substances frequently gives trouble, and here is no exception. Somehow the author's thermodynamics teaches him (p. 100) that if λ_B and λ_{SL} are the free energies per unit area of grain boundary and of solid–liquid interface, respectively, then at some temperature below the melting point, at which ΔF is the free energy of melting per unit volume, a thickness $t = (\lambda_B - 2\lambda_{SL})/\Delta F$ should melt at the boundary, and he is left wondering why there is so nice a balance as there appears to be between λ_B and $2\lambda_{SL}$. He could have reflected that it is the property of a free energy to tend to a minimum, rather than to the value you first thought of, and $t\Delta F + 2\lambda_{SL}$ is minimum when t is zero. Nevertheless, by carefully reviewing all the experimental evidence he reaches the sane conclusion that grain-boundary melting has probably only been observed where there are impurities. A sharper-minded theoretician might have skipped the experimental evidence, to our loss.

F. C. FRANK

LATTICE DEFECTS IN IRRADIATED SOLIDS

Radiation Effects in Solids

By G. J. Dienes and G. H. Vineyard. (Interscience Monographs in Physics and Astronomy, Vol. 2.) Pp. viii+226. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1957.) 6.50 dollars.

THE production of various types of lattice defects in solids by the action of high-energy radiation, and the changes of physical properties brought about by these defects, have become in recent years one of the most actively studied branches of solid-state physics. This activity is a double response to the development of nuclear technology; on one hand, the experimentalist is now provided with sources of high-energy radiation far beyond those available fifteen years ago, and on the other he is expected to provide materials for nuclear reactors that are able to withstand intense radiations for long periods of time. The subject of 'radiation damage' is thus quite unique in the way that it links solid-state physics directly to both nuclear physics and the technology of materials.

Although several review articles have been published, this is, to the best of my knowledge, the first book that has appeared on the subject, and the authors are to be congratulated on a very successful outcome to their efforts. They have concentrated deliberately on effects of 'knock-on collisions', in which atoms are displaced from their lattice sites by particles such as fast neutrons, protons, electrons, and fission fragments, rather than on ionization effects. This is reasonable because these collisions are particularly important in nuclear reactors and because they can be exploited to study atomic binding forces in the solid state.

The book brings out clearly the tantalizing stage that the subject has now reached. Looked at qualitatively, or semi-quantitatively, the physics of radiation damage is fairly clear. The underlying theory of displacement collisions has been given a good start by Bohr and Seitz, and appears not to contain any major mysteries. Furthermore, the basic perfection of the crystal lattice has enabled us to define fairly sharply the nature of the various atomic defects that are possible, such as vacancies, interstitials, divacancies, and clusters; also, to understand in broad terms the ways in which they can move about and anneal themselves, and their effects on physical properties. The experimental study of annealing kinetics, and of changes in electrical resistivity, lattice constants, stored energy, and other properties, has also shown that this physical picture is certainly broadly correct. On the other hand, as soon as we ask for precise quantitative values, for example, for the numbers of displaced atoms, for the energies of formation and movement of the various defects, and for their effects on physical properties, the subject becomes difficult and progress is slow. Basically the reason is that we have very few techniques as yet for 'seeing' these lattice defects individually, with the result that their experimental study is mainly inferential, from changes of bulk properties, and uncertain. It seems doubtful that the subject will advance far beyond the semi-quantitative stage until new techniques are developed.

All these aspects are discussed clearly by the authors. The practical problems of radiation damage are less fully treated, although embrittlement of steel and radiation growth of uranium are mentioned, and an interesting account is given of the method used to anneal away the stored energy in the graphite moderator of the Brookhaven reactor. Transmutation effects, and the interesting behaviour of inert gases in solids, are not discussed; this is a pity, although it may perhaps be argued that the important aspects of these belong more to the theory of solid solutions than to the theory of lattice defects.

In conclusion, this book can be recommended as a useful introduction to the physics of radiation damage in solids.

A. H. COTTRELL

HYDRAULIC SYSTEMS IN AIRCRAFT

Aircraft Hydraulics

Vol. 1: Hydraulic Systems. Edited by H. G. Conway. Pp. ix+146. 35*s*. net. Vol. 2: Component Design. Edited by H. G. Conway. Pp. ix+198. 45*s*. net. (London: Chapman and Hall, Ltd., 1957. Published under the authority of the Royal Aeronautical Society.)

THESE two volumes are text-books sponsored by the Royal Aeronautical Society; and several well-known authorities in the aircraft hydraulics field have contributed chapters on their own special subjects. These have been edited by Mr. H. G. Conway, who also contributes himself.

Vol. 1 deals with the more general aspects of the subject. Mr. Bingham, in Chapter 1, discusses the requirements for an aircraft hydraulic fluid and then goes on to deal with the properties of various fluids. Their effect on different sealing materials, storage and inflammability characteristics, etc., are described, and a very useful collection of graphs and tables of the physical properties of these fluids is also provided.

In Chapters 2 and 3 Mr. Collinson deals briefly but effectively with hydraulic theory and fluid flow in orifices and pipes, providing some useful nomograms and charts for determining rates of flow. There are sections on surface tension, viscosity, com-