bilities, characteristic energy losses) and also a section on lattice-electron interaction.

There are two remaining articles in Vol. 1: an account by H. Y. Fan of the properties of germanium and silicon which, although comprehensive, will be found comprehensible by physicists who are not well informed on the subject of semi-conductors; finally, an article on order–disorder transitions in alloys by T. Muto and Y. Takagi which includes a specially valuable discussion of the influence of ordering on electrical, magnetic and mechanical properties.

The subject of order–disorder transitions in alloys is given a more original treatment by L. Guttman in Vol. 3. He makes a serious attempt to judge the Ising model in the light of experiments; the discussion is fascinating and—of course—inconclusive.

There are two stimulating reviews of new subjects in Vol. 3: an account of the unusual semi-conducting properties of Group III–Group V 'intermetallic' compounds by H. Welker and H. Weiss (the electron mobility in InSb is so high that it is possible to use the Hall effect in a small, sensitive device for measuring magnetic fields); and a more theoretical and very elegant article on the continuum theory of lattice defects by J. D. Eshelby.

The masterly survey by C. Kittel and J. K. Galt, "Ferromagnetic Domain Theory", improves and brings up to date a well-known article, now seven years old, by the first author. D. Turnbull writes with his customary authority on the kinetics of phase transitions but is less than happy in other parts of an article entitled "Phase Changes". The remaining contribution to Vol. 3 is a long and turgid, but no doubt expert, treatment of imperfections in crystals by F. A. Kröger and H. J. Vink. It is concerned with their concentrations and uses the methods of physical chemistry.

It is now clear why the quality of "Reviews of Modern Physics" has declined during the past few years: some at least of its potential contributors are giving of their best to collections of the type under notice. R. O. Davies

EFFECTS OF IONIZING RADIATION

Proceedings of the International Conference on the Peaceful Uses of Atomic Energy

Held in Geneva, 8 August–20 August, 1955. Vol. 7: Nuclear Chemistry and Effects of Irradiation. Pp. x+691. 10 dollars; 70*s*.; 43 Swiss francs. Vol. 11: Biological Effects of Radiation. Pp. viii+402. 8 dollars; 57*s*.; 34 Swiss francs. (New York: United Nations; London: H.M. Stationery Office, 1956.)

VOL. 11 of the Proceedings of the Geneva Conference should be familiar to all those engaged on nuclear research projects where the danger of exposure to radiation is not negligible. In detail it treats with many subjects, in terms not always readily understood by physicists and the like, but there is a sufficient number of general articles extremely well written which will repay careful reading by the non-specialist. Those of us who can remember the conditions of nuclear experimentation, even before the Second World War, in the Cavendish Laboratory will recognize the great improvement which has taken place in our knowledge of radiation hazards and in techniques for their assessment.

Fortunately for the rest of Nature, if we take sufficient care radiobiologically to look after mankind, says Dr. Loutit, Nature will take care of itself, because sensitivity to ionizing radiations is well correlated with the degree of evolutionary complexity (I recall that in another volume the lethal radiation dose for humans was given as 500 röntgen units, for insects 50,000, and for trichinosis 1,000,000). There has been so much experience gained from X-ray and radium damage to human beings that scientists enter the nuclear age reasonably well informed of the general hazards to be faced and, in addition, several Japanese papers give accounts of the first victims of fission.

Apart from radioactive fall-out and war, scientists are only likely to encounter by accident higher doses of radiation than 'permissible', and more evidence is needed about the effects of, and treatment for, doses near to or above 'permissible' levels of radiation. At appreciably lower radiation-levels, profound questions are raised that might not be answered for a long time to come, such as whether radiation, which we know can cause changes in genes, is likely to cause mutations which determine the change from normal to malignant potentiality. It seems that we know virtually nothing about the effects of radiation on the genetics of man, and can only guess what is the dose necessary to double the spontaneous mutation-rate of some genes. An American writer suggests that we might some time arrive at a 'permissible' dose determined by genetic considerations and not merely a dose based on physical injury. As a general precautionary measure the radiation-level of the Thames drinking-water was lowered by a factor of 100, but ultimate figures have not yet been selected, for there is no answer to the question: At what value does the dose-rate assume importance? In spite of these long-term uncertainties, E. Rock Carling's assessment is that in nuclear research establishments where attention is correctly given to radiation dose symmetry, average levels of exposure are far below those recommended as permissible.

L. H. Gray presents a most interesting review of what is known in detail about the biological damage caused by ionizing radiations. At low doses the proportion of cells affected by single ionizing particles increases linearly with the dose. There is no threshold below which the radiation is without effect, and structural damage to chromosomes can be directly observed in strict proportion to the dose, but different cells show differences in sensitivity to radiation. They may all suffer damage, but the injuries in some cells are not manifest. Injury is often made manifest only at the time of cell division, and in the case of seeds this might be years after the date of irradiation. In addition to the physical act of ionization there are the chemical changes which occur even in water, such as the formation of hydroxyl, atomic hydrogen and hydrogen peroxide radicals, and Gray concludes that there are good grounds for believing that the radicals revealed by studies in radiation chemistry play an important part in the development of some forms of radiobiological damage. It is encouraging to turn to later papers by Hollaender and Stapleton, dealing with chemical treatment to prevent or to reduce radiation damage. Certain reducing chemicals will produce effects similar to those obtained when oxygen is absent: some have been found to reduce by a factor of six the damage caused by a given dose of radiation if these chemicals are present at the time of irradiation, and the properties of radiation protectors suitable for use on a large clinical scale can now, at least, be defined, and work on these seems to be extensive.

