of the magnetic disorder scattering has given information on the localized moments in the lattice. Values for the atomic moments deduced from such measurements will be presented.

T8. Ferroelectricity in Oxides of Fluorite Structure. W. R. Cook, Jr. and Hans Jaffe, *The Brush Development Company*.—The compounds $Cd_2Nb_2O_7$ and $Pb_2Nb_2O_7$ have been studied structurally and electrically. Regarding $Cd_2Nb_2O_7$, the high dielectric constant reported by Wainer and Wentworth[1] has been confirmed. On one body with a dielectric constant (K) of 450 at room temperature, we found a Curie point at $-103°C$ where K reaches 2850. Hysteresis loops on this material taken at $-196°C$ show a remanent charge density of 0.7 ± 0.2 microcoulomb per centimeter^2. Powder x-ray diffraction patterns show a cubic fluorite structure with $a=5.185\pm0.003$A and one molecule per unit cell. This pattern can be accounted for by an arrangement with oxygens occupying statistically seven out of the eight anionic positions, and niobium and cadmium distributed statistically over the cationic positions of the fluorite structure. The analogous lead compound $Pb_2Nb_2O_7$ has a K of 110 at room temperature, and no Curie point above $-196°C$. The x-ray diffraction pattern shows a distorted fluorite structure of rhombohedral symmetry, with $a=5.285\pm0.003$A and $\alpha=89°15'$. The significance of these results in the study of ferroelectricity will be discussed.

[1] E. Wainer and C. Wentworth, J. Am. Ceram. Soc. **35**, 207–14 (1952).

T9. Thermal Conductivity Values for Barium Titanate.* Stanley S. Ballard and Kathryn A. McCarthy, *Tufts College*.—We are conducting a program on measuring the thermal conductivity of optical crystals as a function of temperature, over the temperature range $-40°C$ to $150°C$. The same techniques[1] have been applied to measuring the thermal conductivity of multicrystalline barium titanate, in view of the current interest[2] in its physical properties. The particular samples tested were furnished by the Brush Development Company of Cleveland, Ohio, and are designated as "Brush Ceramic *A*." Preliminary results give a thermal conductivity value at room temperature of about 3.2×10^{-3} cal sec^{-1} cm^{-1} C$^{\circ -1}$, and it was observed that the curve of thermal conductivity *versus* temperature is flat for at least forty degrees above room temperature. At temperatures just above 120°C, a much lower thermal conductivity was found; the value at 128°C is 1.6×10^{-3}. It was also observed that when the material cooled to room temperature, passing back through the Curie point, its thermal conductivity returned to the value previously determined.

* Assisted by a grant from the Penrose Fund of the American Philosophical Society.
[1] Ballard, McCarthy, and Davis, Rev. Sci. Instr. **21**, 905 (1950); McCarthy and Ballard, J. Opt. Soc. Am. **41**, 1062 (1951).
[2] A. von Hippel, Revs. Modern Phys. **22**, 221 (1950).

T10. Electret-Like Behavior in Polarized $BaTiO_3$ Ceramic. R. W. Thickens and R. J. MacDonald, *Armour Research Foundation*.—Electret-like behavior has been observed in polarized ceramic $BaTiO_3$ disks with fired electrodes. Measurements with a high impedance (5×10^9 ohms) vacuum tube voltmeter have shown that, after a short is removed, a potential between 1 and 100 volts builds up in approximately a minute and remains constant. The potential is sensitive to pressure and heating to the extent that heating on one side will make the potential go negative. Chopped light was found to produce an ac potential at the output of an electrometer. The thermal sensitivity of thick disks could be made to exceed 5 volts/watt. A tentative explanation is that the forming field is slowly decaying at a time dependent rate as postulated by Swann. Similarly, the ac output may be a pyroelectric effect resulting from thermally reversible changes in domain polarization. The ac output is greatly increased by thermal biasing near the Curie temperature.

T11. Double Hysteresis Loop of $BaTiO_3$ at the Curie Point. Walter J. Merz, *Bell Telephone Laboratories*.—It is known that the Curie point θ of the ferroelectric $BaTiO_3$ shifts to higher temperatures when a dc bias field is applied. Since in our crystals the transition is very sharp, we expect by applying an ac field at the Curie temperature that the crystal would become ferroelectric and nonferroelectric in the cycle of the ac field. This can be seen in the shape of the hysteresis loop at temperatures slightly above θ. In the center of the polarization P *versus* field E plot we observe a linear behavior corresponding to the paraelectric state of $BaTiO_3$ above θ. At both high voltage ends, however, we observe a hysteresis loop corresponding to the ferroelectric state. A change in temperature causes a change in size and shape of the double hysteresis loops, ranging from a line with curves at the ends (higher temperature) to two overlapping loops (lower temperature). The results obtained allow us to calculate the different constants in the free energy expression of Devonshire and Slater. One of the results shows that the transition is of the first order since the P^4 term turns out to be negative, and since a second-order transition cannot give double loops.

Saturday Morning at 10:00

Geology Lecture Room

(J. H. McMillen presiding)

Fluid Dynamics

U1. The Variation with Time of Flow Variables in the Shock Tube.* R. J. Emrich, J. E. Mack, and R. A. Shunk, *Lehigh University*.—The ideal theory of the flow in the shock tube after bursting of the diaphragm predicts steady flow in the regions between shock and cold front, and between cold front and rarefaction. Measurements of gas density have been made at various positions along a 3.5-cm diameter tube with the chrono-interferometer.[1] These show that the density increases steadily with time after the passage of the shock, increases rather abruptly with the passage of the cold front, and continues to rise further as the cold gas flows past. The density increase from just after the passage of the shock until just before the arrival of the cold front may be as great as 25 percent of the density increase across the shock front. Both the density increase across the shock and the density decrease across the rarefaction are less than predicted by the ideal theory. Indications from three types of pressure gauge suggest that the pressure continues to rise with time after passage of the shock.

* Supported by the ONR.
[1] Curtis, Emrich, and Mack, Phys. Rev. **87**, 913 (1952).

U2. Study of Transonic Flow Past Wedge Profiles by Hydraulic Analogy. E. V. Laitone and Helmer Nielsen,