LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Transverse Barkhausen Effect in Iron

In observing the sudden small changes in magnetization discovered by Barkhausen, experimenters have generally confined themselves to determining the changes in magnetization taking place in the direction of the applied magnetic field, and have not considered the changes which may occur in the directions at right angles. It occurred to us that measurements of this transverse effect might give us more detailed knowledge of the nature of the reversal of the elementary regions. For example, if the magnetization is closely aligned with the field before and after the reversal (parallel and antiparallel), there will be little or no transverse effect. On the other hand, if the magnetization is inclined to the field at a considerable angle and the reversal is 180°, or if the reversal is less than 180°, the transverse effect will be relatively large.

The results, discussed more fully below, indicate that when the magnetization is small (at the coercive force) the reversals are practically all of the former kind, and when the average magnetization is large (over one half of saturation) reversals of the latter kind become of increasing importance.

The specimen used in the experiments was a drawn iron tube 60 cm long and 6 mm in diameter, and with a wall 0.5 mm thick. The longitudinal Barkhausen effect was determined in the way previously described[1] and the results expressed in terms of the average change in magnetic moment for a single discontinuity. To determine the transverse effect the tube was magnetized circularly by passing current through a copper wire placed along the tube axis, and the small sudden changes in transverse magnetization were picked up by the same search coils, used in the same position, as were used to detect the longitudinal effect. The magnetization cycle was in each case a hysteresis loop with a maximum field strength of 10 gauss.

The ratio of the change in moment perpendicular to the applied field, to the change parallel to the field, is plotted in the Fig. 1.

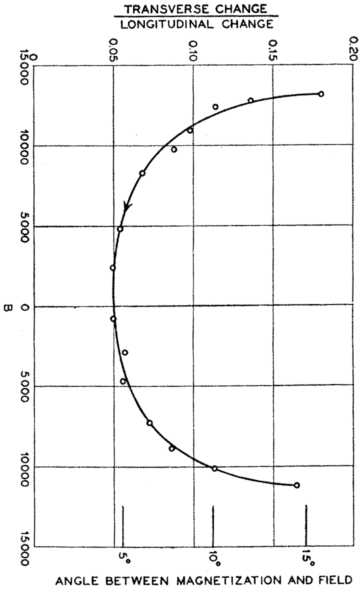

Fig. 1.

The minimum in the curve is for $B=0$, and corresponds to a reversal of 180°, with the average direction of magnetization inclined 5° to the direction of the field. This small inclination is probably best accounted for by the inhomogeneities in the material due to

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[1] Bozorth and Dillinger, Phys. Rev. **35**, 733–52 (1930).

crystal boundaries and the local changes in the number of elementary regions magnetized in each direction. When the magnetization has larger values in either direction the ratio is larger, and when $B=13,000$ the ratio corresponds to the complete reversals of magnets having an average inclination of 15° to the field. It has been shown by several experimenters, and recently emphasized by the theoretical studies of Akulov,[2] that iron crystals are magnetically isotropic until the induction exceeds 10,000 gauss, and that in the neighborhood of 16,000 gauss the direction of magnetization coincides with the crystallographic direction (100) within a fraction of a degree. When the material is anisotropic and the reversal is 180° or less the transverse component will be relatively large.

Although the results show the nature of the reversals at low inductions, they have not been extended so far to the high inductions for which the anisotropy is greatest; they indicate, however, that the transverse component is comparable with the longitudinal in this region, as would be expected.

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June 10, 1931

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[2] Akulov, Phys. Zeits. **32,** [2] 107–8 (1931).

On the Elastic Scattering of Electrons by Spherically Symmetrical Atoms

In several recently published papers[1] the elastic scattering of electrons by A and (in particular) Hg atoms has been observed in its dependence upon the angle of scattering and for different electron energies. The experiments show very clearly a series of intensity maxima and minima which in general move toward smaller angles with increase of the electron velocity.

Although, from well-known wave-optical analogies, this sort of behavior may not seem surprising, we are nevertheless not in a position to designate precisely the mechanism responsible. In the first place it may be a matter of the diffraction of the electron wave in the field of unchanged atoms; the polarization of the atoms may, on the other hand, play a determining rôle; and finally it may prove necessary, in order to obtain complete agreement with observation, to treat the problem not in three dimensional but in configuration space so that the electron exchange may be taken into account.

The following considerations will perhaps somewhat clarify this situation. If it is a matter of first order scattering in a centrally symmetrical field the eigenfunctions, in their dependence upon the scattering angle θ and the electron velocity v, will be of the form $\psi(v \sin(\theta/2))$. This displacement law may easily be tested on the minima given by Pearson and Arnquist, which should belong to the same value of the argument. Table I shows to what extent the law is obeyed.

Table I

θ	$\sin(\theta/2)$	v	$v \sin(\theta/2)$
65	0.537	10.0	5.37
57	.477	11.2	5.34
50	.423	12.2	5.18
44	.375	13.2	4.96
40	.342	14.1	4.84

The argument decreases by about 10 percent corresponding to an increase of the electron energy by the factor 2. These experiments can thus only approximately be explained by this simple scattering process.

It is the intention of the authors to return to this problem in a more detailed treatment.

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June 4, 1931.

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[1] E. C. Bullard and H. S. W. Massey, Proc. Roy. Soc. **A130,** 579 (1931); F. L. Arnot, *ibid.* **A130,** 655 (1931); J. M. Pearson and W. N. Arnquist, Phys. Rev. **37,** 970 (1931).

Excitation of High Optical Energy Levels

The one-way high tension condensed spark method used by Professor Siegbahn's students[1] in the photography of spark spectra, is capable of ionizing and exciting atoms to energy levels considerably higher than any reported hitherto in optical spectra.