sults in the theory of multidimensional singular integral equations are included. The first seven chapters are identical to the book *Methody Potentsiala v Teorii Uprugosti* (Moscow, 1963) by the same author. This latter book contains additional chapters which present another method of approximate solution of the integral equations.

Cryogenics. By Michael McClintock. 270 pp. Reinhold, New York, 1964. $10.75. *Reviewed by R. P. Hudson, National Bureau of Standards.*

The author of this book aims to give the noncryogenics scientist or engineer and the educated nonscientist "a qualitative understanding of the basic aspects and some of the representative applications of cryogenics". In a Foreword, the book is recommended as "an easy-to-read treatise" for the nonspecialist and as enjoyable and informative for the specialist too. The publisher presents it as a comprehensive survey for the education of scientists, engineers, and managers who are, so to speak, on the verge. How well, one is thereupon led to ask, are these aims met and the literature-void filled?

The subject matter is extensive and ranges over engineering topics such as refrigeration, insulation, mechanical properties, and applications; and over the physics of liquid helium, superconductivity, transport properties, magnetic phenomena, and thermometry. The discussion is nonmathematical, generally lucid and readable, and up-to-date. The chapter on mechanical properties, the author's specialty, is particularly well done.

This much said, the reviewer finds it to be open to a number of criticisms. To a certain extent, it falls at times squarely between the two stools of simplicity and discussion-in-detail, presumably alternately distressing the questing "verge-stander" and the bedtime reader. (A minor but not entirely insignificant annoyance rises from the pertinent diagram or tabulation lying, as often as not, over the page from the text.) The author makes due acknowledgment to Mendelssohn's *Cryophysics* and Scott's *Cryogenic Engineering* and, indeed, the present book is essentially a fusion and condensation of these works. One feels it should be mentioned that, present aims notwithstanding, the former contains rather more of the physics and the latter far, far more engineering information, while both together may be purchased for the price of *Cryogenics*. Occasional lapses into whimsicality do lighten the tone but are hardly needed; one especially questions the value, even propriety, of reproducing such comic-strip suggestions as magnetic-field shielding of spacecraft against charged particles or "tapping a supercurrent" to propel an automobile.

Detailed faults come to eye most readily in the physics portions. In discussing the Dewar vessel the important role played by the effluent gas is not recorded, although the point is referred to off-handedly in a later discussion of "support members". Possibly the greatest drawback to the use of semiconductor thermometers at low temperatures is their electric power dependence and extreme sensitivity to unscreened rf radiations. This is not mentioned, but these thermometers are quite erroneously maligned as being nonreproducible after severe thermal cycling. The discussion of magnetic cooling gives the impression, at least, that the temperature drops as a result of heat being extracted from the paramagnet's lattice, rather than the converse—an incorrect concept that has, unfortunately, been presented not infrequently in the past. It is due, perhaps, to a similar lack of clarity that nuclear magnetic moments appear to be being ascribed to a simple pairing-off of the constituent nucleon moments and the term "asymmetrical nuclei" may mislead further. The reader might well develop an unduly rosy picture of the quality of the commercial cyclic magnetic refrigerator, or the mistaken notion that cooling by adiabatic magnetization of superconductors is something more than an intellectual divertissement.

Turning to thermocouples, the disadvantage of using a room-temperature reference for low-temperature thermometry is properly emphasized, while the particular usefulness of the dilute copper alloys in minimizing this effect is not. Loose statements abound: all substances are said to show a decrease in heat capacity upon cooling into the cryogenic region, just prior to giving details on low-temperature anomalies; the superfluid (component) conducts heat; the "Schottky anomaly" in a paramagnet is due to an "electric dipole interaction with the electric field of the crystal"; 0.5°K is "low enough" for orienting nuclei by the magnetic hfs alignment method; "phonons" are invoked in discussing pre-1911 forecasts concerning electrical resistivities at low temperatures, and "ions" in discussing ferromagnetic metals.

It cannot be denied that such defects (and the above is by no means an exhaustive compilation) detract seriously from the quality of a book, yet much of value remains. If one may be permitted a further effrontery, it would be to state that many of the needed revisions could be made fairly easily and one would then have at hand a quite attractive introduction to the wide field of cryogenics.

Energy Band Theory. By Joseph Calloway. 357 pp. Academic Press, New York, 1964. $10.00.
Reviewed by Gerald G. Johnson, Jr., Materials Research Laboratory, The Pennsylvania State University.

The calculation of the energy levels of electrons in solids has been given considerable attention in recent years. In writing a book unifying the myriad of works on this subject, Dr. Calloway, in *Energy Band Theory*, has undertaken a formidable project. Dr. Calloway's background, along with his earlier work on this subject (*Electron Energy Bands in Solids*, SSP Vol. 7), well qualifies him for this task.

Finding a text at the advanced graduate level that is clear and well written is certainly a pleasant surprise. Dr. Calloway's insight into the subject material enables him to elaborate on the explanation of many calculations that are too often hidden in the mathematics.

The notation, language, and general principles of band theory are developed early in the text. Through the methods of space groups, crystal symmetries are utilized in the solving of band structures and energy degeneracies. In addition to the spatial symmetries usually considered—translations, rotations, and reflections—the introduction of time inversion complements the spatial group theory.

The book contains a comprehensive survey of the general principles and methods of calculating the energy bands in a solid. The solving of the one-electron Schrödinger equation with the proper crystal potential and appropriate boundary conditions is approached by expanding the unknown function in a set of linear functions. Initially, plane-wave expansions are considered in detail. Due to the usual difficulties associated with plane waves, the orthogonalized plane wave and augmented plane-wave methods are then introduced. The alternate method of Wigner-Seitz is considered but only used in conjunction with the variational method in order to satisfy the boundary conditions by the easiest means. The evaluation of the crystal potential in Schrödinger's equation is first accomplished by means of the Hartree-Fock equations and the self-consistent fields obtained from them. Due to the iterative difficulties involved in the Hartree-Fock method for multielectron atoms, the Wigner-Seitz approximation is carried to the empirically constructed crystal potential. The experimental method for the determination of the crystal potential is finally considered in the quantum defect method.

The experimental results are excellent and complete. In the light of theoretical calculations, various types of crystals are considered—alkali, noble, and transition metallic crystals, and group IV type valence crystals. Specific examples of metals, semimetals, and semiconductors are given in detail. Avoiding mere tabular representation of these results, Dr. Calloway presents the transition from raw data to physical understanding in a logical step-by-step manner. The conclusions are interpolated and many references to experimental results are given for all the solids considered.

The book closes with a selected group of special topics, each of which is covered in good depth. An account of the effect of perturbations, electric, magnetic, and point defect, is discussed in view of the results of band theory. The last chapter gives