Licensee Contact Engineer for RCA licensees in the Central and Eastern States (1942–1960). In 1960 he was assigned to RCA Service Co. and was stationed at Redstone Arsenal, Huntsville, Ala., where he worked on a motion-picture project which involved filmed progress reports on missile systems. His work included installation and maintenance of sound systems.

In 1949, Mr. Ulmer was granted a U.S. Patent for the invention of a mask aperture to be used in the optical system of a recorder to eliminate the need for two masking apertures in the slit aperture plate. The entire operation of both recording and exposing the masking areas on the sides of the track was produced through one long slit in the slit aperture plate made possible by the unique shape of the opening in the mask aperture plate. In speaking of his invention, Mr. Ulmer said that as far as he knew it had never been used in the United States but had been assigned for use in several foreign countries.

When asked about his trip to Argentina, Mr. Ulmer recalled that it was "quite interesting, even somewhat exciting." In his own words, "Since as a student engineer, I had worked with such pioneers in sound recording as Edward Kellogg, Glenn Dimmick, Larry Sachtleben and Art Blaneyn in what was then RCA Photophone Division, RCA International Division thought I had enough information to impart to the Argentinian technicians, even though my Spanish was limited.

"When I arrived in Argentina, I found that it was not just a simple job of installing equipment and training technicians. Not a thing had been done. So we bought a used 35mm Bell & Howell camera. It was noisy. So we built a blimp and also built a dolly and even a microphone boom. The disc recording studio needed help so we changed the acoustics of the studio and built movable acoustic baffles. Then with the help of Argentinian technicians, I connected several pieces of existing equipment into the new sound recording equipment and a mix on a three-reel picture with Spanish narration. I considered the sound anything but good, but they thought it was wonderful. It was in Spanish! It did not need titles to explain American narration. After many heartbreaking moments of 'making do' with what we had in the way of equipment and of trying to train technicians who were groping in an entirely unfamiliar field, we were finally ready to start production."

Mr. Ulmer's many activities on behalf of the Society include service on the Membership Committee (1955–1956) and on the Samuel L. Warner Award Committee. He has also been very active in assisting the educational work of the Society. He recalls his efforts in getting together instructors, meeting places for the SMPTE course in Sound Recording Techniques during his service as a member of the Education Committee.

Books Reviewed

Fiber Optics—Principles and Applications

By N. S. Kapany. Published (1967) by Academic Press, 111 Fifth Ave., New York, N.Y. 10003. 429 + xviii pp. incl. glossary, indexes, bibliography, appendixes. Illus. Diagrams. 6 by 9 in. Price $17.50.

A comprehensive treatise on fiber optics is overdue and the publication by Dr. Kapany has filled the need.

The book is especially valuable in that it has the fullest bibliography of the subject which has yet appeared. The author is well qualified to write this work since he contributed to the early work at Imperial College, London, and later at the Illinois Institute of Technology Research Institute. From the work performed at these two establishments, the fiber optics industry in the United States has developed rapidly.

Starting from basic optical principles, the book opens with an excellent chapter on the theory of geometrical and physical optics of fibers, which will provide the reader with a guide on how to specify and select a fiber optics component for a particular application. A chapter on the phenomena of waveguide propagation and coupling is a good treatment and is of especial importance when the use of extremely small fibers is contemplated.

The technology of manufacturing large fiber bundles or faceplates and other optical components is held a closely guarded secret by manufacturers, and the chapter presented on manufacturing technology will serve only as a general guide to those vicariously interested.

However, in the description of fiber testing for transmission and other properties, the reader's needs are well met, while the chapters on medical, photoelectronic and photographic applications will be appreciated by engineers and designers in these specialist fields.

An account of the present state of technology in infrared and ultraviolet transmitting fibers is presented, followed by an interesting chapter on the development of fiber lasers.

Two examples of fiber optics in nature are discussed, represented by natural ulexite crystals and the rods and cones which make up the retinal receptors of the eye. A contributed appendix treats the retina as a fiber bundle.

