electric but antiferroelectric, being different from the phase of pure $PbZrO_3$.

The effect of a dc biasing field of 10 kv/cm upon the permittivity of these two solid solutions was studied, with the results shown in Figs. 1 and 2. In $(Pb92.5-Ba7.5)ZrO_3$, the permittivity value in the ferroelectric phase is lowered considerably by the biasing field as in the case of barium titanate.[7] The situation is very different for $(Pb95-Sr5)ZrO_3$. Below the upper transition temperature, the permittivity of this specimen is slightly increased by a dc field. A comparison of this result with that[2] of pure $PbZrO_3$ gives further support for the above assumption of the antiferroelectricity of the intermediate phase in this specimen. The atomic arrangement of this antiferroelectric phase must of course be different from that of pure $PbZrO_3$. An x-ray study is now in progress.

The phase diagram of the $(Pb-Ba)ZrO_3$ and $(Pb-Sr)ZrO_3$ systems is shown in Fig. 3. The situation is to be summarized as follows:

(1) When some of the Pb ions in $PbZrO_3$ are replaced by other suitable ions, an intermediate phase can be observed between antiferroelectric and paraelectric phases. The temperature range of this intermediate phase increases with the concentration of substituted ions.

(2) In the $(Pb-Ba)ZrO_3$ system, this intermediate phase is clearly ferroelectric, just as in the case of $Pb(Zr-Ti)O_3$ system.

(3) In the $(Pb-Sr)ZrO_3$ system, the intermediate phase seems to be another antiferroelectric phase which is different from the phase of pure $PbZrO_3$.

These facts show that the antiferroelectric phase in pure $PbZrO_3$ is very critical in nature; namely, the free energy of this phase is very closely adjacent to those of a ferroelectric phase and another antiferroelectric phase, especially near the Curie point. This peculiar situation indicates that a ferroelectric state and an antiferroelectric state can be realized by only a small change in the polarizabilities of constituent ions. Detailed results will be reported shortly.

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The Change in Electrical Resistance of Magnesium on Melting

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THE change in the electrical resistance of magnesium was determined using Johnson, Matthey and Company, Ltd., spectrographically pure metal (99.95 percent) and two commercially pure magnesium samples (99.52 and 98.67 percent with small amounts of Al, Fe, Mn, Cu, Si, and Cr). The resistivity-temperature data are shown plotted in Fig. 1.

There are three interesting features of the data. First, the ratio of the resistivity of liquid, ρ_l, to that of the solid, ρ_s, is 1.63 for the spectrographic material (1.56 for the commercially pure metal). This value is considerably less than the value 2.1 calculated from the equation of Mott and Wills[1] relating the ratio ρ_l/ρ_s to the latent heat of fusion. The value is also less than that observed for cadmium and zinc with which it may be compared structurally. The low value of ρ_l/ρ_s suggests that there are a larger number of

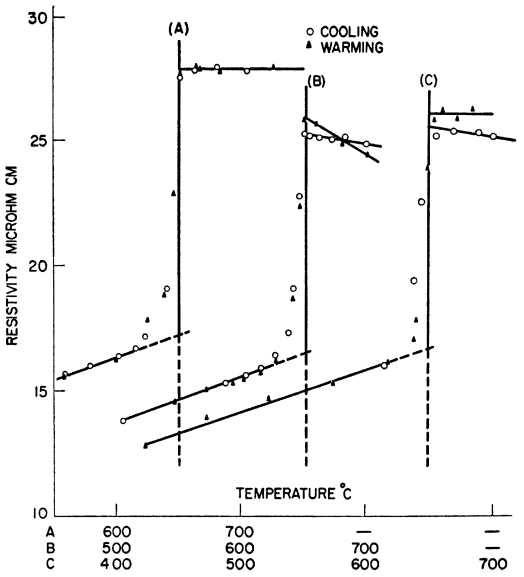

FIG. 1. Magnesium metal resistivity *vs* temperature. (A) Spectroscopically pure; (B) commercially pure, 98.7 percent; (C) commercially pure, 99.5 percent.

