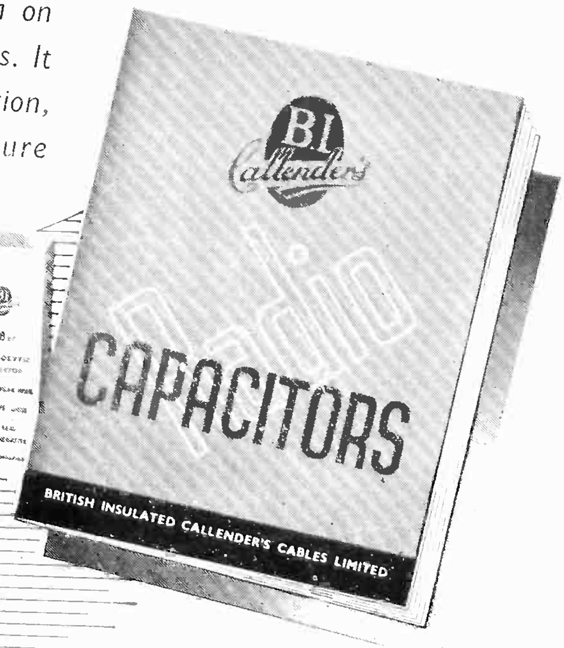
Electronic Engineering

Incorporating... ELECTRONICS, TELEVISION & SHORT WAVE WORLD

VOL. 21 No. 252 FEBRUARY 1949 PRICE 2/-

You'll need this new handbook...

because it contains additional data on the B.I.C.C. range of Radio Capacitors. It gives dimensions, methods of connection, capacitance tolerance, temperature ranges, etc., for all paper dielectric and electrolytic types. Write for your free copy today.



1 ECT (Electrolytic. Waxed carton). For domestic radio receivers—reservoir and smoothing.

2 EAC (Electrolytic. Aluminium can).* For domestic radio receivers—reservoir and smoothing.

3 PTB (Paper dielectric. Steel case).*† For amplifiers, power-packs, etc. — reservoir and smoothing.

4 PMT (Paper dielectric. Moulded Tube).*† For radio transmitters, receivers, radar and television—by-pass and coupling.

5 PPT (Paper dielectric. Bonded paper tube). For domestic radio receivers — by-pass and coupling.

6 ETU (Electrolytic. Bonded paper tube). For radio receivers and power-packs — smoothing and by-pass.

* Tropical type † Type-approved

B.I. Callender's RADIO CAPACITORS

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

CLASSIFIED ANNOUNCEMENTS

The charge for these advertisements is twelve words or less 5/- and 4d. for every additional word. Box number 2/- extra, except in the case of advertisements in "Situations Wanted" when it is added free of charge. A remittance must accompany the advertisement. Replies to box numbers should be addressed to: Morgan Bros. (Publishers) Ltd., 28, Essex Street, Strand, London, W.C.2 and marked "Electronic Engineering." Advertisements must be received before the 10th of the month for insertion in the following issue.

OFFICIAL APPOINTMENTS

ancies advertised are restricted to persons or employ-nts excepted from the provisions of the Control of gagement Order, 1947.

INISTRY OF SUPPLY invites applications from ysicists, Mechanical or Electrical Engineers for established posts in grade of Senior Experimental ...er at the Royal Aircraft Establishment, Farnborough and other establishments in S. England. ndidates should possess at least Higher School rtificate or equivalent, be aged 35 or over and have perience in one of the following fields:—experimental ht mechanical engineering and functional testing of ht mechanisms, design of optical instruments, photophic techniques and processes in connexion with ical measurements, circuit design, engineering of naturised radio and radar equipment. Inclusive ary range £705-£895 (men) and £580-£790 (women). portunities to compete for established posts may ur later. Write quoting A.437/48/A to Ministry of bour and National Service, Technical and Scientific gister (K) York House, Kingsway, London, W.C.2 application form which must be returned completed 5th February, 1949.

OYAL NAVY. Short Service Commissions in the ctrical Branch. Short Service Commissions of five rs are offered in the Electrical Branch of the Royal vy to ex-R.N.V.R. officers under 35 years of age on January, 1949, who served in the Torpedo, Special, ctrical or Air Branches and were employed on nnical duties connected with radar, wireless, air io, air electrical or ships' electrical equipments. ndidates will be entered in the substantive rank held release, with seniority adjusted by the time out of service. Promotion will be in accordance with regulations in force at the time for R.N. officers g. a Lieutenant (L) is at present eligible for promotion Lieutenant-Commander (L) at eight years' seniority). icers who complete the full period of five years on Active List will be eligible for a gratuity of £500 x free). Daily rates of pay are as follows:—b-Lieutenant (L), 13s.; Lieutenant (L) on promotion, 17s., after two years, 19s., after four years 4s., after six years, £1 6s.; Lieutenant-Commander) on promotion, £1 12s., thence in biennial increments 2s per day to a maximum of £2 2s. Marriage owance of £337 per annum if aged 25 or over, or 46 if under 25, is payable, and accommodation and ions are provided free, or allowances in lieu. ply to the Director, Naval Electrical Department, miralty, Queen Anne's Mansions, London, S.W.1, fuller details and application forms.

INISTRY OF SUPPLY invites applications for pointment as Senior Scientific Officer or Scientific ficer for duty in the first instance at an Establishment Worcestershire and later at the Atomic Energy search Establishment, Harwell, Berks. Duties will lude the development of ceramic loaded wave-guides centimetric wave work, the design and measurement waveguide components and the development of sociated frequency and power monitoring equipment. ndidates should possess a good Honours Degree, or uivalent, in Physics and have experience in design d development of waveguides. Inclusive salary nges are: Senior Scientific Officer £670-£860 (men); 45-£760 (women). Scientific Officer, £380-£620 en); £380-£495 (women). The appointment is established but carries F.S.S.U. benefits. Opportunities to compete for established posts may occur er. Write quoting A.450/48/A to Ministry of bour and National Service, Technical and Scientific egister (K), York House, Kingsway, London, .C.2, for application form which must be returned mpleted by 7th February, 1949.

THE MEDICAL RESEARCH COUNCIL have a acancy for a Technician (Male) at their Unit for esearch on Molecular Structure of Biological Systems Cambridge, for the construction and maintenance X-ray equipment. Candidates should be aged etween 25 and 35, and must have had experience in ectrical engineering and, if possible, vacuum technique. In addition, they should have taken the Higher National Certificate in Electrical Engineering) some equivalent qualification, and have some knowledge of workshop practice. The salary will be at a oint on the scale £450 by £20-£530 per annum, ccording to qualifications and experience. The ppointment would be subject to a six months' probationary period, and if this period were served satisfactorily, the member of the staff would be admitted to a contributory superannuation scheme. Annual and sick leave would be given at the same rate as for Civil Servants in analogous grades. Applications, in writing, giving name, age and address and full details of scholastic qualifications and subsequent career, and the name and address of at least one referee under whom the candidate has worked, should be sent to Dr. M. F. Perutz, Cavendish Laboratory, Cambridge.

MINISTRY OF SUPPLY invites applications from Physicists and Electrical Engineers for unestablished posts in grades specified below at the Royal Aircraft Establishment, Farnborough and other establishments in S. England. Senior Scientific Officer: Salary range, £670-£860. Scientific Officer: Salary range, £380-£620; rates for women are somewhat lower. Candidates should possess good Honours Degree or equivalent. The posts call for experience or special interest in one of the following fields: Radio and radar research including design and development of new systems, miniaturisation, VHF technique, aerial design, electronic circuit theory, electronic measurements, digital computing mechanisms. The appointments carry F.S.S.U. benefits. Opportunities to compete for established posts may occur later. Write quoting A.436/48/A to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, London, W.C.2, for application form, which must be returned completed by 5th February, 1949.

SITUATIONS VACANT

TECHNICAL ASSISTANT required for prototype testing and developments of radio and electronic measuring instruments. Apply giving full particulars of qualifications and experience to Marconi Instruments Ltd., St. Albans, Herts.

WIREMAN required, able to wire prototype electronic apparatus, working direct from circuit diagram. Accustomed to interpreting diagram and making initial cable forms and putting job on production basis. First-class opportunity for competent man to join staff. Excellent prospects of early advancement for right man. Apply, giving full particulars of experience to Marconi Instruments Ltd., St. Albans, Herts.

DRAUGHTSMAN (Senior) required in connexion with electronic measuring instruments. Apply, giving full particulars of qualifications and experience to Marconi Instruments Ltd., St. Albans, Herts.

SALES ENGINEER required for Head Office Staff of well-known company in Hertfordshire. Applicants must possess necessary technical qualifications and experience of X-ray and electro-medical apparatus. Box No. 447, E.E.

SENIOR RESEARCH ENGINEER required with Honours Degree in Electrical Engineering or Physics for advanced work on radar, radio and electronics. Apply quoting Ref. 187 to Central Personnel Services, English Electric Co., Ltd., Queens House, Kingsway, W.C.2.

ELECTRICAL ENGINEER REQUIRED for design of battery charging and other equipment incorporating metal and valve rectifiers. Higher National Certificate or equivalent, with some general engineering experience, together with natural ability. Work will include design, both electrical and mechanical, estimating and investigation of customer requirements. Previous experience with rectifiers desirable but not essential, a good opportunity for a progressive young man. Write stating salary required, qualifications and experience to, Personnel Manager, Edison Swan Electric Co., Ltd., Ponders End, Enfield, Middlesex.

ELECTRONIC ENGINEER or Physicist required to take charge of a department engaged on the design and construction of special purpose electronic test gear. A suitable applicant must have an Honours Degree in Electrical Engineering or Applied Physics and previous experience of the class of work. State qualifications, experience, age and salary required to Box No. 449, E.E.

PHYSICAL CHEMIST REQUIRED for research on dielectric properties of new ceramic materials. Applicants must hold a University Degree and should possess experience in the dielectric or ceramic fields. The post is in Northamptonshire. Salary according to experience. Write to Box No. 425, E.E.

DRAUGHTSMEN—Senior and Junior are required in the Research and Development Division of a large manufacturer in the East London area. Preference will be given to draughtsmen with electronic experience but all men with good drawing office experience will be given the most careful consideration. The vacancies are in connexion with a development project that holds excellent prospects for the future. State experience, age and salary required to Box No. 450, E.E.

RADIO ENGINEERS REQUIRED for development work on communication equipment by large and progressive company in the East London area. Applicants should have technical education to Degree standard and some experience of electronic research. State full details including age and salary required to Box No. 440, E.E.

SENIOR ENGINEER REQUIRED by leading firm of radio capacitor manufacturers. Applicant must have sound knowledge of circuit technique and capable of carrying through development of highly specialised test gear. Post is within 20 miles radius of London. Salary according to experience and qualifications. Box No. 439, E.E.

THE MULLARD RADIO VALVE COMPANY require graduates in Science or Engineering (or equivalent) aged 25–35 years with some works experience for senior posts in the production and engineering branches of the company. Salary according to age, experience and qualifications. Apply in the first instance to the Works Personnel Officer, The Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey, for a form of application and quote the reference "SA."

LEADING FIRM of component makers with factory in London have vacancies for Physicists and Engineers, preferably with experience in dielectric research or condenser manufacture. Write giving full particulars to Box No. 426, E.E.

PROMINENT ENGINEERING FIRM in North-West requires Senior Engineer having experience in development of centimetric radio aerials and wave-guide technique. Reply Box No. 427, E.E.

YOUNG MAN with Higher National Certificate in Electrical Engineering required, preferably with some knowledge of measurements to carry out electrical and magnetic measurements on all kinds of special alloys and the application thereof. Full particulars to Box No. 429, E.E.

ELECTRONIC CIRCUITRY ENGINEER with considerable experience of pulse technique required for development of industrial electronic equipment in expanding organisation. Salary according to experience. Woking, Surrey area. Apply, stating experience, academic qualifications and salary required to Box No. 433, E.E.

DRAUGHTSMEN are required by the Research Laboratories of the General Electric Co., Ltd., North Wembley, Middlesex for work in the field of radio or telecommunications. Vacancies exist for seniors with several years experience as well as for more junior candidates. Apply to the Director, stating age, academic qualifications and experience. This advertisement is inserted by permission of the Ministry of Labour and National Service under the Control of Engagement Order, 1947.

ANGLO-IRANIAN OIL COMPANY requires an Electronic Engineer for work at their research station in connexion with the development of engine inductors, special amplifiers, control equipment and other apparatus for research on the behaviour of internal combustion engines and their fuels, etc. Applicants, who should have had experience on development of electronic apparatus, should be aged 20–30 and possess Higher National Certificate or a University Degree. Salary according to age, qualifications and experience. Write quoting Dept. H. 827, to Box 5508, at 191, Gresham House, E.C.2.

INDEX TO ADVERTISERS

SEE PAGE 36

CLASSIFIED ANNOUNCEMENTS (Cont'd.)

ELECTRONIC & GENERAL DEVELOPMENT Engineer required for development of electronic and associated apparatus for industrial purposes. Considerable experience of development or design in radio or industry is essential. Sound mechanical knowledge an asset. Write stating salary required, qualifications and experience to Personnel Manager, Edison Swan Electric Co., Ltd., Ponders End, Enfield, Middlesex.

MURPHY RADIO LTD., invite applications for the following vacancies in the Electrical Design Laboratory. (1) Senior Radio Engineer with good Honours Degree in Physics or Electrical Engineering and several years industrial experience in television or radio receiver development. (2) Radio Engineer with good academic qualifications in Physics or Electrical Engineering, preferably with some industrial experience. Apply to Personnel Dept., Murphy Radio Ltd., Welwyn Garden City, Herts.

BELLING & LEE LTD., Cambridge Arterial Road, Enfield, require services of experienced and qualified electronic engineer to investigate problems in connexion with broadcast and television receiving aerials, radio interference suppression and radio and electronic components. This type of work presupposes a working knowledge of physics and electronic mathematics, together with an inventive flair. Applicants age should lie between 25 and 35 years and the scale of salary commensurate with experience and knowledge will not exceed £600 per annum.

THE FOLLOWING VACANCIES exist in a large radio manufacturing company, London area: (1) Radio Research Engineers for the development of domestic receivers for the home and export markets. (2) Television Research Engineers. (3) Specialists in time base and E.H.T. circuit development. Extremely good positions offered to keen men with ideas and ability to develop equipment to the stage of production. Write in confidence stating age, qualifications, experience and salary required. Box No. 432, E.E.