In a technology which is developing as fast as fiber optics, it is inevitable that a most recent and burgeoning development may be given scant treatment. Thus, it is unfortunate that it was not possible to present a more complete assessment of the potential of synthetic fiber optic materials for light pipe and imaging applications. But then it was 40 years before the Brownie camera appeared with a plastic lens.—*Rupert L. Stowe*, SPIE Fiber Optics Group, Chairman Publications Committee, c/o CBS Laboratories, High Ridge Rd., Stamford, Conn. 06905.

Integrated Circuit Technology:

Instrumentation and Techniques for Measurement, Process and Failure Analysis

Ed., Seymour Schwartz. Published (1967) by McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 340 + xxii pp. Illus. Diagrams. 7 by 10 in. Price $15.

In this book the complexity of the techniques and of product analysis is reflected in the multiplicity of authorship —25 authors from ten organizations.

Integrated-circuit technology is based primarily on the "planar silicon" technology, with adjuncts in the "thin-film" and the "thick-film" technologies. Most integrated circuits (either bipolar or field-effect) are made entirely by the planar silicon method, the circuits being fabricated in a thin slice of monocrystalline silicon about an inch in diameter. A single circuit is typically a 50-mil square, so that a slice contains hundreds of identical circuits, which are obtained from the slice as individual chips of silicon. Diffusions of impurities from external sources form transistors, diodes, p-type layers used as resistors and p-n junctions which insulate the components. Interconnection is done by metallic film, and insulation of metal from silicon is accomplished by a layer of oxidized silicon. Localization of diffusion, metal and oxide is achieved to the order of ±0.1 mil, by photomasks and photosensitive etchant resists. Depth of junctions and thickness of oxide and metal are all in the micron range, so that their measurement and control employ the techniques of thin-film optics.

Thin- and thick-film methods sometimes are used in conjunction with silicon elements to form hybrid integrated circuits. In the thin-film technology, evaporated or sputtered films of metals and/or metallic compounds are used to make capacitors, and precision resistors and to interconnect many silicon circuits, as in logic systems. The thick-film techniques, which involve stencil screens and fired pastes, are used to make cheap resistors and connections over relatively large substrates.

There are twelve chapters: (1) "Diffusion and Epitaxial Equipment," (2) "Vacuum Systems," (3) "Photomasks," (4) "Metallization, Dicing and Circuit Assembly Equipment," (5) "Electron Beam Instrumentation," (6) "Final Sealing and Encapsulation," (7) "Infrared Testing and Mask Alignment," (8) "Screened Circuit Fabrication Equipment," (9) "Automatic Integrated Circuit Test Equipment" (10) "Instumentation for Advanced Microelectronic Measurements," (11) "Investigating Failure Mechanisms" and (12) "Microelectronic Facilities Concepts."

Chapters 1 through 4 and Chapter 7 deal with aspects of planar silicon processing. Chapter 1 has useful introductory material on oxidation of silicon, diffusion of impurities, merits of impurity sources, and epitaxial growth. Its sections on equipment describe the control systems of diffusion and epitaxial furnaces, the user's means of measuring temperature distribution, and show exotic fashions in boats. A minor flaw, which is typical of the book, is the inordinate repetition of photographs of commercial equipment.

Chapter 3, which should be especially interesting to readers of this *Journal*, covers a vital subject and is nicely done. Photomasks for planar technology represent an unusual and demanding problem, which may be summarized in the following way: A given integrated-circuit design requires a set of several masks. Each mask is a rectangular array, at least an inch square, repeating many hunderds of times the structure of the circuit in that step of the process, e.g., the metallic interconnection. Requirements for 1968 on such masks are severe. Typical tolerances are: position of an edge of a feature, ±1.0 μ; dimension of a feature, ±0.5 μ. Both high resolving power and high degree of sharpness of edges are needed. Chapter 3 covers the automatic layout table for artwork for the element of the array, the reduction cameras, and the step-and-repeat cameras, which produce the array.

