parallel strips contains two substrates, but the passive elements, such as inductances and capacities, form a composite circuit, where the active elements (transistors, diodes varicap, etc.), form an auto-oscillating system that generates microwaves.

I. INTRODUCTION

Results and analysis of multiple publications on the issue clearly demonstrates that the applied possibilities of UEMA in various fields of medicine, biology, food industry, environmental protection, industrial technology began to be conceived according to its real value only in recent times. It was built an impressive volume of empirical results based on which they were established the overall limit a series of unique phenomena: the benefic resonant influence to all living organisms of non-ionizing electromagnetic waves with very low non-thermal intensity (UEMA) (under 10 mW/cm2) in some segments of the extremely high frequency bands (EIF) (wavelength 4.9, 5.6, 7.1mm) has a universal character; UEMA radiation interaction with living objects has not a thermal nature, but wears a specific information character for all bio-medical systems [1,2].

The device described has been called "DVG-001" and was developed within the institutional project 06.408.027A "Devices and methods for irradiation of living matter and the study of millimeter-wave-induced biophysical effects" (scientific Academician Dmitry Ghitu).

The device contains a number of original techniques.

Projects of the manufacture of non-thermal millimeter wave generators (UEMA) have started the design of generators that used Gann diodes. This concept was chosen because of the use of Gann diodes in construction of analog devices produced in Russia and Ukraine in the late XX century [3].

Priorities Gann diodes are well known: - Simple construction.

- Techniques that are well described in literature.
- A very simple power scheme.
- A very small number of elements used in construction.

At the same time we used millimeter wave machines, developed and manufactured in the Institutional and State Programs at the Institute of Engineering and Computer Science "D. Ghitu" ASM [4,5], as well as devices showed produced Russian Federation, that showed a number of shortcomings related to the use of Gann diodes, among which can mention:

- Gunn diodes, used in domestic appliances, are of Russian production. these items fall under the restrictions there, relating to prohibiting the export of components, which can be used in the military.
- Poor reliability of Gann diodes. These elements are used in military systems such as rockets "air-air", therefore their lifetime is small - a few hundred hours. This was confirmed by the large number breaks of Gann diodes, used in appliances generator model of UEMA devices.
- the frequency of oscillations Gunn diodes is very narrow and larger deviations can be made only by means of mechanical processes which cannot be easily handled by the CPU.

That is why our first decision was to develop a millimeter wave generator using techniques that allow the generation of very high frequency oscillations without using Gann diodes.

II. THE TOPOLOGY OF THE GENERATOR

Figure 1 shows the topology of the first variant of the plate with parallel stripes, designed to manufacture a sample layout generator in laboratory conditions.

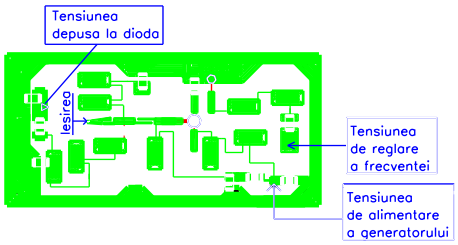


Fig.1. Topology parallel plate strip

The plate dimensions are 58.600 x 28.600 mm; the material used is 0.500 mm thick sapphire. The plate was designed to be produced in laboratory conditions by electroplating method.

Output frequency oscillations are connected to "Iesire" terminal, which is a hole in which it engages a probe, which is an antenna that transmits output frequency

oscillations in the waveguide. Waveguide is a filter because the frequency fluctuations that are lower than the critical frequency will not pass through the waveguide. The waveguide technology has been used in the construction of millimeter wave generator with Gunn diode.

The perimeter of the plate is composed of a layer of copper joined with the bottom surface unit (grounded). This area is connected to the common terminal "-" of the generator voltage supply and the frequency adjustment is made to the diode voltage multiplier. The points where "+" is applied are shown on Figure 1. We can see some lines on the drawing that can be grouped by thickness into three categories: flat, medium and narrow. Flat lines represent the capacities, implemented by parallel stripes technology. The medium lines represent are the one with calculated characteristics (impedance), and narrow lines represent inductances, made using parallel strips technology.

III. GENERATOR FEATURES

Among the basic features UEMA generator can be mentioned:

1. Frequency band has a generator:
   - Not narrower than (40-45) GGZ;
   - Not narrower than (50-55) GGZ;
   - Not narrower than (60-65) GGZ.
2. Maximum generator output power density, measured at a distance of 2 cm
   - not more than 10 mW / cm ² (10 x 10-3 W / cm ²)
3. Minimum power density generator output, measured at a distance of 2 cm
   - not more than 5 ηW / cm ² (5 x 10-6 W / cm ²)
4. Materials used in preparing the generator - not limited
5. Generator dimensions - we are limited, but to satisfy the conditions to be easily held in hand
6. Weight - no more than 0.5 Kg
7. Maximum power absorption of a generator - no more than 1.0 W

Power supply - not more than 48V (for security reasons); Maximum current work - in accordance with the terms "Caietul sarcinii".

