

**RADIO AND TELEVISION  
ENGINEERS' REFERENCE  
BOOK**

# RADIO AND TELEVISION ENGINEERS' REFERENCE BOOK

*Editor :*

J. P. HAWKER

*Advisory Editor :*

W. E. PANNETT, A.M.I.E.E.

50 SPECIALIST CONTRIBUTORS

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## EDITORS' FOREWORD

THE earlier editions of RADIO AND TELEVISION ENGINEERS' REFERENCE BOOK have firmly established its value as a comprehensive and authoritative reference book, written at a practical engineering level. The rapid progress which is continuously being made in all branches of radio and television makes it essential, however, that such a book should be frequently and extensively revised.

In this fourth edition, many new developments have been covered for the first time, and a number of sections completely rewritten or recast to take the latest techniques and trends fully into account.

The effects of the semiconductor revolution continue to be felt throughout the radio and television field. TRANSISTORS (Section 26) has again been revised and expanded, and now includes such devices as AVALANCE DIODES, SILICON-CONTROLLED RECTIFIERS and TUNNEL DIODES. The needs of the service engineer dealing with modern equipment have not been overlooked, and SERVICING TRANSISTORIZED EQUIPMENT (Section 39) has been further enlarged.

Important progress continues to be made also in VALVES (Section 23), and this is reflected in new information on PARAMETRIC AMPLIFIERS—including electron-beam and semiconductor types—TRAVELLING-WAVE TUBES, MASERS and LASERS.

Many of the new low-noise microwave devices and techniques find particular application in the latest satellite communications systems. The equipment used in experimental communications satellites such as Telstar and in the associated ground tracking stations are described in the expanded Section 20 (RADIO ASTRONOMY AND SPACE COMMUNICATIONS SYSTEMS).

The supply of television studio equipment has increased for both home and overseas markets. In Section 4 (STUDIOS AND STUDIO EQUIPMENT) a completely new sub-section on VIDEOTAPE RECORDERS has been added, and all material on CAMERA TUBES has been entirely rewritten for this edition.

The techniques of MICROMINIATURIZATION are assuming considerable importance, and the various methods under active development form the subject of a new sub-section of the revised Section 3 (MATERIALS) which also includes additional information on PRINTED CIRCUITS.

The introduction of U.H.F. TELEVISION and the use of both 405- and 625-line standards in the United Kingdom are leading to far-reaching changes. Section 15 (TELEVISION RECEIVERS) has been extensively revised; additional material on COLOUR TELEVISION is included in Section 2 (COMMUNICATION THEORY, ELECTRON OPTICS AND COLOUR TELEVISION).

Mobile two-way communications services now have narrower channels, and this change is reflected in the revised Section 8 (V.H.F. TRANSMITTER-RECEIVER EQUIPMENT). Frequency allocations for all radio services were revised at the Geneva I.T.U. Conference, and the new allocations and other important recommendations are summarized in Section 44 (QUARTZ OSCILLATORS, FREQUENCY ALLOCATIONS AND IONOSPHERIC FORECASTING).

Section 35 (GRAMOPHONE MECHANISMS) has been completely re-written for this edition in order to take into account the steady progress which has been made in this field.

Section 46 (PROGRESS AND DEVELOPMENTS) again provides concise information on developments and products resulting from the work of specific firms and organizations.

It is the aim of this Reference Book to bring together, within one convenient volume, the information required by engineers, technicians, radio amateurs and all who are engaged in the design, maintenance, technical sales, operation and servicing of modern radio and television transmitting and receiving equipment.

The Reference Book is arranged in forty-seven main sections, mostly dealing with a specific branch of the subject and written by authorities in the particular field concerned. A list of the main contributors appears on pages xiii-xx.

Throughout the book, emphasis has been placed on essentially practical information and theory, so as to ensure that the work will be of the utmost value to field engineers and technicians. Nevertheless, the instructor and student will also find much material—not readily available elsewhere—that will be of the greatest use in teaching or studying for careers in this rapidly expanding industry.

The Editors are indebted to the many contributors who have co-operated so whole-heartedly in the production of this new edition. Grateful acknowledgement is also made to the many leading firms and organizations who have kindly allowed their engineers to contribute to this work or who have assisted by supplying illustrations, information and data.