effective free electrons in the liquid than in the solid—a suggestion consistent with the brillouin-zone picture. Second, the temperature coefficient of resistivity for molten magnesium is extremely small (negative in the case of the commercially pure samples). In the case of zinc, in which a marked negative temperature coefficient of resistivity is observed, Mott and Jones[2] have suggested that in the liquid a further distortion of the lattice increases the number of free electrons. Third, for each of the materials studied, the resistivity departs from a linear temperature dependence some 20–30° before the melting point is reached at 651°. This anticipation of melting is evidenced whether the cell is warming or cooling and is therefore not readily explained by a hysteresis effect. The effect may be of an undetermined experimental origin. Such an anticipation of melting has been observed for antimony[3] which, however, has a lower resistance in the liquid than solid phase, thus making direct comparison tenuous. The nonlinear change in resistance at a temperature considerably below that required for melting in the case of magnesium may be real. It would be of interest to clarify this effect through the use of other techniques, such as possibly x-ray diffraction.

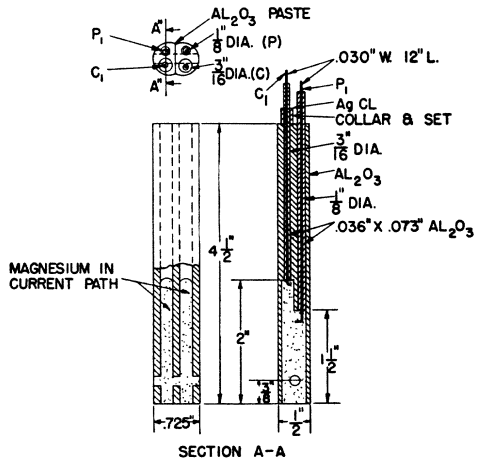

FIG. 2. Ceramic cell for electrical resistance measurement.

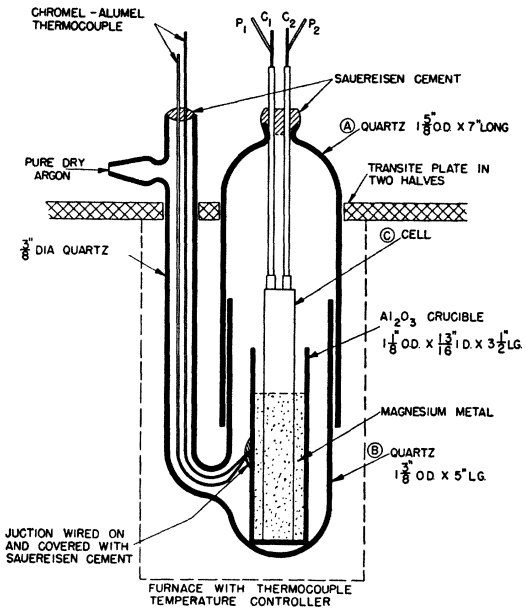

FIG. 3. Assembly for measuring electrical resistance of magnesium.

The cell construction and assembled apparatus for these measurements are shown in Figs. 2 and 3, respectively. The cell and crucible were made of a ceramic containing more than 95 percent Al_2O_3 with added MgO and SiO_2. Tests had shown this a material satisfactory for handling molten magnesium to at least 800°C, if finally fired at 1750°C. The electrodes were tungsten. Spectroscopic analysis of the magnesium metal taken from the electrode region after operation of the cell indicated no tungsten. The magnesium was protected from oxidation by keeping under streaming dry argon. Temperatures were determined using an ice compensated chromel-alumel couple attached to the exterior of the crucible. The resistance of the cell was measured potentiometrically using separate current and potential contacts with the magnesium as indicated in Fig. 2. Measurements were made only when the thermocouple indicated constant temperature. Polarity was reversed during measurement and the average values used to calculate resistance. The resistance of the cell was converted to resistivity from a determination of a cell constant using triple distilled mercury for which the room temperature resistivity was taken at 95.8 microhm cm. No correction was applied for the change in cell constant with temperature.

