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attained without introducing seriously objectionable distortion. Signals resulting from $N^{15}H_3$ lines can readily be observed without introducing serious distortion. If signal size for the 66 line of $N^{15}H_3$ was maximized, the signal-to-noise ratio could be made as large as sixty, but under these conditions the observed signal showed little resemblance to true line shape.

One serious objection to the use of the present double modulation method is that all irregularities in power received by the crystal are amplified in the same manner as the spectral lines. Hence, the beginning and end of the "mode" will always give large signals. Any sharp reflection peaks existing in the transmission line will also give rise to unwanted signals. For short wave guides the reflections are usually much broader than spectral lines observed at low pressure, and hence may be distinguished from lines visually or by means of low frequency rejection filters.[4] However, as the absorption sections are made longer the observed reflection peaks become sharper and hence more difficult to distinguish from spectral lines. Hence, there are definite limitations in the length of "absorption cell" which can be used in this method of detection; these limitations are the same as those for any method involving "sharpness" as a criterion of the recognizability of absorption lines.

We wish to thank Professor E. B. Wilson and Dr. C. H. Townes for helpful discussions last spring during the early stages of our experiments, to thank Professor Walter Gordy for telling us of his work prior to publication of his recent note, and to express our appreciation to Dr. W. D. Hershberger for sending us information concerning his more recent work on the subject.

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[1] W. Gordy and M. Kessler, Phys. Rev. 72, 644 (1947).
[2] E. B. Wilson, unpublished report: Progress Report 3, N5ori-76 Harvard.
[3] W. D. Hershberger, paper before Symposium on Molecular Spectra and Molecular Structure, Ohio State University, June 1947.
** Note: For low modulation frequencies, the modulation products are proportional to the "sharpness" of the absorption lines.
[4] The use of low frequency rejection filters obviously introduces distortion of line shapes, since the rejected frequencies make a definite contribution to true line shapes. However, it is possible that properly designed filters can be used without introducing *objectionable* distortion. Gordy and Kessler report that the use of filters can actually result in an apparent gain in resolution. (Phys. Rev. 71, 640 (1947).) Hershberger, who has used filters in his work for some time, reports definite distortion of line shape but has used filters quite successfully.

On the Pressure-Volume and Pressure-Compressibility Relation of Metals

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IT has been shown in a previous work[1] of the author that, by further development of the statistical theory of the atom, it is possible to develop a statistical metal theory[2] which enables us to give a full account of the metallic bond of the alkali and alkaline earth metals and, further, to compute the constants of these metals as well as several relations between them without the help of empiric or semi-empiric parameters. The lattice energy U per metal atom—from which all further conclusions can be derived in a simple way—can be expressed as follows:

$$U=A_0+\frac{A_1}{R}+\frac{A_2}{R^2}+\frac{A_3}{R^3}+\frac{A_4}{R^4}, \qquad (1)$$

where R denotes the radius of the elementary sphere containing one metal atom and the coefficients A_i are constants, their value being determined only by the distribution of the electrons and the potential within the ions, and the number of the metal electrons per atom. The constants A_i can be easily calculated.

With the help of (1) the pressure P at the absolute zero point of temperature can be expressed as follows:

$$P=-\frac{dU}{d\Omega}=-\frac{1}{4\pi R^2}\frac{dU}{dR}=\frac{1}{4\pi R^7}\times(A_1R^3+2A_2R^2+3A_3R+4A_4), \qquad (2)$$

where $\Omega=4\gamma R^3/3$ denotes the volume of the elementary sphere. Substituting the expression $(3\Omega/4\pi)^{\frac{1}{3}}$ for R, the equation yields the pressure-volume relation of the metal.

In the above mentioned work I calculated this relation for the metals Na, K, Rb, and Cs up to pressures of about 4.10^4 kg/cm², and I compared the results with those of Bridgman corrected for the absolute zero point of temperature. Recently, the measurements of Bridgman were extended[3] to the alkali metals Na, K, Rb, and to several other elements up to pressures of 10^5 kg/cm² at the temperature $T=296°$K and this induced me to extend theoretical investigations to high pressures of the same order and compare my results with those of Bridgman.

It appears—supposing a constant density distribution of the metal electrons throughout—that the theory is applicable even to these high pressures without change. As long as we apply to the metal ions the statistical model corrected by the electron exchange, the so-called Thomas-Fermi-Dirac model, even at these high pressures there is no overlapping of the electron clouds of neighboring ions. And even calculating the electron distribution of the metal

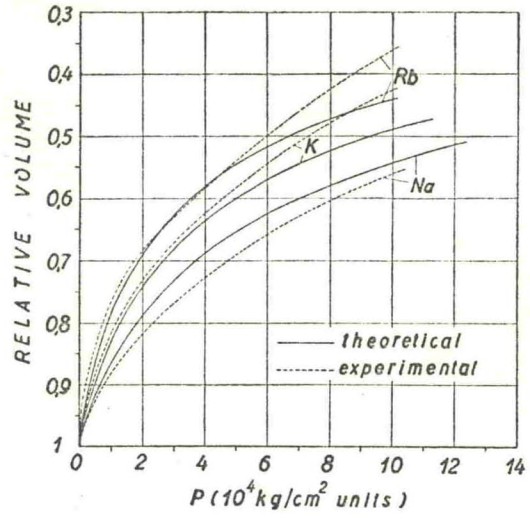

FIG. 1. Comparisons of theoretical and experimental values of pressure-volume relations.