Five samples purified from KCl which had received neutron exposures of 1.3×10^{18} and 2.3×10^{18} neutrons/cm² gave an average value in agreement with that obtained from the more active sample, but the increase in counting rate as a result of irradiation in these experiments was in the range of only 5–15 counts per minute so the accuracy with which it could be determined was relatively low.

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[1] A. O. Nier, Phys. Rev. **50**, 1040 (1936).
[2] C. Lapointe and F. Rasetti, Phys. Rev. **58**, 554 (1940). The value of 3.2×10^{-24} cm² which they give is based on the assumption that the thermal neutron absorption cross section of boron is 600×10^{-24} cm². If the more recent value of 703×10^{-24} cm² for boron is used the value obtained by these authors for potassium would be 3.7×10^{-24} cm². Way and Haines, United States AEC Declassified Document 2138, cite a value of 2.5×10^{-24} cm² for the natural potassium cross section.
[3] L. Seren, H. N. Friedlander, and S. H. Turkel, Phys. Rev. **72**, 888 (1947).
[4] L. B. Borst and J. J. Floyd, Phys. Rev. **74**, 989 (1948). Other references are given in this paper.
[5] The samples, obtained from the Oak Ridge National Laboratory of the U. S. AEC, were the result of irradiations made for the purpose of producing high specific activity Cl^{36}. The values for neutron exposures were kindly furnished by J. A. Cox of the Isotopes Office of the Oak Ridge National Laboratory.
[6] Further details of these determinations are given in a M.S. thesis field with the University of Wisconsin library in August, 1948, by John L. Hansen.

Investigation of the Attractive Forces between the Persistent Currents in a Superconductor and the Lattice*

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We have investigated the behavior of a superconducting sphere in a magnetic field in order to answer the question of whether the persistent surface currents can move with respect to the metal or are rigidly bound to it. An early experiment of Tuyn's[1] has been interpreted as indicating that the supercurrents are in fact rigidly fixed in the superconductor. Since Tuyn employed a hollow sphere, one would expect the intermediate state to set in and produce a strong frozen-in moment. Therefore his experiment is not conclusive.

It also appears that the hypothesis of currents rigidly bound to the metal is incompatible with the Meissner effect. Since

$$\mathbf{B}=\mathbf{H}+4\pi\mathbf{I}, \tag{1}$$

we may regard the condition $\mathbf{B}=0$, the Meissner effect, as resulting from the building up of a $4\pi\mathbf{I}$ in the metal which is everywhere equal to $\mathbf{H}$ and oppositely directed to it, inasmuch as (1) is a vector equation and $\mathbf{I}=-\mathbf{H}/4\pi$ vectorially. If we were now to regard the surface currents, or what amounts to the same thing, the magnetization $\mathbf{I}$, as fixed to the metal sphere, then on turning the sphere in a magnetic field, the vector $\mathbf{I}$ would rotate with respect to $\mathbf{H}$, and therefore the condition $\mathbf{H}+4\pi\mathbf{I}=0$ could not be fulfilled.

We have investigated this matter experimentally by suspending a tin spheroid of radius 1.8 cm in a magnetic field and observing the period of oscillation of the resulting torsion pendulum as a function of the field strength. Observations have been made at temperatures down to 1.74°K and at field strengths sufficiently below the critical field to avoid the appearance of the intermediate state. The earth's field was compensated to within one or two milligauss before cooling so as to avoid the possibility of frozen-in moments.

If the currents were rigidly fixed to the sphere, then we should have, in addition to the restoring torque of the suspension, a torque of $\mathbf{H}^2/4\pi$ dyne-cm/rad. cm³ due to the interaction between the currents and the applied field. We have observed no torques greater than about 1 percent of this quantity and therefore conclude that except for effects of the order of 1 percent or less, the currents do not remain bound to the metal.

We have, however, observed a restoring torque which is 1 percent or less of the value $\mathbf{H}^2/4\pi$ and which is an interesting function of the applied field strength. Since we used a rather soft suspension (approximately 130 dyne-cm/rad.) these effects were well within the precision of measurement. A typical result is plotted in Fig. 1

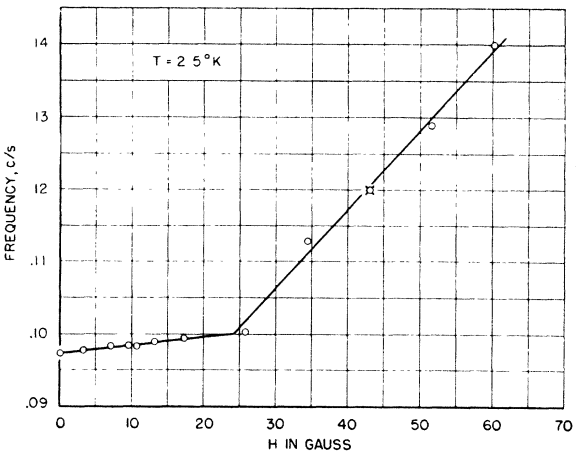

FIG. 1. Relation between frequency of oscillation and magnetic field for tin spheroid. ⊙ Points taken with ascending magnetic field. × Point taken with descending field.

which gives the frequency of oscillation *vs.* the applied field for a temperature of 2.5°K. Note the curious discontinuity in the slope at 24 gauss. The same general behavior has been observed at other temperatures. No hysteresis is apparent as long as we do not exceed the critical field.

The experiments are still in a preliminary stage so that it is entirely possible that the effect we observe is due to small departures from true cylindrical symmetry or other secondary features. We have some indication of dependence on the relative orientation of field and spheroid and are investigating this point further. It is also planned to measure the torque under static conditions, to extend the measurements to other superconductors, and possibly to study the effect using a long cylinder with circumferential persistent currents.

After we observed these phenomena it was brought to our attention that effects of this sort have been observed and briefly reported on by Mendelssohn.[2]

* Supported by the ONR.
[1] W. Tuyn, *Quelques essais sur les courants persistants*, Leiden Comm. No. 198.
[2] K. Mendelssohn, *Report of an International Conference on Fundamental Particles and Low Temperatures* (Physical Society, Cambridge, 1946), p. 128.

Thresholds for Photo-Neutron Reactions in Mn, Zn, Zr, Mo, Cd, Pr, Nd, Au, Hg, Tl and Pb

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Measurements on thresholds for photo-neutron reactions, using x-rays from the 22-Mev betatron, have been extended to include a number of other elements. The experimental arrangements are similar to those already described.[1] The energy scale is again determined relative to the threshold for the 10-minute activity from the $Cu^{63}(\gamma,n)Cu^{62}$ reaction which is taken as 10.9 Mev.

The thresholds for the production of characteristic radioactivities were measured in samples which varied from a single 10-mg sample enriched in Zn^{70} to a number of large cylindrical samples of the more common elements. Metallic samples were used in all cases with the exception of the Zn^{70}, Pr, and Nd which were in the form of oxides.