# A SIMPLE DEVICE FOR THE ANALYSIS OF SOUND WAVES

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This sensitive device was designed while research was being done on the wave form of the sound emitted by C. T. Knipp's singing tube. The principle used is similar to the one employed by D. C. Miller in his phonodeik. The optical reflecting system, however, was entirely different, being at the same time much simpler. The diaphragm of dermatype paper was stretched over a two inch circular opening in a brass plate, 0.159 cm. in thickness, and held in place by a flat brass ring of the same thickness screwed to the plate. To the center of the diaphragm were attached perpendicularly four or five silk fibers, the other end of which was held by a very fine conical aperiodic spring. Across the diaphragm, 0.476 cm. above and parallel to it, was very tightly stretched one strand of a three strand silk thread. This was passed 0.154 cm. from the perpendicular fibers. A small mirror, 0.0435 cm. in width and 0.154 cm. long, was mounted with its plane parallel to the diaphragm between the horizontal silk strand and the vertical silk fibers. When a sound wave was caught by the diaphragm the mirror vibrated with it around the horizontal silk strand, causing a beam of light to vibrate and trace out the sound wave form on a moving photographic plate.

F. A. Schultze* has shown that paper is aperiodic and that a paper diaphragm is sensitive to sounds of any wave length. The dermatype paper used was taken from dermatype stencils manufactured for the Edison-Dick mimeograph. This paper is flexible, and very strong.

In the diaphragm mounting the author has incorporated some new features which are shown in Figs. 1 and 2. No horn or resonating device of any sort was used in any of the work to increase the intensity of the sound brought to the diaphragm. Professor Foley, of Indiana University, read a paper before the St. Louis meet-

* Annalden d. Physik IV, Folge, Vol. 24, p. 75, 1907.

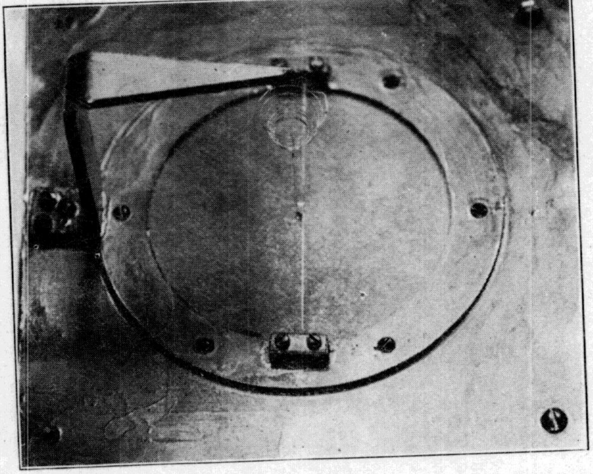

Figure 1.

ing of the American Physical Society in December, 1919, in which he clearly demonstrated the distorting effects of bent tubes and straight horns on sound waves. Although this diaphragm mounting was designed before Professor Foley's paper was read, the author was very careful in the designing to avoid air pockets of any sort.

The inertia of the moving parts of the mounting is probably smaller than that of any diaphragm mounting heretofore used in sound-wave analysis. The only masses involved are, the mass of three or four silk fibers 3 cm. long, the mass of the mirror 0.154 cm. long, 0.0435 cm. wide and of microscopic thickness, and the mass of the small specks of shellac used to mount the mirror.

The spring used was made by winding No. 40 steel wire on a brass cone of small dimensions. The period of any

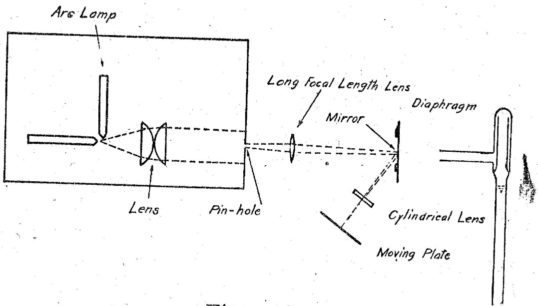


Figure 2.

spring is a function of its diameter and the elasticity of the material used. The diameter of each turn of wire was different from that of any other; therefore each turn had a different period and the spring as a whole was aperiodic. While in use a small tuft of cotton was placed inside the spring to damp out sidewise vibrations.

