independent of H_t. Maximum magnetic hardness apparently corresponds to initiation of an optimum number of nuclei between 800° and 900°C and growth of the precipitate in plates at 600°C which divide the matrix into plate and rod-like units whose shortest dimensions may be 100 to 1000A, so that they will behave as single ferromagnetic domains.

The coercive force presumably may be accounted for by the crystalline and magnetostatic anisotropy energy of the matrix units: the plate-like part of the volume will have $H_c=2K/I_s$, requiring a K of only $\sim 5\times 10^5$ ergs/cc, which is not unreasonable; additional coercivity of $\sim 2\pi p\Delta I_s$(20°C) from the rods may be important for reasonable values of ΔI_s and p, the fractional volume of precipitate.

The above theory does not require internal strains to have an important effect on the coercive force, and is in keeping with the fact that the disregistry strain of the transition lattice[5] is unusually small in Alnico V as compared with other permanent magnet alloys; further, on geometrical grounds it seems likely that the plate-like portion of the volume should be under large loading with symmetry axis normal to the plates. This gives no contribution to the coercive force if the magnetostriction is isotropic; if the magnetostriction is anisotropic, as in Ni, a strain of 0.1 percent (the disregistry strain) will give a small directional anisotropy in the plane of the plate, but in Ni this would only be about 2×10^4 ergs/cc, and it seems unreasonable to suppose a 25 times larger value in Alnico V.

We are indebted to J. H. Hollomon for general education on nucleation theory, to R. M. Bozorth under whose stimulus the experimental part of this investigation was undertaken, and to W. P. Mason, R. D. Heidenreich, and J. K. Galt for discussions on particular points.

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The Thermal Neutron-Capture Cross Section of A^{36}

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THE thermal neutron-capture cross section of A^{36} has been measured as 6.5±1.0 barns. Approximately 500 cc (N.T.P.) of commercial argon were sealed in a boron-free glass flask and irradiated in the thermal column of the N.R.X. pile for one hour. The neutron flux through the gas was measured with manganese foils and found to be 8.6×10^9 neutrons/cm²/sec. These foils had been calibrated[1] by irradiating them in a neutron flux, the value of which was measured by means of a small pulse ion chamber filled with a known amount of BF_3. The neutron flux through the argon was thus based on the neutron-capture cross section of boron, the number of boron atoms in the ion chamber and the counting rate. The experimental error is given as 3.5 percent.

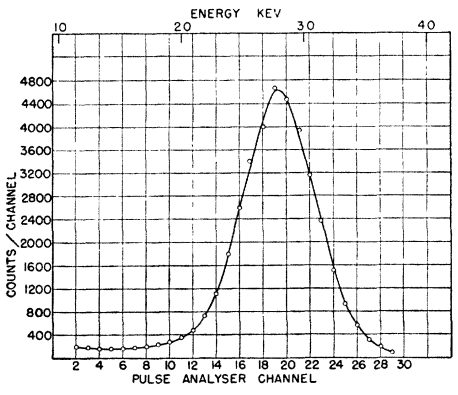

FIG. 1. Activity caused by K-capture in A^{37}.

It was found by comparing foils irradiated inside and outside of a similar glass flask that neutron absorption in this glass was negligible.

After removal of the flask from the reactor, the 110-minute A^{41} activity was allowed to decay through forty half-lives before introducing an accurately measured pressure (10.58 cm) of the irradiated gas into a proportional counter[2] preparatory to counting the A^{37} activity. The pulses from the counter were suitably amplified and fed to a thirty-channel pulse analyzer in parallel with a commercial scaler. (The latter served as a check on the total number of counts.)

The operation of the counter and the location of the 2.8 kev K-capture peak of A^{37} were checked by comparing the amplitude of the argon pulses with those produced by a beam of 17.4 kev x-rays (Mo $K\alpha$ line, selected by a crystal spectrometer). A typical run is shown in Fig. 1. The fraction of K-capture radiation which escapes from the counter must be allowed for, and has been estimated as 4.5 percent. Moreover, there is a low energy tail associated with the K-capture peak due to the reduced field strength at the ends of the counter. This tail must be extrapolated down to zero pulse size and its contribution added to the counting rate. The active volume of the counter (130.2 cc) was taken as the volume enclosed by the cylindrical cathode. It should be noted that the measurements do not extend below 1.2 kev and thus the L-capture radiation was not included. The contribution from L-capture has been measured by Pontecorvo, Kirkwood, and Hanna[2] as between 8 and 9 percent and calculated by Rose and Jackson[3] as 8.2 percent. A correction of 8.5 percent is applied.

