LETTERS TO THE EDITORS

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Effect of Heat Treatment on the Sintering of 'Active' Ceramic Oxide Powders

In recent years much attention has been paid to the preparation of 'active' oxide powders by decomposition of compounds; the oxide powders obtained in this way are agglomerates of fine crystallites, have high surface area and show enhanced sintering characteristics compared with the highly calcined powders normally used[1]. With pure powders prepared in this way, variations have been noted in the sintering behaviour which are difficult to account for.

It has now been found that in the sintering of compacts of these oxide powders, intermediate heat treatment at a temperature lower than the normal sintering temperature significantly increases the final bulk density. Two conditions are necessary to benefit from the effect: (1) The calcination of the original compound, such as the hydroxide before pressing, should be carried out at an optimum temperature, for example, with beryllium between 1,000° and 1,250° C. Compacts made from powder calcined at lower temperatures crack excessively on sintering, whereas the particle-size of powder calcined at higher temperatures is too large for appreciable densification to occur. (2) The pressed compact should be annealed at or near the calcination temperature of the powder and at successively higher temperatures to the temperature at which the rate of densification is high enough for the maximum bulk density to be reached in a reasonable time. In the annealing treatment, weld junctions are formed between the particles in contact in the pressed powder and the fine pore structure of the pressed compact is retained until the temperature is reached at which the rate of sintering becomes rapid. If the annealing treatment is omitted and the compact rapidly raised to the maximum temperature, uncontrolled shrinkage occurs within the agglomerate particles and these separate within the compact to form fissures and pores too large to be eliminated afterwards. The final bulk density is therefore much lower.

As an example, compacts made from beryllium oxide (BeO) prepared by calcining the hydroxide to 1,250° C. sinter to bulk densities of 2·2 gm./c.c. (that is, 27 per cent porosity) if rapidly heated to 1,600° C. in 1 hr. If similar compacts are heat-treated for several hours at 1,300–1,400° C. prior to the temperature being raised to 1,600° C., bulk densities of 2·75 gm./c.c. (that is, 8 per cent porosity) are obtained.

Confirmation of the hypothesis put forward to explain this effect has been obtained by applying an external pressure at high temperatures to the compact. Here the particles are prevented from separating at the points of contact by the external pressure, and high bulk densities result in all cases, independently of the heat treatment.

A fuller account of this work will be published elsewhere.

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[1] Quirk, J. F., Mosley, N. B., and Duckworth, W. H., *J. Amer. Cer. Soc.*, **40**, 416 (1957). Livey, D. T., Wanklyn, B. M., Hewitt, M., and Murray, P., *Trans. Brit. Cer. Soc.*, **56**, 217 (1957).

Investigation of the Ionosphere using Signals from Earth Satellites

I propose to discuss some possible effects of the ionosphere on the radio signals from artificial satellites on the basis of my theoretical results[1].

The occurrence of focusing of radio waves from the point antipodal to the observer could probably be demonstrated from measurements of Doppler frequency shift (Fig. 1*a* (i)). Let O denote the position of the observer, S the satellite, Z and N the points on the orbit of the satellite in the observer's zenith and nadir. Let the critical frequency f_c of the ionosphere increase from Z to N, where it attains a value slightly greater than the transmission frequency, f_0, of the satellite. Neglecting the presence of the Earth, the trajectories of ray paths and the corresponding Doppler curve are shown in Fig. 1*a* (i) and (ii), using dotted and continuous lines for the free-space and ionospherically propagated cases respectively. When the satellite moves from a typical point K to N, the frequency received via the free-space path increases slowly to the value f_0 transmitted by the satellite. In the ionospheric case, however, the frequency will remain nearly constant at a value f_K

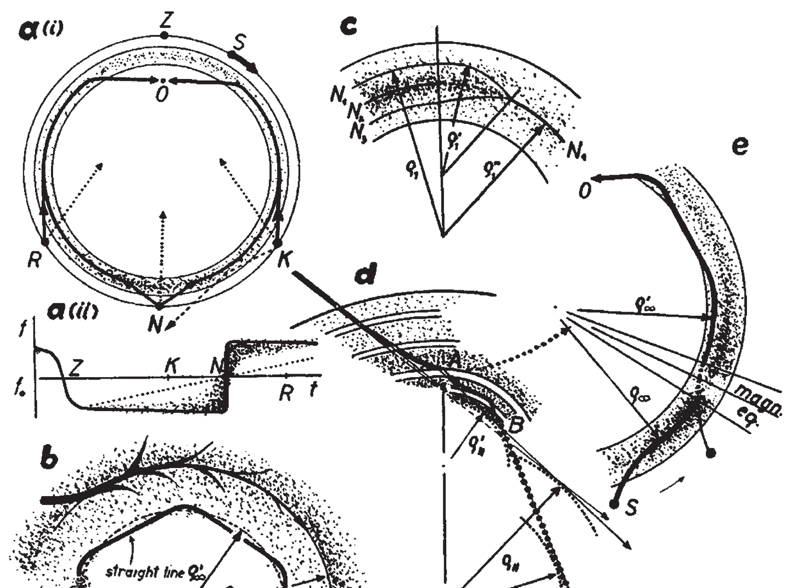

Fig. 1