CO-ORDINATE POSITION OF SENSOR IN MASS OF CUTTING TOOL

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Abstract

Mathematical research which leads to is considered in the article, necessity of location of sensor in the direction of maximal action of vibroacoustic wave in-bulk toolpiece for the receipt of effective informative signal from the area of metal-workingness.

1. Basics

In modern metal-workingness there is a great number of problems of the details related to making for which it is important not so much to get high exactness of size how many correct geometry of form. This problem causes after itself complication. Character of which has mathematical and technical problems which are related to the direct binding in one unit system MAID (machine-tool – accessory – instrument – detail), for that, to get the reserved technological circle. Mostly these problems decide directly, that is uses intermediate devices of control.

2. Formulation of the problem.

For the decision of the put task problems were studied which arise up in this case.

For the first general theoretic subsoil of distribution of sound-wave in instrument or detail. In most cases sizes of ultrasonic emitters comparing to length of sound wave in an environment. Therefore radiated by them voice energy is in one or another measure concentrated in certain direction. At the use of ultrasonic transformer for the reception of voice signal his sensitiveness depends on direction of receipt of wave. The orientation of reception an ultrasound sometimes appears the effective method of selection of useful signal on a random noise background. As a radiation and reception of sound is one-to-reverse, orientation of certain transformer on a reception and on a radiation is identical [1,2].

This task is difficult enough, as there is plenty of instrument exactly after geometrical configuration, and it requires the enough difficult decision of this problem. The basic factor of this situation is the construction of cutting instrument became which does not change by decades and absolutely not adjusted to establishment on him of transformers of control of metal-workingness.

Consider, case of the real instrument. Distance of plane of basing of transformer from the top of instrument - l_k

$$l_k = \frac{\rho}{\sqrt{\sin\frac{\xi}{2}\cdot\sin\frac{\eta}{2}}},$$
$$l_k = \frac{\rho}{\sqrt{\sin\frac{\eta}{2}\cdot\sin\frac{\sigma}{2}}}, \qquad (1)$$
$$l_k = \frac{\rho}{\sqrt{\sin\frac{\sigma}{2}\cdot\sin\frac{\xi}{2}}},$$

where, ρ is a radius of piezoelectric element;

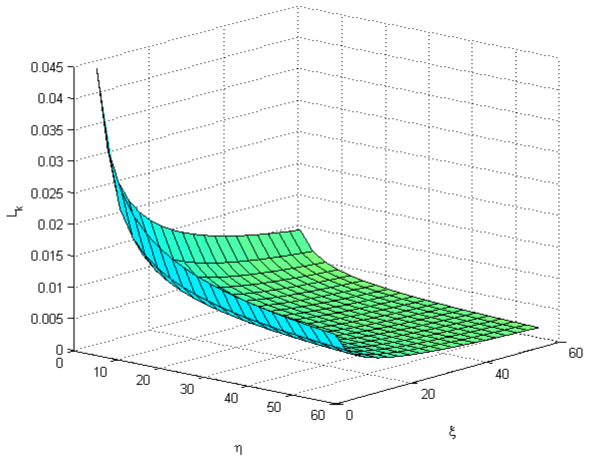
ξ,η,σ are angles between the workings edges of instrument.

Consequently at consideration of dependences (1) it is possible to reach to the conclusion, that we have relation between the remoteness of plane of basing of transformer (lk) and corners between the workings edges of instrument (ξ,η,σ). At free interpretation of expressions (1) in relation to the sizes of instrument (corners) we will get general dependence represented on fig. 1a.

