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INVESTIGATIONS OF VIBRATION AND NOISE OF GEAR BOX BODY

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Abstract: *In this paper vibration and noise of the simple model of toothed gear were examined. In first step, induced by impact free vibration and noise of the gearbox body were detected. In second step forcing vibration and noise generated by working gear (without load and with two different working loads) were observed. Signals of vibration and noise of gear box body were recorded by means of digital tape recorder. Then the frequency spectra of the above signals (determined by means of the computer program MATLAB®) were discussed.*

Key words: acoustics, noise, mechanics, dynamics, vibration, gear

1. Introduction

The force interaction between co-working teeth of gear is a direct reason of vibration of the gear and then noise of course. Amplitude of tangent force acting on toothed wheel depends on different properties of a gear for example:

- a width of tooth,
- a power passed on by a gear,
- a rotational speed of shafts,
- a number of teeth,
- a pressure angle.

Spectrum of vibration of a cylindrical gear (investigating one) depends on working factors and technological ones. Impacts, in meshing region, generate eigen vibration of gear parts.

Level of noise, generated by working gear, also depends on some factors, which can be divided on three groups:

- structural ones,
- technological ones,
- operating ones.

Taking into account the above, precise theoretical model of gear dynamics will be too complex. Then, in practice, some simple models of gear are examined but their correctness is verified by means of experimental investigations.

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2. Experimental investigation of gear box body

The scheme of gear, which vibration and noise are investigated, is shown on Fig.1.

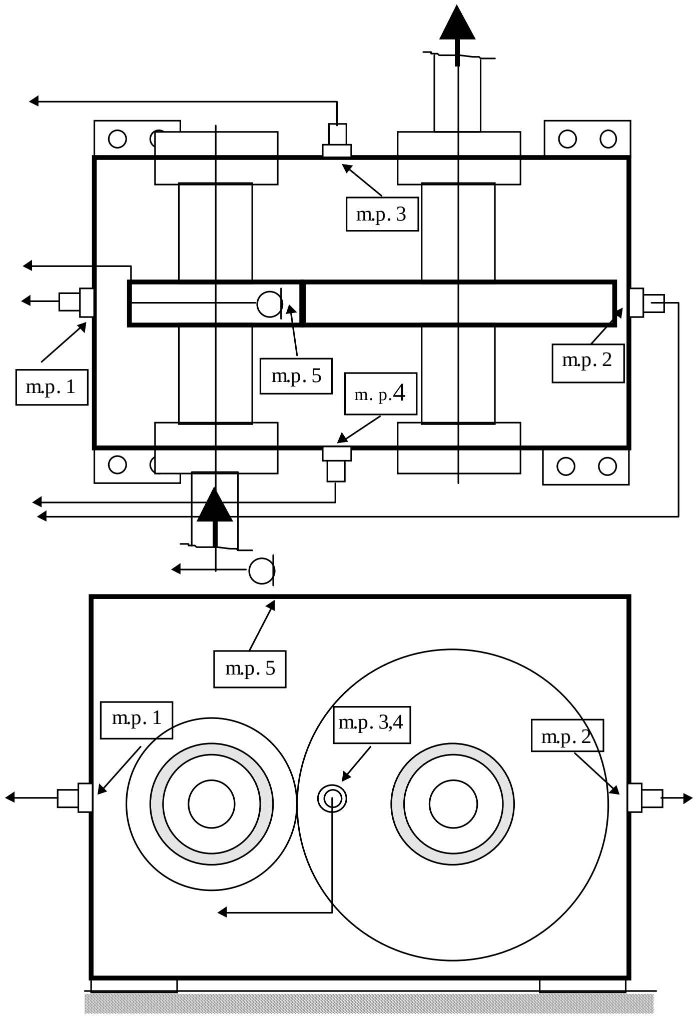

Fig. 1. The scheme of investigated gear.

The investigations of vibration and noise were realised in two steps.

In first step, free vibration, induced by non-calibrated impact, were measured. In this case two different hammers, first made from brass and second made from hard rubber, were applied. The points of impacts were situated over the measuring points m.p.2 and m.p.4 (see Fig. 1). Vibration of gearbox walls were measured in four measuring points (m.p.1 – m.p.4) and noise were measured in one measuring point situated near co-working wheels of gear.

The forcing vibration and noise, generated by working gear, were observed for tree cases: without working load (loading coefficient $m_1 = 0$) and with two different working loads (loading coefficients $m_1 = 1$ and $m_1 = 3$). This part of experimental examination was realised on stand shown on Fig. 2. Experimental investigations were made for several values of rotational speed, which are shown in Table 1.

The signals of vibration and noise of gear for both steps were recorded with digital technology – the scheme of stand for recording vibration and noise signals is shown on Fig. 3.

