than figure 1 for measuring the relative strengths of the components. In figure 1 there appears to have been a drop in intensity just before 24 was reached, in the measurement from high to low atomic weights. The curve is of interest as still containing 28 faintly and so serving to accurately locate the weights which otherwise would have been uncertain to a fraction of a unit.

Figure 2 is one of several later curves taken under steadier conditions. These all have very closely the same appearance. The components 25 and 26 are present very nearly in equal amounts; in some measurements 25 was found about nine-tenths the intensity of 26. The component at 24 is approximately 6 times as strong as the one at 26. The ratio of 1 : 1 : 6 gives an average atomic weight 24.375, which is in as good agreement with the accepted atomic weight for magnesium as could be expected with the wide slits used in these first experiments.

THE ENERGY CONTENT OF THE DIAPASON

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In *Science*, **52,** 1920 (586–8), I indicated a method by which the intensely luminous achromatic fringes could be used, without further mechanism, to determine the compression in the interior of a sounding organ pipe.

Meanwhile Profs. A. T. Jones, of Smith College, and H. F. Stimson, of the Bureau of Standards, have called my attention to papers of Boltzmann (*Pogg. Ann.*, **141,** p. 321) and Raps (*Wied. Ann.*, **50,** p. 193) and to some work of Stimson himself, which I had overlooked. These researches make most of my work superfluous. I will, therefore, confine myself to a few special features, as the interferometer which I set up, admitting of any separation of the interfering beams, longitudinally or laterally, is better adapted for work of this character than the Fresnellian fringes or the Jamin interferometer used heretofore. Two opposed nodes may be examined simultaneously. Moreover the ease with which fringes of any size or inclination are producible is a further advantage.

As the transformations are adiabatic, the density increment $\Delta\rho$ at any time is of the form $\Delta\rho = C.n\lambda/lR$, if n fringes of wave-length λ are displaced when the ray passes through a pipe of length l. R is the gas constant and

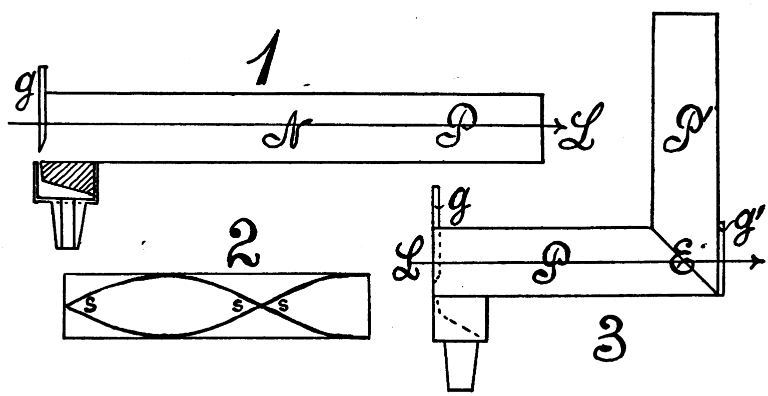
$$C = \frac{p_0}{\vartheta_0(\mu_0 - 1)} = 10^7 \times 1.27$$

the optic constant when p_0 and ϑ_0 are standard pressure and absolute temperature, and μ_0 the corresponding index of refraction of air. Thus the mean mechanical energy per cm.^{3} is $p\,\Delta\rho/\rho$ for the length l surveyed, and if this comprises $\lambda/2$, the maximum energy will be $\pi/2$ times larger. Thus the maximum work spent in compressing a cm.^{3}, for n fringes between trough and crest, if $p = 10^6$, $\lambda = 60 \times 10^{-6}$, $\rho = 0.00129$, $l = 24$ cm., $R = 10^6 \times 2.87$, is

$$p\,\Delta\rho/\rho = \frac{\pi p C \lambda}{2\rho l R}\,n = 10^3 \times 13.7\,n$$

and the compression, $\Delta\rho/\rho = 10^{-3} \times 13.7\,n$.

Observations with longitudinal pipes.—The open pipe, figure 1, was of



wood, with an inner cross-section 2.8×2.8 cm.^{2} and length 24 cm. It responded perfectly to the fundamental, the softest producible note showing about 0.1 fringe in double amplitude, the loudest full note not more than a whole fringe. Blown so hard that the note sharpened, the amplitude rather diminished. As in the case heretofore described, the mean energy lies between ($l = 24$ cm. here)

$$p d\rho/\rho = 10^3 \times 0.87 \text{ ergs/cm.}^3$$

and ten times this quantity. The maximum energy would, therefore, be $\pi/2$ times larger, which makes the energy content $10^4 \times 1.37$ ergs/cm.^{3} for the full note.

The pipe did not at first admit of the production of the octave free from the fundamental. The wave pattern consisted of fundamental waves along the contours of which octave waves passed to and fro. The embouchure was, then, reset to give the clear shrill overtone alone. The waves now vanished evidencing complete symmetry in the dense and rare nodes present; proving, moreover, that the interferometer contributed nothing.

