Proceedings of the Iowa Academy of Science

Volume 28 | Annual Issue Article 15

1921

Measurements of the Amplitude of Vibration of the Diaphragm of the Hewlett Tone Generator

C. E. Lane
State University of Iowa

MEASUREMENTS OF THE AMPLITUDE OF VIBRATION OF THE DIAPHRAGM OF THE HEWLETT TONE GENERATOR

(ABSTRACT)

C. E. LANE

The "New Tone Generator" [1] designed by Dr. C. W. Hewlett promises to be a very valuable instrument for use as a precision source of sound. The operation of the instrument has been investigated mathematically by its designer [2] and a method is given for calculating the amplitude of vibration of its diaphragm from the electrical input. The writer herein describes a method whereby it has been possible to make actual measurements of the amplitude by mechanical means for comparison with the calculated amplitudes.

The tone generator was used in a vacuum tube oscillatory circuit from which the desired frequencies of alternating current were obtained.

For the purpose of making these measurements an electrical micrometer was constructed (Fig. 9). This micrometer operated

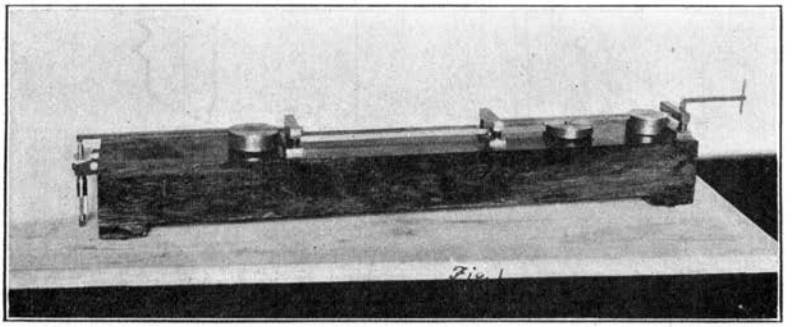


Fig. 9

on the same principle as the one described by P. E. Shaw in the Proceedings of the Royal Society, Vol. 76, page 350. The smallest divisions of this micrometric arrangement measured distances of 10.6 cm. and estimations could be made to tenths of a division.

1 Physical Review, Vol. XVII, p. 257.

2 Work not yet published.

Shaw used his instrument only for measuring the displacement of the diaphragm of a telephone receiver. In this work the instrument was used to measure the amplitude of vibration of the diaphragm when it was excited by an alternating current.

Measurements were not made directly on the tone generator because its position of equilibrium did not remain fixed. The amplitude of vibration of the diaphragm of an ordinary head receiver was measured and then by a method of comparison the desired measurements were obtained. From data on the receiver, curves were plotted which showed the relation between the amplitude of the receiver diaphragm and the current through it. Figure 10