ENGINEERS REQUIRED by Loudspeaker Manufacturers for Research and Production Department. Preferably with experience in pressure unit design and development. Write full particulars of age, experience, qualifications and salary required to Box No. 430, E.E.

DESIGNER DRAUGHTSMAN required for development of mass produced electro-mechanical devices and mechanical design of industrial electronic equipment in expanding organisation. Salary according to experience. Woking, Surrey area. Apply, stating experience, academic qualifications and salary required to Box No. 434, E.E.

VALVE ENGINEER. A well-known company in the London area has a vacancy for an Engineer to act as Technical Assistant to manager in their Transmitting and Special Valve Section. Applicants should be fully conversant with modern manufacturing methods, and have had experience in the design and manufacture of radiation-cooled and external anode type valves. Knowledge of valve application, particularly in the R.F. heating field an asset. Write stating qualifications, experience and salary required to Box No. 435, E.E.

E.M.I. ENGINEERING DEVELOPMENT LTD. In an organisation which is continually expanding there are still many progressive vacancies open for men with a Degree or the equivalent in Engineering or Physics, coupled with actual design experience. For these posts the normal starting salaries are £400 to £800 according to qualifications, experience and responsibility. Applicants for junior positions should have either an Engineering Degree or actual design experience. The types of development to which these vacancies relate are major radar projects, radio communication, television, audio-frequency engineering, magnetic recording, and tropicalised components. There are also particular liaison posts available in connexion with technical requirements on materials and components, and the collection of technical information and preparation of instruction manuals. Send full details of experience and qualifications to Personnel Department, E.M.I. Ltd., Blyth Road, Hayes, Middlesex.

EXPERIENCED SENIOR AND JUNIOR Radio, Radar, Television, Electronic, Acoustic Engineers, preferably B.Sc., H.N.C., also similarly experienced Draughtsmen, Testers, Inspectors, etc. required. Technical Employment Agency, 179, Clapham Road, S.W.9. (BRIxton 3487).

RADAR AND HIGH FREQUENCY Engineers required. Knowledge of radar systems and/or waveguide technique and component design essential. State salary required, personal details and full experience to Box No. 445, E.E.

CONTINUED EXPANSION of the E.M.I. Electronics College has created further vacancies for lecturers in Radio Communications. Two lecturers whose duties will include some technical writing are required immediately. Applicants should possess a good Physics or Electrical Engineering Degree and also experience in radio, television, etc. Age 22–28. Commencing salary according to age, qualifications and experience, not less than appropriate Burnham scale. Superannuation benefits in addition. Apply, giving fullest possible particulars to Professor H. F. Trewman M.A. (Cantab.) M.I.E.E., M.I.Mech.E., M.Brit.I.R.E., E.M.I. Institutes Ltd., 43, Grove Park Road, London, W.4. Tel.: CHIswick 4417/8.

McMICHAEL RADIO LTD., require Senior Project Engineers in their Equipment Division Development Laboratory at Slough. These appointments are of a stable and progressive nature, satisfying the keenest appetite for the expression of initiative and the acceptance of responsibility. Training and experience in the field of Applied Electronics (including Communications) and experience of working with Government departments are the chief qualifications required. Salary will be commensurate with ability. Write stating age and full details of training, qualifications and experience to the Chief Engineer, Equipment Division, McMichael Radio Ltd., Slough, Bucks.

REQUIRED, several Senior Mechanical or Electrical Draughtsmen with experience in the design of mercury arc rectifiers, high vacuum plant or nuclear physics equipment. Manchester district. Five day week. Paid overtime. Salary according to experience. Apply giving qualifications—educational and training, and details of experience. Mark envelope "TTE," Box No. 448, E.E.

REPRESENTATIVE, with sound electrical knowledge, required by West London manufacturers, for London area. Must have commercial experience and possess a car. Should be fully conversant with electrical indicating instruments and relays. State experience and salary to Box No. 446, E.E.

EXPERIENCED MEN AND WOMEN required in the Cambridge area as testers on blind landing radio equipment. Interesting work. Profit sharing scheme. Five-day week. Box No. 451, E.E.

YOUNG ENGINEERS required for sales and servicing of industrial electronic instruments. Progressive position for hard workers with pleasing personality. Successful applicants will be based on London. State age, experience and salary expected. Marconi Instruments, Ltd., 109, Eaton Square, London, S.W.1.

LEVER BROTHERS & UNILEVER LTD. require, at the Research Laboratories, Port Sunlight, several scientists with a working knowledge of electronics and electrical circuitry. Ability to design and develop electro-mechanical devices is also desirable. Candidates must be under 30 years of age and hold a Degree with Honours or equivalent qualifications in Physics or Electrical Engineering. The salary for these posts will be assessed according to qualifications and experience. Applications should be addressed to Lever Brothers & Unilever Ltd., Personnel Department (FMD), Unilever House, Blackfriars, London, E.C.4.

BUSH RADIO LIMITED. Applications are invited from experienced radio engineers for the following positions: (a) Development work on communications and domestic radio receivers; (b) Development work on test gear for quality control television production and laboratory use. Apply in writing only, giving age, details of experience, qualifications, salary required, etc., to the Labour Manager, Bush Radio Ltd., Power Road, Chiswick, W.4.

PHYSICISTS required by manufacturers in southeast England to carry out work on semi-conductors phosphors, etc. Applicants should preferably have some experience of work on electronic equipment. Apply, quoting Ref. 192 to Box No. 454, E.E.

SITUATIONS WANTED

TECHNICAL REPRESENTATIVE, extensive connexions electrical and chemical industries this country and Continent, London office. Able to undertake representation of manufacturer of specialised electrical apparatus or components. Box 441, E.E.

TECHNICIAN, 33, 12 years experience radiocommunications, desires change to progressive post in radio/radar/television, in which essential qualifications required are practical ability, initiative, ability to work without supervision. City and Guilds, R.S.A., Borough and Northampton Polytechnic training. Prospects more important than pay. Box 444, E.E.

HONOURS ENGINEERING Graduate (telecommunications, measurements, power materials, structures). Aged 21, seeks opening. Box 428, E.E.

RADIO ENGINEER. Ex W.O. R.E.M.E. City and Guilds finals, technical electricity. Radio communication, Assoc. Brit. I.R.E. 7 years general experience, including lecturing, seeks progressive, responsible appointment, research preferred. Box 438, E.E.

LADY TRACER requires position London. Radar experience. Box 436, E.E.

DEVELOPMENT ENGINEER, middle 30's, A.M.Brit.I.R.E. Seeks change. Some television experience. Box 443, E.E.

EDUCATIONAL

A.M.I.E.E., City and Guilds, etc., on "NO PASS—NO FEE" terms. Over 95 per cent. successes. For full details of modern courses in all branches of Electrical Technology send for our 112-page handbook—FREE and post free. B.I.E.T. (Dept. 337B), 17, Stratford Place, London, W.1.

THE POLYTECHNIC, 309, Regent Street, W.1, Electrical Engineering Department. A special course of six lectures on Electronics in Industry will be given by L. I. Farren, M.B.E., Whit. Schol. A.M.I.E.E., A.C.G.I., D.I.C. (Member of the Staff of the Research Laboratories of the General Electric Co., Ltd.). On Fridays at 6.30 p.m. Commencing 4th February, 1949. Fee for the course: 10s. A syllabus may be obtained on application to the undersigned. J. C. Jones, Director of Education.

SERVICE

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, London, N.1.

REWINDING. A specialist winding service covering A.F. transformers, relays, solenoids, and to specification. S.T.S., Ltd., 297/299, High Street, Croydon, Surrey. Telephone: CROydon 4870.

RADIO MANUFACTURERS can undertake development and assembly of radio or electronic equipment. Winding shop with vacuum impregnation plant. Ample space and labour available. Box 316, E.E.

COMPLETE coil winding service. Rewinds, "Specials," Prototypes or quantity production. Layer, Wave and Progressive wave winding. Design and Development. Rynford Ltd., 17, Arwenack Street, Falmouth.

MISCELLANEOUS

WE WILL BUY at your price used radios, amplifiers, converters, test meters, motors, pick-ups. speakers, etc., radio and electrical accessories. Write, phone or call, University Radio Ltd., 22, Lisle Street London, W.C.2. GERrard 4447.

PHOTOGRAPHY. We specialise in advertising and catalogue-photography, and in series photographs for instruction sheets. Our pictures tell the story. Behr Photography, 44, Temple Fortune Lane, N.W.11 (SPEedwell 4298).

PATENT

THE PROPRIETORS of British Patent No. 563561, relating to Electronic Translating Devices, are desirous of entering into arrangements by way of licence or otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. Interested parties who desire a copy of the Patent Specification and further particulars should apply to S. E. Matthews, 14-18, Holborn, London, E.C.1.

FOR SALE

CHASSIS, panels, racks and metal cabinets, stock sizes or made to specification. "Reosound," Coleshill Road, Sutton Coldfield.

WEBB'S 1948 Radio Map of World, new multi-colour printing with up-to-date call signs and fresh information; on heavy art paper, 4s. 6d., post 6d. On linen on rollers, 11s. 6d. post 9d.

IN STOCK. Rectifiers, Accumulator Chargers, Rotary Converters, P.A. Amplifiers, Mikes, Mains Transformers, Speakers of most types, Test Meters, etc. Special Transformers quoted for.—University Radio, Ltd., 22, Lisle Street, London, W.C.2. GERrard 4447.

CLASSIFIED ANNOUNCEMENTS
continued on Page 4

CLASSIFIED ANNOUNCEMENTS (Cont'd.)

COPPER WIRES: enamelled, tinned, Litz, cotton, silk covered. All gauges. B.A. screws, nuts, washers, soldering tags, eyelets. Ebonite and laminated Bakelite panels, tubes. Paxolin coil formers. Tufnol rod. Permanent detectors, etc. List S.A.E. Trade supplied. Post Radio Supplies, 33, Bourne Gardens, London, E.4.

RADAR SETS, type AN/APN4, 5 in. short persistence electrostatic C.R.T., suitable for oscilloscope or television, 25 valves, circuit diagram available, £7; 6SN7's, 6SJ7's, 6SL7's, tested, 6s. each. Stamp for details. Box 378, E.E.

TELEVISION E.H.T. TRANSFORMERS in stock: 5KV, 4V, 1.5A, rect. guaranteed. C.O.D. or C.W.O. at 3 gns. each, post 1s. 6d. R. F. Gilson Ltd., 11a, St. George's Road, Wimbledon, S.W.19.

FELICITY "Extended Range" 8 watt amplifiers are now available with remote tone control unit standard amplifier, price £27 10s., or with remote control unit and 42 in. lead extra 30s. Full details from F.S.R. Ltd., 87a, Upper Richmond Road, London, S.W.15.

CAMBRIDGE INSTRUMENT Test Set comprising unipivot galvanometer thermo couples and all voltage and current shunts: Max. voltage 2400, max. current 24 amp. Further details on request. Cost over £120 consider any reasonable offer. Box No. 437, E.E.

DUMONT 6 in. OSCILLOSCOPE model as new £40. Cossor model oscillator £13. RTS precision R/C bridge, cost £18, accept £12. AVO valve tester £12 10s. 145, Merrivale Road, Exeter.

SELLING OUT best offers Radio Amateurs Laboratory. Collection Proc. I.R.E., 1933-1948, Cossor DB. oscillograph 339, impedance bridge, cameras, photocell counter, Marconi 1000 Kc/s. inductance bridge, valve voltmeter, Muirhead decades, Evershed bridge megger, Bowthorpe testometer, Philco 'scope, Ferranti meters, rack mounted radiogram, etc. Box No. 442, E.E.

A QUANTITY of Type 100R Variacs 2 KVA. Thoroughly inspected and tested. 8 gns. each. carriage extra. Box No. 452, E.E.

ELECTRONICS, 1946, 1947, 1948, £6 10s. Electronic Industries Mar. 1945–July 1946, 30s. Nucleonics Sept. 1947–Nov. 1948, £5. Martin, 3, Cliff Ave, Loughborough, Leics.

COPPER WIRE, enamelled, synthetic, covered, tinned, flex, sleeving, etc. S.A.E. list. Armes, 37, Birchwood Drive, Leigh-on-Sea.

GERMAN MAGNETIC TAPE RECORDER. Superb outfit, 110-250 volts, phonic motor control 9-120 cm/sec. 3 hrs. per drum. 3 motors. Fully metered. Fine quality, low noise. 200 per cent. spare valves, etc. 14 spools. Offers over £75. Box No. 453, E.E.

REMOTE POSITION indicators, accuracy one degree, comprising Magslip transmitter and receiver, as well as auto-transformer for operation direct from 200/240 volt mains. Few only at 50s. per set complete with instructions. Send also for list with data on other magslips and selsyns, complete range available from .05 oz. to 45 lb. per inch torque. Also 10 watt linear wirewound Berco M10 potentiometers 1K. 4s. 9d. 50K 5s. 2-gang carbon pots. 1 Meg.-1 Meg. 3s. 6d. All goods ex-Govt. but fully guaranteed and post free. Hopton Radio, 1 Hopton Parade, Streatham High Road, London, S.W.16. STReatham 6165.

QUANTITY DCC Copper Wires and ex-Government condensers, moulded mica, neoprene, silver mica, ceramic, tubular cans, trimmers. Write for list: G. Barnaper, 1, New Court, Carey Street, London, W.C.2. HOLborn 5244.