Other chapters of special interest are 5, 7, 10 and 11, which discuss observations on completed circuits, such as structure and detection of structural faults. Chapter 5 has excellent discussions of the scanning electron microscope, electron mirror microscopy, and the wonders of electron-probe micro-analysis. The latter is already of significant everyday use in identification of contamination.

Chapter 7 is a combination of two unrelated subjects, i.e., infrared observation of thermal properties of operating integrated circuits and alignment of photomask and slice during processing. Details of operation of infrared microscopes and their application are given. There is, also, a discussion of

the scanning type of infrared microscope which is not, as yet, prominently useful in this work because of lack of spatial resolution. Mask alignment, i.e., alignment of the photomask to the pattern on the slice from the previous photomask, is done visually with a microscope. Precise machinery is needed for final positioning. Exposure of the photoresist through the mask is done *in situ* with actinic light. A serviceable treatment is given of the many detailed problems of this key operation.

Chapter 10 covers some interesting applications of optics. There is a presentation of the spectrometric method of measurement of the thickness of various films: oxide, photoresist and epitaxial silicon. These methods are in everyday use in the industry. Also, there is mention of the determination of the bulk carrier concentration through the minimum in the infrared reflectivity. There is material basic to optoelectronics, i.e., photonic coupling between integrated circuits and electroluminescent diodes. This subject is welcome because it is one of intensive exploratory development.

Chapter 11 is mainly a compendium of means of detecting the multitudinous minute defects which can cause circuit failure. The tendency here is to quote ultimate, rather than useful, resolution of each technique. The virtue of this chapter lies in showing the many approaches which can apply and in giving an extensive list of references to them.

Chapter 12 is excellently and succinctly done. It explains how to put together a laboratory and/or factory for integrated-circuit technology. It covers such questions as power requirements, temperature and humidity control, maintenance of extreme purity of water and gases, disposal of chemical waste, and the like. One subject, touched upon, but, I think, not expanded sufficiently for this book, is that of control and measurement of airborne particulate matter (some call it dust). A chapter might well have been included on this subject. A useful reference is: P. R. Austin and S. W. Timmerman, *Design and Operation of Clean Rooms*, Business News Publication Co., Detroit, 1965.

Another subject which could usefully have been included in this book is that of thin-film-component technology. Chapter 2 covers some of this indirectly. An excellent reference is: N. Schwartz and R. W. Berry, "Thin-Film Components and Circuits," in *Physics of Thin Films*, Vol. 2, page 363, 1964, Academic Press, G. Hass and R. E. Thun, editors. Two books also are being prepared for publication: R. W. Berry, P. M. Hall and M. T. Harris, *Thin-Film Technology*, Van Nostrand; and, L. I. Maissel and R. Glang, *Handbook of Thin-Film Technology*, McGraw-Hill. The book concludes with a substantial appendicular listing of manufacturers of state-of-the-art equipment.

Both in the text and in equations, typographical errors occur in most of the chapters. The errors are so frequent that they recall Lawrence Durrell's wonderful story, "Frying the Flag," *Esprit de Corps*, E. P. Dutton & Co., 1957, in which the Serbian typesetters of the *Central Balkan Herald* produced such beauties as: "Wedding Bulls Ring Out for Princess" and "Britain Drops Biggest Boob Ever on Berlin." Another complaint concerns Chapter 9, in which considerable material on automatic test equipment is reproduced verbatim from sales literature without quotation marks or independent comment.

The timing of this book is quite good, since the planar technology is in what appears to be a period of relative stability. The book covers much of the state of the art and even looks ahead. In so doing, some of the techniques long in use have been neglected, but references are usually given for these. As yet, there are not many comparable books, perhaps because of the magnitude of the job of getting into print the diverse methods in this complex industry.

Integrated Circuit Technology is a potentially useful acquisition, whether one wants to design a whole laboratory or to learn a new job quickly or only to find out if a given technique might apply in another field—*Paul Miller*, Bell Telephone Laboratories, Inc., 555 Union Blvd., Allentown, Pa. 18103.