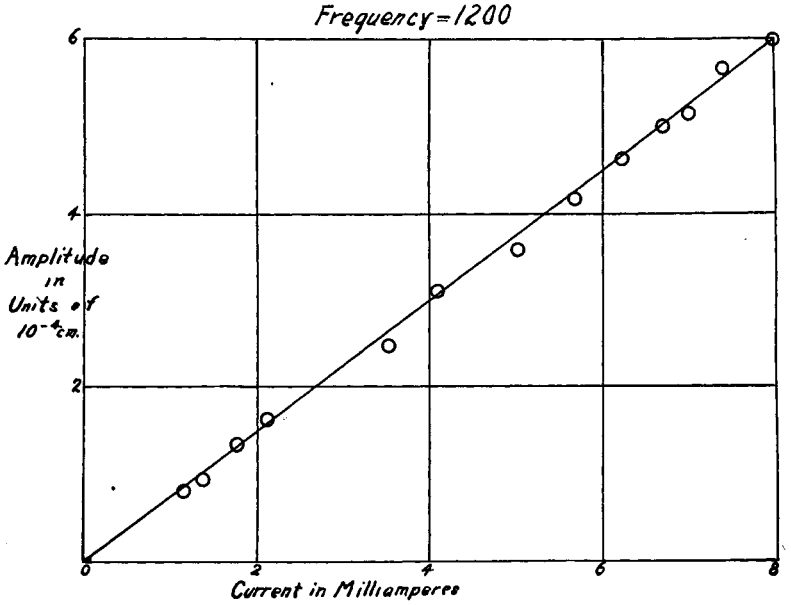


Fig. 10

shows one of the curves for a frequency of 1200 vibrations per second. All of the curves obtained were similar to this, showing an approximate linear relation between the current and the amplitude. In Table 1 below are some of the constants which when

TABLE I

Frequency	Constant (Amplitude for 1 Ampere)
1200	.075 cm.
1440	.0235 cm.
1600	.0175 cm.
2200	.0070 cm.
3700	.0412 cm.

multiplied by the current for the corresponding frequency give the amplitude. After these constants were once obtained it was only necessary to measure the current through the receiver in order to know its amplitude for any given frequency.

To make the comparison between the amplitude of the receiver and the tone generator the arrangement shown in figure 11 was

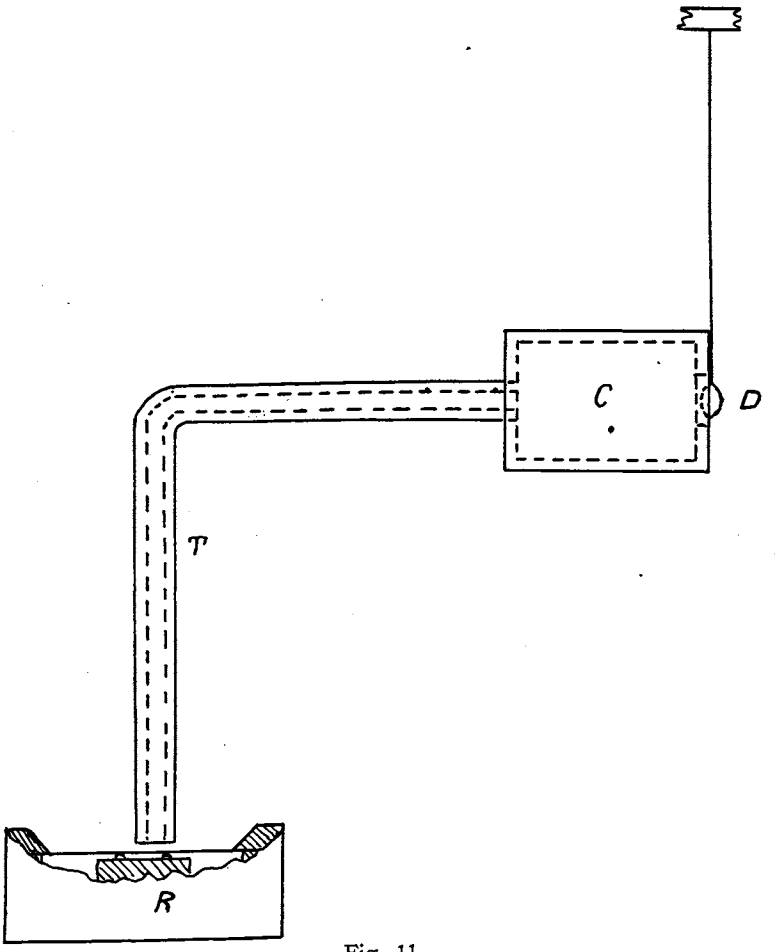


Fig. 11

used. R is the receiver, T is a tube leaving the resonating chamber C and terminating just above the receiver diaphragm, D is a Rayleigh disc mounted at an opening in the opposite end of the chamber from which the tube leaves. In this comparison it was assumed that if the diaphragm of the receiver thus arranged and vibrating at a given frequency and amplitude gave a certain de-