The activity thus determined was corrected back to zero decay time using a half-life value of 34.1 days[4] for A^{37}. The calculation of the cross section was based on an isotopic abundance of 0.307 percent for A^{36}. The error shown in the value of the cross section 6.5±1.0 barns is the standard error. We thank Mr. G. C. Hanna for putting his apparatus at our disposal and for valuable help with the experiment.

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Temperature Dependence of Microwave Line Widths*

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IN their pioneering work on the pressure broadening of the ammonia inversion spectrum, Bleaney and Penrose[1] assumed that the cross section σ for collisions interrupting the microwave radiation or absorption was independent of the average velocity of impact $\bar{v}$. Although the agreement between their data and theory is actually independent of any possible variation of σ with $\bar{v}$, their assumption has crept into many estimates of microwave intensities, by way of the assumed dependence of the line width parameter $\Delta\nu=(n\bar{v}\sigma)/(2\pi)$ on temperature. Thus the above "hard sphere" theory predicts a line width at constant pressure proportional to $T^{-\frac{1}{2}}(V\simeq T^{\frac{1}{2}}; n\simeq P/T)$.

Recent theories proposed by Anderson[2] and Margenau,[3] while differing in their basic assumptions, both predict a line width independent of the impact velocity, with σ inversely proportional to $\bar{v}$. These theories, too, are in agreement with Bleaney and Penrose's data, although Anderson's theory alone includes an explanation of observed saturation effect.[4]

We have performed the simple experiment of measuring $\Delta\nu$ for the ammonia 3,3 line as a function of temperature. The results

TABLE I. Temperature dependence of line widths.

Temperature Kelvin	$\bar{\mu}/\mu$	$P/\Delta\nu$ arbitrary	$(T\Delta\nu\mu)/(\bar{\mu}P)$	$(T^{\frac{1}{2}}\Delta\nu\mu)/\bar{\mu}P$
300	0.54	1±0.02	556±10	32.1±0.6
195	0.516	0.66±0.02	574±15	41.0±1.0

are summarized in Table I. In interpreting the data, it is assumed that the line width is also proportional to the average component of dipole moment $\bar{\mu}$ of the colliding molecules along the angular momentum axis.[2,3] As $\bar{\mu}$ varies slightly with temperature, its ratio to the static dipole moment μ is also tabulated.

The experiment clearly shows that $\Delta\nu$ is inversely proportional to the temperature and hence σ is inversely proportional to the impact velocity, confirming Anderson's theory. These results however should not be extrapolated indiscriminately to all types of microwave collision broadening. They may be expected to hold rigorously only for an inverse cube dependence of interaction energy on molecular separation—exemplified by the above symmetric top dipole-dipole interactions. Experimental and theoretical papers on these and other interactions are now in preparation.

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Recoil Electron Spectrum of the K^{40} Gamma-Ray

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THE observation that the ratio of positron emission to electron capture in the decay of K^{40} is $\lambda^{\beta+}/\lambda^{c}<0.005$, leads to the conclusion that the $A^{40}-K^{40}$ mass difference must be less than 1.6 Mev, if expressions for either third or fourth forbidden beta-transitions and axial vector or tensor interactions are used.[1] As considerations of the K^{40} β^- energy end point[2] seem to indicate that the gamma-ray from K^{40} be placed on the A^{40} side of the decay scheme, it is remarkable that the energy which has been observed[3] for the gamma-ray of 1.55±0.05 Mev should be so close to the maximum possible $A^{40}-K^{40}$ mass difference. It was therefore thought of interest to measure the energy of the gamma-ray more accurately, using the new scintillation spectrometer which we have developed.[4]

