*The following ten papers are the first part out of seventy papers, read before the semi-annual meeting of the Institute on December 4th and 5th, 1953.*

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# 1. On the Rotating Diffraction Grating Method of Measuring the Velocity of Ultrasonic Sound

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Previously (I. Takahashi, Y. Ishida and M. Ōta: *Memoirs of the College of Science, Univ. of Kyoto*, Series A, Vol. 27, No. 1, 1953), we reported on the new method which we devised to measure the velocity of ultrasonic sound by using a rotating diffraction grating. By this method, the measurement can be performed in a far shorter time and a still higher precision is expected than by any one of the heretofore known methods by Debye and Sears and Lucas and Biquard and moreover our method is characterized by its merit that the sound velocity can be directly read. Here we present the theoretical consideration of our method.

We take a diffraction grating of constant $d$ consisting of $m$ slits of breadth $s$, and choose the $y$-axis in the direction of a straight light source (slit of length $\delta$) and denote the acute angle which the direction of slits of the grating makes against the $x$-axis by $\theta$. We rotate the grating in its plane from the position $\theta=\frac{\pi}{2}$. By Kirchhoff's Expression of the Amplitude in Fraunhofer's Diffraction, the intensity $J_P$ of the light (of wave length $\lambda$) at an observed point $P$ is expressed by the following formula:

$$\left.\begin{aligned}
&J_P=A\ J_{P1}\cdot J_{P2}\cdot J_{P3},\\
\text{where}\quad &A\equiv\frac{f_A}{l\lambda\pi}\cdot(S\cdot\operatorname{cosec}\theta\cdot l)^2,\\
&J_{P1}\equiv\left(\frac{\sin\dfrac{\pi S\operatorname{cosec}\theta}{\lambda f_B}x}{\dfrac{\pi S\operatorname{cosec}\theta}{\lambda f_B}x}\right)^2,\\
&J_{P2}\equiv\left(\frac{\sin\dfrac{md\pi\operatorname{cosec}\theta}{\lambda f_B}x}{\sin\dfrac{d\pi\operatorname{cosec}\theta}{\lambda f_B}x}\right)^2,\\
\text{and}\quad &J_{P3}\equiv\sum_{n=1,2}\left\{S_i\left(\frac{l\pi}{\lambda f_A}\delta+(-1)^n\cdot 2\frac{l\pi}{\lambda f_B}(y+\varepsilon x\cot\theta)\right)\right.\\
&\qquad\left.-\frac{1-\cos\left(\dfrac{l\pi}{\lambda f_A}\delta+(-1)^n\cdot 2\dfrac{l\pi}{\lambda f_B}(y+\varepsilon x\cot\theta)\right)}{\dfrac{l\pi}{\lambda f_A}\delta+(-1)^n\cdot 2\dfrac{l\pi}{\lambda f_B}(y+\varepsilon x\cot\theta)}\right\}
\end{aligned}\right\}\quad(1)$$

In the above, 1) we let the light be projected on the region of the grating which extends from $y=0$ to $y=l$,

2) we let the focal-lengths of the lenses placed before and behind the grating be $f_A$ and $f_B$ respectively,

and 3) $\varepsilon=+1$ (or $-1$), according as $\theta$ is the angle formed with the positive sense (or the negative sense) of the x-axis.

From (1), we can derive

i) the inclination of the system of spectra as a whole,

ii) the change of the distance between two spectra of different orders,

iii) the symmetry of the intensity distribution of spectra,

iv) the defect of some spectra of certain orders owing to the internal structure of the grating, etc.,

when we rotate the diffraction grating and we could ascertain the almost perfect agreement between theory and experiment.

In our method a rotating diffration grating is situated parallel to the propagation direction of ultrasonic wave in Fraunhofer's diffracting region, and two kinds of spectra diffracted by both the ultrasonic wave and the diffration grating are obtained. At a certain value: $\theta=\theta_0$, the two spectrum distributions in the x-direction agree with each other, and then the velocity of ultrasonic sound is determined by

$$V=N\cdot\Lambda=N\cdot d\cdot\operatorname{cosec}\theta_0\,. \qquad (2)$$

Thus we can expect to obtain the direct reading of the sound velocity. The formula (2) has been shown to agree perfectly with the experimental results for the samples $CHCl_3$, $C_6H_6$, $C_5H_{11}OH$, $C_3H_5(OH)_3$, $(C_2H_5)_2O$, $HCl$, $C_2H_5OH$ and $H_2O$ with the frequency 4 Mc/s and at t=30°C as we reported previously.

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## 2. New Methods of Dielectric Measurement in the Centimeter Wave Region II

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In the previous papers (This Bulletin, 31, 108 (1953); 31, No. 7, (1953)), the authors have proposed several new methods for dielectric measurement using the wave guide in the centimeter wave region. These methods contain as special cases both the method by S. Roberts and A. von Hippel and that by W. H. Surber and G. E. Crouch which have been well used so far, and we have performed the experiment on $C_{15}H_{31}CH_2OH$ by three methods out of our proposed methods.

Our methods are such that we measure $\Gamma_i$ (VSWR) and $x_{0i}$ (the position of $E_{min}$