This combined impulse voltage and current generator or lightning-stroke generator simulates in effect the dielectric and dynamic stresses imposed on wood poles, insulator strings, electrical apparatus, etc., much the same as these occur from natural lightning. As an example of the destructive effect of the laboratory tests, full-sized wood poles—exactly identical with the poles employed in the distribution of electricity—have been split lengthwise by one or two discharges of the lightning-stroke generator. The resemblance of the poles split in the laboratory to those split by natural lightning is markedly close. Other interesting tests with the lightning-stroke generator will appear in due course in the technical literature.

P. L. BELLASCHI.

Sharon High Voltage Laboratory,
Westinghouse Electric and Manufacturing Co.,
Sharon, Pa.

An Atomic Theory of the Magneto-Caloric Effect

As a result of an investigation on the change of temperature with magnetisation, Mr. T. Okamura has succeeded in separating the reversible and irreversible thermal effects. He has shown that the irreversible temperature variation agrees satisfactorily with the Honda-Okubo theory of ferromagnetism[1].

An explanation of the reversible effect may be given on the basis of the same theory. It is concluded that there are two factors contributing to this effect, the first being the volume change due to magnetostriction. According to the Honda-Masumoto theory[2] of latent heat of fusion, the increase of energy, δW_1, due to the volume expansion, δv, of the substance during fusion is given by

$$\delta W_1 = p|\delta v| = (c|\delta v|)/(6v_s\alpha) \qquad (1)$$

where c, v_s and α are the specific heat, the specific volume and the coefficient of thermal expansion at the melting point; p is the effective 'dynamical pressure'. The observed latent heats of fusion of a large number of elements agree fairly well with the theory. Taking for δv the volume change due to magnetostriction, and using the room temperature values of c, α and v_s, the heat absorption associated with the magnetostriction volume change may be obtained.

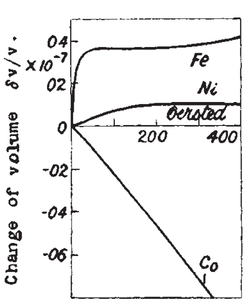

FIG. 1. Change of volume due to magnetostriction.

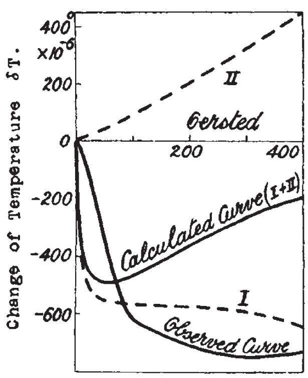

FIG. 2. Magneto-caloric effect for iron.

According to the Honda-Okubo theory of ferromagnetism, as the magnetic field increases, there is an increase in the kinetic energy of the magnetic atoms associated with their rotational vibration about their mean positions. This contributes a second factor to the reversible thermal effect. Near saturation the calculation of δW_2 is very simple and leads to the following relation:

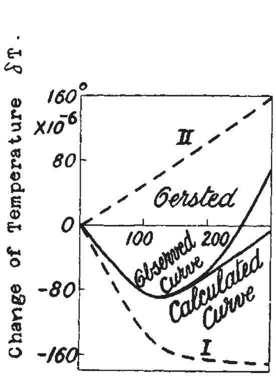

FIG. 3. Magneto-caloric effect for nickel.

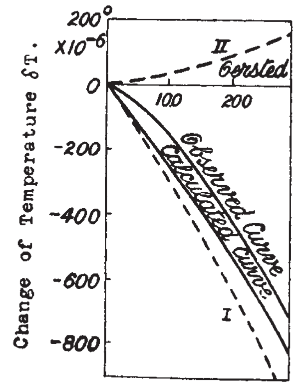

FIG. 4. Magneto-caloric effect for cobalt.

$$\delta W_2 = 2MN\ [1 - \{E(\beta_0/2)\}/\{K(\beta_0/2)\}]\ \delta H \qquad (2)$$

Here M is the magnetic moment of one atom, N the number of atoms per unit volume, K and E complete elliptic integrals of the first and second kind, and β_0 the initial amplitude of vibration, which is a function of temperature. In the initial stages of magnetisation, however, many of the atomic magnets are directed oppositely to the field. The effect of magnetisation on such magnets is to reduce their kinetic energy by an amount which can be calculated from (2). For weak magnetisation, therefore, an approximate value of δW_2 may be obtained by substituting NI/I_0 for N, where I and I_0 are the intensity in the given field and the saturation intensity. The total change of temperature due to the two effects considered is then given by

$$\delta T = -\frac{1}{6\alpha}\cdot\frac{1}{v}\cdot\left|\frac{\partial v}{\partial H}\right|\delta H + \frac{2MNI}{c\rho I_0}\left\{1 - \frac{E(\beta_0/2)}{K(\beta_0/2)}\right\}\delta H \qquad (3)$$

where ρ is the density. In Fig. 1 the magnetostriction data[3] used in the calculations are given; the curve for nickel is based on a provisional estimate, as the available experimental values do not agree even in sign. Figs. 2, 3 and 4 show the theoretical curves for δT together with the experimental curves of Mr. Okamura. In these figures (I) and (II) refer to the first and second terms respectively in equation (3). In view of the experimental difficulties, and of the approximations made in the calculations, the agreement between the observed and theoretical values may be considered satisfactory.

KOTARO HONDA.
TOKUTARO HIRONE.

University of Sendai,
Japan.

[1] K. Honda and J. Okubo, *Sci. Rep. Tôhoku Univ.*, **5**, 153 (1916).
[2] K. Honda and H. Masumoto, ibid., **20**, 342 (1931).
[3] Fe: new measurements by Y. Masiyama. Co: M. Kornetzki, *Z. Phys.*, **87**, 560 (1934). The effective field corresponding to the applied field in Kornetzki's experiments was deduced from a magnetisation curve for cobalt.