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THE FORMATION OF FRONTAL ACOUSTIC SCENERY IN ECHOSCOPY

E. Pileckas

Antanas Gustaitis Aviation Institute of Vilnius Gediminas Technical University, Department of Avionics.
E-mail: jugen@delfi.lt
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Eugenijus PILECKAS, Prof Dr Habil
Date and place of birth: 1941, Trakai, Lithuania.
Education: 1965- Kaunas Polytechnics. 1974 – PhD, 1985 - D Sc, 1987- Prof.
Experience: Head of Department of Ultrasonic Medicine Technology in Radio Measurements Scientific Researches Institute 1965-1986. Head of Department of Electronics in Kaunas Technology University 1986-1991. Director General of "Elita" – Institute of Scientific Researches in Electronics 1991-1998. Professor in Antanas Gustaitis Aviation Institute of Vilnius Gediminas Technical University, Department of Avionics since 1998.
Awards: laureate of two state science prizes.
Publications: Author of two monographs, three books, 80 inventions, several hundred articles and conference papers.

Abstract. With the wider use of composite materials in aviation, the observation of their quality during production and exploitation is becoming more topical. We are of the opinion that acoustic technologies of all-in-one control give us promising possibilities to watch and research the characteristics and parameters of composite materials. The acceptable way to form acoustic scenery for composite material research is discussed in this paper.

Key words: composite materials, ultrasonic waves, C-scan, antenna grating with sectorial acoustic beam scanning.

Introduction

More and more often ultrasonic echoscopy systems are used in nondestructive testing of composite materials in aviation technologies. The acoustic scenery in this sort of nondestructive testing is formulated by using a two dimensional view of the object and signal selection in time.

The C-type scenery of the acoustic section is formulated. We can use the mechanical actuator or acoustic antenna gratings with manageable beam [2-3].

However, in the first case, we must accept a fairly slow formation of the scenery. In the second case, we must tolerate technological problems (control of the acoustic grating).

But there is a compromise. We can use a mechanical ultrasonic scan in one direction and electrical control of acoustic grating in the other direction.

The use of antenna grating with sectorial acoustic beam scanning

In this part, we will examine some features of antenna grating with the sectorial acoustic beam scanning [3].

Let us say that we have an acoustic antenna grating with an ultrasonic beam scanning a sector of 90°.

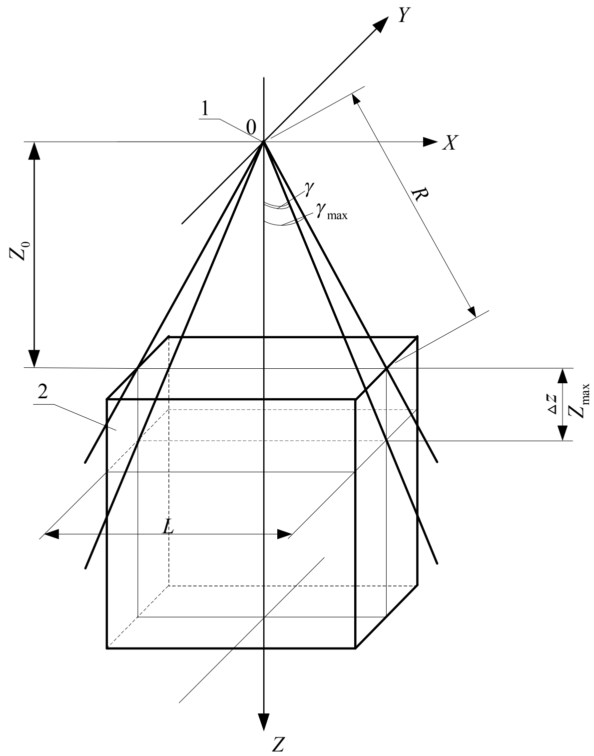

Fig 1. The scheme of acoustic scenery formation: 1 – antenna grating; 2 – object

Let us put our grating into the system of axes so that the electrical scanning of the acoustic beam is in the ZOX plane (fig. 1). The mechanical slip of the grating will be lengthwise axis Y. The ultrasonic scanning volume will be a cube. The maximum angle of scanning is $\gamma_{\max}$.

