tion produced in air by the reaction $_7N^{14}(n, p)_6C^{14}$ and determined the Q-value of the reaction as 0.606±0.005 Mev assuming the proportionality between the ionization and the energy. Then, the Q-value of this reaction has been determined to be 0.626 Mev from several well-founded bases.

In the present work, we have redetermined the total ionization produced in air by this reaction. If we assume the proportionality between the ionization and the energy, the present result also gives the Q-value of 0.609 Mev which accurately agrees with the previous result. We have thus ascertained that our experiments were not in error. So the origin of the discrepancy between our result of 0.609 Mev and the accepted nominal value of 0.626 Mev must be attributed to the nature of the relationship between the ionization and the energy for protons in air.

On the bases of the present result and our results on the ionization by alpha-particles in air (this Bull. **26**, 62 (1951)), some preliminary arguments have been made on the relationship between the ionization and the energy for protons in air.

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8. On the State of Fluidized Bed

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The fluidization of solid particles accompanies slugging and eruption, which we examined photographically by using a box-type vessel with parallel glass-plate windows on both sides.

An abnormal fluidized state, i. e. the slugging is caused by the different buoyance of foams: the smaller foam goes up more slowly than the larger one, and the foam grows larger by joining together until their diameter reaches to the magnitude of the vessel, the so-called slugging state.

This phenomenon is similar to the continuous foaming in liquid. The net-plates of moderate mesh in the vessel, through which particles are capable to pass freely, are effective to prevent the slugging.

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9. Study on High Dielectric Constant Ceramics. (XIII)

Analytical Research on Coupled Vibration

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Mathematical analysis about the mechanical vibration of a rectangular plate or cylinder is generally so complicated that it is hard to get a perfect solution except only approximate one. In a vibrator having two or more freedoms of vibration, there appears mutual interference among each vibration, and this effect is especially conspicuous when the resonant frequencies of each vibration have similar values. This phenomenon is called a coupled vibration.

Such mechanically coupled vibration is apparently very similar to that in an electrically coupled resonance circuit, and so we can solve the former using the analogy to the solutions about the latter. At first, in this report, fundamental equations of mechanically coupled vibration were introduced and they were compared with the experimental results previously obtained about $BaTiO_3$ ceramic vibrators.

As is well known, the resonant angular frequencies of electrically coupled resonance circuit can be described as follows:

$$w^2=\frac{w_a^2+w_b^2\pm\sqrt{(w_a^2-w_b^2)+4\kappa^2 w_a^2 w_b^2}}{2(1-\kappa^2)} \tag{1}$$

where

$$w_a^2=\frac{1}{L_1C_1},\qquad w_b^2=\frac{1}{L_2C_2},\qquad \kappa^2=\frac{M^2}{L_1L_2} \tag{2}$$

L_1, C_1 and L_2, C_2 are self-inductance and capacitance of primary and secondary circuit respectively and M is mutual inductance.

In mechanical vibration, the resonant frequency is determined by the following quantities: dimension (l), Young's modulus (E) and density (ρ), and as for a longitudinal length mode, it is given by the next formula,

$$w^2=\frac{\pi^2E}{l^2\rho}, \tag{3}$$

In a rectangular plate, whose length and width are a and b respectively, two independent vibrations must have the resonant frequencies as follows:

$$w_a^2=\frac{\pi^2E}{a^2\rho},\qquad w_b^2=\frac{\pi^2E}{b^2\rho}, \tag{4}$$

These two vibrations are actually coupled and so it may really be observed next two resonant angular frequencies,

$$w^2=\frac{\pi^2E}{\rho}\cdot\frac{a^2+b^2\pm\sqrt{(a^2-b^2)^2+4\mu^2a^2b^2}}{2a^2b^2(1-\mu^2)} \tag{5}$$

where μ is mechanical coupling coefficient and it can be shown that it corresponds to Poisson's ratio σ.

Experiments have been carried out about the resonant frequencies of rectangular $BaTiO_3$ ceramic plates. (K. Abe, T. Tanaka, S. Miura and I. Saito: this Bulletin, **26**, 73). It was confirmed after some calculations, that the experimental values agree quite well with those derived from the above equations.