The Editors also wish to thank those readers who have kindly submitted comments or suggestions—many of these have been incorporated in this new edition.

W. E. P.  
J. A. R.  
J. P. H.

## SPECIALIST CONTRIBUTORS

- L. S. A. L. S. ALLARD**, B.Sc., A.Inst.P., was educated at Gravesend County Grammar School and graduated at Chelsea Polytechnic. He joined the Research Laboratories of the General Electric Company (now The Hirst Research Centre) in 1941, and has worked on various aspects of cathode-ray-tube design. He is at present in charge of the Cathode-ray Tube Group.
- S. W. A. S. W. AMOS**, B.Sc.(Hons.), A.M.I.E.E., was born in Smethwick, Staffs., in 1915 and was trained as a teacher, obtaining a degree in Physics from the University of Birmingham in 1936 and the Ministry of Education Diploma in the following year. After four years as an Assistant Master in H.M. Dockyard School, Devonport, he joined the B.B.C. as a Maintenance Engineer, later transferring to the newly formed Engineering Training Department as an Instructor. In 1947 he joined the B.B.C. Technical Instructions Section, being appointed Assistant Editor in 1957 and Editor in 1959.
- E. S. B. E. S. BACON**, M.Sc.(Lond.), A.R.I.C., is Chief Supervisor of the Electrical Laboratories of the Ever Ready Co. (G.B.) Ltd.
- C. H. B. C. H. BANTHORPE**, technical director of Central Equipment Ltd., of which Derwent Television is a part. Throughout the war he was at the Telecommunications Research Establishment, after which he returned to Central Equipment to take charge of radar production and test, transferring to television shortly before the B.B.C. transmissions recommenced. For several years he has been works manager of the Derwent factory at Perivale, Middlesex, and has been responsible for the designing of their television receivers since 1951.
- H. M. B. H. M. BARLOW**, Ph.D., B.Sc.(Eng.), M.I.E.E., is Pender Professor of Electrical Engineering at University College, London, and specializes in high-frequency electrical engineering. His interest in this field of study started when in the First World War he joined as a Sub-Lieut. R.N.V.R. the Staff of the Signal School, Portsmouth, and worked on the reception of wireless signals under water. Subsequently, as a student of University College, London, he came under the influence of Sir Ambrose Fleming, and after practical experience in the engineering industry he was invited to join the staff of that College. The Second World War drew him into the Air Ministry as a Scientific Officer with the Telecommunications Research Establishment, and when the War ended he had become Superintendent of the Radio Department of the Royal Aircraft Establishment. By that time micro-waves had found an important place in ultra-high-frequency technique, and Professor Barlow made a special study of their applications. He has written books on the subject entitled *Microwaves and Waveguides*, and, with Dr. A. L. Cullon, *Micro-wave Measurements*.
- T. W. B. T. W. BENNINGTON**, is a Research Engineer of the B.B.C. Engaged in short-wave radio since 1932 he joined the B.B.C. in 1934 and was for 15 years in the Department concerned with short-wave planning. Both there and in Research Department he has been concerned with the application of ionospheric data to long-distance transmission. He is the author of *Short-Wave Radio and the Ionosphere*.

