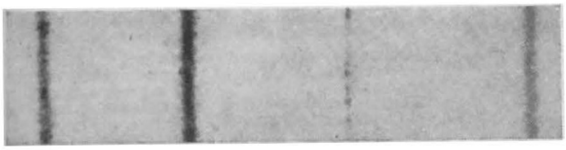

Fig. 2. PORTION OF ELECTRON DIFFRACTION PATTERN FROM CADMIUM OXIDE PARTICLES, SHOWING DIFFERENT LINE BREADTHS FOR *222*, *400*, *420* AND *422* REFLEXIONS. ENLARGEMENT 16 DIAMETERS

interstitial sites in the crystal, can explain the elongation of component spots into streaks.

Progressive change from regular cubic to irregular habit was accompanied by the merging of the individual components into one broad ring. For zinc oxide smoke particles, where only the prism faces parallel to the hexagonal axis are well developed in the characteristic long spines, only one pair of streaks is expected from each single-crystal reflexion. Hillier and Baker[3] have observed these streaks for zinc oxide smoke and have interpreted them as low magnification electron-optical images of the individual spines. If this were so the streaks would be radial on the *002* ring and circumferential on the *100*, whereas in the patterns obtained by us, and in those published by Hillier and Baker, the opposite is the case, in accordance with the refraction theory.

For spherical particles, or the similar case of completely irregular shapes, the refraction effect will produce a broadening of the rings of calculated angular half-width $1 \cdot 4 \frac{P}{2E}$, and width for one tenth intensity $3 \cdot 8 \frac{P}{2E}$. This broadening is of the same magnitude as that due to finite crystal dimensions for particles of only several hundred angströms diameter for voltages most commonly used, and so must be taken into account in crystal-size determinations. For regularly shaped particles the estimation of particle shape and dimensions on the basis of ring breadth must likewise take into account the selective broadening of the rings by refraction, which may be as large as $\frac{5P}{2E}$ (Fig. 2). Moreover, in this case the relative intensities, as judged by peak intensity values, will be smaller for those rings undergoing refraction-broadening, thus giving rise to apparent intensity anomalies in electron diffraction patterns. Particles having well-developed crystal faces will therefore show deviations in relative intensity of the various reflexions from the X-ray values. In contrast to the explanation offered by Ehrhardt and Lark-Horovitz[4], this is the case with zinc oxide, where the relative intensities of the *110* and *103* rings, in particular, are inverted for material showing hexagonal prism habit.

Details of this work will be published in full at an early date.

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[1] Sturkey and Frevel, *Phys. Rev.*, **68**, 56 and 209 (1945).
[2] Hillier and Baker, *Phys. Rev.*, **68**, 98 (1945).
[3] Hillier and Baker, *J. Appl. Phys.*, **17**, 12 (1946).
[4] Ehrhardt and Lark-Horovitz, *Phys. Rev.*, **57**, 603 (1940).

'Container-dent Sensitivity' of Solid Explosives

WHEN explosions result from rough handling of bomb-type ammunition, they generally must be ascribed to accidental fuse action; because, with fuses generally present, alternative explanations appear less reasonable. But during the War there have been some explosions of items of bomb-type ammunition where (with partial detonations) fuses were recovered intact, and other cases where bomb-type ammunition items were exploded without any fuses in them. The impacts which resulted in these explosions were caused by only relatively light bumping, or by the items falling from heights ranging from 4 in. up to 4–5 ft.; and they were too slight to have caused rupture or more than mere dents.

This phenomenon, now called 'container-dent sensitivity', differs essentially from 'bullet sensitivity', or from 'fragment sensitivity', which produce detonations of explosives in thin metal containers when such containers are penetrated by bullets or fragments at high velocities of the order of 2,000 ft./sec. or more (but are only ignited, or are unaffected, at much lower, though still 'penetrative', velocities).

Also, this phenomenon is by no means the same as that involved where an even greater height of fall of a small weight is used to explode a few milligrams of *bare* explosives in conventional 'impact sensitivity' tests. Its existence seems, in fact, not implied by results of usual explosive sensitivity tests; and it appears to have had little or no important mention in the literature of explosives.