As we can see, it is necessarily to change angle γ to keep the steady quantity of the data points in the section XOY so that the scanning depth is variable. Beside, the scanning grating must be placed distance Z_0 from the surface of the object to elude the "invisibility" zone. In this case,

$$Z_0 = \frac{L \cdot ctg\gamma_{\max}}{2}, \qquad (1)$$

Where: Z_0 is the distance between acoustic grating and the sector; L is the linear dimension of the object we are scanning; and $\gamma_{\max}$ is the maximum scanning angle of the ultrasonic beam.

The law of maximum scanning angle variation is:

$$\gamma_{\max}\left(\frac{\Delta Z}{L}\right) = arctg\left(\frac{Z_0}{L} - \frac{\Delta Z}{L}\right), \qquad (2)$$

It is very important to know the variable value of R (or its standard value $\frac{R}{L}$). R is a function of angle γ.

$$\frac{R}{L}(\gamma) = \left(\frac{Z_0}{L} - \frac{\Delta Z}{L}\right)\sec\gamma, \qquad (3)$$

The diagrams shown in figures 2 and 3 were done according to equations (2) and (3) respectively.

Figure 2 shows the law of maximum scanning angle variation. This process depends on the depth of the frontal acoustic layer (the value of $\frac{Z_0}{L}$ is constant).

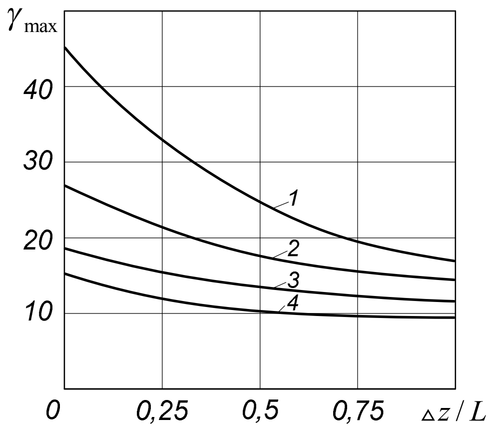

Fig 2. The dependence of maximum scanning angle on the depth of the frontal sector: 1 is 0,5; 2 is 1; 3 is 1,5; and 4 is 2

We can see (fig. 2) that the law of the maximum scanning angle variation depends on the value $\frac{Z_0}{L}$. This expression is not linear. But with the growth of $\frac{Z_0}{L} \rangle 1$, the function $\gamma_{\max}$ can be changed into linear dependence.

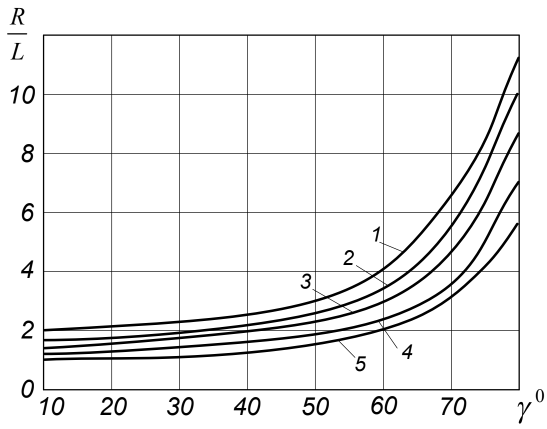

Fig 3. The dependence of the strobe pulse delay on the scanning angle: 1 is 1; 2 is 0; 3 is 0,5; 4 is 0,25; 5 is 0

The law of $\frac{R}{L}$ variation (as we can see in figure 3) is nonlinear in the wide area of scanning angles. But when $\gamma = 45^\circ$, every curve has fairly linear section.

Conclusions

The given analysis shows:

1. The use of antenna grating with the sectorial acoustic beam scanning for the formation of acoustic scenery of the frontal sector demands the electronic devices realize. Those devices must control maximum scanning angle according to equation (2) and delay time of the pulse according to equation (3).
2. But in most practical cases equations (2) and (3) can be changed into linear dependence.

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