- E. W. B.-J. E. W. BERTH-JONES**, B.Sc.(Eng.), was born in 1911, in North Wales, and was educated at Oundle and Manchester, receiving his B.Sc. degree in electrical engineering in 1933. His introduction to sound recording was in the laboratories of Messrs. British Acoustic Films Ltd., and he later acquired operational experience at Denham Studios with London Film Productions. He joined the staff of the Gramophone Company Ltd., Recording Department, in 1937. After specialized work for H.M. Government during the war, he returned to this company, under its new title of E.M.I. Studios Ltd., as Development Engineer, concerned principally with the introduction of magnetic tape recording and in the circuit design of new high-quality recording equipment. From 1961 until his death in 1962 was Chief Engineer of the Broadcasting and Recording Equipment Division of E.M.I. Electronics.
- B. R. A. B. B. E. A. BETTRIDGE**, A.M.Brit.I.R.E., Commercial Manager of the G.E.C. Semi-conductor Division. After many years of experience with thermionic valves, he became interested in germanium diodes and, since the introduction of transistors, has been engaged on the application of transistors and other semiconductor devices to radio, television and electronics.
- W. T. B. W. T. BLACKBAND**, M.Sc., A.M.I.E.E., engaged on aerials and propagation research at R.A.E., Farnborough. Chairman of R.C.R.D.C. subcommittee on Radiofrequency Cables and N.A.T.O. committee on transmission lines. Member of British National Committee for I.G.Y. artificial satellite studies.
- F. D. B. F. D. BOLT**, B.Sc.(Eng.), M.I.E.E., graduated at Queen Mary College, London University, in 1929. He joined Standard Telephones & Cables Ltd. and worked on short-wave transmitter development between 1929 and 1934. Since 1934 he has worked for the B.B.C. on the planning and installation of transmitting equipment, particularly aerial and feeder systems. He was awarded the Fahie Premium of the Institution of Electrical Engineers jointly with Mr. F. C. McLean, in 1946. In 1951 he visited South Africa to advise the South African Broadcasting Corporation on the planning of a short-wave centre for that country. As Head of Aerial Unit, Planning and Installation Department of the B.B.C., he is responsible for the engineering of the aerials and feeder systems for all broadcast transmitting stations. Elected Member of the Institution of Electrical Engineers in 1953.
- F. H. B. F. H. BRITAIN** joined the staff of the Research Laboratories of the G.E.C. (The Hirst Research Centre) early in 1926, and worked on absorption-type refrigerators. In 1928 he worked on photo-electric cells, transferring to the Acoustics Laboratory in 1930. During the war he worked on silicon for use in Radar sets, and returned to the Acoustics Laboratory in 1947.
- J. E. B. J. E. BRYDEN**, A.M.I.E.E., was born at Strood, Kent, in 1917 and educated at Sir Joseph Williamson's Mathematical School, Rochester. He enlisted in the Royal Artillery in 1939, and in 1941 was posted to the Military College of Science as an Instructor for Radar and Wireless, with the rank of Captain (R.A.O.C., later R.E.M.E.). After the war he joined the Staff of the Research Laboratories of the General Electric Company, and in 1951 was appointed Group Leader of the Radio Communications Group. In 1955 he joined the Engineering Department of Canadian Marconi Company, in Montreal, Canada; he is now Manager of the Radio Relay Department, and is responsible for

Development, Systems and Sales Engineering. He has been intimately involved in the development of Broad-band Radio Systems since 1948.

- R. H. B. R. H. BURDICK**, A.C.G.I., A.M.I.E.E., was educated at Woolwich Polytechnic, gaining senior science scholarship to the Imperial College of Science, and, in 1930, A.C.G.I. He trained initially as a mechanical engineer, transferring to the electrical branch, and, after considerable experience on the design of telephone and radio equipment, he joined the telephone laboratory of Messrs. Siemens Brothers & Co. Ltd. He is at present with Marconi's Wireless Telegraph Co. Ltd., working on the development and design of radio and radar equipment.
- M. C. M. COOPER**, is the Video Service Manager of Ampex International S.A. of Fribourg, Switzerland.
- V. J. C. V. J. COOPER**, B.Sc.(Eng.), A.C.G.I., M.I.E.E., M.Brit.I.R.E., Assoc.I.R.E., is a member of Marconi's Wireless Telegraph Co. Ltd. and is at present Manager and Chief Engineer of the Closed Circuit Television Division. For some years he has been responsible for the development of V.H.F. and U.H.F. transmission equipment of television equipment in general.
- J. H. C. J. H. COZENS**, B.Sc., A.M.I.E.E., was educated at George Green's School and London University. After a short period in the teaching profession, spent two years on the staff of Telegraph Construction & Maintenance Co. Ltd. Joined the Telegraph Condenser Co. Ltd. in 1932, taking charge of the Development Department in 1938. Since 1945 he has been Chief Technical Officer of this Company.
- G. W. A. D. G. W. A. DUMMER** is Head of the Components, Environmental Testing and Constructional Techniques Divisions of the Royal Radar Establishment. He was associated with the design of the first P.P.I. to be used in radar, and later with radar synthetic trainers, for which he was awarded the M.B.E. He has written numerous papers on printed and potted circuit techniques and was awarded an I.E.E. Premium for a paper on this subject. Author or co-author of many books on electronic components, design and construction and reliability. He is a Member of the I.E.E., Senior Member of the I.R.E., Member of the Brit. I.R.E., etc., and has travelled extensively and lectured in many countries.
- L. D. L. DRISCOLL**, B.Sc., A.M.I.E.E., M. Brit.I.R.E., has been with Murphy Radio Ltd. in various capacities since 1935. At present he is in charge of the Radio Link Section of their Electronics Division Laboratories.
- B. Z. de F. B. Z. de FERRANTI**, B.Sc., B.E.(Hons.), Graduate I.E.E., Stud. I.E. Aust., was born in Sydney, Australia, in 1928, and educated at North Sydney Boys' High School and The University of Sydney. Worked on digital-computer techniques with C.S.I.R.O. before joining G.E.C., Coventry, in 1951. In 1953, joined the G.E.C. Research Laboratories, Wembley, (The First Research Centre) working on electronic telephone exchanges.
- E. A. F. E. A. FIELDING**, B.Sc.Tech.(Hons.), A.M.C.T., M.I.E.E., A.I.R.E., was born in 1913, and educated at Oldham High School and Manchester University. Studied Electrical Engineering, specializing in Communications Engineering, and graduated with first-class honours in 1934. After graduation he secured employment with Salford Electrical Instruments Ltd., as a development engineer, and in 1938 became manager of the Quartz Crystal Department, a position he still holds. Since the end of 1951 he has also been manager of the Company's Chestergate works.