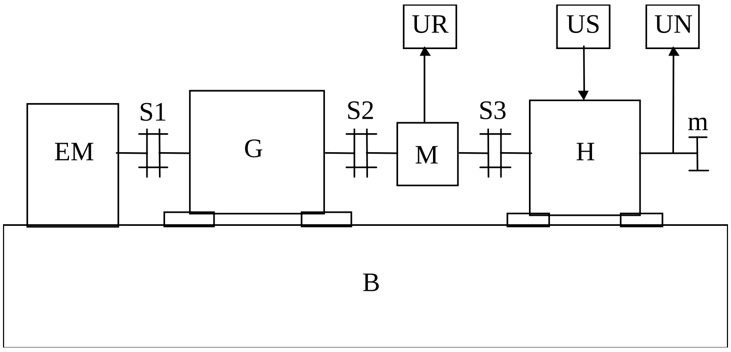

Fig. 2. Scheme of test stand of gear;
G – gear,
EM – electric motor,
M – torgue meter,
H- - electromagnetic brake,
B – base,
S1, S2, S3 – couplings,
UR, US, UN – control systems.

Table 1. Values of rotational speed of gear;

rotational speed [rev/min.]*)	without load	load I	load II
165	+	+	+
168	+		
171	+		
174	+		
180	+	+	+
450	+	+	+
454	+		
459		+	+
481	+		
527	+		
544	+		
592	+		

*) –rotational speed of smaller wheel

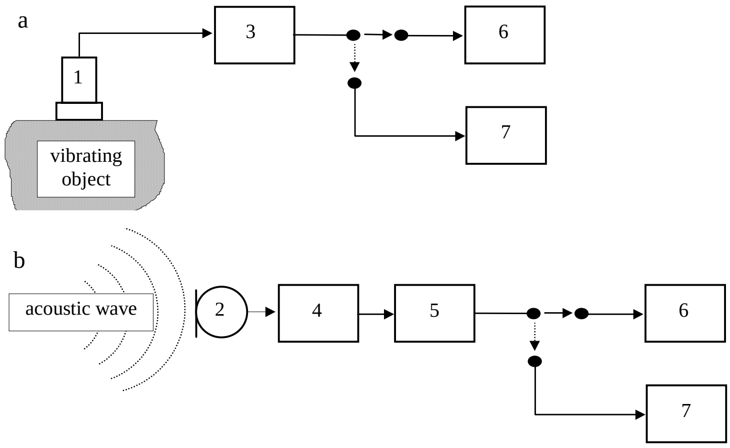

Fig. 3. Scheme of recording stand for vibroacoustic signals:
a) - – vibration acceleration, b) – sound pressure.
1 – piezoelectric transducer,
2 - microphone
3 - amplifier,
4 – microphone amplifier,
5 – sound level meter,
6 – digital oscilloscope,
7 – digital tape recorder.

3. Results

Recorded signals of vibration and noise of gearbox were processed by means of special set, which is shown on Fig. 4. Using computer program MATLAB and specially developed computer programs the power spectral density functions, auto-correlation and cross-correlation functions and amplitude spectra for all recorded signals were determined.

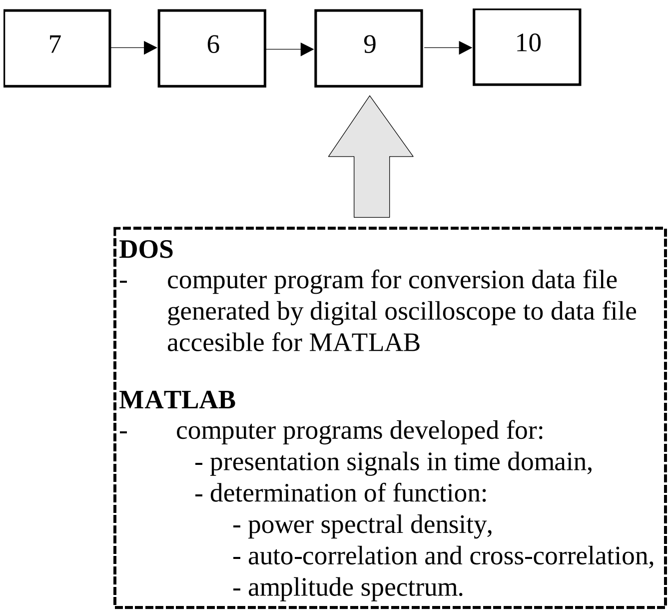

Fig. 4. Scheme of processing set for vibroacoustic signals.
7 – digital tape recorder,
6 – digital oscilloscope,
9 – computer,
10 – peripheral equipment.

In this paper the amplitude spectra of forcing vibration and noise of working gear for rotational speed equal to 450 rev/min and different working loads are shown on following figures only.