Dents on U.S. bomb-type ammunition caused by impacts at least as severe as impacts causing these occasional explosions probably occur by the million; so that explosions from denting impacts are fortunately of extremely low frequency. With U.S. bomb-type ammunition during the War there have been only about twenty incidents probably ascribable to this cause; but they have included particularly bad ones which, by one rough estimate, involved total property losses of many millions of dollars, and thousands of deaths and injuries.

Such occurrences seem more frequent with the more sensitive explosives; but T.N.T. and amatol, as well as R.D.X. explosives, have all been involved. Very thin-walled containers, such as those of depth bombs and torpedo war-heads, appear relatively more susceptible. One may surmise a trivial local ignition is produced by certain unidentified critical conditions of denting, and that burning to partial or complete detonation is peculiarly favoured by confinement afforded by the dented, but unbroken, container.

Adequate understanding of the mechanism of this phenomenon apparently requires further fundamental research, which possibly may result from more widely disseminated knowledge of the existence of 'container-dent sensitivity' and from fuller appreciation of its practical importance.

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An Electronic Method of Tracing the Movements of Beetles in the Field

RECENTLY a new form of Geiger–Müller tube has been developed (by G. A. R. T.) which has been found extremely useful in studying the movements of Elaterid beetles of the genus *Agriotes* Esch. As these beetles are known to fly but rarely in Britain, a study of the extent to which they may move by walking is of considerable interest.

A beetle is taken from the field, and 5 µgm. of radium sulphate, deposited between aluminium foil disks (2 mm. in diameter and weighing in all only 0·5 mgm.), are inserted with resin adhesive beneath the elytra. The beetle is replaced, and its position afterwards found by detecting the radiation from the disk with a Geiger–Müller tube. The tube, which has the advantage of quiet background, stable operation, and high sensitivity, together with its associated power supply, operates a loudspeaker directly, without any valve amplification, and is thus very convenient for field use. When it is passed over the region in which the beetle is thought to lie, periodic ticks increase in frequency to a maximum when the tube is directly overhead. The quantity of radium sulphate used is sufficient to enable localization through four inches of soil, and the beetle's position may thus be ascertained to within a few inches with only the preliminary interference of marking, although it is quite invisible, either at night, or by day under soil, or among the dense stem bases of meadow plants.

It is probable that this robust apparatus will find many applications in ecological field work in the future.

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Statistical Weather Forecasting

IN the regression equation

$$P = K_1x_1 + K_2x_2 + \ldots K_nx_n, \quad (1)$$

characteristic of all equations employed in statistical weather forecasting, including long-range forecasting, let P represent the atmospheric pressure at a station A at time $t = z$, $x_1 \ldots x_n$ representing the pressures at n evenly spaced points on a circle of unit radius at time $t = 0$. This equation serves to predict the value of P for a time z in advance, and the well-known method to obtain the n unknown regression coefficients is to apply the method of least squares:

$$\Sigma(P - K_1x_1 - \ldots - K_nx_n)^2 = \text{min.} \quad (2)$$

in which the summation extends over a long series of previous records.

If the differentials of (2) with respect to the K's are each equated to zero, there emerge n linear equations

$$r_{Aq} = \sum_{s=1}^{n} K_s r_{qs} \ (q = 1, 2 \ldots n). \quad (3)$$

In (3) r_{Aq} denotes the correlation between P and x_q, and r_{qs} that between x_q and x_s.

The reliability of the predicted P depends upon the closeness with which R_z, the multiple correlation coefficient between P and $x_1 \ldots x_n$, approaches unity; where, according to a well-known theorem of correlation theory,

$$R_z^2 = \sum_{q=1}^{n} K_q \, r_{Aq}. \quad (4)$$

If the number of 'control stations' n be increased indefinitely, the above equations assume the form

$$r_{(Aq)} = \int_0^{2\pi} K_{(s)} \, r_{(qs)} \, ds, \quad (5)$$

and

$$R_z^2 = \int_0^{2\pi} K_{(q)} \, r_{(Aq)} \, dq. \quad (6)$$

The practical application of these equations was performed as follows. Correlations between the daily pressures at a large number of barometric stations in South Africa were computed for the five-