- D. H. F.** **D. H. FISHER**, A.M.I.E.E., was born in Halstead, Essex, in 1926, and received early education at Halstead Grammar School and Gosfield School, Essex. He commenced studies in Telecommunications Engineering at The Polytechnic, Regent Street, London, W., in 1942, and qualified with Polytechnic and Higher National Diplomas. He then joined E.M.I. Engineering Development Ltd., to work on defence projects and later television development, and subsequently with Pye Ltd., Engineering Department, specializing particularly in Television Receiver design and production, and since February 1952 on domestic receivers. Technical Director of Regentone Radio and Television Ltd. and later of Magnavox Electronics, Ltd. Contributor to the I.E.E. Television Convention, May 1952 and to the *Television Engineers' Pocket Book* (Newnes).
- W. I. F.** **W. I. FLACK**, Assoc.I.E.E., Senior Member I.R.E., Fellow of the Television Society, has been connected with the radio industry for twenty-five years. Received electrical training at the Regent Street Polytechnic. Worked on radar during the early part of the war, and was with the Telegraph Condenser Co. Ltd. for fourteen years. Joined the production engineering department of Radio and Allied Industries, Ltd., in 1957. Apart from developing new types of capacitors has also designed television receivers and a magnetic tape recorder for amateur constructors.
- L. S. F.** **L. S. FOSKETT** formerly served in the Royal Corps of Signals and was a member of the B.B.C. engineering staff. Joined the H.M.V. (The Gramophone Co.) Film Recording Unit and is now a member of the Sound Equipment Planning and Estimating Division of E.M.I. Sales and Service Ltd.
- R. H. G.** **R. H. GARNER**, B.Sc.(Eng.), A.M.I.E.E., M.Brit.I.R.E. Principal of The Technical College, Coatbridge, and former Chairman of the Scottish Section of the British Institution of Radio Engineers. Has wide interests in radio and electronic matters, especially in their applications to the Automatic Factory. Regular contributor to the Scottish radio press.
- R. C. G.** **R. C. GLASS**, M.A., B.Sc., A.M.I.E.E., is Lecturer in Applied Physics at Northampton College of Advanced Technology, London, and a Scholar of Trinity College, Dublin. After graduating with first class honours in physics, he was engaged in research on magnetrons at the Research Laboratories of the General Electric Company and on travelling-wave tube applications at the Research Laboratories of Decca Radar, being awarded an I.E.E. Premium for his magnetron work in 1951. He is also editor of the English edition of the Russian technical journal *Radiotekhnika* (Radio engineering).
- F. J. G.** **F. J. GRIMM**, A.M.Brit.I.R.E. of Pye Telecommunications Ltd.
- J. P. H.** **J. P. HAWKER** first became interested in radio communication as an amateur, obtaining a licence (2BUH, later G3VA) in 1936. Served in the Special Communications Units of the Royal Signals, 1941-46. Appointed as Assistant to the General Secretary of the Radio Society of Great Britain in 1947, and later became Assistant Editor of the *R.S.G.B. Bulletin*. Joined the Technical Books Department of George Newnes Ltd. in 1951.
- P. J.** **P. JONES**, was born in Cheshire in 1914, and educated at Chester City Grammar School and Liverpool Technical College. He began his career as an organic chemist with Messrs. British Insulated Callender's Cables Ltd. in research on natural and

