

obtained indicate that it is worthy of further investigation.

A more detailed description of the dichroic filters and their use in various methods of microscopy will appear elsewhere.

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<sup>1</sup> Hartley, W. G., *Nature*, **159**, 880 (1947). Kastler, A., and Montarnal, R., *Nature*, **161**, 357 (1948). Osterberg, H., *J. Opt. Soc. Amer.*, **37**, 726 (1947). Taylor, E. W., *Proc. Roy. Soc., A*, **190**, 422 (1947).

<sup>2</sup> Payne, B. O. (in the press).

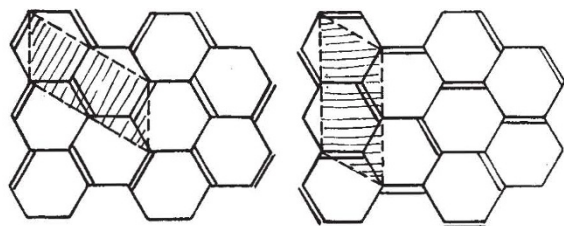
<sup>3</sup> Oettlé, A. G. (in the press).

<sup>4</sup> Rheinberg, J., *J. Roy. Mic. Soc.*, **16**, 373 (1896); **19**, 142 (1899).

### Structure of Graphite

In the electron diffraction patterns formed by single crystals of graphite (transmission) we have discovered new spots which would be indexed ( $\frac{1}{2}00$ ) or ( $\frac{1}{2}\frac{1}{2}0$ ) (and their symmetrical associates) in the usual unit cell. These new spots are very weak (perhaps a hundred times less intense than the strong (100)); they appear in all the graphites (Ceylon, Madagascar, Canada) tested. They do not appear in similar structures such as molybdenite; thus they are not due to electrons of twice the velocity indicated by the accelerating potential.

These new spots are not connected with the layer arrangement or disarrangements described by Lipson and Stokes<sup>1</sup> and studied in single crystals by Hoerni<sup>2</sup>; they oblige us to take a unit cell twice as large as the usual one in the *basal plane* (the layer arrangements have changed the height of the unit cell).



Possible arrangements of double bonds (the shaded part represents the unit cell)

We offer the following tentative explanation. The double bonds between the carbon atoms resonate between structures such as those shown in the accompanying diagram, giving a unit cell twice as long as the usual one in one direction and then in another, doubling the cell on the average. The fact that extra spots appear only for low indices seems to indicate that the unequal distribution of the outer electrons is responsible for them.

So far, we have been unable to see a phase relationship between the assumed positions of the double bonds in different layers, because spots of the type ( $\frac{1}{2}l0$ ), where  $l$  is non-integral, always appear when the crystal is turned from the position normal to the beam.

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<sup>1</sup> Lipson and Stokes, *Proc. Roy. Soc., A*, **181**, 101 (1942).

<sup>2</sup> Hoerni, *Nature* [**164**, 1045 (1949)].

### Luminescence of Barium-Strontium Oxide

THE application recently of the semiconductor model to the oxide cathode used as a thermionic emitter in vacuum tubes directs attention to the possibility of observing luminescence in such materials.

Luminescence has been observed in this Department in a special valve constructed by E. Hopkins for other purposes, and I have carried out measurements on the characteristics of this luminescence in specially constructed valves. Well-activated oxide cathodes of barium-strontium oxide were found to give a pale blue fluorescence under electron bombardment, and spectrographic measurements show a broad intensity maximum at 4900 Å., the total emission spectrum extending from 4600 Å. to 5400 Å. The intensity of the emitted radiation decreases as the temperature of the barium-strontium oxide is increased, falling rapidly at 700° K., and no appreciable luminescence is observed at 800° K. Preliminary measurements indicate that afterglow is negligible, showing the absence of any electron-trapping mechanism.

Detailed investigations are being carried out using both electron bombardment and ultra-violet light excitation, on activated and unactivated oxide cathodes; and it is considered that such measurements will give useful information on the energy-levels in barium-strontium oxide. Such information is necessary for a full explanation of the properties of the oxide cathode.

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### An Application of Resistance Networks to the Problem of Adjustment by Least Squares

It is well known that the normal equations for the least squares adjustment of networks of spirit-levelling and similar observations can be solved very simply by relaxation<sup>1</sup>; but the determination of the standard deviation of the  $n$  heights requires the solution of  $n$  sets of  $n$  simultaneous equations, and by any numerical method this is more laborious than the determination of the heights themselves. If  $\sigma$  is the standard deviation of an observation of unit weight, the standard deviation of a height  $h_i$  is  $\sigma\omega_i^{1/2}$ , where  $\omega_i$ , the reciprocal of the weight of  $h_i$ , is the solution of an equation of the form

$$(x_1 \dots x_{i-1}, \omega_i, x_{i+1} \dots x_n). \mathbf{A} = (0, \dots, 0, 1, 0 \dots 0).$$

$\mathbf{A}$  in this set of equations is the matrix of the coefficients of the normal equations and, therefore, known. Now, if a network of resistances is constructed which is topologically identical with the network of levelling, and is such that the admittance of each element is proportional to the weight of the corresponding observation, the admittance matrix will be proportional to  $\mathbf{A}$ , and the above equation becomes the equation for the voltage appearing between the initial point and the  $i$ th point, when unit current is injected between these two points. Unlike Liebmann's applications of resistance networks to the solution of partial differential equations<sup>2</sup>, no high