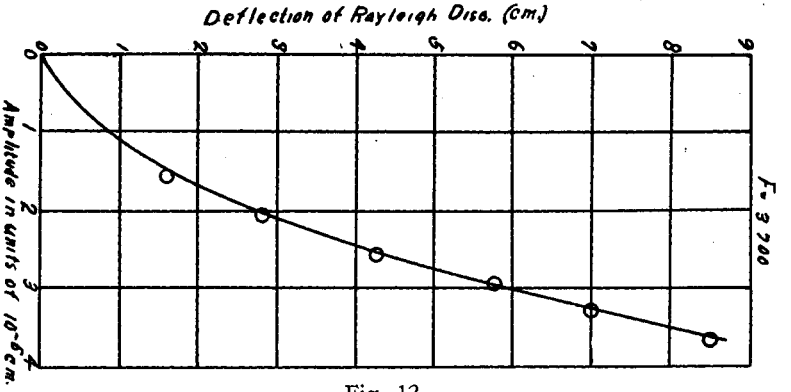
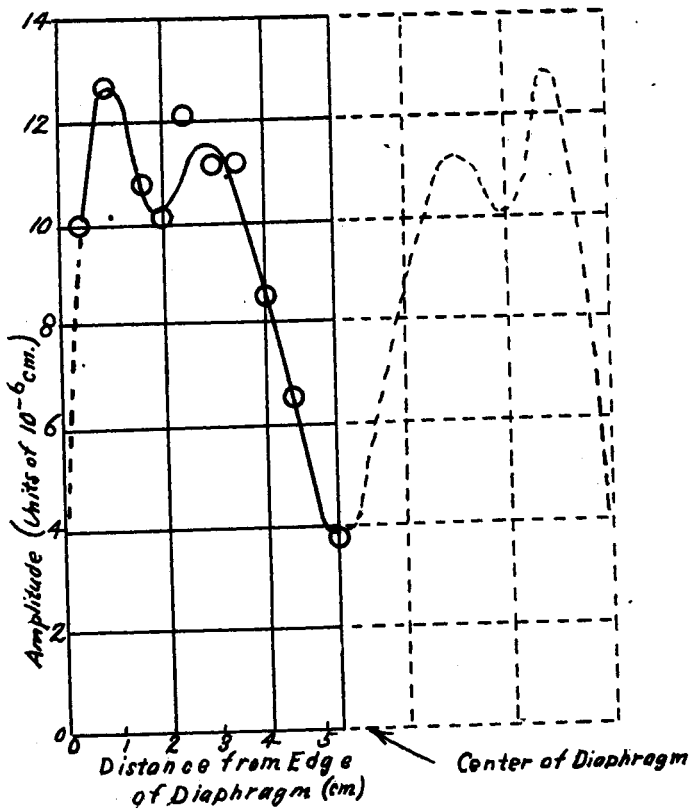


Fig. 12



Frequency = 2200

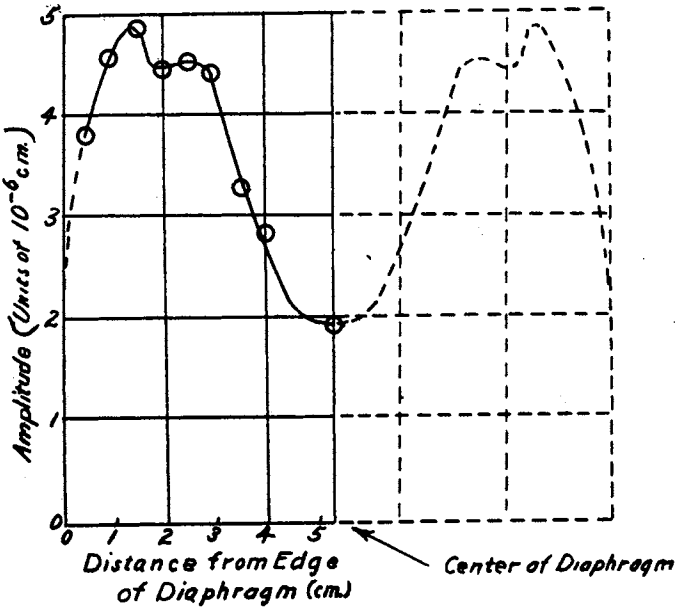
D.C. = 1.0 Ampere, A.C. = 0.1 Ampere

Mean Amplitude = 1.01 x 10^{-6} cm.

