RADIALLY VIBRATING FERROCERAMIC TRANSDUCER AS A SOURCE OF ULTRASONIC VIBRATIONS RADIATING IN THE DIRECTION OF THE TRANSDUCER AXIS

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The results of measurements of ultrasonic intensity radiated by the ferroceramic transducer with electrodes covering all the planes of the bases are presented in this paper. In the direction of the transducer axis sharp maxima have been found at frequencies below the theoretical frequency of the thickness resonance. The sharpest maxima comparable with the maximum of the thickness resonance are at frequencies of the first and second radial modes.

It is suggested to use these modes for transducers radiating into gases and liquids at frequencies below 150 kc/s where there is a lack of effective sources of ultrasonic waves.

For some purposes of diagnostic measuring techniques it would be suitable to use ultrasonic waves with frequencies below 150 kc/s.

For the radiation into gases either thickness-dilational or flexural vibrations of plate transducers have been used till now.

The great disadvantage of flexurally vibrating transducers are troubles with finding the transducer on the perimeter of the nodal circle [1].

Transducers vibrating at frequencies of a thickness-dilational resonance cannot be used for frequencies lower than 150 kc/s because of complications connected with the production of thick transducers.

We have measured the intensity of ultrasonic waves radiated into air by a freely supported circular transducer made of poled ferroceramics with electrodes covering all the surfaces of the bases. The intensity of radiation in the direction of the normal has some strong resonances even at frequencies below the called fundamental resonant frequency of thickness-dilational vibrations.

First measurements have been done on ferroceramic transducers made on the basis of a solid solution of $PbTiO_3$ — $PbZrO_3$ of Czechoslovak production

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(Tesla Hradec Králové). The samples had circular discs shapes with the diameter of 50 mm and the thickness of 10.0—10.5 mm. The thickness resonance had the frequency 180—190 ks/s.

The measuring scheme is shown in Fig. 1. The used microphone Bruel-Kjaer of the type 413 had linear characteristic up to the frequency of 180 kc/s.

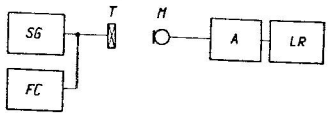

Fig. 1. Measuring of ultrasound intensity radiated by the ferroceramic transducer. SG — signal generator TT 0250, FC — frequency counter TESLA BM 445 E, T — transducer, M — microphone Brüel and Kjaer 4138, A — amplifier Brüel and Kjaer 2604, LR — level recorder Brüel and Kjaer 2305.

The example of intensity measured in the transducer axis at the distance of 1000 mm is shown in Fig. 2.

The measured transducer had the number of expressed resonance at lower frequencies besides the maximum at the frequency of approximately 190 kc/s, which was the fundamental resonant frequency of thickness vibrations. It was interesting that two of these resonances were in a magnitude comparable to the fundamental thickness resonance and others were only about 6 and 8 and 10 dB smaller, respectively.

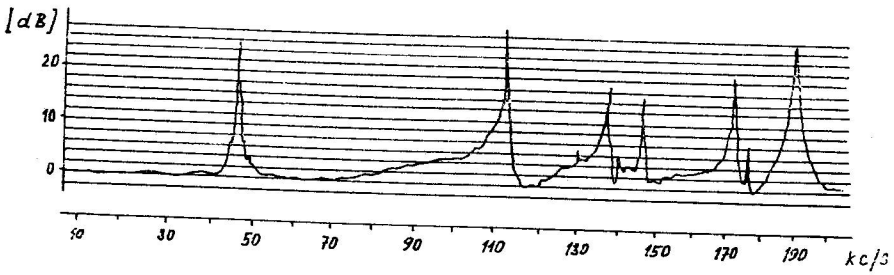

Fig. 2. Frequency characteristics of ultrasound intensity.

Further studies of nodal patterns described in paper [2] showed that the first and second maxima of ultrasonic intensity radiated by a circular transducer of a similar geometry corresponds to the resonant frequency of the first and second radial modes.

The fixation of the transducer in the holder by means of three elastic tapes touching the transducer on the perimeter has been tried. The decrease of ultrasonic intensity level in the direction of the transducer axis was about 2 dB.

From the present experiments it is obvious that a circular ferroceramic transducer with electrodes covering all the planes of the bases can be used

as an effective source of ultrasonic waves radiating in the normal direction to the bases not only at frequencies corresponding to the thickness-dilational frequencies but also at frequencies of radial modes.

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REFERENCES

[1] Kritz J., *A high-efficiency transducer for transmission to air.* IRE Trans. on Ultrasonic Engeneering, March 1961.
[2] Mazák E., Fyz. čas. SAV *21* (1971), 136.

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