synthetic resin cable dielectrics, later developing an interest in electronic techniques for measurement and control in this field. Subsequently in 1950 he joined Aerialite Ltd., now being responsible for the design of radio and television receiver aerials, telecommunications cables, etc. He is the originator of numerous patents in the fields of high-frequency electronics, television aerials and accessories. He is actively interested in Amateur Radio communications, particularly on ultra-high frequency in the 70-, 24- and 3-cm. bands. Station call-sign G2JT.

- P. R. K.** **P. R. KELLER**, B.Sc., joined Marconi's Wireless Telegraph Co. Ltd. in 1944 after graduating at King's College, London University. Following a course of practical training at the Marconi College, he joined the Design and Development Division, and has specialized in V.H.F. transmitter-receiver equipment from 1946-1956. He is at present in charge of a section developing error-correcting telegraph equipment. He is a patentee and a part-time lecturer in the Engineering Department of the Mid-Essex Technical College. Author of *V.H.F. Radio Manual*.
- J. M. K.** **J. M. KIRK**, M.B.E., B.Sc.(Hons.), D.I.C., A.C.G.I., M.I.E.E., was born in Canton, China, and educated at Mill Hill School and Imperial College, London. Royal Corps of Signals, 1939-46. Member, since 1946, of the Radio Project Planning Section of Standard Telephones and Cables, Ltd. Amateur Transmitting Licence since 1935.
- R. T. La.** **R. T. LAKIN**, M.B.E., A.M.I.E.E., M.Brit.I.R.E., is Chief Research Engineer, Whiteley Electrical Radio Co. Ltd. He has specialized in the design of loudspeakers and associated equipment, and is the author of several papers on loudspeakers, one of which was the subject for a series of Lectures for the Institution of Radio Engineers.
- L. P. L.** **L. P. LEARNEY** studied mathematics and physics as a full-time student at the Polytechnic, Regent Street, London, and joined the staff of Redifon Ltd. just after the outbreak of war. He assisted at first in the development of war-time military equipment, including beacon transmitters and radar training devices, and later as senior engineer has developed a wide range of equipment for airborne, marine, mobile and fixed use, including receivers, and a valve and transistor transmitter and amplifiers for commercial and service application. He has also been engaged recently in standardization work.
- R. T. Lo.** **R. T. LOVELOCK**, A.M.I.E.E., first entered the drawing office of a telephone manufacturer, and became a designer-draughtsman of subscriber's and exchange apparatus. From there he transferred to a radio development laboratory to design and develop electronic instruments, and with the initiation of the British television service became a television development engineer. During the last war he was responsible for special measurement and design techniques within a laboratory, and a member of many Service-Industry liaison committees. More recently he was in charge of a laboratory responsible for material and component approval, for instrument calibration and maintenance, and for the clearance of special design and production problems. Now senior research engineer (materials) at Belling and Lee Ltd.
- H. A. McG.** **H. A. MCGHEE**, Grad.I.E.E., was educated at the Technical College, Coatbridge, and the Royal Technical College, Glasgow. He is the author and joint author of a number of papers on television technique, and is a member of the engineering staff of Pye Ltd., Cambridge. Author of *Industrial Television*.