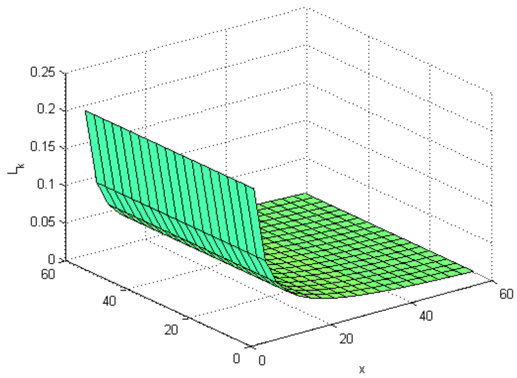
But analysis of expressions (1) shows that can exist critical situation when angles ξ,η,σ is equal. In such case we have a situation with distance of lk which differs from previous. In this case angles ξ,η,σ a maximal value takes just one value that $\pi/3$ from the point of view to maximal perception of vibroacoustic signal. Thus expressions (1) assume:

$$l_k = \frac{\rho}{\sin\frac{x}{2}} \qquad (2)$$

where $0 \prec x = \xi, \eta, \sigma \le \pi/3$. Because of this situation description of lk assumes a laminar character and location of transformer after distance in the body of cutting instrument does not matter very much, but here a problem appears realization of cutting instrument with parameters ξ, η, σ which are equal $\pi/3$ (fig. 1).



a)



b)

Fig. 1. Dependences of distance of sensor from the point of radiation after (1)
a) invariance of lk from standard angles, 6) invariance of lk from standard angles at ξ, η, σ **=60°**

According to this possible to define a angle between the working planes of instrument and plane of maximal intensity of acoustic radiation is a raster angle (fig. 2)

$$\beta = 2arctg\sqrt{\sin\frac{\xi}{2}\cdot\sin\frac{\eta}{2}},$$
$$\beta = 2arctg\sqrt{\sin\frac{\eta}{2}\cdot\sin\frac{\sigma}{2}}, \qquad (3)$$
$$\beta = 2arctg\sqrt{\sin\frac{\sigma}{2}\cdot\sin\frac{\xi}{2}}$$

Dependence (3) proves that a raster angle β is formed on the lateral edges of cutting instrument according to the accepted pyramidal model (fig. 2).

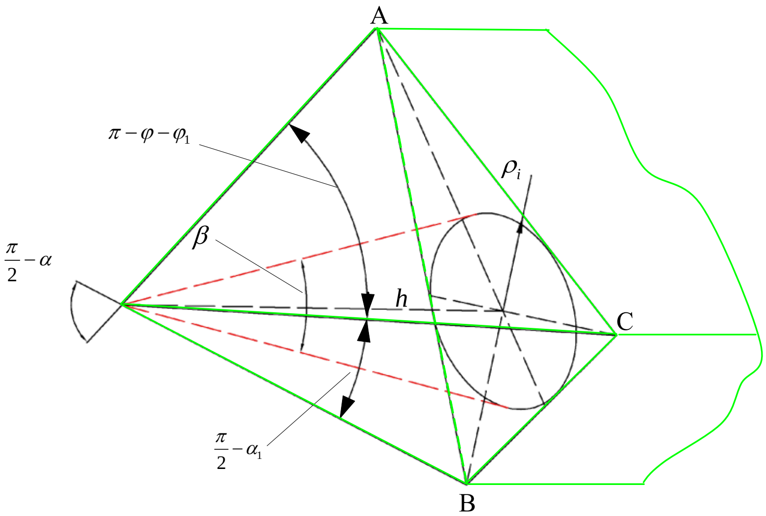
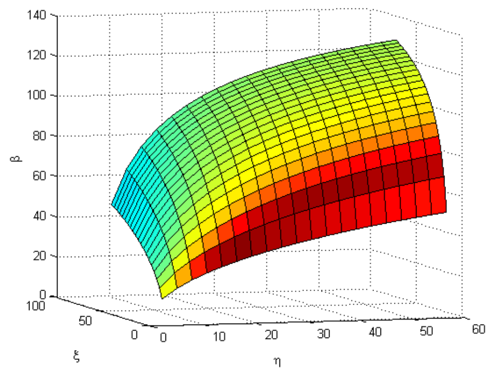


