simple interpretation, and that sometimes the wood can be seen only after the removal of some of the trees.

The first chapter is concerned with specific heats and the lattice vibrations are described in simple terms, no explicit reference being made to actual forms of frequency spectrum. The electronic specific heat of metals and alloys, and various types of anomalous specific heat, are also briefly discussed. Following a short account of thermal expansion, Chapter 3 deals with the thermal conductivity of non-metals and contains a clear description of umklapp-processes and other scattering mechanisms, together with their experimental manifestations. In the next chapter, on electrical conductivity in metals, some preferential ordering of the material is discernible. A careful analysis is made, for example, of the various factors contributing to the residual resistivity, whereas the anomalous skin effect and magneto-resistance are dealt with in a comparatively short space.

The discussions of the thermal conductivity of metals and semiconductors, and of superconductivity, which are contained in Chapters 5 and 6 respectively, form admirable illustrations of the philosophy of the book. The experimental observations and underlying principles are welded into a readily intelligible pattern with all the essential features illuminated, yet free from oppressive detail. The non-specialist should find particularly helpful many sections, for example on the Bardeen–Cooper–Schrieffer theory, which are largely qualitative but far from superficial. The chapter on semiconductors follows fairly standard lines in the discussion of mobility, optical properties, etc., but it is somewhat surprising to find so little attention directed to cyclotron resonance.

Thermoelectric effects in metals and semiconductors are discussed in Chapter 8 and this is followed by one on magnetic properties. Here a substantial portion is devoted to paramagnetic effects, and the sections on ferromagnetism are so brief that one wonders whether much purpose is served by their inclusion. The de Haas–van Alphen effect has a short chapter to itself and the final chapter, which assumes some acquaintance with dislocation theory, deals with mechanical properties of metals comprising tensile properties, fatigue, creep and internal friction.

In view of the wide range of topics, it would scarcely be reasonable to lay too much stress on what has been left out. Some slight disappointment may, perhaps, be felt that there is no reference to ultrasonic attenuation, Azbel'-Kaner resonance or oscillatory magneto-absorption, all of which have figured prominently in the development of solid-state physics. Such personal preferences, however, do not alter the overall impression that this is a valuable and enlightening exposition, lucidly presented and liberally illustrated, which assuredly provides much more than the 'simple explanations' of the preface.

B. Donovan

PHYSICS OF FLOTATION

An Introduction to the Theory of Flotation

By Dr. V. I. Klassen and V. A. Mokrousov. Translated by Dr. J. Leja and G. W. Poling. Pp. xiv + 493. (London: Butterworth and Co. (Publishers), Ltd., 1963.) 126*s*.

It was indeed a salutary experience for me—a physicist who had not then read *An Introduction to the Theory of Flotation*—to watch the first trials of a newly installed flotation plant, removing sulphides with xanthate, from the rough cassiterite concentrate, in a tin mill.

I watched the dark glistening froth of arsenopyrite forming, being skimmed off and breaking up within a second, to a grey liquid pulp running down the sulphide launder. Then, even as I watched, the dark froth reddened and swelled and stiffened to a stable porridge-like consistency, overflowing the sulphide launder in an ever-growing cascade, making a pool of red 'porridge' several yards wide on the floor.

"Now", said the vacation-student operator, "you are a physicist. What is the theory of this, and what would you do ?"

"Improve the desliming. Remove the limonite earlier in the circuit, and this will stop".

"Oh, yes—and that will be done. But we have to do something at once. What would you do ?"

He waved his hand towards the plant. . . . "It is all yours !" I cut off the pine oil : I increased the *p*H, since he said froth was usually worse with an acid circuit. And still the pool of red 'porridge' spread. . . .

"All right; I give you best; I'm beat !" He picked up an oil-can, filled with kerosene: "This sometimes works", he said, and dropped six drops—only six !—into the first cell. Within seconds the red 'porridge' subsided; within a minute the dark short-lived sulphide froth was back again, and limonite-reddened tin concentrate went sulphide-free to the tin-yard.

Only the large red expanse of 'porridge' on the floor remained as a goad asking Why ? Why did six drops of kerosene cure it ?

Klassen and Mokrousov's excellent book, *An Introduction to the Theory of Flotation*, supplies a large part of the answer. For this book is concerned not primarily with how to run a flotation plant, but with how to understand the physics—as competely as possible—of all phenomena occurring at or near the three interfaces, solid–liquid, liquid–gas, gas–solid—and along the three-phase line in which these interfaces meet. Its theoretical account is constantly checked by reference to experiments—not, as a rule, experiments with flotation plant, but laboratory experiments specially designed to throw light on the theory. It uses modern concepts—for it must deal with real solids and real liquids: it shows photographs, for example, of the detailed distribution of collectors over the surfaces of crystals, obtained by using 'tagged' xanthate, to illustrate the point that it is on the lattice imperfections rather than the surface as a whole that collectors are adsorbed.

The theoretical account is simple, and should be helpful to any physics student, not so much because it leads to flotation (though that is of enormous economic, and hence sociological, importance), but because it leads directly to simple confirmatory experiment, and so can help to give reality to molecular, ionic and radioactive concepts. Therefore the book should be in the library of every physics department.

Returning to the goad of the 'porridge' pool, the authors show photomicrographs by Klassen and Plaksin, showing that kerosene (coloured red) spreads along the 3-phase line around hydrophobic minerals: Krokhin found that the presence of this 'border' of kerosene along the 3-phase contact sharply increases the tenacity of attachment of hydrophobic grains to bubbles, even with kerosene concentrations as low as 6 parts per million. This explains the increased preferential attachment of sulphide grains. May it also be that the kerosene carries in solution the oxidized oils (from the mine) which were responsible for making the red porridge ?

The book is so comprehensive that it would be unreasonable to look specially for omissions. But one omission strikes me: the authors discuss methods for floating even larger particles—but they do not mention the method of blowing the particles 'dry' and letting the separation depend on whether they will then penetrate the water film. Yet this also is a method of flotation—Holman–Michell table flotation.

The authors and their Russian co-workers have made an immense contribution to the understanding of flotation. Let us be thankful that we, on our lesser scale, have also contributed ideas. For had we not, we could not earn their respect; and respect is an essential prerequisite of friendship.

C. R. Burch