The crystal element of activated NaI, $1''\times1''\times1''$, was surrounded by approximately 90 g of KF, and the recoil electron spectrum which was obtained after filtering of the radiation by 4 mm of Al is shown in Fig. 1. The shape of the spectrum was later confirmed using another source of KCl. The pulse height distribution for the background is given and also the recoil electron spectrum of an uncollimated beam of Co^{60} gamma-rays for purposes of comparison and calibration. The Co^{60} scale is greatly reduced and ordinates refer only to the K^{40} and background spectra. In these experiments the spectrometer was enclosed in a three-inch wall lead castle. The photo-cell noise becomes apparent only below 20 kev on the pulse scale and the rise in the recoil electron spectra at low energies is attributed to degenerate radiation entering the crystal, as well as to the loss of recoil electrons from the surfaces and possible low energy gamma-rays in the case of $K^{40}\rightarrow Ca^{40}$. Any differences in the form of the two spectra are due, in addition, to the nature of the extended source in the case of K^{40}, and to the existence of two Co^{60} gamma-rays. It would not be possible from these results to draw any conclusions

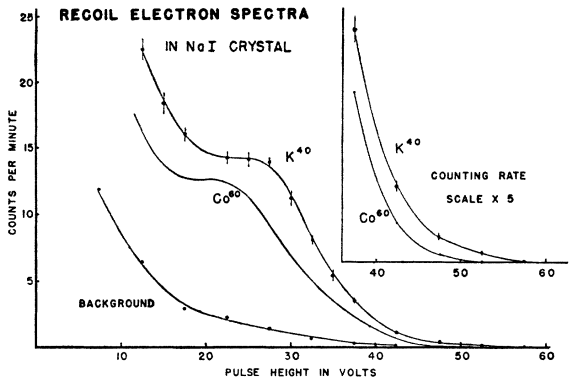

FIG. 1. Differential pulse height distributions obtained with scintillation spectrometer. The curves for K^{40} and Co^{60} have been corrected for background.

regarding a possible complexity of the K^{40} gamma-radiation. Careful consideration has been given to the manner of approach to the axis of the two spectra near the end point (Fig. 1) and, due account being taken of resolving power, the form of the Compton distribution, etc., a value has been estimated for the gamma-ray energy for K^{40} of 1.47±0.03 Mev in terms of the 1.33 Mev Co^{60} gamma-ray. This means that the energy available for electron capture to the excited state of A^{40} is less than 0.13±0.03 Mev. Coincidence experiments are being carried out to elucidate further the decay scheme.

The scintillation spectrometer has been used to measure the possible gamma-activity of certain members of the isobaric pairs of nuclei of neighboring Z. In some cases (notably cerium) activity has been observed but measurements with the spectrometer have indicated these activities to be due in the main to minute traces of thorium. Attempts are being made to have the purest possible materials prepared for this work.

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The Cation Distribution in Ferrites with Spinel Structure

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FROM studies of the cation distribution in spinels it was concluded by Verwey and co-workers[1] that, for the ferrites with this structure, zinc ferrite and cadmium ferrite are normal spinels while nickel-, copper-, magnesium-, ferrous- and manganese-ferrite are inverse spinels.[2] In the normal spinel the divalent ions (zinc or cadmium) occupy the tetrahedral position while the trivalent iron occupies the octahedral position. In the inverse spinel the tetrahedral position is occupied by one-half of the trivalent iron ions while the octahedral positions are occupied by a random distribution of the remainder of the iron ions together with the divalent cations (e.g., Cu^{+2}). In addition, it was indicated that a solid solution of a normal-spinel ferrite with an inverse-spinel ferrite (for instance, zinc ferrite in solid solution with copper ferrite) had a structure in which, in the example taken, the tetrahedral positions were occupied preferentially by Zn^{+2}, the remainder of these positions being filled by Fe^{+3}; the octahedral positions were occupied by the remaining Fe^{+3} and the Cu^{+2}.

Néel,[3] however, from a consideration of the magnetic properties of the ferrites concludes that the cation distribution is not as "ordered" as in the description given. The distribution according to Néel may vary so that, for instance, the distribution in copper ferrite is not simply $Fe\,[FeCu]O_4$ but may be $Fe_{0.82}Cu_{0.18}$