Fig. 2. Pyramidal model of cutting instrument

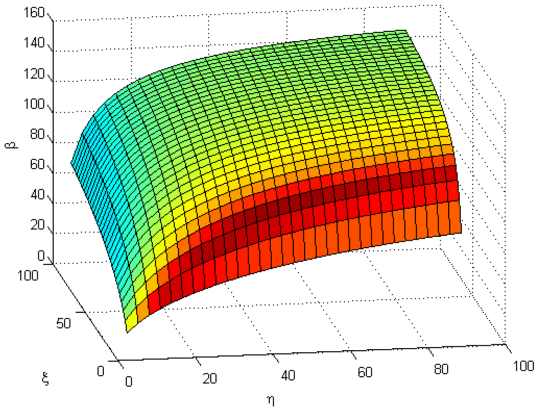
As the best indexes from the receipt of maximal power of vibroacoustic signal are dependency upon geometry of instrument, the best location of transformer of vibroacoustic signal takes a place at equality of angles ξ, η, σ. Thus raster corner which actually corresponds to the amount of energy which will be got by a sensor increased at approaching of plane of transformer to the point of radiation, but from the technological point of view there is not sense and possibility to dispose it directly in the point of radiation.

Therefore, as raster angle β indicates the maximum possible diameter of the sensor, it is best to use it according to calculations (fig. 3), when the theoretical angles ξ, η, σ oriented to value $\pi/2$. The main factor behind this conclusion is that increasing the angle beyond does not lead to increase efficiency of the converter. But it should be noted that there is a dependence on the size of angles as raster angle β dependence of the external dimensions of the cutting tool has a sharp change.

Also note that raster angle is physical - mathematically linked with a maximum radius of sensor - ρ. Implement a structure element in the body of the instrument can not and should not. Therefore, the actual sensors have radii twice, three times smaller than the theoretically calculated. In the opposite case, its installation will lead to some technical difficulties and a significant decrease in the strength of the cutting tool which is not desirable. So as a result, note that the theoretical dimensions can not be implemented on a real instrument.



a)



b)

Fig. 3. Size of raster angle β (2) where
a) $0 \le \xi, \eta, \sigma \le \pi/3$ **, b)** $0 \le \xi, \eta, \sigma \le \pi/2$

The angles defining the direction of the acoustic cone defined as follows:

$$
\begin{aligned}
\alpha' &= arctg \frac{\rho l_k}{\sin \frac{\xi}{2}}, \\
\alpha'' &= arctg \frac{\rho l_k}{\sin \frac{\eta}{2}}, \\
\alpha_1' &= arctg \frac{\rho l_k}{\sin \frac{\eta}{2}}, \\
\alpha_1'' &= arctg \frac{\rho l_k}{\sin \frac{\sigma}{2}}, \\
\varphi' &= arctg \frac{\rho l_k}{\sin \frac{\sigma}{2}}, \\
\varphi'' &= arctg \frac{\rho l_k}{\sin \frac{\xi}{2}},
\end{aligned}
\qquad (4)
$$

where $\alpha', \alpha'', \alpha_1', \alpha_1'', \varphi', \varphi''$ is angles at the top of the working tool.

Analyzing the dependence (4) we can conclude invariance adjacent angles $\alpha' = \alpha''$, $\alpha_1' = \alpha_1''$, $\varphi' = \varphi''$ depending on the angle ξ, η, σ as shown in Fig. 4. This proves that the necessary angles to choose within the greater than 20 - 30 °, while the value of the angles will be located within the laminar part of the functions (4) (Fig. 4).

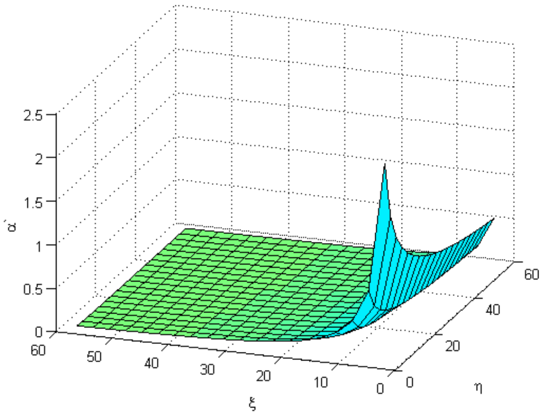


Fig. 4. Invariance angles to the direction sensor relative to projections of its edges

For more visibility location of the converter was calculated according to the possible angles (4) and length of generatrix - l_k.

