result in the formation of an arc. Further experiments at higher currents with the cathodes cooled to prevent melting produced uncontrolled discontinuous transitions. It may be that in these cases local melting and solidification take place with subsequent transitions at the points of irregularity thus produced. Should it be possible to avoid the formation of such irregularities, it is considered that an arc may well be finally formed on copper and mercury cathodes when the cathode current density is such as to produce field emission as calculated, for example, by Mackeown[9].

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Secondary Expansion of Perlite Concrete and Plaster

Expanded perlite, which is made by rapidly heating small particles of suitable volcanic glass, has recently been used extensively as a lightweight aggregate for gypsum plaster and concrete in the United States, and to a lesser extent in Australia and Europe. The phenomena described below are therefore of some concern to the building industry in those countries.

Unrestrained specimens of perlite plaster show at first a setting expansion followed by a short-term shrinkage, as does normal plaster. At an age of about three weeks, however, a relatively slow secondary expansion at a rate of about $0 \cdot 1$ per cent length increase per annum commences, and under normal atmospheric conditions this expansion continues at a slightly decreasing rate over a long period. The oldest specimens under test in this Division are still expanding at about half the initial rate after 600 days. Perlite concrete shows a similar, though much slower, expansion following an initial shrinkage period of some months[1].

Work which I have done indicates that a slow ion-exchange reaction is the cause of the secondary expansion. Expanded perlite is a glass which contains some exchangeable alkali and alkaline earth ions. In the presence of water, the main process which occurs is that hydrogen ions from the solution are exchanged with sodium ions, and to a lesser extent potassium and calcium ions from the glass. The rate of exchange for a given perlite depends, among other factors, upon the temperature and pH of the solution, being greatest at high temperature and low pH. Such exchanges taking place in perlite plaster and concrete lead to the formation in the matrix of alkaline hydroxides which may then react with carbon dioxide and moisture from the air, causing the matrix to expand. The quantity which may be exchanged is about 8 m.equiv. per 100 gm. after 60 days and is sufficient to account for the observed expansion.

There is evidence that a further cause of the expansion in perlite plaster is the exchange of calcium ions in the plaster for sodium ions from the glass; the hydrated sodium sulphate which would form in the matrix has a greater volume than the gypsum it replaces. The rates of expansion of perlite plaster and concrete increase with increasing temperature, humidity and proportion of perlite in the mix, and vary considerably for different perlites.

Although some degree of control of expansion may be achieved in the laboratory, it appears that control in job conditions is impracticable. However, preliminary tests on restrained specimens of perlite plaster have shown that all but a small part of the stress caused by expansion is relieved by internal creep. The secondary expansion is therefore not likely to cause failure of perlite plaster provided the rate of expansion of unrestrained specimens at 70° F. and 60 per cent relative humidity is less than $0 \cdot 1$ per cent per annum, and provided suitable construction methods are used. Similar considerations apply to the use of perlite concrete, in which the expansion is usually more than offset by the high initial shrinkage.

A more detailed account of this work is to be published at a later date.

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Condition of Boron in Alpha Iron

The question as to whether boron forms an interstitial or a substitutional solid solution in α-iron is of considerable theoretical and practical interest. Recently measurements have been made, by orthodox methods, of the solubility and diffusivity of boron in both α- and γ-iron[1-3]. These gave the maximum solubility of boron in α-iron as about $0 \cdot 008$ weight per cent at 900° C. The data on the diffusion in α-iron[4] were not precise but indicated an activation energy of 62 kcal. per mole and a D_0 of 10^6 cm.^{2} sec.$^{-1}$. This suggests that boron behaves substitutionally. Some calculations based on estimates of the atomic radius of boron[8] also suggest that boron may be substitutional in α-iron. However, we felt that this evidence was somewhat speculative and not sufficiently conclusive. Obviously, if boron were interstitial, it should be possible to observe an internal friction peak similar to that caused by carbon and nitrogen in α-iron[5,6]. The purpose of the present communication is to describe some exploratory measurements on internal friction which suggest that boron is in interstitial solution in α-iron.

The internal friction technique has been described in detail elsewhere[7]. Essentially a wire specimen forms the torsional suspension of a freely oscillating system. When the logarithmic decrement is plotted against temperature of measurement, the presence of an interstitial solute gives rise to a peak in the curve. The diffusion coefficient is calculated from the frequency of vibration for the temperature at which the peak occurs. The height of the peak is proportional to the amount of interstitial solute in free solution.