Characteristics and Operation of MOS Field-Effect Devices

By Paul Richman. Published (1967) by McGraw-Hill Book Company, 330 W. 42 St., New York, N.Y. 10036. 150 pp. Illus. Diagrams. 6 by 9 in. Price $10.00

The practicing engineer who needs to find out quickly what is important about MOS devices, and to be able to work with their circuit equations, will be helped by this book. The 150-page text is the kind which could be worked through in an evening or two at home. If the reader then wishes to go further, a good selection of references is listed. The author has condensed his story of the MOS device skillfully, and where the reader may stumble over an idea he is referred to the short, but adequate elementary semiconductor theory section. The book is thus a textbook run-through of the theory of MOS device operation with a useful extension into circuit applications, including integrated-circuit techniques, and with some pictures of physical layouts of device on the silicon chip. Prints and line-drawings are clear, well marked but uncomplicated, while photographs are of good quality.

If this book has any drawbacks at all, it may be that it makes the MOS field look too simple and straightforward. For example, there is no mention of the processing defects which can land the engineer with a "bad" sample of MOS device (e.g., one with high concentrations of interface states). Diffusion technology is accepted as being adequate. While the fact of bias-temperature instability is mentioned, other causes of bulk space-charge buildup in the oxide, for example, its introduction by high-energy radiation, are not mentioned. The existence of leaky oxides, or oxides which break down unexpectedly, is not mentioned. These "failure mechanisms" may loom quite large in the engineer's life and he should be made to realize their importance. It is assumed here that the manufacturer is always going to provide an ideal device that never breaks down.

The author (a member of the staff at General Telephone and Electronics) is a working device design engineer, but he reveals none of his own original ideas or prejudices, rather summarizing his well-balanced reading of the MOS field. The flavor of the book is that it originated as an

easy introductory report for the "re-treading" of a department of tube engineers at GT and E.

The author includes, somewhat haphazardly, mention of specific commercial types by type number (GME gets three "ads," GI, two, RCA only an indirect one and the others are nowhere). It would have added much value to have included a more comprehensive survey of what is available on the market plus, perhaps, some data sheets to show just what electrical performance was aspired to in the year 1967.

However, the book appears to be a technically sound, well-condensed and readable digest of what these new and important devices can do, ideally, for the electronic world.—*Dr. A. G. Holmes-Siedle*, 159 Carter Rd., Princeton, N.J.

A Technological History of Motion Pictures and Television

Ed., Raymond Fielding. Published (1967) by University of California Press, Berkeley, Calif. 94720. 255 pp. + Table of Contents, Introduction. Illus. 8½ by 11½ in. Price $14.00

Anthologies of poetry are not uncommon but anthologies of historical motion-picture articles are rarely published. In fact, to the best knowledge of this reviewer, this interesting and useful compilation, by Raymond Fielding, of 32 complete historical papers is unique in its field. All the articles were published originally by the Society of Motion Picture and Television Engineers in the *Journal of the SMPTE* or the earlier (before 1930) *Transactions*.

In his very interesting "Introduction," Prof. Fielding (University of Iowa) reviews the 75-year growth of the motion-picture as a cultural influence. He points out that the fragmentary knowledge of the origin and development of the cinema has not yet made it possible for the best international scholars to produce a reliable or "definitive" history of this medium. He deprecates the dearth of knowledge in this field by stating, "Absurd as it must seem, we begin by conceding that we know more about the Graeco-Roman civilizations of antiquity than we do about the first fifteen years of the motion picture." Yet he indicates that the motion picture has "revolutionized the entertainment industry and has popularized and compromised the fine arts. Above all, it is a unique art form in its own right."

"Ideally," Prof. Fielding states, "future research in film history will proceed along three different lines," (1) the consolidation and appraisal of studies which have already been conducted; (2) the execution of exhaustive well-documented studies into particular aspects of film history; and (3) the production of broadly based international histories of the cinema which cut across geographical boundaries and different periods of time. He defines the purpose of this anthology as filling a need for an historical survey whose perspective is definitely technological. He admits that the assemblage is by no means a complete and coherent history and that critical examination of some of the articles will reveal many conflicting claims. Nevertheless he feels that it represents "... one of the most valuable resources for the investigation of film and television history."