In Fig. 5 shows the nearside split cutter with triangular cutting plate.

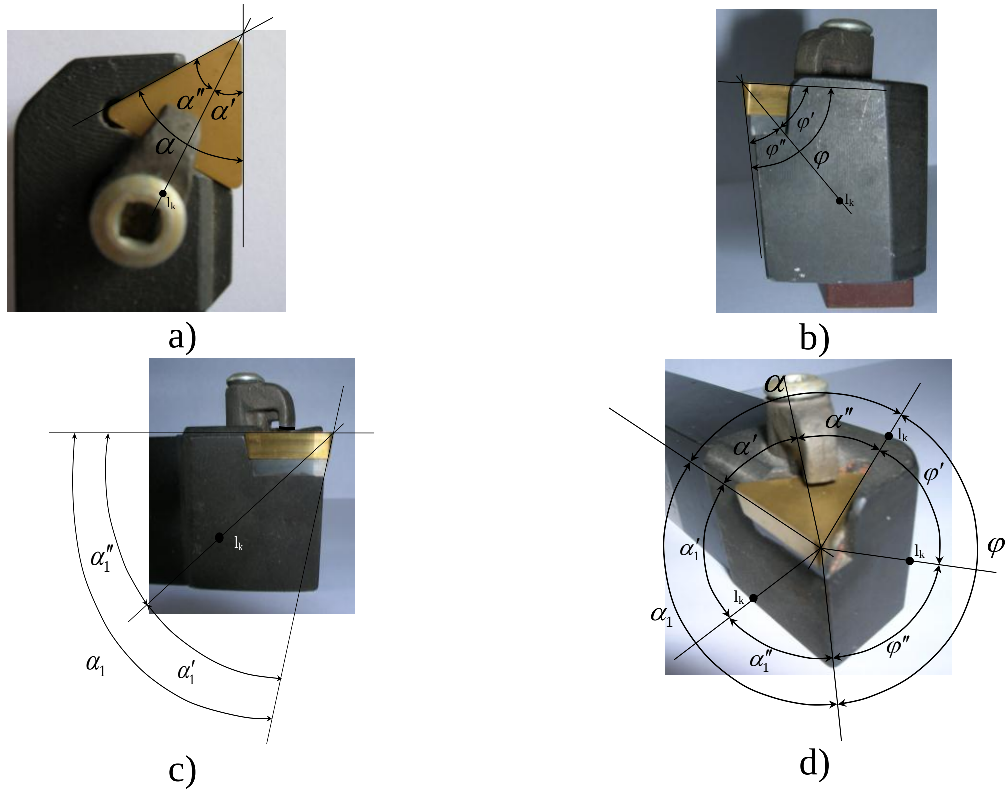


Fig. 5. Leftside scoring tool with coordinate traces to the location of the converter. a)-top view, b)-type front, c) - side view, d) - form an angle in front and above

For installation sensor to standard cutting tool necessary to make it design a number of technological surfaces of the main task of which hold sensor in the optimal plane.

3. Conclusions

The physical and mathematical models of distribution of vibroacoustic signal is considered. It enabled to build theoretical principles in relation to the co-ordinates of location of transformer in the body of cutting instrument.

Certainly basic mathematical bases are in relation to the location of vibroacoustic element in-bulk cutting instrument. On the basis of the considered physical and mathematical principles general conception of location of transformer is developed in the body of cutting instrument. It gave possibility to specify the co-ordinates of location of transformer in the body of cutting instrument. Because of it is possible to connect in one unit the construction of cutting instrument and co-ordinate of location of transformer for achievement of maximal effect of determination of moment of touch.

The considered positions of location of transformer specify on that it is necessary to develop the new construction of cutting instrument, which will execute not only the process of metal-workingness but also provide the process of control which will allow considerably to extend the technological abilities.

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