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Gamma-Neutron Cross Sections for N^{14} and O^{16} *

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THE cross sections for the reactions $O^{16}(\gamma, n)O^{15}$ and $N^{14}(\gamma, n)N^{13}$ have been determined using the 25-Mev betatron in the physics department of the University of Saskatchewan. The procedure used was similar to that previously reported for carbon.[1] Ammonium nitrate was used as a source for both oxygen and nitrogen. Above the (γ, n) threshold in O^{16} (16.5 Mev) the two-minute positron activity in O^{15} was separated from the 10-minute positron activity in N^{13} by an analysis of the decay

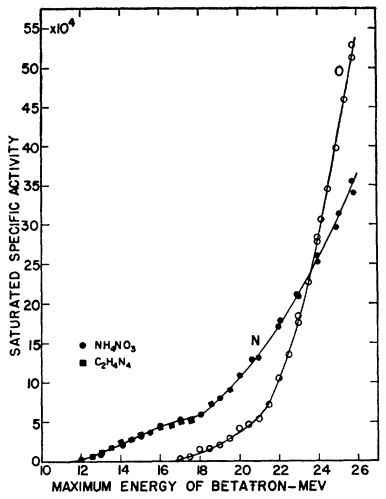

FIG. 1. Saturated specific activity in disintegrations per gram per 100 r as a function of maximum betatron energy, for the reactions $O^{16}(\gamma, n)O^{15}$, and $N^{14}(\gamma, n)N^{13}$. Corrections for geometry etc. have been applied. Points for nitrogen were obtained using NH_4NO_3 and $C_2H_4N_4$.

curve. In this way activities for oxygen and nitrogen were obtained simultaneously. Boric acid was also used as a source for oxygen. Normalization against the $Cu^{63}(\gamma, n)Cu^{62}$ activity[1,2] was carried out at 23 Mev.

The saturated specific activity curve for oxygen obtained in this way is shown in Fig. 1. It has a slowly increasing initial portion with almost constant slope for a range of about 4 Mev. This type of curve is quite different from anything formerly obtained in this laboratory and leads to a rather interesting cross section curve to be discussed below. The neutron yield at 22 Mev is 1.68×10^4 neutrons/mole/r as compared to the value 0.67×10^4 reported by Price and Kerst.[3] Their value is open to some doubt since they report a larger value at 18 than at 22 Mev.

Figure 2 shows the oxygen cross section curve determined by the "photon difference"[4] method. This curve shows an almost constant cross section from 17 to 20 Mev, followed by a rapidly rising portion to a peak value at 24.2 Mev. This anomalous effect can perhaps be explained by a mechanism suggested by Blatt and Weisskopf.[5] These author state that the main contribution to the gamma-ray absorption below 15 Mev comes from electric quadrupole and magnetic dipole interactions. However, at higher energies the absorption is strongly increased by the onset of an electric dipole absorption. The cross section curve in oxygen shows

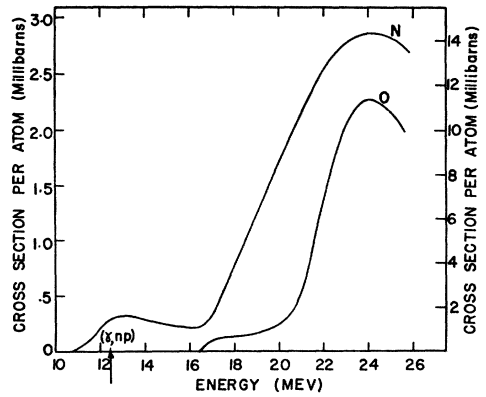

FIG. 2. Cross section *versus* photon energy for the reactions $O^{16}(\gamma, n)O^{15}$ and $N^{14}(\gamma, n)N^{13}$. For nitrogen use left-hand scale and for oxygen, right-hand scale. The (γ, np) threshold in nitrogen is indicated at 12.5 Mev.