The other details of the set-up may be seen easily from the diagram, Fig. 2. This device was found to be very sensitive as is demonstrated by the photographs taken with it in Fig. 3. This is a series of curves taken to show that the diaphragm as used was sensitive to even the faintest overtones. Wave A is the sound wave of an open organ pipe. Several overtones can be found in the wave. Wave B represents the sound wave produced by two tubes sounding together, no resonator being used on either tube. This wave demonstrates the ease with which the dermatype diaphragm followed a complex wave form. At least six wave forms can be traced in this curve.

Waves C, D, and E were taken by C. T. Knipp during the author's absence. In C, the two L-form tubes used were adjusted to each, giving its maximum tone with a resonator attached. A slight adjustment of either gave any desired beat frequency. This curve is exceedingly clear cut and bears a critical study under a glass. For each tube the energy was being supplied by one burner; hence the components of the wave should be nearly pure sine waves. Ununiform motion of the film makes the beats appear to be of different sizes. In D the same two tubes were adjusted to nearly unison, giving six or seven beats per second. The other conditions were the same as in C. In E there was superimposed upon D the tone emitted by a high pitch organ pipe blown to sound its fundamental. The film was moving some faster, otherwise the conditions were the same. Wave F was taken from three open organ pipes sounding together. The pipes ranged from a very low to a very high pitch, and were being blown with considerable pressure so as to produce overtones in each one. This is not a hap-hazard curve as it appears at first sight, but rather an ordered succession of a single configuration, three of which appear on the photograph. Wave G represents a note from a French horn. The wave forms represented in B, E, F and G should remove from the minds of even the most skeptical any doubt as to the sensitivity of the diaphragm.

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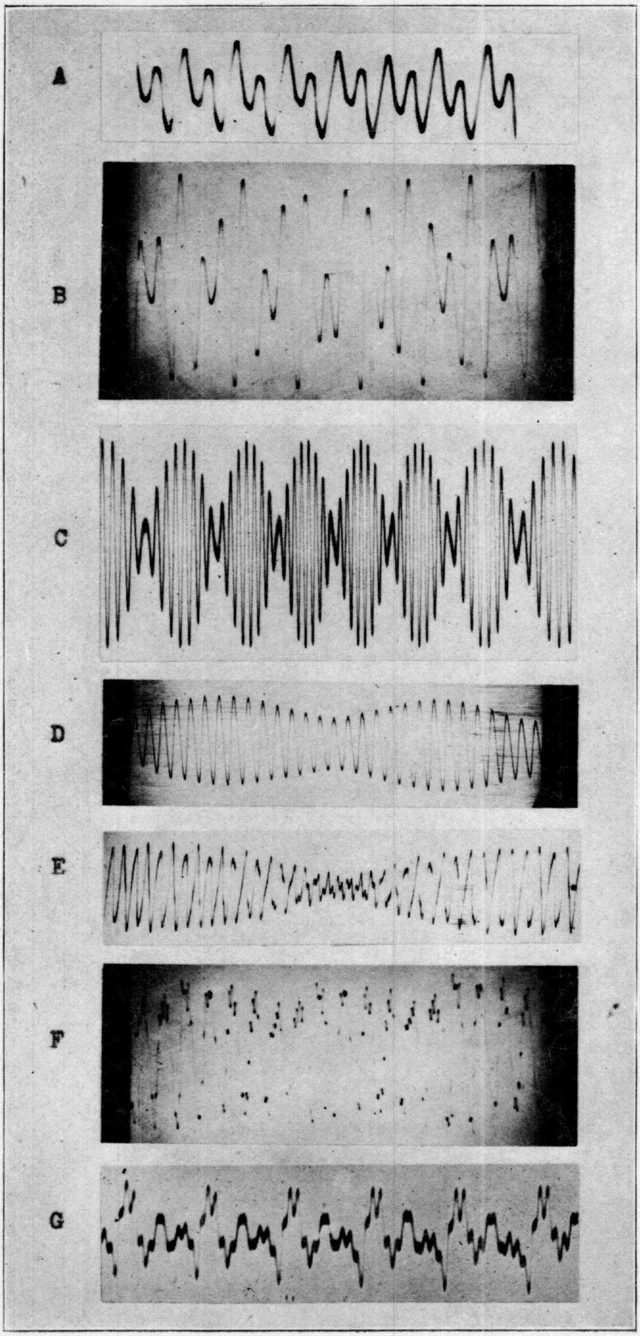


Figure 3.