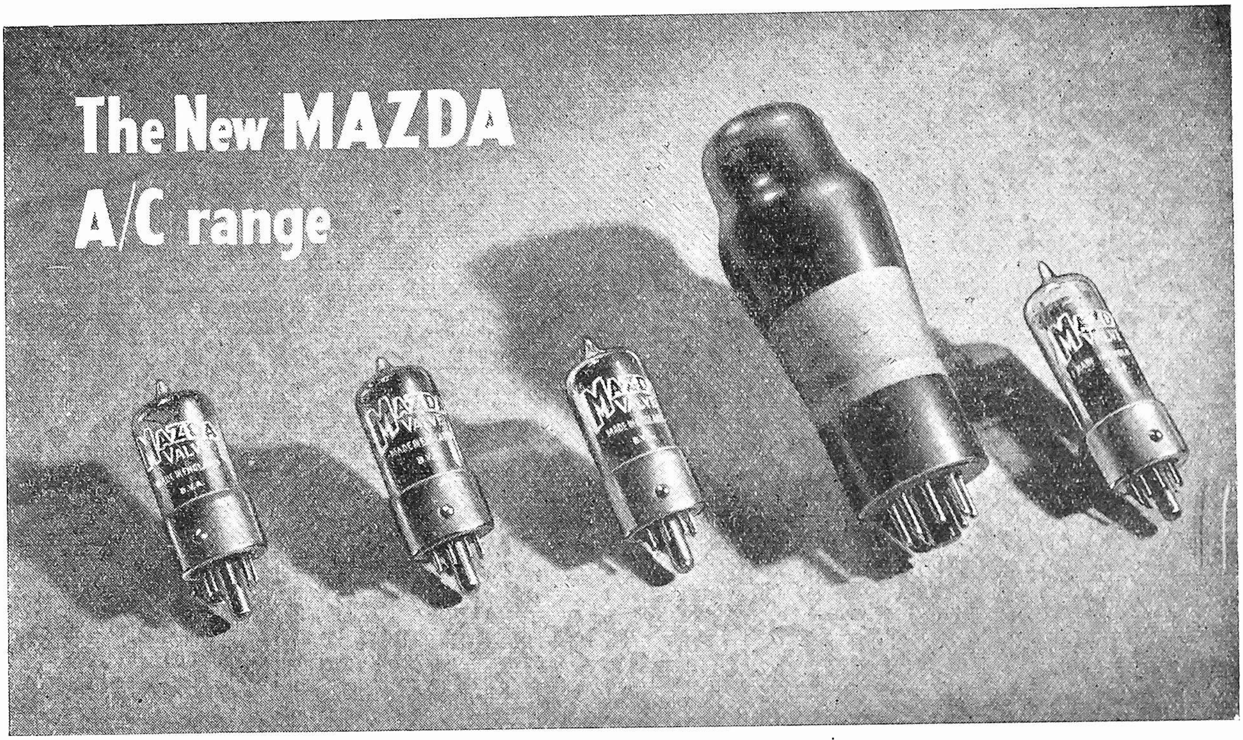
MANY VIEWERS have found that a Spencer-West type AC/2 television pre-amplifier considerably improves results. The unit at 10 gns. is excellent value in itself. The considerable improvement it effects makes it worth very much more. Full particulars from Spencer-West, Quay Works, Gt. Yarmouth.

WANTED

WANTED—Small quantities in good condition. Monitor Unit Type 28 or 27. Transmitter TR 3529A. Power Unit 529 Test Set TS 34/AP. Modulator Unit Type 158A. Test Set TS 13/AP. Amplifier A 3583 or A3531. Signal Generator type 52. Also 3 cm. waveguide components. Box No. 431, E.E.

WANTED — Telephone and Telegraph Carrier Apparatus of all types in any condition. Wilson, 93, Wardour Street, W.1.

WANTED—Teletype apparatus parts and accessories of all kinds. Terry, Strouds, Pangbourne, Berks.



The new MAZDA A/C range includes four miniature B8A valves — a desirable feature where space is an important consideration, as in car radio, for example.

6C9 TRIODE HEPTODE FREQUENCY CHANGER. RATING.

V_h	6.3v
I_h	0.45A
V_a (max)	250v
$V_{a,\,t}$ (max)	150v
V_{g2}(max)	250v
I_k(h)av(max)	10mA
I_k(t)av(max)	6mA
*V_{h-k}(max)	150v

List Price **14/-**

6F15 VARIABLE-MU R.F. PENTODE RATING

V_h	6.3v
I_h	0.2A
V_a(max)	250v
V_{g2}(max)	250v
I_k(av)max	10mA
gm	2.3mA/V
r_a	1.7mΩ
*V_{h-k}(max)	150v

List Price **13/-**

6LD.20 DOUBLE DIODE TRIODE RATING

V_h	6.3v
I_h	0.25A
V_a(max)	250v
I_k(av)max	5mA
gm	3.4mA/V
r_a	9300Ω
μ	31.5
I_a(d)av(max)	0.1mA (per diode)
*V_{h-k}(max)	150v

List Price **12/-**

6P25 OUTPUT TETRODE RATING

V_h	6.3v
I_h	1.1A
V_a(max)	250v
V_{g2}(max)	250v
P_a(max)	10w
P_{g2}(max)	2.5w
gm	9.0mA/V
*V_{h-k}(max)	150v

List Price **13/-**

UU9 FULL WAVE RECTIFIER RATING

V_h	6.3v
I_h	0.63A
V_a(r.m.s.)max	350v
P.I.V.(max)	1100v
I_a(av)max	90mA
I_a(pk)max	360mA
ø V_{h-k}(max)	300v

List Price **11/6**

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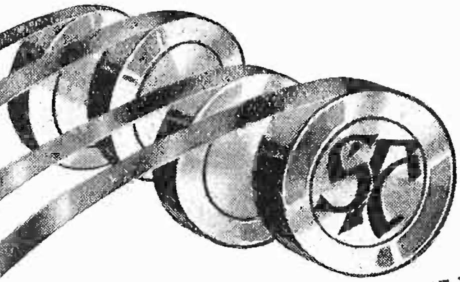

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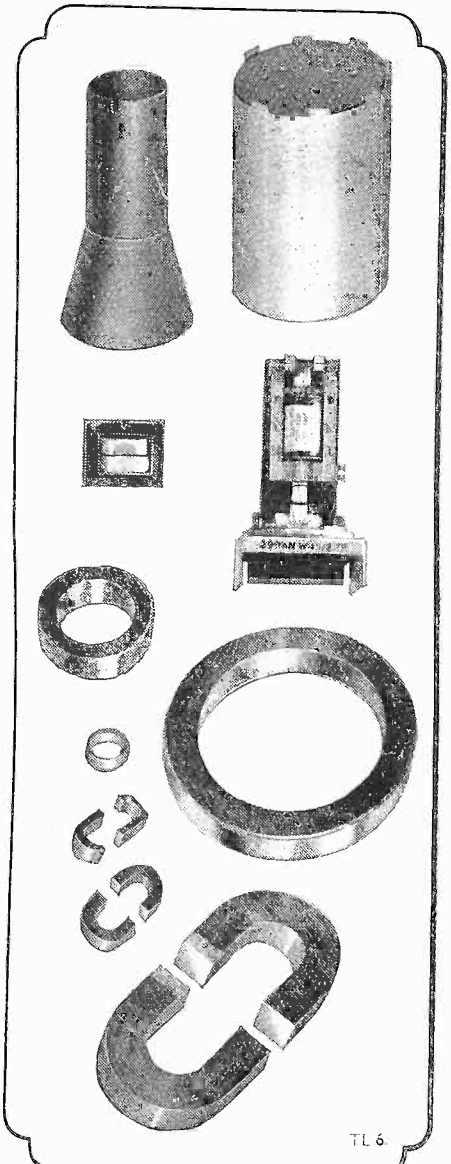

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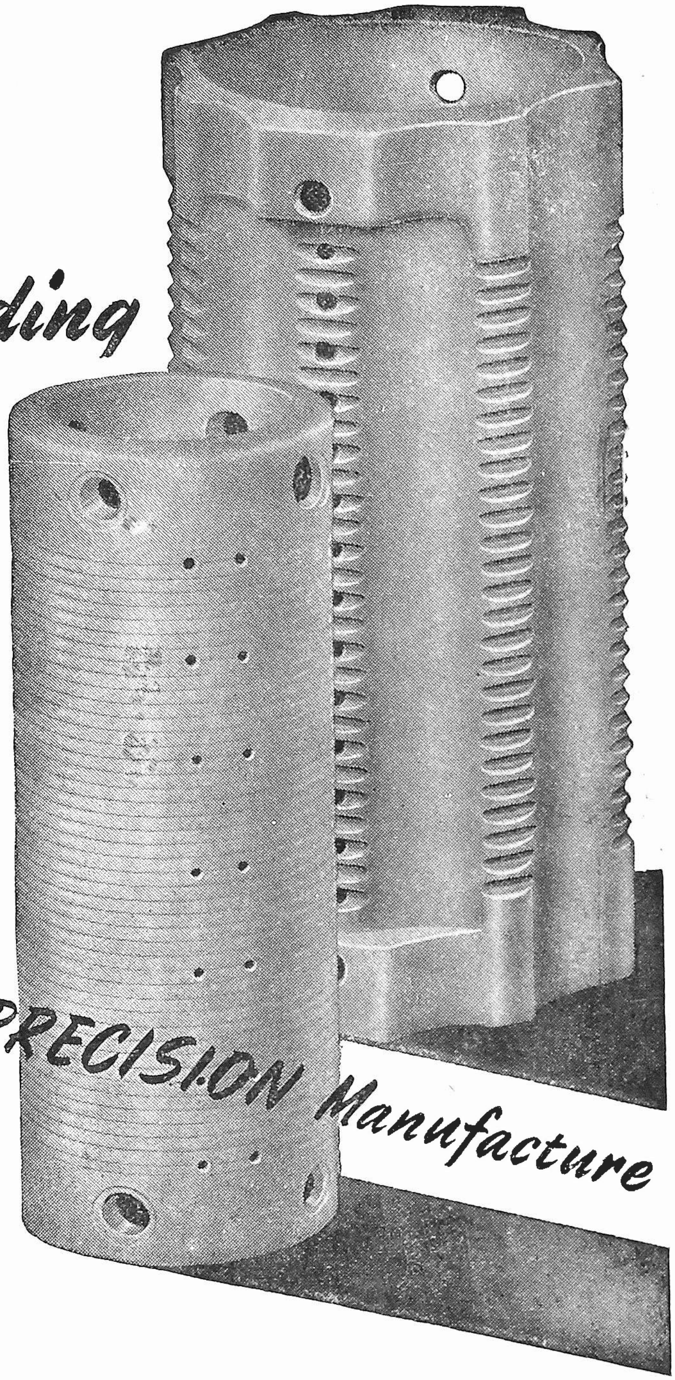

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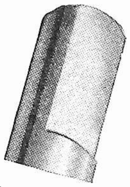

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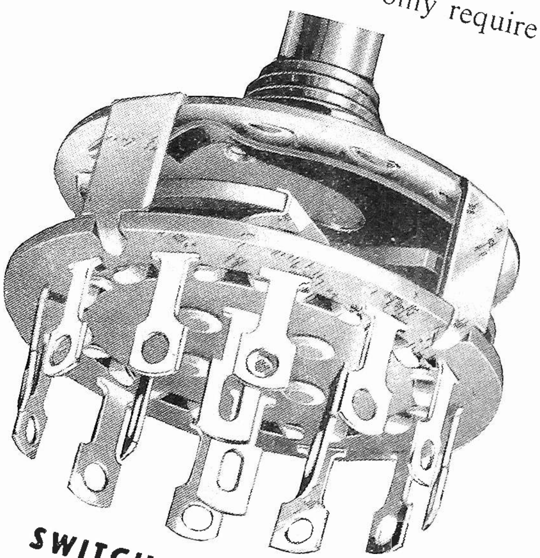

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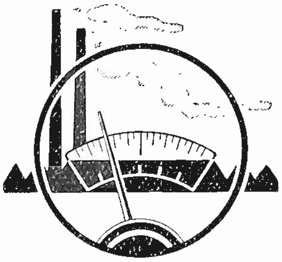

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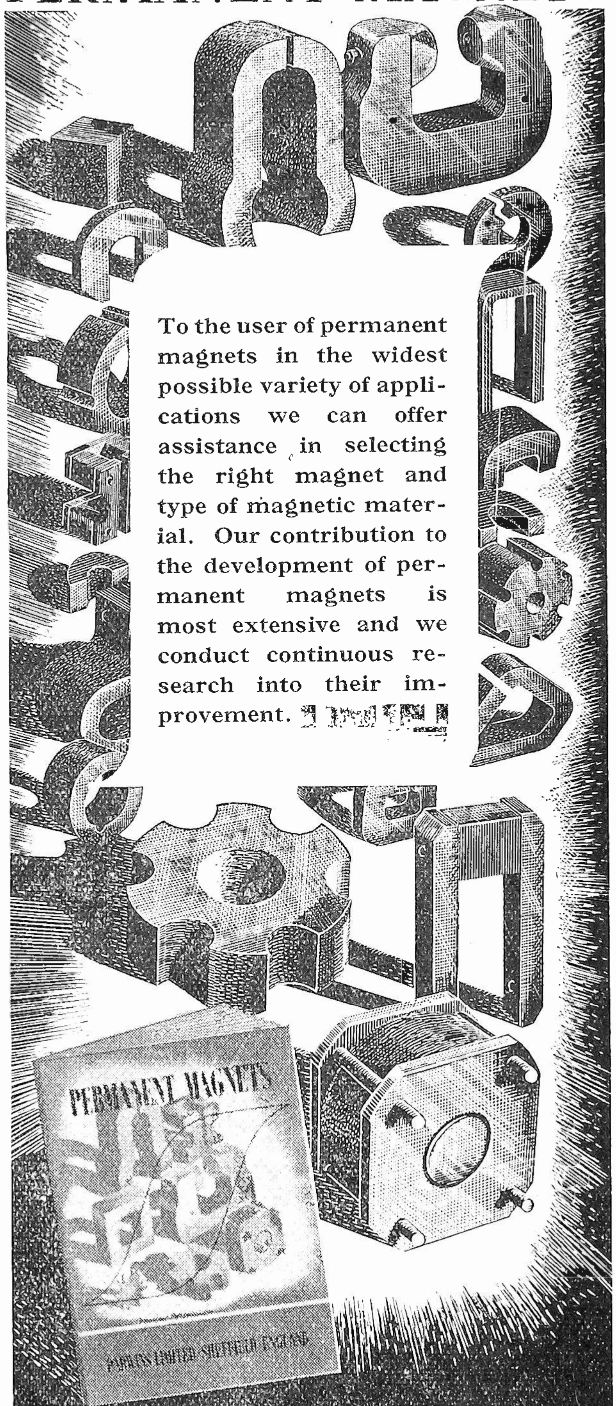