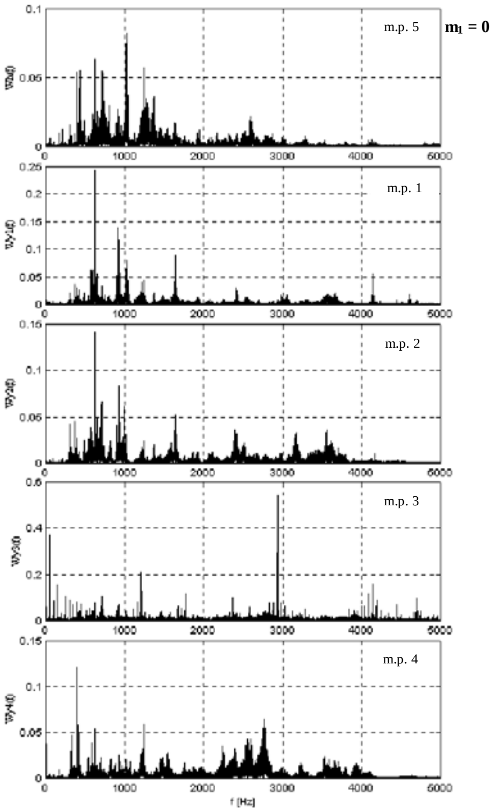

Fig. 5.
Amplitude spectra of vibroacoustic signals of gear: noise - m.p. 5, vibration – m.p.1 – m.p.4; rotational speed n = 450 rev/min;
loading coefficient $m_1 = 0$.

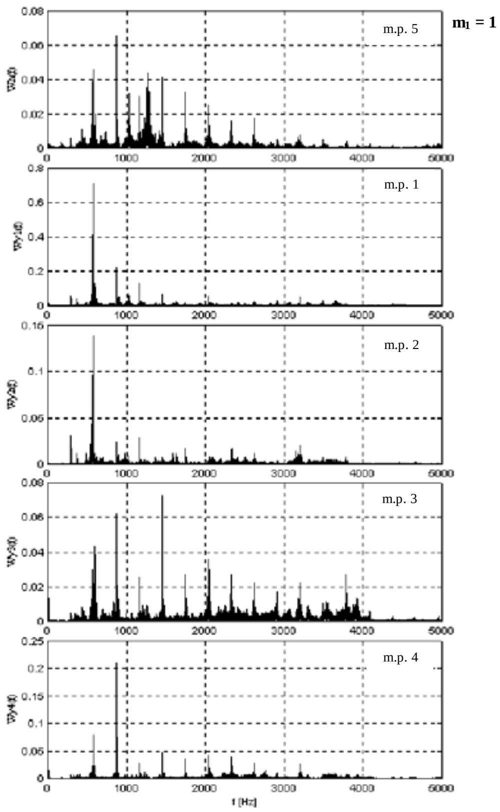

Fig. 6.
Amplitude spectra of vibroacoustic signals of gear: noise - m.p. 5, vibration – m.p.1 – m.p.4; rotational speed n = 450 rev/min;
loading coefficient $m_1 = 1$.

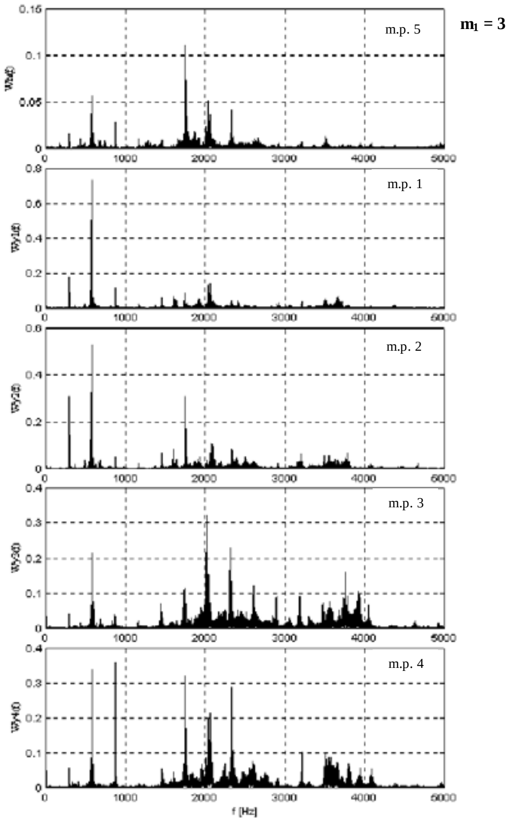

Fig. 7.
Amplitude spectra of vibroacoustic signals of gear: noise - m.p. 5, vibration – m.p.1 – m.p.4; rotational speed n = 450 rev/min;
loading coefficient m_1 = 3.

4. Conclusions

Results of this paper are similar to numerical (FEM method) investigations of dynamics of this gear results (these results will be presented during this Conference). More detailed conclusions will be presented later.

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