- R. D. A. M. R. D. A. MAURICE**, Ing.-Dr., Ing.E.S.E., A.M.I.E.E., received his general education in England and California. Engineering degree, France (1933) and doctorate of engineering from Sorbonne (1952). Graduate trainee (1933) and subsequently development engineer with E.M.I. Ltd. Joined B.B.C. Research Department (1939). Became head of Receiver and Measurements Section, later of Television Group, and now assistant head of B.B.C. Research Department.
- E. M. E. MOLLOY**, formerly General Editor, Technical Books Department, George Newnes Ltd. Trained Royal Technical College, Salford. Obtained King's Prize in Applied Mechanics, 1911. After practical experience with Lea Recorder Co. Ltd., and United Brassfounders & Engineers Ltd., joined staff of *Electrical Engineering*. Assistant Examiner, Inventions Dept., Ministry of Munitions, 1917-19. In 1919 joined staff of Sir Isaac Pitman & Sons Ltd., and in 1924 was appointed Technical Editor. Joined staff of George Newnes Ltd. in 1929, retired in 1958.
- J. M. J. MOIR**, M.I.E.E., M.I.R.E., Technical Director of Goodmans Industries and formerly in the Electronic Engineering Department of the B.T.H. Co. as Head of the Section dealing with the development and engineering of audio-frequency and communication equipment, telemetering units, and with architectural acoustical problems, particularly in the sound film field. Privately a high-fidelity sound reproduction enthusiast. Member of the Institution of Electrical Engineers and the American Acoustical Society-Institute of Radio Engineers.
- E. W. M. E. W. MORTIMER**, joined the Garrard Engineering & Manufacturing Co. Ltd. in 1919, and served a five-year apprenticeship to precision engineering. He was responsible for the design of the first Garrard Record Changer, and has since been actively engaged on the development of record reproducing equipment. He has travelled extensively, studying the export requirements for gramophone equipment.
- L. A. M. L. A. MOXON**, B.Sc.(Eng.), A.M.I.E.E., was educated at Clifton College and the City and Guilds Engineering College, obtaining the London University B.Sc. degree in 1929. After two years research under the auspices of the D.S.I.R. he joined the staff of Murphy Radio Ltd., where he was responsible for development and research in connection with broadcast reception. In 1941 he joined H.M. Signal School, Portsmouth, where he was concerned with the development of radar receivers. He is now a member of the Royal Naval Scientific Service.
- W. E. P. W. E. PANNETT**, A.M.I.E.E., was with Cable and Wireless Ltd. and Marconi's Wireless Telegraph Co. Ltd. for many years. From 1921 to 1928 he was engaged in pioneer research and development work on microphones and reproducers at 2LO, the original London broadcasting station, and communication recording apparatus. From 1928 until 1956 he was successively occupied in charge of the construction and administration of some of the early Beam transmitting stations, the design of transmitters, station planning and installation design. He was latterly in charge of the Power Equipment and Installation Division of Marconi's Wireless Telegraph Co. Ltd. He is author of *Radio Installations: Their Design and Maintenance*, *Radio Engineering Formulae and Calculations* and *High Fidelity Pocket Book*.