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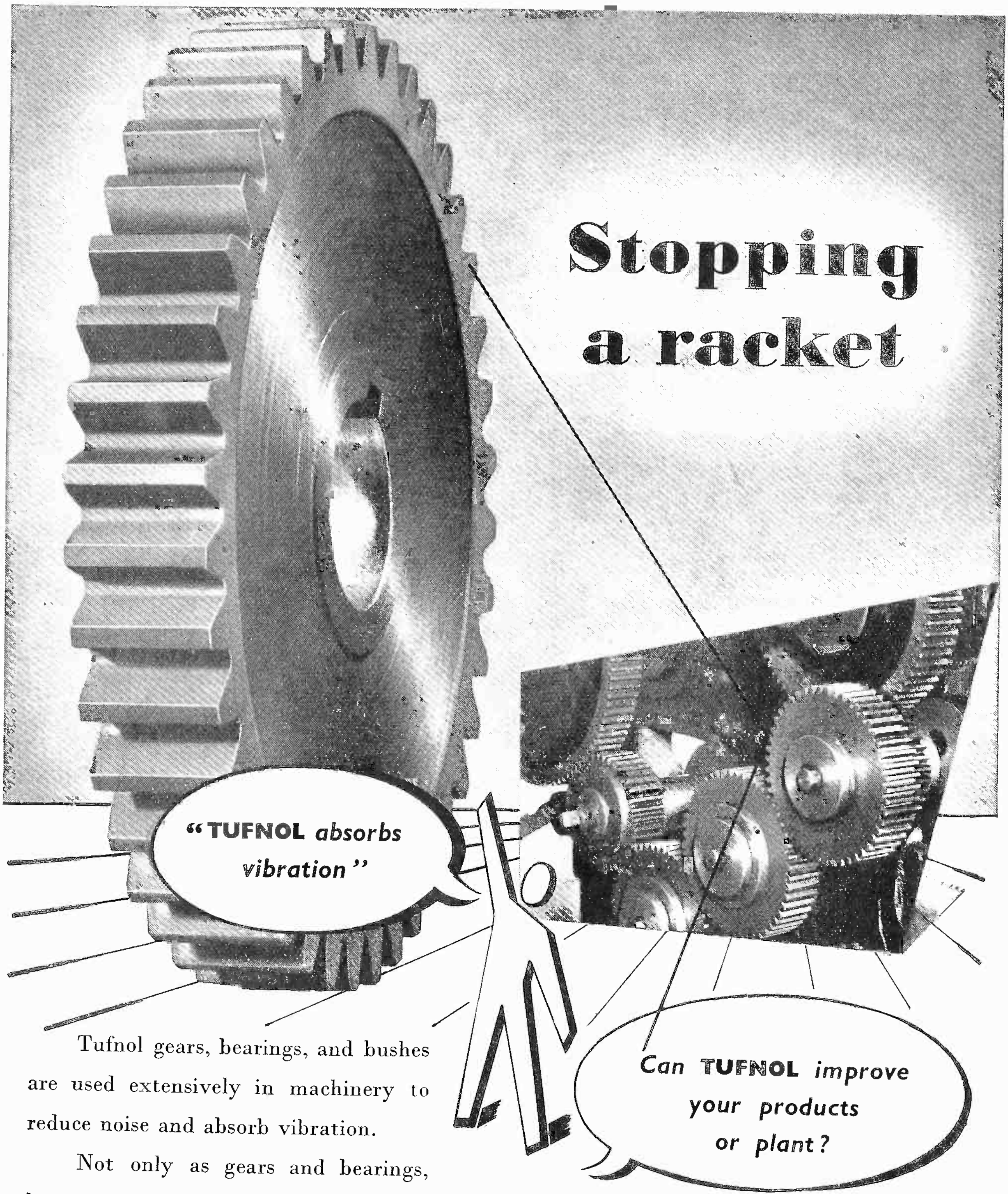
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CONTENTS

Special Degrees in "Radio"

A DISCUSSION of considerable interest to all those engaged in Electronic Engineering was recently held at the Institution of Electrical Engineers in London.

It was on the motion "Should British Universities consider the establishment of special degrees in Radio?" and was opened by Prof. E. B. Moullin, M.A., Sc.D., who speaks with long teaching experience in Electrical Engineering.

He said that the motion should be considered from two aspects; firstly, did the qualifying word "special" raise the issue whether the contemplated degree should admit a student to graduation such as a B.A., or B.Sc., or whether it should be an additional qualification after graduation such as a Diploma?

If it was the first, then the idea was an abomination; if the second, then it was tolerable. Diplomas after graduation were quite usual in other subjects such as Public Health so that a Diploma in Radio was just acceptable.

Secondly, what was the definition of the word "Radio," and what should be the scope or syllabus of an examination for a degree in Radio Engineering?

After reviewing the broad, and well established principles upon which a University education should be based, he put forward the subjects which might reasonably be included in such a projected Radio course, and showed that this would be merely a dilution of a normal Electrical Engineering course.

His concluding words are well worth quoting here in full, "Let us," he said, "give up thoughts about degrees in Radio for they will only open up a fresh gate to detailed and pedestrian technological instruction of the 'immediately useful' variety; let us instead encourage the Universities to include in their Degree courses in Electrical Engineering some theory of molecular structure and kindred matter, and discourage them from paying too much attention to details of special circuits or design office nicetes of machine design, etc.

"We want their graduates in Electrical Engineering to become professional engineers and we do not want them to be men loaded with technicians' 'expertise.'"

One surprising piece of factual information given was that about two students (presumably full time) in every thousand enter "Radio" Engineering after graduation at British Universities. If one attempts to relate this figure to the estimated number of full-time students entering in 1949, namely 83,000, then the new intakes after graduation will be less than two hundred!

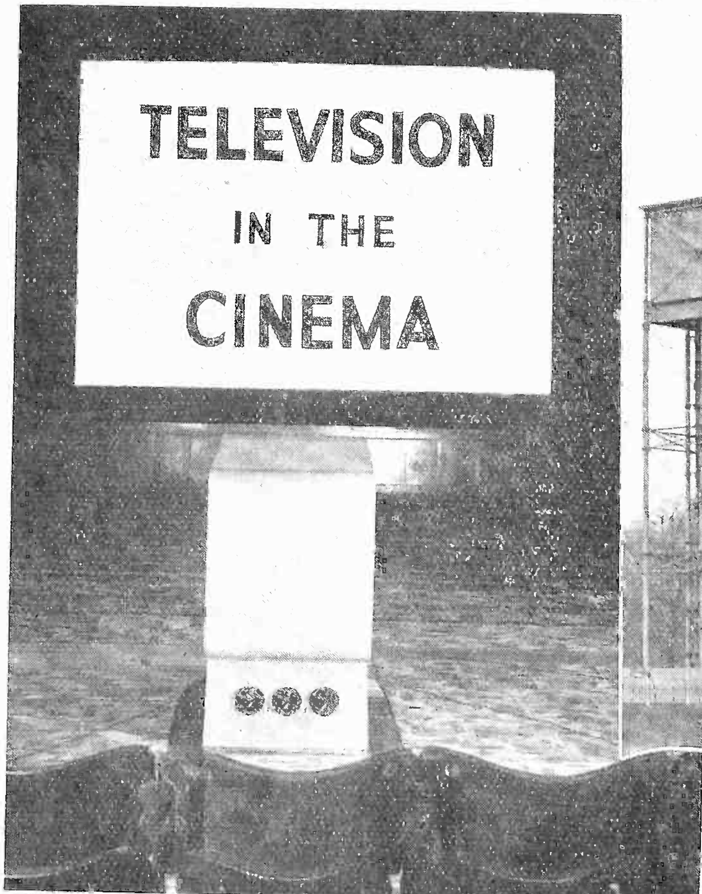
To us this seems remarkably low, but, if true, the establishment of Special Degrees is even more unnecessary.

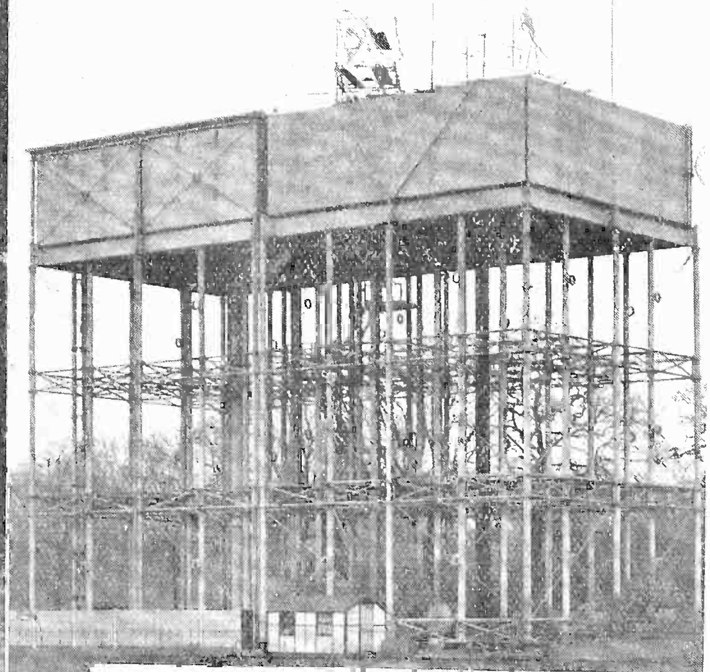
The corresponding number in American Universities was given as thirty per thousand, although the large majority were absorbed by the more general applications of Radio Engineering.

It should not be overlooked, however, that the Physics Departments of the Universities train a large number of Physicists with a background of Radio and that these men are readily acceptable to the Research organisations in the Services and in Industry.

During the war it was common experience, particularly in Radar, that these Radio Physicists developed into very capable "Radio" Engineers and the reason is not far to seek. Their knowledge of the fundamentals of Physics—or Natural Philosophy as Dr. Moullin preferred to call it—was sound, and the engineering "know-how" followed without difficulty.

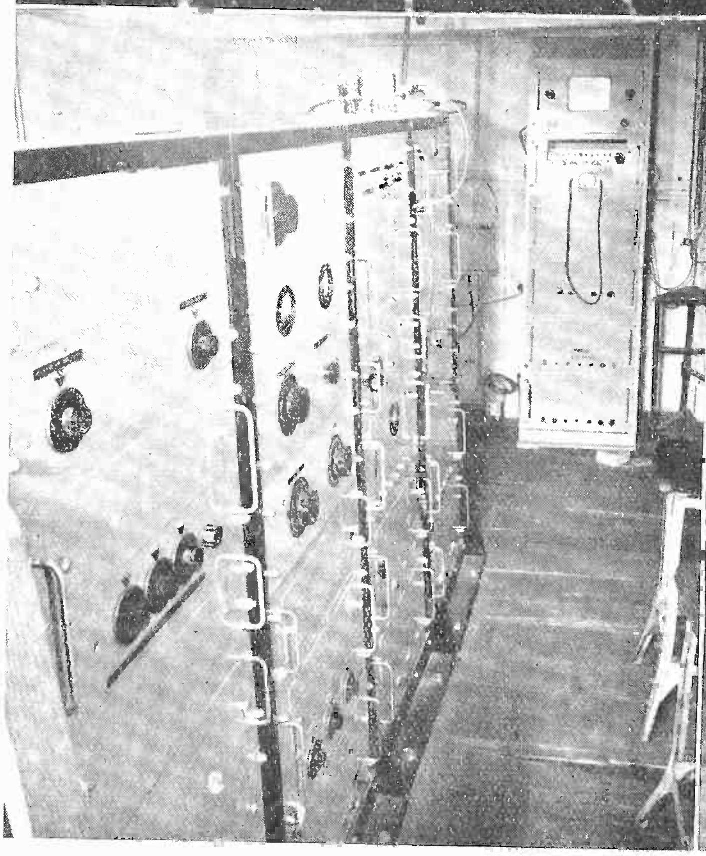
It seems, therefore, that so long as British Universities resist the temptation to specialise, they already provide an adequate and sound course.

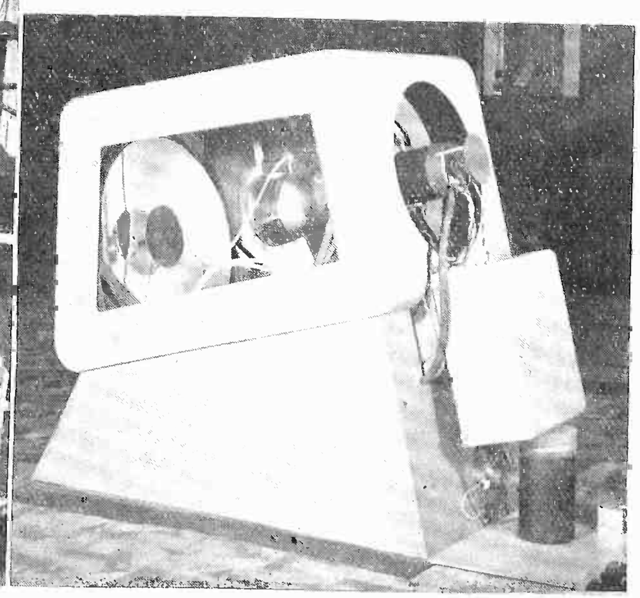




On December 21st, at the Palais-de-Luxe Theatre, Bromley, Kent, a successful demonstration was given of large screen television (16 ft. by 12 ft.) using "Cintel" projection equipment. The B.B.C. television programme was received by radio from Alexandra Palace and a transmission was also received from the Cinema-Television factory at Sydenham.

Top left : View of screen from the rear of the television projector.
Top right : Radio beam aerial system mounted on the water tower of the Crystal Palace, providing television coverage to cinemas in the London area.
Lower left : Projector Control Room at Palais-de-Luxe Cinema.
Below : View of the television projector with one side of the casing removed to show the cathode ray tube, mirror, and correcting plate.
The projector is placed in the auditorium, 40 feet from the screen, and is remotely controlled from the projection booth at the back of the theatre





A Watch Rate Recorder

By

H. G. M. SPRATT, B.Sc., M.I.E.E.

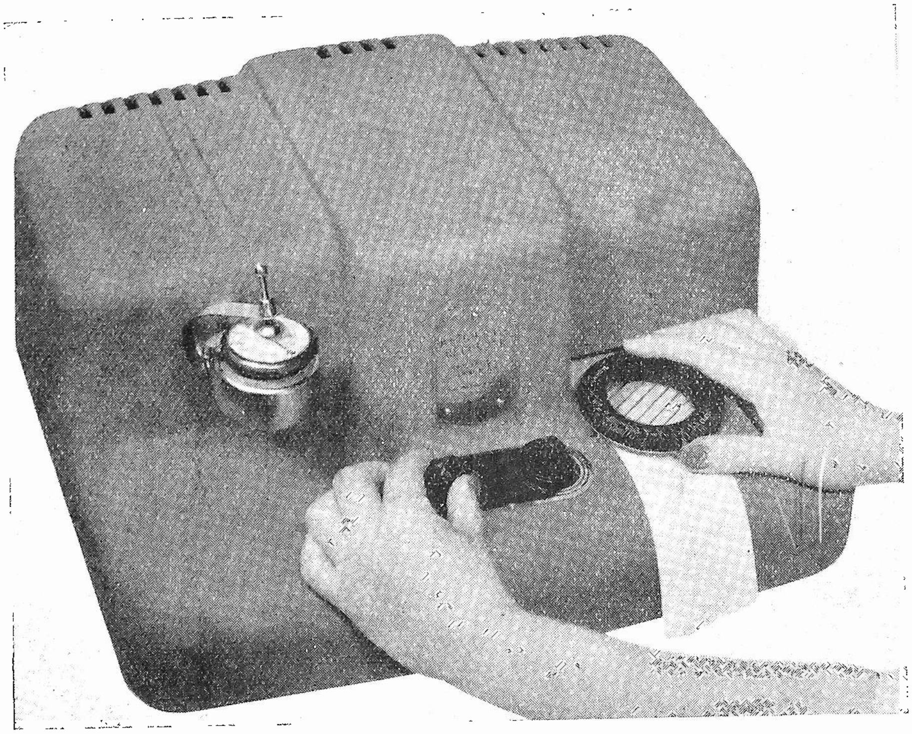


Fig. 2. Watch Rate Recorder with watch in testing position
By courtesy of Dawe Instruments, Ltd.