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Perhaps the most useful feature of this assemblage of important references is that the reader can easily refer to the complete paper without having to consult a library. Not many libraries have complete files of the *SMPTE Journal* for the more than 50 years of the Society's existence. It is encouraging to find here papers by some of the recognized pioneers of the industry. For example, in F. H. Richardson's paper, "What Happened in the Beginning" (pp. 23–41), we can find statements in their own words by Edison, Eastman, Armat and Jenkins, among others, concerning their early work in the development of the motion picture. Or again, if one is interested to find an exact account of the growth of the various Technicolor processes, he has but to turn to page 52 (52–59) where he will find the information set forth by the late Dr. Herbert Kalmus, who headed the Technicolor Corporation for many years.

In the field of amateur motion-picture film on safety support a comprehensive account describing the development of 9.5-mm and 16mm films will be found in a paper by G. E. Matthews and R. G. Tarkington (pp. 129–140). An extensive review of motion-picture laboratory practices is covered in a well-illustrated and documented article by J. I. Crabtree (pp. 150–171). One of the most complete reviews ever published on the history of sound motion pictures is the well-written authoritative paper by the late Dr. E. W. Kellogg originally published in three installments in the *Journal of the SMPTE* in 1955. It is reproduced completely with its bibliography of 406 references on pp. 175–220.

The book is divided into three broad classifications: Pt I—Autobiographical Reminiscences (10 papers); Pt II — Historical Papers — Motion Pictures: (A) Early Film Technology (8 papers); (B) Cinematography and Film Stocks (5 papers); (C) Laboratory Practice (one paper); (D) Sound Motion Pictures (4 papers) and Pt III — Historical Papers — Television (4 papers). Titles and authors of 48 additional significant historical papers are listed on p. 255. Of this group, it is the opinion of this reviewer that it would have given even greater stature to the anthology had it been possible to have included the papers by deForest, Fleischer, Kellogg, Mees, Newman, Narath, Norling, Rackett, Rose, Sponable, Tuttle and Waddell. Let us hope a future volume will include these significant historical articles.

In general, the quality of the text and figures, apparently made from the original papers by direct lithography, is very acceptable, although several of the illustrations in the Richardson article (on pp. 33, 37 and 40) lost some detail in reproduction. By comparison, the 49 figures of the paper by Crabtree (pp. 150–171) are remarkably good. A useful addition for the reference reader would have been the inclusion of complete pagination for all papers and the issue number for each paper from the *Transactions*.

These omissions and limitations are minor, however, and historians and engineers in the motion-picture and television fields should congratulate Prof. Fielding for his efforts to assemble here such a useful anthology of valuable references for convenient reading.—*Glenn E. Matthews*, 55 Stoneham Road, Rochester, N. Y. 14625

The following booklets, published by National Aeronautics and Space Administration, are available from Clearinghouse, U.S. Department of Commerce, Springfield, Va. 22151. These publications were selected as being of special interest for review. Unless otherwise noted, each report is priced at $3.00.

N 67-31481: The Oculometer: By John Merchant. vi + 170 pp. (reduced 2:1) 8½ by 11 in., July 1967.

For many years men have dreamed of controlling events by the motion of their eyes. In more recent times, since the development of sensitive photocells, paper designs have appeared for carrying this out.

The "oculometer" represents some tangible hardware that has been designed and put together to explore what can be accomplished in this direction. Two successive designs were tried. Essentially they consist of a telescope type of optical system through which the observer looks at a scene. Through beam splitters, a light beam is projected on the eye and its reflection directed to a photocell, with an electronically operated mechanism provided to locate the position of the pupil or iris. This information, as an electrical signal, can be used for control.

The device has been designed with an idea of possible use by astronauts, but a number of other possible applications, from air traffic control to psychological vision tests, are discussed. Within the rather severe limitations in which it can work, the device seems to operate reasonably well, and the author gives suggestions for further exploration.—*Pierre Mertz*, Consultant, 66 Leamington St., Lido, Long Beach, N.Y. 11561.