Fig. 13

flection of the Rayeigh disc, then any other membrane placed in the same position and vibrating with the same frequency that gave the same deflection would have the same amplitude. Thus it was possible by means of the receiver to calibrate the deflection of the Rayleigh disc in terms of the amplitude of the vibrating membrane under the tube. Calibration curves were obtained for four different frequencies. Figure 12 shows the one obtained for a frequency of 3700.

The amplitude of the diaphragm of the tone generator was determined by this means for frequencies of 1440, 1600, 2200, and 3700. These amplitudes were measured for larger values of current and then reduced to values for a direct current of 1.0 ampere and an alternating current of 0.1 ampere. The amplitude was not the same at different distances from the edge of the diaphragm. Figures 13 and 14 show the value of the amplitude for different positions on the diaphragm for frequencies of 2200 and 3700. The other two frequencies gave similar curves. The mean value of the amplitude was obtained by taking the



Frequency = 3700

D.C.= 1.0 Ampere, A.C.= 0.1 Ampere

Mean Amplitude = 4.32 × 10^{-6} cm.

Fig. 14

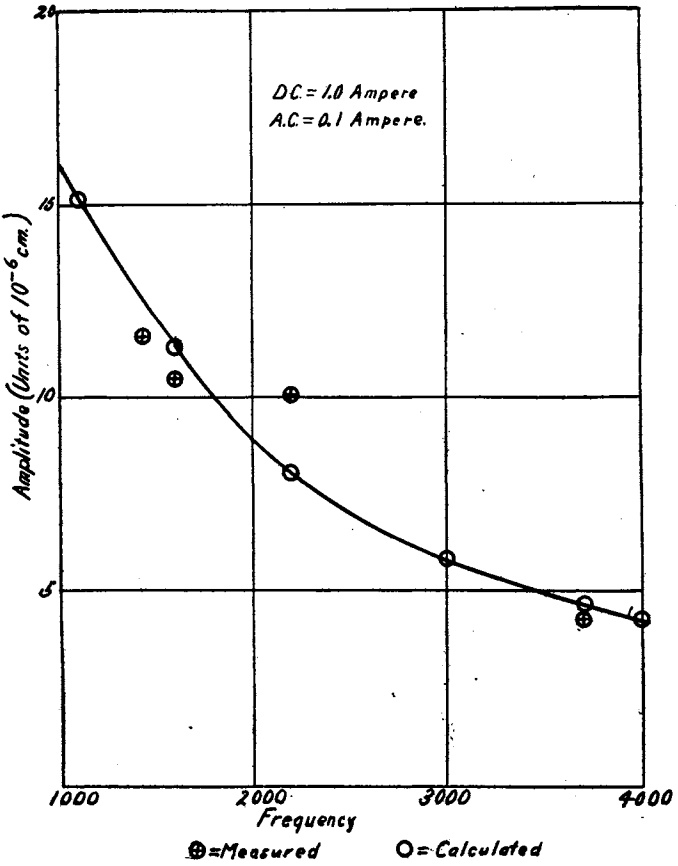


Fig. 15

root-mean-square of the amplitude over the instrument weighted with the area to which the different amplitudes corresponded. In figure 15 a curve is given which shows how near the measured amplitudes lie to the curve of the calculated amplitudes.

These measured values of amplitude agree as well as might be expected with the calculated values for the chance of experimental error in the method used is fairly great. In conclusion, it would seem that one is safe in assuming that the method for calculating the amplitude of vibration of the diaphragm of the tone generator as provided by Doctor Hewlett will give the true amplitude nearly enough for practical purposes.

Physics Department
State University of Iowa.