IN the past it has always been recognised that the rating of a watch could not be carried out in less than a few days and, generally, several more were considered desirable. Two main factors contributed to make this long period inevitable, namely, the essential need for a 24-hour period to test for isochronism in one position alone and the absence of a differential form of tester.

Isochronism is the ability of a watch to maintain a constant rate over the whole of a 24-hour period, starting from the fully-wound condition. It was obviously impossible to test for isochronism without carrying out a 24-hour run. Furthermore, as the rate of a watch is liable to considerable variation according to the position in which it is held, at least five separate runs, one for each position, were necessary for a complete test. Such a form of testing, however, is obviously of an integrating character and does not reveal the action of the watch at any particular instant. Now it is possible for a watch to have a number of faults or irregularities of an intermittent or repetitive nature, which are "smoothed out" in an integrated 24-hour run. Some of them, indeed, such as those associated with the faster moving parts, would escape notice in an integrated run of a minute or two. Every irregularity of this kind constitutes a fault of a more or less serious nature which will prove a source of trouble in the future, yet most of them would never show up in a 24-hour run, while a few could not possibly be detected from the most expert inspection.

Until recently, no precise means of determining the differential rate of a watch existed. Of late, however, the position has been completely changed by the development of the Watch Rate Recorder. This instrument uses the quartz crystal oscillator as a standard frequency source, or timer, and recording equipment by which the instantaneous performance of a watch can be compared with it. Every tick of the watch is individually recorded on the chart and its time relationship with any other tick can be quantitatively determined at a glance. A short record covering 15-20 seconds is generally found sufficient for any one watch position. Incidentally, it might be mentioned at this stage that the existence of additional noises, apart from the legitimate tick, will be recorded on the chart.

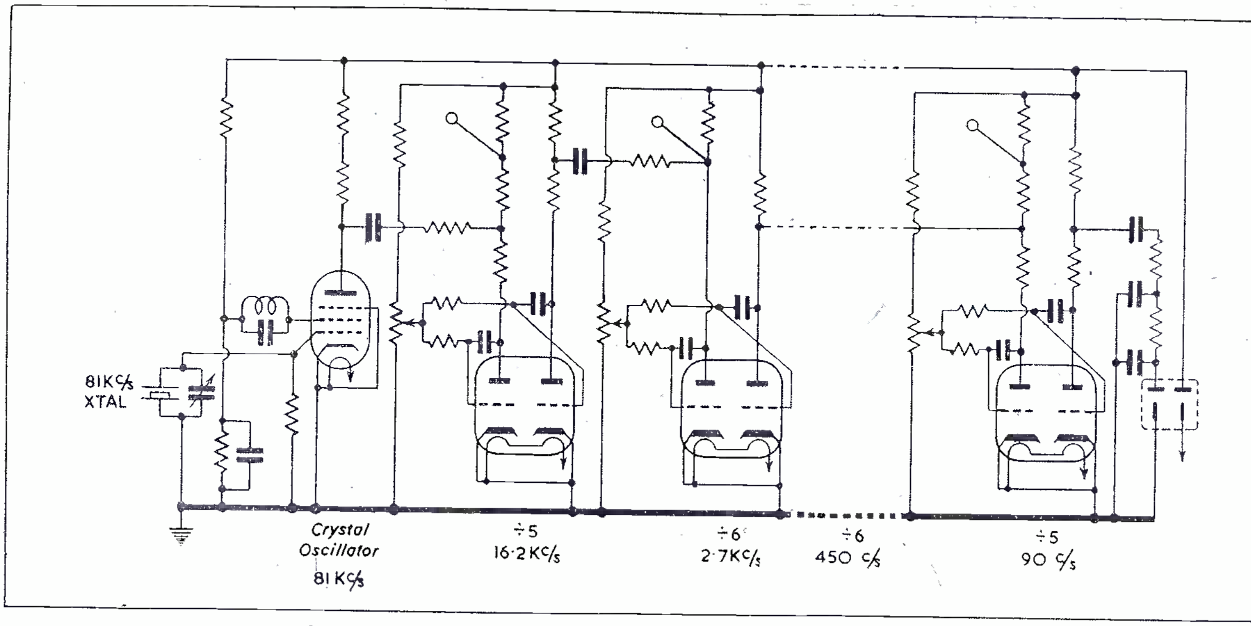
TABLE I
SPECIFICATION OF WATCH RECORDER

Range	2 seconds per day to 10 minutes per day.
Accuracy ...	1 second per day.
Time for Determination	About 15 seconds.
Position Test ...	Adjustable to any angle.
Power Supply...	200/250 V. 40-100 c/s. 65 watts.
Dimensions	17 in. by 14½ in. by 8¼ in.
Weight ...	29 lb.

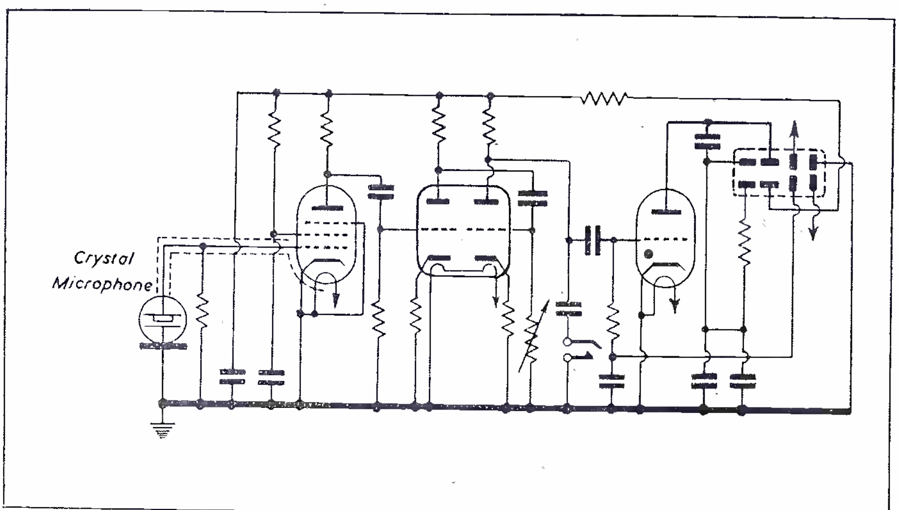
As already stated, a quartz crystal oscillator is employed as a standard frequency source, its frequency being stepped down to drive the recording chart paper at a known constant rate. The watch noises are picked up by a microphone, passed through an amplifier, and provide pulses for driving a printing bar. A complete circuit diagram is shown in Fig. 1, while Fig. 2 is an illustration of the whole instrument. The instrument specification is scheduled in Table I.

Oscillator, Frequency Divider and Drive

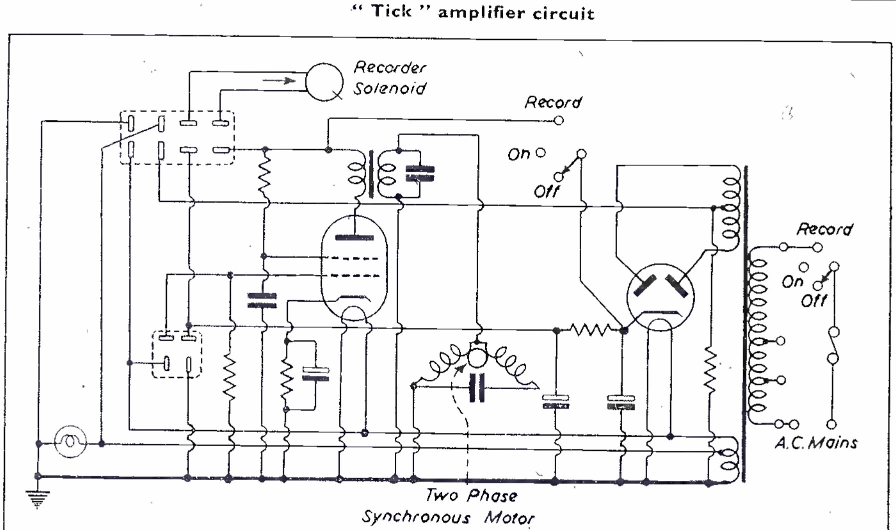
The crystal, whose operating frequency is 81 Kc/s., is a vacuum-sealed, low-temperature-coefficient crystal, ground to within 0.005 per cent of its correct frequency, the final setting being effected by adjustment of a parallel trimming capacitor. It is included in the control grid-screen grid circuit of a 6F12 pentode and with it forms a conventional crystal oscillator circuit.



Standard frequency circuit



" Tick " amplifier circuit



Output and power unit circuit
Fig. 1.

The final frequency required for driving the recorder motor is 90 c/s. and the necessary frequency division is effected by the use of four multivibrator stages, each incorporating a 6SN7GT/G double triode. The dividing factors are 5, 6, 6, 5, corresponding to frequencies of 16.2 Kc/s., 2.7 Kc/s., 450 c/s. and 90 c/s. respectively. The multivibrators, which are of the symmetrical type, follow conventional circuit practice as can be seen from the diagram, and do not call for further description. The last multivibrator in the chain feeds into a 6L6 power stage and this in turn drives the recording motor through a 1:1 transformer tuned on the secondary side.

The motor is a split-phase, 90 c/s. synchronous motor running at 2,700 r.p.m. with an input of 7 watts. This motor has to provide three drives, details of which are given later.

Microphone Circuits and Actuator

A crystal microphone, designed to be as free as possible from spurious vibrations and acoustic effects, is employed to pick up the watch sounds. The usual beat note of a watch is 5 per second and consequently these are received by the microphone as 5 pulses per second, but as suggested above, the latter will, of course, be sensitive to any other noises generated in the watch. The microphone feeds through a 6J7 pentode to a 6SN7GT/G double triode which is connected in cascade to provide two resistance-coupled amplifying stages. The second stage has a volume control included in its grid circuit, while provision is made for plugging a pair of headphones across the anode load. The output from this stage is taken to a 2D21 thyratron. In its anode circuit is a solenoid, known as the actuator, and every time the thyratron is fired by a pulse, the solenoid is magnetised and drives the printer bar in the recording mechanism. The variation in time delay between pulse arrival and marker action is within ± 100 microseconds.

Recorder

The method of recording is as follows:—

The synchronous motor drives the chart paper, which is in the form of a continuous roll, through a gear train at a speed of 6 in. per minute. The chart paper passes over a metal drum 2 in. long driven from the motor at 45 revolutions per second, and fitted with a hardened-steel wire helix of one turn, this helix projecting slightly above the surface of the drum. An inked ribbon, similar to that used in typewriters, and driven at a slow rate by the motor, passes across the paper directly above the drum and again, above the ribbon and mounted across the chart is the printer bar. When in action the paper travels at constant speed over the drum and the printer bar is pulled down by the solenoid every time the thyratron fires. When the printer bar drops, it records a mark on the chart at the point where it crosses the helix. Now the helix is rotating at 45 revolutions per second and the watch should be ticking at a rate of exactly 5 per second. Consequently between two ticks the helix should rotate exactly 9 times, and if this does in fact take place, the printer bar will strike the helix, through the tape and the paper, at exactly the same place each time. The chart will accordingly show a perfectly straight line of marks space 0.02 in. apart, see Fig. 3a. If, however, the watch timing is incorrect, say, 5 seconds per 24 hours slow, the helix will complete 9 rotations and a fraction more between two ticks and each mark will be displaced laterally to a small extent, with respect to the previous one, in this case amounting to:—

$$\frac{5}{24 \times 60 \times 60} \times \frac{2 \times 45}{5} = 0.00104 \text{ in.}$$

The resulting record will be a diagonal trace across the paper, the angle between the trace and the edge of the paper being a measure of the rate error. The same applies in the case of a watch running fast, only here the displacement will be in the opposite direction. Figs. 3b and 3c show the traces of a watch losing and gaining 5 seconds in 24 hours respectively, while Fig. 3c shows the trace for a gain of 20 seconds in 24 hours. It should be borne in mind that Fig. 3a represents the chart of a watch perfect in all respects, while Figs. 3b and 3c only exhibit faults in timing.

The constants of the "Dawe" Watch Rate Recorder have been so chosen that a rate of error of one second per day will cause the printed record to travel $\frac{1}{8}$ in. across the tape while travelling 12 in. along the tape. Thus, a record which travels $\frac{1}{8}$ in. across the tape while travelling $1\frac{1}{2}$ in. along the tape indicates an error of 8 seconds a day. The rate may be calculated by the following formula:

$$R = \frac{A \times 96}{B}$$

where R = Rate of watch in seconds per day.
A = Distance in inches which the record has travelled across the tape.
B = Distance in inches which the record has travelled along the tape.

The above is true of watches beating 5 per second or 18,000 per hour. Several baguettes and some of the current Swiss wrist watches beat 21,600 per hour (6 per second): a number of the Gruen models beat either 20,160, 20,222 or 20,940 per hour; clocks and certain moderately priced watches beat 14,400 per hour (4 per second); and other moderately priced watches beat 16,200 per hour ($4\frac{1}{2}$ per second) or 16,320 per hour.