IV. DESCRIEREA APARATULUI TERAPEUTIC DVG-001

The construction of this device were used known techniques, such as:

- Parallel stripe Technology without the use of Gunn diodes.
- ATMEGA8 microprocessor as a control device,
- Use as an indicator a matrix with almost zero current consumption,
- Use Li-Ion battery as a power source to the system working autonomously
- Use a battery charging device and, simultaneously, the power of the system operating mode of the industrial network.

Each of these processes themselves are not new, but used simultaneously in one device, gave it a range of new properties that allow us to count this as one of the original device.

These techniques have allowed us to receive the following priorities in comparison with Russian equipment and ASM IIETI developed in previous years:

- Enlargement of the frequency band amplitude modulation up to 400Hz in comparison with 10Hz to 8Hz and 16Hz,
- Frequencies can drift very high frequency electromagnetic waves with ± 15% of center frequency to ± 2%
- An 8 hours lifetime on battery (in the autonomous regime) and to charge the battery without removing it from the device.

An original program, which was inserted into the microprocessor memory, handles all processes. Language used to indicate the working modes is Romanian. The device was named "DVG - 001" in honor of Academician Dmitry Vasilyevich Ghitu, under whose leadership have started work.

Device "DVG-001" represents a case in which a supply and control board is installed, which is connected to two separate boards (routing board and mode board) and work with the indicator system. The casing is connected to a device, which is coupled with very high frequency generator. Supply feed can be easily removed, if is necessary to work in autonomous regime.

A full documentation of implementation was developed that allows duplicating the device to a specialized production enterprise.

In Fig. 2 we have illustrated the exterior of the appliance.

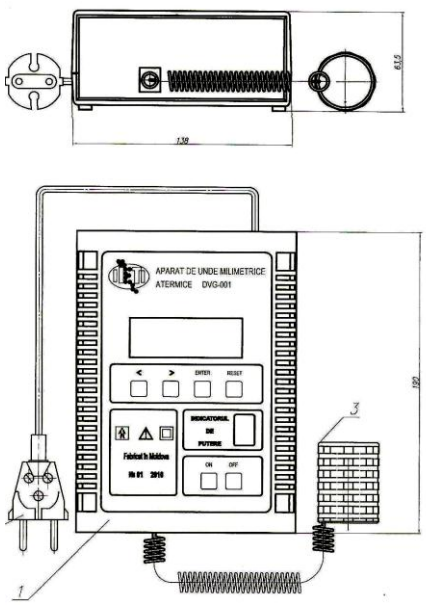


Fig.2 the exterior of the device "DVG-001"

As shown in the drawing, 6 buttons are placed on the control panel, grouped into two groups and a power indicator. The case is coupled to the power network with the supply feed 2 and generator 3 is connected to the case 1 through a connecting wire. For the first time a millimeter wave receiver is used (Fig.3), which receives the oscillations of the generator unit and which is executed on two mixing diodes, united into a bridge. This technique has allowed compensating the change of diode parameters with temperature and high reliability of measurements.

As we can see in figure 3, the construction is a waveguide design, in which two diodes **8** are installed, one of which is the detection diode and the second is used as a compensation diode for the environment temperature.

In Fig. 4 is represented the assembly design of millimeter wave generator, on which we can see generator board (2), a power plate, the waveguide (6), the housing (10) and the wired connection (3).

