

Pension Bergwart.

Gloria Straße, Zürich.

23/25

June 10, 1898.

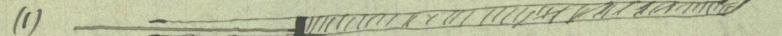
To Professor G. F. FitzGerald.

Dear Sir,

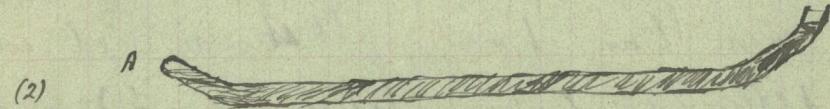
I was encouraged by an article of yours in the Phil Mag. of about two years ago to attempt to obtain the velocities of sound in liquids with the ultimate object of finding the ratio of their specific heats, and I thought you would perhaps be interested to know the present results of my work. I have used the method suggested by you, that of dust figures, but have followed Dorak's modification of Kandt's method as being less open to objection when working with liquids. His modification consists mainly in having one end of the tube containing the liquid bent open, and producing

the note by blowing across the open end.

I have worked mainly with two kinds of tubes:-



where the length of the vibrating column of liquid can be varied by moving the piston.



where at end A the liquid may either fill the tube, or there may be an air bubble so that the liquid vibrates as an open column: tubes about 140 cms. long.

At present I have worked mainly with Carbon Disulphide and Ether as having very little viscosity, but regret to say that up to the present I have been unable to obtain wave figures of tolerably uniform length, though the average wave length of about ten $\frac{1}{2}$ wave figures is fairly constant. I am aware that Dorak & Kandt have measured the velocity in water by this method, but

in their papers in Poggendorff of about 1871 no details are given, I believe, so that one can judge of the regularity of their figures. In those obtained by me which are often so definite that the three readings for the maxima taken by Prof. Weber, a friend, & myself separately do not differ by more than 1 mm., there is yet sometimes a difference of 1 cm. between one $\frac{1}{2}\lambda$ and the next, when $\frac{1}{2}\lambda$ is about 8 cms.

I produced the note by inserting short tubes closed at one end by india-rubber membranes stretched over them of varying diameters & of lengths from 1 to 2.5 cms. - thus supporting & blowing strongly across from a drawn out glass tube connected to ordinary blowing-pipe bellows with india-rubber air reservoir.

I think the irregularities in the wave formation may be due to changes in the pitch of the note due to varying air-pressure, as it is impossible to keep the pressure constant with an india-rubber air-reservoir. I wish to try a

constant pressure reservoir, but there is none in the Institute. Prof. Weber thinks the cause of the irregularities is to be found in the irregularity of bore of the glass tubes; but if this is so, one would expect the irregularities to be fairly constant in position with varying notes; but this is not the case.

The result that is new to me and also to Professor Weber, is the demonstration of both longitudinal and transversal waves travelling simultaneously in the vibrating column. Indeed with a heavy powder like fine iron filings (Terreum limatum) the transversal waves are thrown out at once, and after that the powder winds along the spiral thus formed to the longitudinal nodes. It is the form of the transversal waves, where I have thought I recognised the compound of the harmonics 2:3 & 3:4, that led me to think the irregularities due to the varying air-pressure. With pine-wood & lime charcoal powder no transversal waves are formed but the longitudinal are definite though irregular. I have endeavoured to analyse the curves but the measurements are so irregular that

I have had no success. I do not always obtain the same wave formation with the same air-tube; it sometimes happens that when I have obtained a definite wave formation & have spent some little time in making measurements, on sounding the same air-tube, kept in the same position, the character of the wave-form alters. This seems to imply that slight changes of temperature cause considerable disturbances.

No exact tuning is necessary; in fact for the longitudinal waves tuning seems to make little difference, though the transversal waves are more sensitive to it.

It has occurred to me that some irregularity may be due to changes in the elasticity of the india-rubber membrane closing the air-tube. This is of course attacked by both ether & carbon disulphide. I have tried to get other membranes in Zürich in vain and have had to send to England for them. Tin-foil ^{instead of the membrane} gave a wave-formation but quickly

spoang a leak. I hope to try aluminium foil tomorrow. I am also seeking some lacques with which I may give a smooth flat surface to the glass tube & thus get rid of lack of uniformity of box, as well as obtain larger figures as the powder will not have to climb up the sides of the tube, only the lacque must not be attacked by ether or carbon disulphide.

Professor Weber does not at all encourage me to hope for any success, but while I am more sanguine, the experiment is a difficult one since exact measurements are necessary.

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If any suggestion occurs to you, if I may so far trespass upon your valuable time, I should be very grateful for your help. I have been encouraged, though a stranger, to trouble you so far by the knowledge of your unwavering sympathy with and kindness to students. You may remember my name as one

of the successful honour candidates
at the B.Sc. of London University
in December 1897.

I remain,

Yours very truly,
John H Howell.

The transversal wave formation is that
of a more or less regular spiral line.

so:-

along which with continual sounding
the powder moves to form irregular
lumps owing to the longitudinal vibrations.
Sometimes the gradations are quite sharp:

thus:-



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