It is possible to rate these odd beat movements from the record, although in most cases the record for a watch with zero rate will not consist of a single line, nor will it run straight down the tape. The following table gives the form of the correct record for a number of odd beats:

Beat per hour	No. of lines in record	Indicated rate
21,600	2	0 sec.
20,940	4	153 sec. fast
20,222	1	119 sec. slow
20,160	1	384 sec. slow
19,800	5	152 sec. slow
or	11	0 sec.
19,440	3	0 sec.
19,333	3	476 sec. slow
16,320	1	640 sec. fast
16,200	1	0 sec.
14,400	4	0 sec.

In all cases the actual rate of the watch being tested in seconds per day is the difference between the rate indicated and the rate given in the table above.

The trace on the chart constitutes a permanent record of the watch performance at the time of the test, but to enable an immediate diagnosis to be made during the actual recording, a rotatable inspection window is provided in the instrument case immediately in front of the printer bar. The glass is graticuled and the rim graduated so that it is possible to observe the record and, by turning the window, to line up the graticules with the trace and to read the timing error off the graduated scale.

In proceeding to carry out a test, the watch is slipped into position on the microphone face and held by a spring, dial up or dial down. The main switch is then turned to the "ON" position and preferably left in this position for an interval up

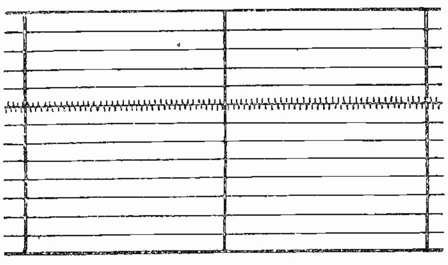


Fig. 3a. Perfect timing

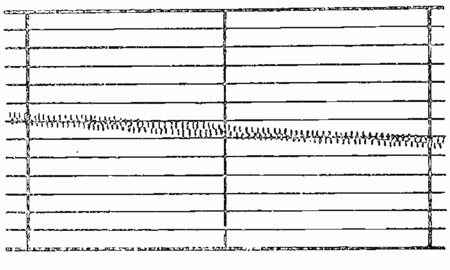


Fig. 3b. Movement losing 5 seconds in 24 hours

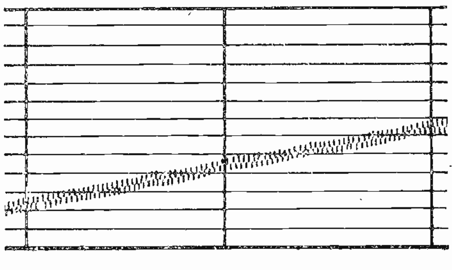


Fig. 3c. Movement gaining 20 seconds in 24 hours

to half a minute. Under these conditions, the instrument is switched on, but no H.T. is supplied to the 6L6 or the thyratron, consequently the recording mechanism is inoperative. There are a number of reasons for the provision of this intermediate switch position. In the first place, time must be allowed for the valves to warm up and settle down to stable working conditions. Secondly, the watch itself will need several seconds to resume stable running after handling. Thirdly, it is possible to listen to the watch action through the headphones in this position without disturbance from the printer bar, the volume control being adjusted to a suitable level. It will, of course, be immediately appreciated even by those unfamiliar with watch manufacture and repair, that the amplified tick can convey considerable useful information to the skilled watch maker or repairer.

After some 20-30 seconds, or later if the headphones are being used to good purpose, the switch is turned to "Read" and the recording mechanism immediately starts to operate. A glance through the inspection window, and possibly a readjustment of the volume control, will give a rough idea as to the watch's performance and timing, so that probably one-half to one minute's recording will be adequate. For a complete test of the watch, it is essential to check its rate in the five recognised positions, dial up, dial down, pendant up, pendant right and pendant left. Accordingly, the instrument is switched off, the watch position changed, either by turning the watch upside down or by turning the microphone round, and the same recording procedure carried out again. This is repeated three more times for the other watch positions and the records compared. It is, of course, not essential to switch off when altering the watch position, but it should be borne in mind that the watch beat may be affected momentarily by the movement.

(a)
(b)
(c)

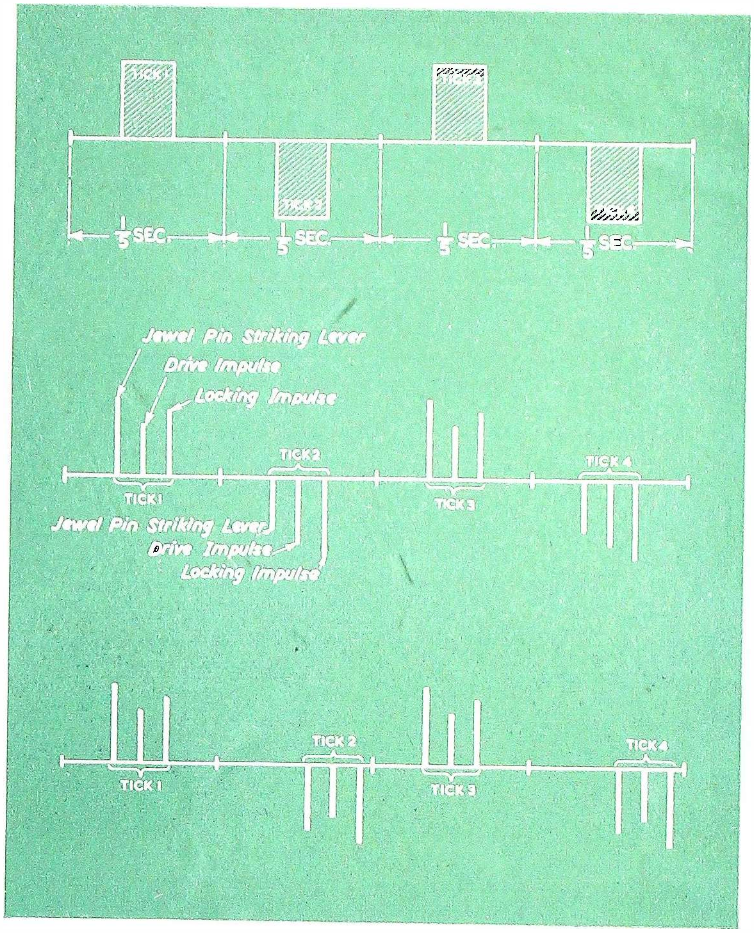


Fig. 4. (a) Showing ticks in simplest form on time-scale
(b) Showing composite nature of ticks
(c) Showing unequal phase of "positive" and "negative" ticks

Interpretation of Records

A detailed account of the various trace shapes and abnormalities which may be observed and the subsequent interpretation would take longer than the description itself and would in any case be outside the scope of this article. It is however, desirable to discuss this subject at somewhat greater length than has already been done.

First of all it is proposed to refer back to the readjustment of the volume control, which, it was suggested, might be necessary at the start of recording. The possibility of a multiplicity of unorthodox sounds emanating from a watch has already been mentioned. Apart from abnormal sounds, however, a full analysis of the escapement action in a standard lever movement shows that the normal tick of a watch is made up of a number of different sounds caused by the various impulses occuring during the action.

Before emunerating these, however, it must be realised that one tick occurs when the balance wheel is turning clockwise and the next when it is returning in an anti-clockwise direction. In other words, there are two ticks "of opposite polarity" to "one cycle." A rough visualisation of this is given in Fig. 4a. But such a visualisation is, in fact, over-simplified for a number of different reasons:

(a) Each tick has several components of which three are predominant in a good watch, (1) jewel pin-striking lever, (2) drive impulse, and (3) locking impulse.

(b) The relative loudness is not necessarily the same for each tick, even with a watch in first-class condition, indeed it would be very remarkable if it were so. For it must be remembered that ticks 1 and 3 are made when the movement is in a "positive" direction, while ticks 2 and 4 occur when the movement is "negative." There will, accordingly, probably be close similarity between all positive ticks and between all negative ticks, but some dissimilarity between positive and negative ticks. Fig. 4b is an attempt to show this effect. As a result, unless the volume control is correctly set, the thyratron may fire on the jewel pin-striking-the-lever

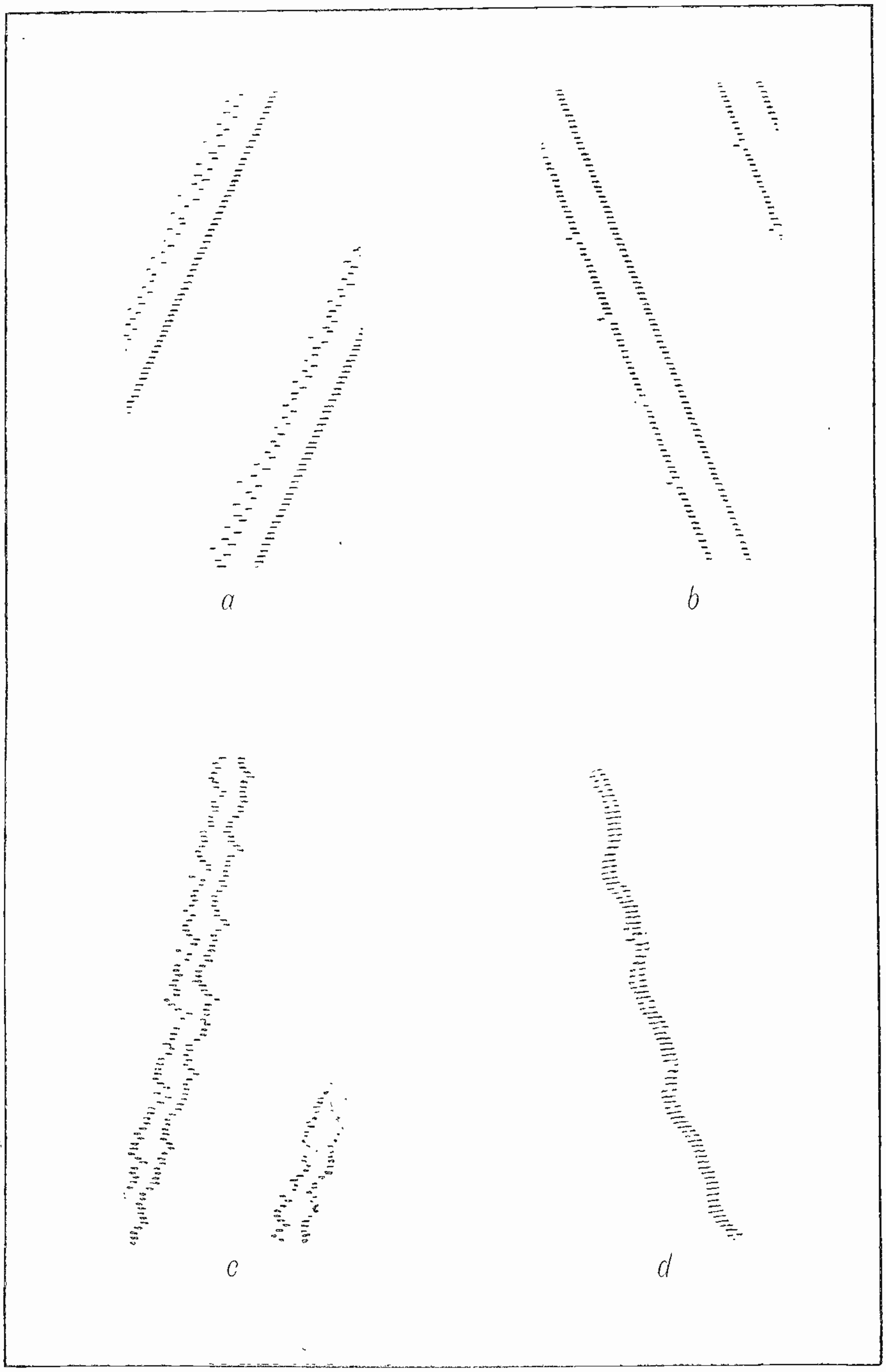


Fig. 5. (a) The timepiece gains 25 seconds per day and the escapement has a fault
(b) One of the teeth of the escapement wheel is slightly damaged
(c) The power transmission of the second wheel to the pinion of the escapement is irregular
(d) The pivots of the escapement and of the balance wheel have too much play

pulses for positive ticks and on the locking pulses for negative ticks. The result will be a double trace on the record chart, as shown in Fig. 4c and this will not only make the record difficult to interpret, but may be definitely misleading for the following reason.

(c) So far it has been agreed that the positive and negative pulses may be different as regards amplitude, or perhaps more correctly harmonic content. But in addition, the phase may not be the same either. This effect is shown schematically in Fig. 4d. It is a very common fault in watches, perhaps too common to be called serious, but nevertheless undesirable, and the watch is said to be " out of beat." It will readily be understood that the record of such a watch, with firing taking place correctly on corresponding tick components will be exactly similar to that shown in Fig. 4c. Conversely, of course, as suggested above, a watch in perfect beat may appear to be out of beat if the volume control is incorrectly set. Hence the necessity for adjustment of this control at the start of recording. It should be emphasised that such an adjustment will not in any way mask any irregularities in the beat, and that if one beat is not an exact replica of those preceding it as regards rate, but not necessarily amplitude, it will certainly show up as a displacement on the trace.

Referring back to the interpretation of the records of a watch timed in all five positions, it is obvious that if the traces are straight lines, or irregular ones through which mean straight lines can be drawn, it is easy to compute all five rates from the lateral and longitudinal time scales. It is highly unlikely that they will all be the same, but if the maximum difference does not exceed 3-5 seconds per 24 hours, it is usual to pass the watch after adjusting it to correct timing or, in the case of a wrist watch, to run a few seconds per 24 hours fast. This is done because wrist watches, when worn, invariably run slower, up to 30 seconds per 24 hours, than in a stationary position. If the deviation is greater than some 5 seconds per 24 hours, it is an indication of some such fault as excessive shake or looseness in the escapement or balance, causing a variation in the stresses on the balance spring in the various positions. The cause is generally one which can easily be detected by the skilled watch repairer who can then proceed to make the appropriate correction or adjustment.

Apart from the above, irregularities in the watch action show up as irregularities in the trace, as can be seen from the examples shown in Figs. 5a, 5b, 5c and 5d. Fig. 5a shows the effect of a fault in the escapement, Fig. 5b a variation in the amplitude of the balance wheel motion, Fig. 5c a damaged tooth in the escapement and Fig. 5d a knock in the balance wheel. These examples could be continued indefinitely, but it is only necessary to say that they are generally capable of immediate interpretation by the experienced craftsman.

It was pointed out at the beginning that a test for timing and isochronism in one position can only be carried out by a 24-hour run. If this instrument is employed, this 24 hours is still needed for a full test, but now three or four sets of spot readings would be taken during the period and all five positions covered in the same 24 hours.