The effects of radiation on water is the subject of several papers in Vol. 7, the emphasis here being on water used at ordinary or high pressures, and at low or high temperatures, for the cooling of power reactors, and also on water intimately associated with the fission process as it is in the aqueous homogeneous reactors. Gamma-rays absorbed in water produce mainly the hydrogen and hydroxyl radicals, whereas heavy particle radiation produces molecular hydrogen and hydrogen peroxide. In the presence of intense gamma- and neutron-radiation, as in the Chalk River and other heavy-water reactors, the formation of the hydrogen and hydroxyl radicals is so great that two reverse reactions occur in which the hydrogen ion unites with the hydrogen peroxide molecule and the hydroxyl ion unites with the hydrogen molecule, with the net result that no decomposition of water is observed. This recombination reaction is of comparatively recent discovery, for it was not suspected when water-moderated reactors were first designed. If radicals are removed by some reactive substance, the reaction balance is altered and rapid decomposition of water sets in. In high-pressure water-moderated reactors, control of dissolved gases and acidity of the water are very important, for mass transfer of corrosion products due to temperature or electro-potential gradients can become serious. All the contributors state that the various mechanisms discovered are far from being understood, and a great amount of work yet remains to be done.

A few papers deal with the effect of radiations on liquids other than water, and, in particular, there is the American account of the study of the aromatic hydrocarbons, especially the di- and ter-phenyls under irradiation. These materials are stable up to temperatures of the order of 400° C., but in the presence of radiation form compounds of both higher and lower molecular weight and evolve hydrogen, but in this respect the ter-phenyls show less decomposition than any other substance studied. The conclusion is reached that the stability of these materials is sufficient to justify their use as coolants and moderators in high-temperature reactors operating in the 400° C. range.

Many papers deal with the effect of radiation on solids, primarily on uranium, on moderators such as graphite and beryllium, and on other structural materials used in reactors. The subject is of enormous size and importance and continues to have almost a dominating role in the reactor research and development since Geneva. The damage done to uranium during its life in a reactor is a combination of two phenomena: a change of shape caused by local expansion of the lattice around the fission fragment track, followed by plastic flow on cooling; and an increase in volume due to the accumulation of gaseous fission products, but the damage is especially troublesome because uranium has most unusual crystalline properties. Thorium suffers far less damage but, of course, we are not yet ready to use thorium as a fuel on a large scale. The improvements made to uranium to reduce damage are described in an American paper. Fortunately, the graphite used in reactors is a conglomeration of crystallites, so that radiation damage is not markedly anisotropic: radiation damage to a flake of natural graphite causes expansion one order of magnitude higher than that to artificial conglomerate of graphite. One disturbing report states that damage to graphite in the M.T.R. reactor cannot be correlated with damage to graphite taken from the Hanford reactors. There is very little written about the change of properties of other structural materials used in reactors, but the Russians and Americans who use stainless steel in water- and sodium-cooled reactors give brief accounts.

Vol. 7 deals also with the fission process, and the chemistry of the fission products and the transuranic elements up to curium. It was a pleasure to see Dr. Otto Hahn in the chair at the session on fission process; whereas he discovered barium in the neutron-bombarded uranium in 1938, to-day we know that thirty-six different elements are found and, in all, 300 different isotopes of these elements occur due to fission. He spoke of the safety inherent in the small sources he used, and the papers delivered in that session report the extreme complexity of the modern 'hot' laboratory for handling the fission products.

T. E. ALLIBONE

THE MECHANICS OF THE MIND

Schools of Psychoanalytic Thought

By Dr. Ruth L. Munroe. Pp. xvi+670. (London: Hutchinson Medical Publications, 1957.) 42*s.* net.

IT is a favourite jibe of those who dislike psychoanalysis that it is not a science (or even the beginnings of a science) but another form of religion. Such people disregard the fact that the analyst, remaining almost constantly silent, observes the patient and his thoughts for an hour a day over a period of months or years. Psychoanalysis is based on these observations, and the deductions made from them regarding the deeper levels of the mind. Religion is static except for accretions due to absorbing minor beliefs, but psychoanalysis is daily growing and developing.

This book, which is an excellent one, describes the paths along which the work of Freud is developing. Some of his original views have been modified, and a great deal has been added to his systems.

Dr. Ruth Munroe is a professor of psychology who, moreover, is married to an American psychoanalyst who has contributed a great deal of work on his subject, and lives in an environment with many analytical contacts.

The book is divided into three parts. The first is called "An Overview" and is more or less introductory. The views of the various analysts considered are placed under headings: the terms of the organism, the terms of the milieu, the genetic process, dynamics of the functioning personality, pathology and treatment. This allows the author to compare and criticize the different ideas. The second part of the book considers, from this point of view, the systems of Freud and those who have not deviated too far from him still to retain the term 'Freudians'.

The third part of the book is devoted to Adler, Horney, Fromm and Sullivan. Their investigations and conclusions are put through the same sieve. The fourth section is devoted to Jung and Rank. The last part summarizes the matter which has gone before and collates the whole into a pattern.

It will be seen that such a scheme is a very ambitious one, and it says much for the author's