Similar results were obtained with the closed pipe. The surprising feature of this closed pipe, however, was the occurrence of strong waves for the first overtone (fifth above octave). The two nodes, therefore, are here not symmetrically rare and compressed. The double amplitude of these waves for the very shrill note was 0.3 to 0.4 fringe. Neither the waves nor the sound gave any indication of the fundamental. Thus the node at the closed end of the pipe is a semi-node S, figure 2, while that nearer the open end is a full node SS, and the difference found is equivalent to the mean energy of the former and should be trebled. The duodecimal overtone was also obtained sharply.

Finally the temperature equivalent of the mechanical energy per fringe, computed either as $Jc\rho\Delta t = p\Delta\rho/\rho$, or as $\Delta t = \tau(k/c-1)\Delta\rho/\rho$ comes out 1.5° C., if $\tau = 273°$. Some years ago I tried to measure this with a bolometer-telephone device, but failed. This reason seems to be that in case of these rapid alternations, heat does not enter the wires appreciably.

Reed Pipes. Voice.—In the endeavor to obtain waves of larger amplitude, the device resorted to was a brass pipe 32 cm. long and 3 cm. in diameter, through which the component ray of the interferometer passed, provided with a tubulure about 1 cm. in diameter at its middle. This was then connected with flexible tubing to the reed box. The note was coarse like a bassoon.

With the flexible connector very short, the first experiments gave a display of enormous waves, 20 or 30 fringes high. I suspected that this could only be a direct mechanical effect of the sonorous reed on the interferometer. The reed pipe was, therefore, mounted on a separate scaffolding, entirely independent of the interferometer. The result was an immediate reduction of double amplitudes to a few fringes. On replacing the reed by an clarionette mouth piece, the results were similar.

The pipe was now moved, as a whole, out of the range of the rays of the interferometer and sounded. To my astonishment, strong waves were again produced, nearly as much so as when the pipe was in position for interference. In other words, these reed notes act directly on certain parts of the interferometer, and excite the parts selected by resonance.

To test this further, I made use of the voice, singing a foot or more away from the interferometer. At certain chest notes (b, c'), the fringe bands broke into marked waves near a fringe in double amplitude, the effect being absent from the remainder of the scale. A clarionette played about a yard or more from the interferometer evoked the following response:

$e..g$	a	b	c'	d'	e'	f'	g'	$a'..f''$
0..0	strong	stronger	Max. 1.2 fringes	strong	weak	0	weak	no response

Resonating pipes on the interferometer had no discernible effect. The seat of receptivity is probably the iron base of the apparatus. Loading it depressed the maximum to b. A totally different interferometer, in a new location, showed the same behavior on the same base (lathe bed). In a third interferometer of different construction and on a different base, the clarionette e was most effective, b, c', f', a' marked the remaining notes ineffective. I also constructed diapason pipes over 60 cm. long and 5 cm. in diameter, which were excited with my adjustable embouchure. The full c' obtained had the same direct effect on the interferometer as the clarionette. This discrepancy is exceedingly difficult to eliminate as it calls for a detection of the resonant member of the interferometer.

With the 1-foot diapason organ pipes used above, there is much less danger of direct influence. This is shown, for instance, in the balance obtained with nodes of opposite sign. Moreover, I made control experiments by blowing equipitched diapason pipes strongly in the neighborhood. There is even here liable to be a little response. The tendency to assume wave form may be recognized; but it is much smaller than the pipe note proper, and quite absent in the overtones. Finally, the elbowed pipe, figure 3, which blows away from the interferometer, was used for additional guarantee and for overtone nodes.

A PRELIMINARY NOTE ON THE RESULTS OF CROSSING CERTAIN VARIETIES OF NICOTIANA TABACUM

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In connection with a taxonomic study of the various species and varieties of *Nicotiana*, the authors became interested in the extremely varied assemblage of varieties, both botanical and commercial, included under the species *N. Tabacum*. The senior author ventured to suggest a preference for five type varieties as representative of the range of variation found within the species and possibly of fundamental importance as stem forms in the derivation of other varieties. A similar attempt to refer existing commercial varieties to derivation from a limited number of fundamental forms had previously been made both by Comes[1] and Anastasia.[2] These authors agreed in principle on the method of derivation of existing varieties, but they held conflicting views as to which particular forms should be recognized as fundamental. In all three cases the principle followed in attempting to unravel the problem of origin of cultivated forms was to determine which few historically old varieties possessed in various combinations all the characters exhibited by commercial varieties, and then to refer existing varieties to hybridization with resulting segregation and recombination of characters exhibited in the stem forms.

The senior author, having tentatively selected five such stem forms, thought it wise by actual genetic experimentation to determine what results would follow hybridization among them. The authors also found themselves in need of some definite information as to the Mendelian de-