The majority of watches operate at 5 beats to the second and the Watch Rate Recorder is designed to synchronise with this rate, but it is not universally the case. The trace of a watch in good order beating at 4 to the second would be of the form shown in Fig. 6, and can be interpreted in similar fashion to that of a normal beat rate. The same will apply to other beat rates, but naturally the pattern will be different. So far it has rather been implied that the Watch Rate Recorder is intended solely for use on complete watches. It is, however, equally applicable to the checking and timing of a balance spring assembly. The assembly is held by tweezers gripping the outer end of the spring with the lower pivot resting on the microphone

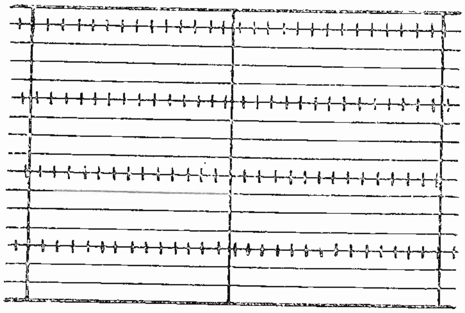


Fig. 6. Perfect movement beating 4 to the second

button. A rocking or dancing motion of the tweezers will start the assembly oscillating, and under these conditions the microphone and amplifier are sufficiently sensitive to operate the marker bar and produce a record on the chart. Thus the spring can be adjusted almost at a glance.

This instrument can also be used to great advantage in watch manufacture, both for spring adjustment as described above, and also for final testing and timing. As regards the latter procedure, a batch of watches would be wound up, regulated on the Recorder and then set aside for subsequent tests at intervals of a few hours. It is obvious that, with this procedure, faulty watches will be thrown out at a much earlier stage than would otherwise be the case.

Routine maintenance of the instrument is a trifling matter, consisting of reversing the ribbon after every 24 hours of recording time and lubrication of the motor once in six months.

The instrument is seen to find a place both in the hands of the repairer and in the watch factory. In both spheres it performs two useful functions; increasing the accuracy and reducing the time required for rating to a fraction of that previously needed and facilitating the detection of a large variety of faults, including some which would otherwise escape notice altogether.

The information for this article has kindly been supplied by Dawe Instruments, Ltd., of Hanwell, London, who are manufacturing this instrument under licence from George W. Borg Corporation of Delavan, Wisconsin, U.S.A. and the Universal Escapement Co., Ltd., of La Chaux-de-Fonds, Switzerland.

A Method of Controlling Gain in Television Receivers

THE use of secondary emission valves for the high frequency portions of television receivers has recently been considered and has certain attractions, one of which is the saving of at least one high frequency amplifier stage. There is, however, an attendant disadvantage with such multiplier valves as have been available and this is connected with the problem of gain control. It is well known that changing the bias on the control grid of an H.F. amplifier valve in order to vary its gain influences, also the input impedance of the valve with disturbing effects on the frequency response of the amplifier. In the ordinary course of events these disturbances are appreciable, and a method therefore commonly adopted has been to arrange a compensating change of bias on the suppressor grid of the amplifier valve to cause the input impedance to remain sensibly unvaried. At the same time the type of multiplier valve that has been ready to hand has no suppressor grid and the principle of gain control by variation of control grid bias has therefore been out of the question.

One attempt to obtain the necessary control has been by variation of the potential of the screening electrode of the valve: but it is found that this affords a limited degree of control only, and furthermore when the screen grid potential is lowered the grid base of the valve becomes contracted, so that the valve more readily overloads.

A method, on the contrary, which has been tried with some success is to abandon the attempt to vary the signal amplitude by control applied in the H.F. stages of the receiver and instead to endeavour to achieve control in the detector stage. The method employs a variation of impedance in the detector load circuit. By way of illustration this impedance may be formed of a pair of resistances in series, one of which is about 1,000 ohms, while the other is of the order of 10,000 ohms variable. The combination of the resitances may be shunted by a high frequency by-pass capacitor of the order of 5 pF, and the rectified picture signals set up across the combined load impedance may be fed in the usual manner to the control electrode of the V.F. amplifier valve. Variation of the 10,000 ohms resistance is found to provide a suitable range of amplitude control.

In a normal receiver the circuit functions with one desirable feature, namely that when a low gain is required the frequency response of the receiver is at its widest and when a high gain is required the frequency response is narrowed. This is on account of the variable load that the detector inevitably throws upon the preceding tuned circuit. If it is desired to avoid the narrowing of the pass range of the receiver with high gain, an inductance and resistance in series may be shunted across the load impedance and arranged to resonate with associated capacities at the upper end of the frequency range, so that when the adjustable resistance is set at its maximum value the upper end of the frequency response characteristic is sufficiently raised.

—*Communication from E.M.I., Ltd.*

The Van De Graaff Generator

By V. W. LOWN

IN 1931 a Rhodes Scholar, Robert Van de Graaff produced the first high voltage electrostatic generator which bears his name, thus bringing to fruition the ideas of Lord Kelvin and other scientists who for many years had toyed with the idea of producing high voltages electrostatically.

Although this is by no means the only method of producing high potentials of the order of millions of volts, it is one of the cheapest and most reliable sources of high, steady D.C. potential. The cost, size, and insulation difficulties of, say, a transformer rectifier set would be prohibitive.

The first generator produced only 80,000 volts, but a later model achieved 1,500,000 and finally in 1936, after much experimenting, the Van De Graaff team produced a generator giving 5 million volts.

Basically the generator consists of an endless insulated belt B, (Fig. 2), which has a charge sprayed on to it from a set of needle points S_1. A transformer rectifier set R supplies these points with anything from 10-100 KV, and this potential is raised until the electric field at the points ionises the atmosphere, which then breaks down. The belt thus becomes charged with electricity of a polarity similar to that at the spray points. This charge is conveyed by the continuously moving belt into the interior of a large metal hollow hemispherical collecting electrode E. Here another set of corona points S_2 remove the charge, whereupon it is distributed over the exterior of the electrode. No electric field exists inside this electrode except that due to charges at the top of the belt before they are removed by the upper corona points. The potential of the electrode with respect to earth will continue to increase until the charge carried to it by the conveyor belt is exactly balanced by leakage current down the supporting column.

As with all high voltage apparatus, the problems and difficulties are largely those of insulation and electric field distribution. The original generator had its high voltage electrode supported by a bakelite column, which although mechanically satisfactory, was electrically unstable. Unequal charges on the electrode supporting column, due to a non-linear potential gradient down the column, caused the field at the base of the electrode to be distorted, resulting in atmospheric breakdown where the column entered the electrode.

This problem was solved by replacing the bakelite column by a cylindrical construction consisting of equipotential aluminium plates separated by three textolite insulators. These plates are connected together by resistors of 400 MΩ, thus ensuring an even distribution of potential down the column. Fig. 1 shows this cylindrical construction for a 2 MEV generator developed by the English Electric Research Laboratories for medical research. The metal hemispherical electrode appears transparent owing to a double exposure effect for revealing various pieces of control gear situated in the interior.

The charge conveyor belt, which must be of high mechanical and dielectric strength, is of a rubberised cotton construction. It is driven by two 15 h.p. induction motors located beneath the electrode supporting column. Fig. 3 shows these two motors and lower portion of belt and Fig. 4 the top portion of belt and roller assembly.

The English Electric Co. have solved the problem of tensioning this belt by allowing it to take the weight of the driving motors and base plate and these in turn are supported by springs resting in dashpots. This ensures correct

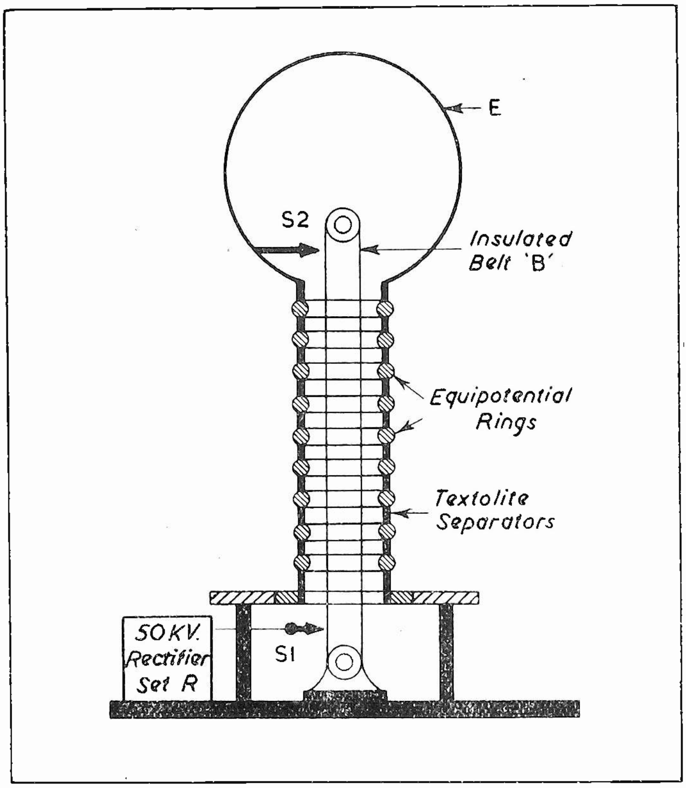


Fig. 2. Diagram showing fundamentals of Van De Graaff Generator

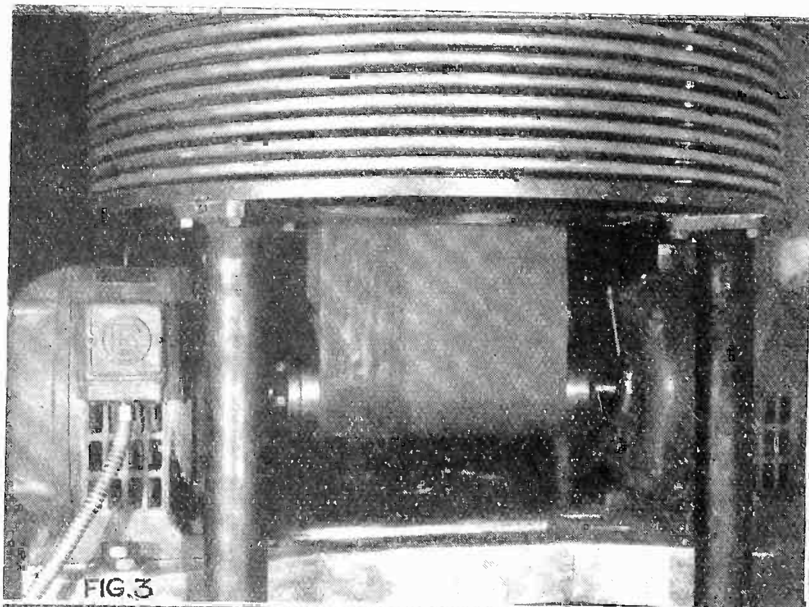


FIG. 3

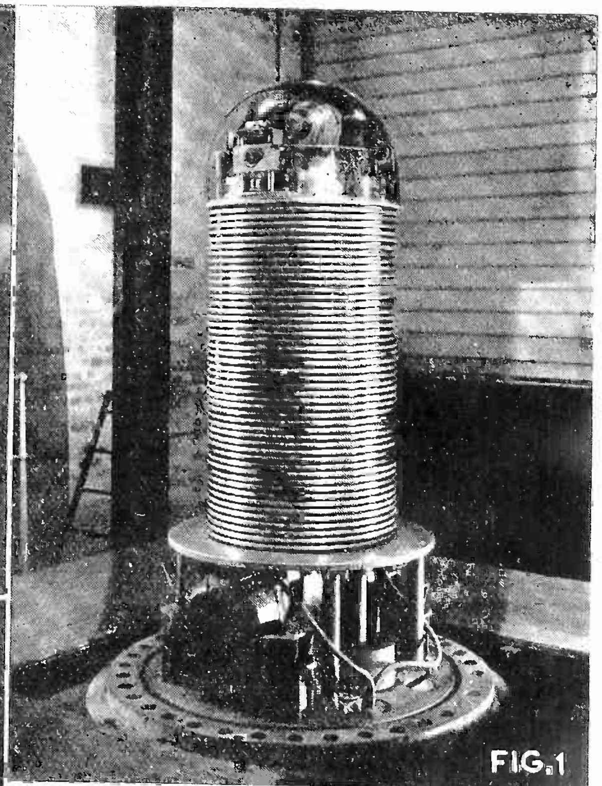


FIG. 1

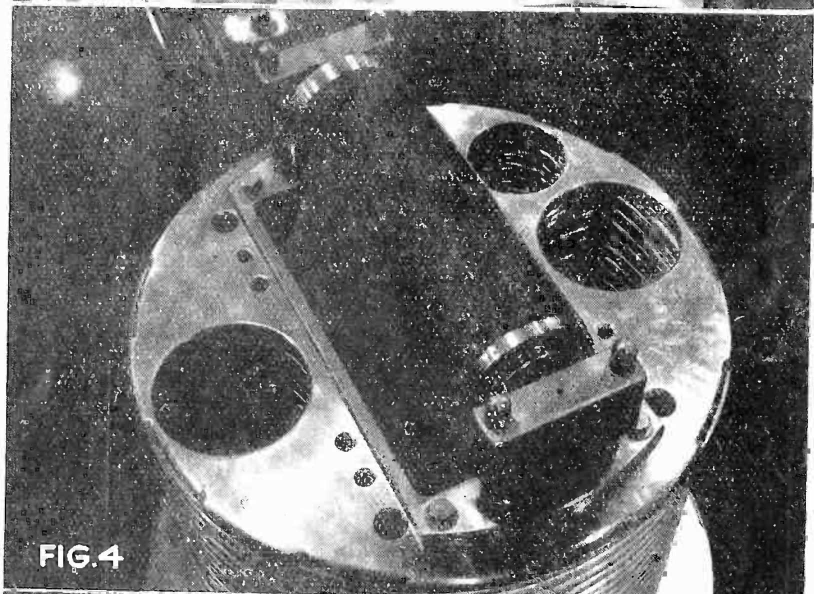


FIG. 4

Fig. 1. General view of a 2 MeV generator with double exposure showing gun supply

Fig. 3. Bottom view of a 5 MeV machine showing driving motors, bottom pulley and belt

Fig. 4. Top view of a 5 MeV generator showing top pulley and plate

Fig. 5. Raising pressure tank of a 5 MeV generator

Fig. 8. Electron gun supply circuit showing 2,000 cycle generator for filament supply