NASA SP-3016: Venus and Mars—Nominal Natural Environment for Advance Manned Planetary Mission Programs (2nd ed.): By Dallas E. Evans, David E. Pitts, and Gary L. Kraus. vi + 52 pp. 6 by 9 in. 1967.

NASA CR-786: Comprehensive Summary of the Available Knowledge of the Meteorology of Mars and Venus: By Edward M. Brooks; vi + 70 pp., 8 by 10½ in, May 1967.

The exploration of the moon and the planets, in diverse ways, has become an enthusiastic scientific activity. Photography and television, direct or delayed, are only a portion of the many probes put to use in the effort. While preparing for each project it is necessary to apply the previously accumulated knowledge in order to maximize the chances of success. It is extraordinary how every scrap of information is turned over and cogitated upon to set up a rational expectation of what may newly be encountered. It makes Sherlock Holmes's famous deductive processes pale to see how these analysts assiduously examine every detail of their evidence — and they are frank to recognize the points on which, at the moment, the quest for exact truth is hopeless.

The booklets describe the current knowledge on Mars, Venus, and Jupiter, covering every feature from orbit, size, rotation, to atmosphere, etc., to satellites (where any) and even possibilities of life. All these data are necessary to the current and future explorers of various kinds if these are not to waste effort in their own searches. Because the booklets are to be consulted by

representatives of many diverse disciplines, they must be in form accessible to them; and it is remarkable how readable much of the material really is — to such an extent that it can profitably be perused even to satisfy mere curiosity. The booklets each contain extensive bibliographies for those who need to delve more deeply into the information.—*Pierre Mertz*, Consultant, 66 Leamington St., Lido, Long Beach, N.Y. 11561.

AD 651-308: Studies of Random Noise: An Annotated Bibliography: By Herbert P. Eckstein, v + 49 pp. (reduced 2:1) 8½ by 11 in., December 1966.

This bibliography contains a selection of papers, most of them annotated, on noise and the effects of noise on signals (1944–1964). It is largely mathematical, mostly on Gaussian noise, though a few studies include non-Gaussian noise.

AD 651-812: An Approach to Software Evaluation: By J. D. Tupac, 12 pp., 8½ by 11 in., April 1967.

The report covers a cursive qualitative discussion on the handling of computation jobs and study of "good" performance on three computers (IBM 7040/7044, IBM 360/30, and Digital Equipment Corporation PDP-6).

AD 656-348: Statistical Communication Theory: By Communication Theory Group, Northeastern University, iii + 88 pp. (reduced 2:1), 8½ by 11 in., April 1967.

The report describes current efforts on various codes, error correcting schemes, and optimum filtering of pulse amplitude modulated signals. It is mostly mathematical.

The following booklets are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. They are each priced at 60 cents.

NASA SP-3029: Handbook of the Physical Properties of the Planet Venus: by L. R. Koenig, F. W. Murray, C. M. Michaux and H. A. Hyatt, vi + 132 pp., 6 by 9 in., 1967.

NASA SP-3031: Handbook of the Physical Properties of the Planet Jupiter: By C. M. Michaux, with contributions by F. F. Finch, Jr., F. W. Murray, R. E. Santina, and P. C. Steffey; vi + 142 pp., 6 by 9 in., 1967—*Pierre Mertz*, Consultant, 66 Leamington St., Lido, Long Beach, N.Y. 11561.

Tape Recording for the Hobbyist, by Art Zuckerman, has recently been published as Photofact Publication 20583 by Howard W. Sams & Co., Inc., 4300 West 62d St., Indianapolis, Ind., 46206. It is essentially a second edition, being a revision of the author's earlier title *Magnetic Recording for the Hobbyist*. It is illustrated, 160 pp. including index, 5⅜ by 8½ in., paper bound and priced at $3.25 ($4.10 in Canada). The book's 17 chapters will answer in brief tutorial fashion a great amount of the queries which amateurs bring to their engineer acquaintances. It provides the amateur a handy reference for types of equipment beginning with the different types of microphones, their limitations and characteristic uses.—*Edit.*