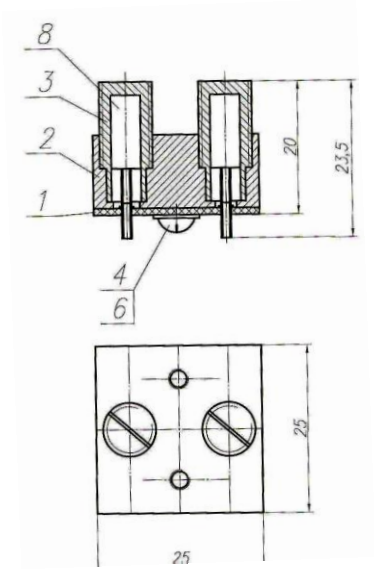


Fig.3 Wave receiver exterior

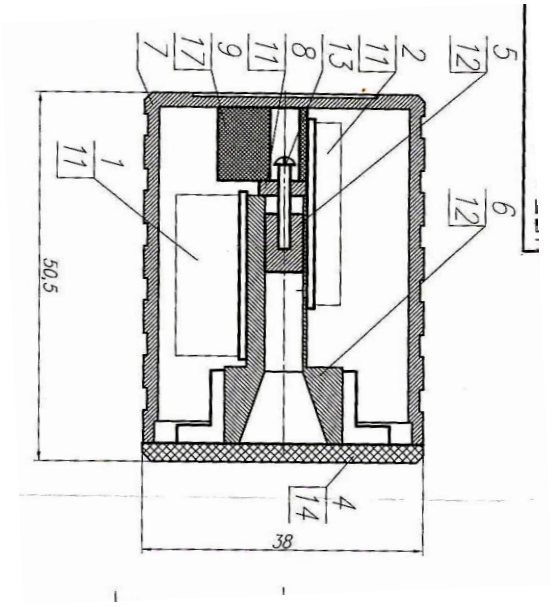


Fig.4 construcţia generatorului

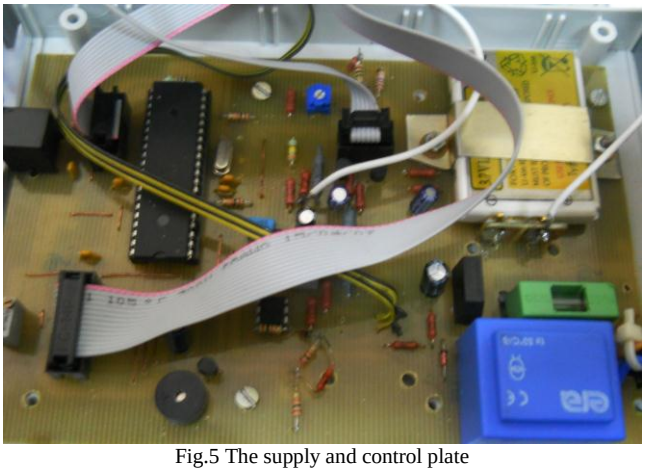
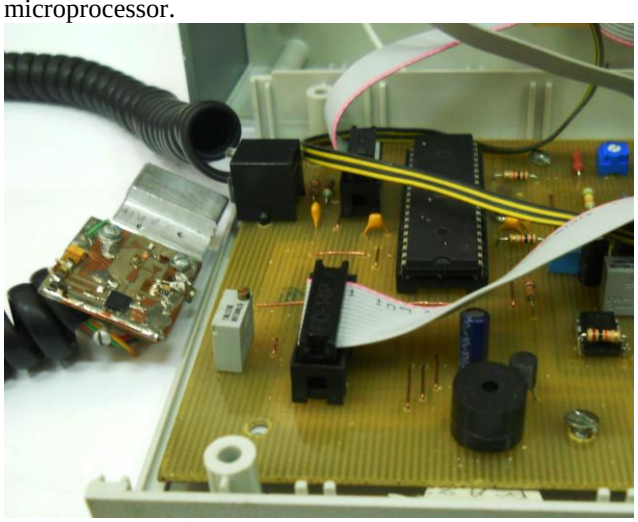


Fig.5 The supply and control plate

In Fig. 5 is the image of power and control board on which we can see a Li-Ion battery, power adapter and microprocessor.



Fi.g.6 The picture of the generator connected to supply and control plate of the „DVG-001” device

In Fig. 6 is shown how the construction of the generator and how the generator is coupled to the control board and power supply.

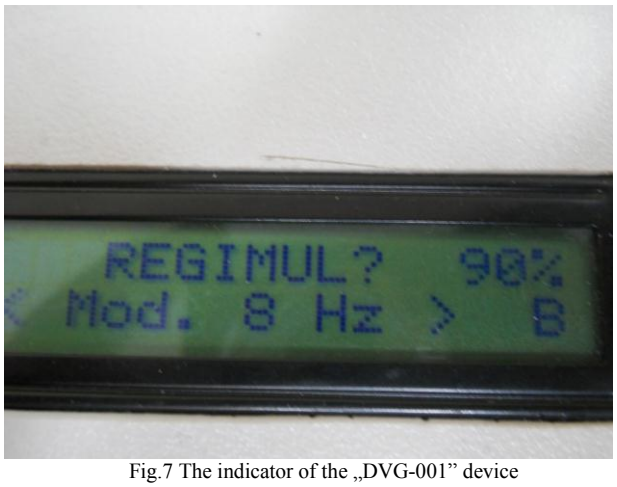


Fig.7 The indicator of the „DVG-001” device

V. CONCLUSION

The main tests that the "DVG-001" device has undergone showed that the construction is reliable and complies with specifications. Frequency deviation versus time and temperature are within the required power level and the deviation at the ends of the band of frequencies is small.

Device "DVG-001" can be recommended for curative procedure at medical, veterinary, microbiology etc. And bring an extra boost in research devoted to one implementation of millimeter non-thermal wave radiation therapy, which practically has no adverse effects or consequences characteristic of drug therapy.

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