- R. D. P.** **B. D. PETRIE**, M.B.E., A.M.I.Mech.E., A.M.I.E.E., was born in 1904 and educated at Hull Technical College. He trained firstly as a mechanical engineer, and later as an electrical engineer. Joined Gaumont British Picture Corporation in 1929, and was appointed Area Engineer for North of England in 1930 and later, the same year, Divisional Engineer for the West End of London and the South Coast Division. He joined the B.B.C. in 1935 and served in the Operational Department a year before transferring to the Equipment Department. Later joined the then Station Design and Installation Department, supervising installation of war-time control room and studios, and later designing reproducing equipment. In 1947 he joined, and in 1956 became Head of, the Studio and Equipment Section of the Designs Department. Elected to Associate Membership of the Institution of Mechanical Engineering in 1934, and to Associate Membership of the Institution of Electrical Engineers in 1940.
- W. C. R.** **W. C. RIDDIFORD** is holder of City and Guilds certificates in Radio I, II, III and IV. Employed from 1927 to 1945 as service and civilian instructor in Radio Engineering to the R.A.F. Recently Senior Lecturer in Radio Engineering to Airways Training College and author of *Radio Reference*.
- F. W. J. S.** **F. W. J. SAINSBURY**, A.C.G.I., D.I.C., is a Whitworth Scholar and is at present with the Receiver Development Division of Marconi's Wireless Telegraph Co. Ltd.
- D. H. C. S.** **D. H. C. SCHOLLES** joined the Marconi Company in 1933. In 1940 he left the Research Department of that Company to join the London Engineering Staff of the B.B.C. Later in 1940 he volunteered for and was commissioned in the Signals Branch of the R.A.F., but gave up this appointment to work for M.A.P. at R.A.E., Farnborough. In 1941 he joined the Royal Navy as an Air Engineer Officer and served at sea, abroad and at home on various engineering duties connected with airborne radio and radar. Promoted to Lt.-Commander 1943, and served the year following the war in the Admiralty. He joined Plessey Ltd. as a Senior Engineer 1946, and was appointed Head of Radio Laboratory in 1948, Chief Radio Engineer 1950, and Chief Engineer in Telecommunications Division 1952. In 1962 he was appointed an Executive Director and Technical Co-ordinator for the Plessey Group.
- J. R. S.** **J. R. SHAKESHAFT**, read for the Natural Sciences Tripos at St. John's College, Cambridge, from 1949 to 1952. Since that date he has been doing research in radio-astronomy at the Cavendish Laboratory, Cambridge. He took a Ph.D. and was elected to a fellowship at St. John's College in 1957.
- R. J. S.** **R. J. SLAUGHTER**, B.Sc.(Hons.), is employed by the Telegraph Construction & Maintenance Co. Ltd. After initial experience on the chemical and physical aspects of cable testing, particularly submarine cable, he spent a short period with the power cable research group. In 1949, after graduating in physics, he specialized in high-frequency cables, and is now in charge of the high-frequency cable research section.
- W.E.T.** **W. E. TURK**, was born at Swindon and studied at the College there. He joined E.M.I. in 1936. In 1944 he went to Birkbeck College and received his B.Sc. degree in 1947. Joined English Electric Valve Company in 1954, since when he has been engaged on the design and development of camera tubes. He is now Manager of the Photoelectric Tube Division.

D. F. U.

**D. F. URQUHART**, has for the past five years been in charge of Engineering Laboratory and Electronic Development at Erie Resistor Ltd. Previously employed on production. His technical education was at Acton Technical College. In 1916 he was invalided from the Forces, and employed in the Proof and Experimenting Department of Armstrong Whitworth Ltd., then engaged on heavy electrical engineering with various firms in the north-eastern area. In 1930 he spent eighteen months in automatic telephones, followed by engagement as a brewer's electrical engineer until war broke out. During the early part of war he was a lecturer in the R.A.F. Technical School. Then followed two years in valve manufacture, after which he took his present employment. Radio enthusiast since 1920.

V. V.

**V. VALCHERA** is Technical Director of Valradio Ltd. and Associated Companies Dar-val Engineering Ltd. and Valmade Ltd. He has been mainly responsible for the development of heavy-duty vibrators and vibrator converters in this country, and has played a prominent part in the development of large-screen projection television receivers for the home and export markets.

A. H. B. W.

**A. H. B. WALKER**, B.Sc.(Eng.), D.I.C., A.C.G.I., M.I.E.E., graduated with first-class honours at City and Guilds (Eng.) College in 1934. He joined the Rectifier Engineering Department of the Westinghouse Brake & Signal Co. Ltd., designing all types of rectifier equipment, and originated various novel constant-voltage and constant-current systems based on transducers and ferro-resonance. In 1938 he joined the Westinghouse Research Laboratory, and has since been concerned with the continuous development of copper oxide, selenium, and germanium rectifiers of all types. While specializing on the numerous applications of metal rectifiers in electronic circuitry, voltage multipliers, etc., he has also developed electronic and magnetic servo controllers for large rectifiers. Other original work includes the "Stabilistor" (A.C. voltage stabilizer), the "Phase Converter" (static single-phase to three-phase power converter) which was widely used during the war for driving three-phase motorized machine tools in single-phase districts, and more recently the "Transbooster" constant-voltage system. In 1952 he was appointed Joint-Chief of the Westinghouse Research Laboratory.

T. W.

**T. WORSWICK**, M.Sc., A.M.I.E.E., was trained at Regent Street Polytechnic and City and Guilds. He joined the B.B.C. as a student apprentice in 1934, working at Alexandra Palace 1936-38. He then transferred to the Lines Department Television Section, and is at present in charge of Engineering Designs Department Television Apparatus Section.

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