[*Photographs by courtesy of The English Electric Co., Ltd.*

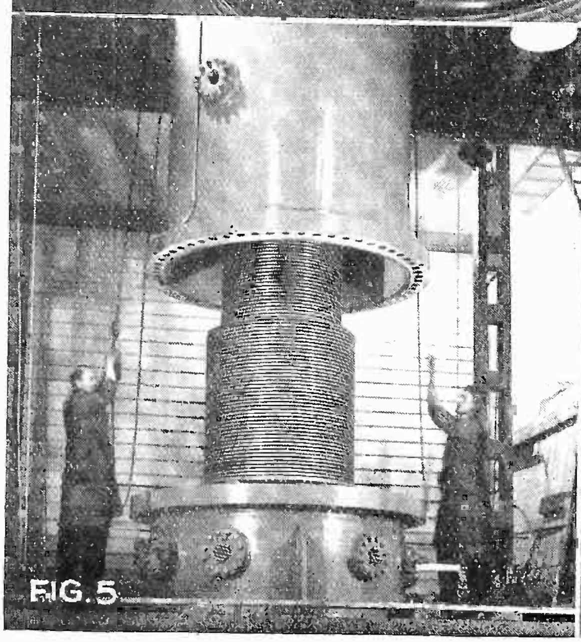


FIG. 5

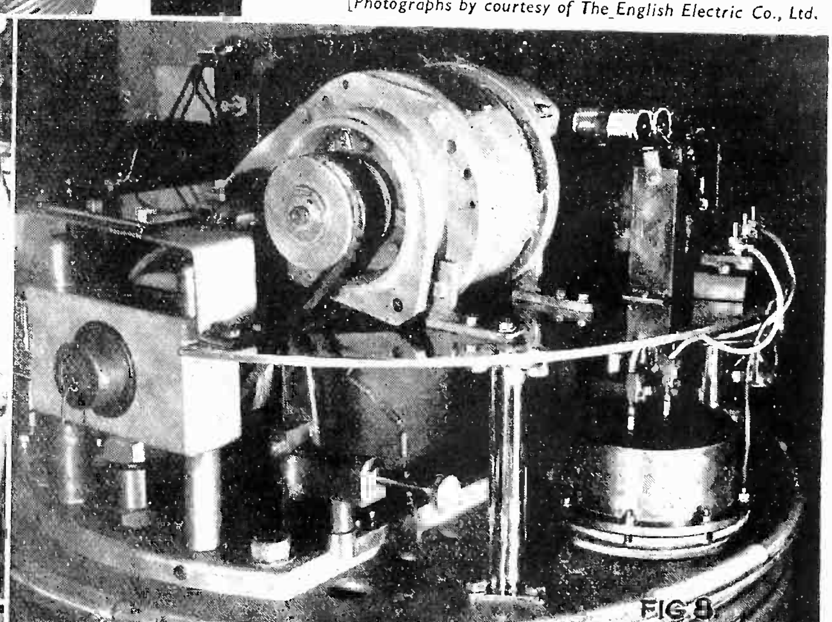


FIG. 8

tensioning of the belt without undue strain.

The control of the electric field along the belt is achieved by means of potential gradient control bars in the form of aluminium rods which are located on each side of the belt and connected to their adjacent equipotential plates. Pyrex guides prevent the belt from touching these control bars, thereby preventing any transfer of charge from the belt to the bars which would cause the voltage to be unsteady.

The very high potential developed by these generators necessitates their enclosure in some medium of high dielectric strength, otherwise flashover occurs to nearby objects from the high voltage electrode.

To avoid impracticably large buildings and also to increase the potential considerably, the generator has been enclosed in a metal cylinder (Fig. 5 shows this being raised) and the pressure inside increased to 400 lb./in.^{2} While increasing the air pressure improves its dielectric strength, it also increases the oxygen concentration to such an extent that sparking causes combustion inside the cylinder. Very often by the time the pressure was reduced sufficiently to remove the cylinder, great damage had been done to the generator owing to fire. To overcome difficulties of this nature a mixture of nitrogen and air was substituted, it being non-inflammable and having fairly good dielectric properties. More recently Freon and sulphur hexafluoride have been used.

Freon, a halogenated hydrocarbonated gas, although superior to mixtures of inert gases and air, tends to decompose when in the vicinity of corona discharge, thus causing conducting deposits to form on insulating surfaces. Another drawback is its destruction of the properties of ordinary lubricating grease. Sulphur hexafluoride on the other hand manifests none of these tendencies and has a relatively high gas pressure of 330 lb./in.^{2} at 25° C.

The generator voltage can be controlled by a Variac, which regulates the rate of spraying the charge on to the belt, and can be measured by means of a generating voltmeter situated in the top of the pressure tank.

This voltmeter consists of a stationary insulated metal plate mounted in the horizontal plane

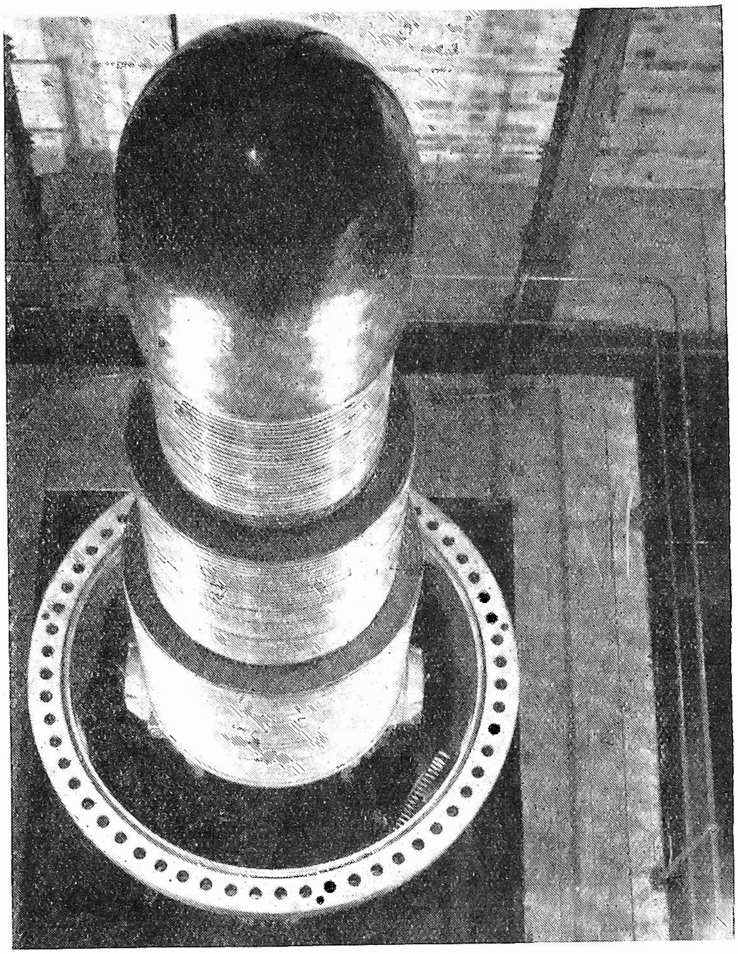


Fig. 7. A plan view of a 5 MeV generator without the pressure tank

[Photo by courtesy of The English Electric Co., Ltd.

and facing the high voltage terminal. Another sector-shaped earthed plate rotates in front of the stationary plate and periodically shields it from the high voltage terminal. This shielding causes the capacity between the insulated plate and the terminal to vary in such a way that the current induced in the stationary plate is approximately proportional to the terminal voltage. The current may

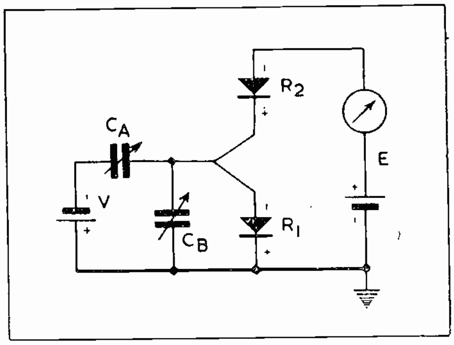


Fig. 6. Circuit of generating voltmeter

be read on a D.C. micro-ammeter by passing in through a rectifier circuit. Fig. 6 shows this basic circuit.

The potential to be measured is V. C_A is the varying capacitance between the high voltage terminal and the fixed insulated plate, and C_B is the capacitance between this insulated plate and earth. The E.M.F. of a single dry cell is used to prevent the flow of current through the rectifier during the non-conducting part of the cycle.

This cycle of operations is as follows:

As C_A increases from its minimum value, the insulated plate is charged through the rectifier R_1 by the potential V, until C_A reaches its maximum value. As the capacitor C_A decreases, the plate discharges through R_2 and the meter until C_A reaches its minimum value when the cycle of operations is repeated.

For the application of the high potential developed by this generator (*Concluded on p.* 61)

The Electronic Measurement and Control of Heat

Part 2—High Temperatures in Industrial Processes

By JOHN H. JUPE, A.M.I.E.E.

WHERE temperatures above about 530° C. are met in industrial processes four main types of electrical instruments can be used:

1. The use of a thermo-couple and direct reading millivoltmeter; a method of quite high accuracy.
2. A thermo-couple and manually operated potentiometer, for use where the highest possible degree of accuracy is required.
3. A thermo-couple and self-balancing potentiometer, where the temperature must be controlled to a fairly high degree of accuracy and perhaps recorded as well.
4. A photo-cell pyrometer used for the same purpose, or where the heated object is only presented for measurement for a short time or is not easily accessible.

Methods 1 and 2 will not be discussed here since they are quite straightforward. There is, however, a slight variation of No. 1 that is not so well known and yet has a number of useful applications. It is the use of a thermo-couple pyrometer as a *heat flow* meter.

A belt, generally of rubber, has a large number of thermo-couples embedded in it such that alternate "hot" and "cold" junctions are at opposite faces. Then, if this belt is placed on a surface emitting heat, such as a lagged steam pipe, the heat flow through it will produce a thermal E.M.F. at the two faces, depending on the heat flow and the thermal resistance of the belt. This thermal P.D. will generate an electrical P.D. in the thermo-couple circuit and it is possible to scale an indicating instrument in B.Th.U. per square foot per hour, or similar units, since all electrical and thermal quantities except the one being measured consist of determinable constants.

The idea of a thermal P.D. may be new to some readers, but it was first suggested in 1911 by Carl Hering and it arises from a consideration of heat flow in watts through thermal insulation, and being equal to the difference in temperature in degrees centigrade across the insulation divided by its total resistance in thermal ohms. In practice, certain precautions are necessary to secure reasonable accuracy, but the instrument is direct reading and is the only simple heat flow meter of which the author is aware. As a matter of interest, the approximate thermal resistance of three common materials in thermal ohms, is given below.

Copper	0.103	per in. cube
Building brick	27.0	,, ,, ,,
Ground cork ...	828.0	,, ,, ,,

High Temperatures — Industrial Methods

Taking the lower temperature boundary as about 530° C., the photo-cell pyrometer is an excellent instrument and there are a number of equipments available. Where pure measurement is concerned and the object is available for, say, a minimum time of about 15 seconds, the radiation pyrometer (thermopile or optical) is perhaps the best instrument, but when it comes to controlling temperature or making measurements on fast moving bodies such as hot bars running along rollers, purely electronic devices are used for the same reason that they are used for other purposes, *i.e.*, because they can perform certain types of operations better, faster, more reliably or cheaper than mechanical or other electrical methods, or because a valve or photo-cell can perform operations not possible by other means.

An example of a photo-cell used to measure the temperature of a hot body is given in the circuit diagram, Fig. 1. In this circuit, two cells are used as a "bridge" one being exposed to the illumination from the hot body and the other to the light from a carbon filament lamp, which has similar spectral characteristics. The usual galvanometer position in

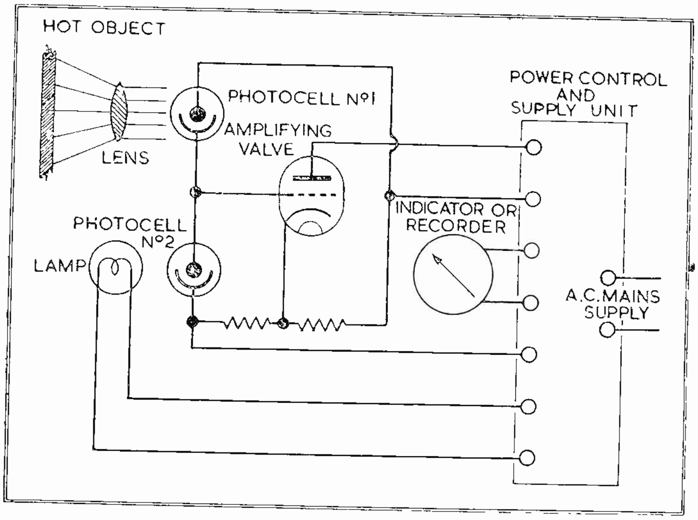


Fig. 1. Photoelectric pyrometer using a "bridge" circuit

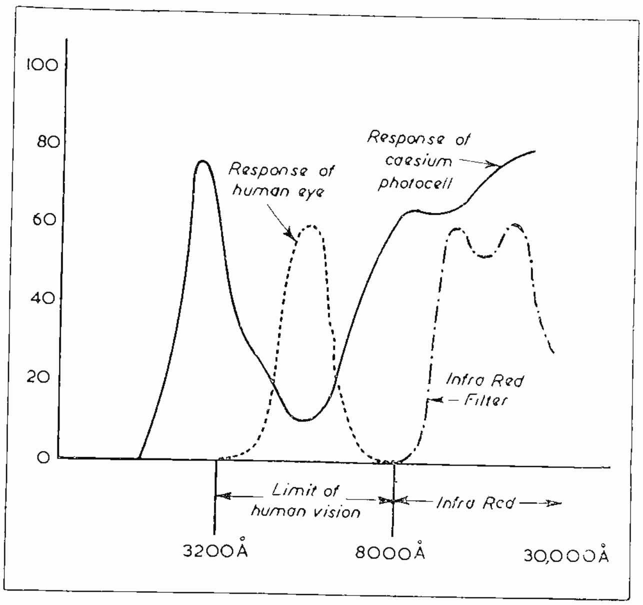


Fig. 2. Comparative response curves of the human eye, a typical caesium photocell and an infra-red filter

the circuit is occupied by a thermionic valve and as the light from the hot body varies, the corresponding cell will respond and vary the grid bias, and thus the anode current of the valve.

This immediately varies the current in the lamp circuit and causes a change in the illumination on the second photo-cell, which rebalances the system. It is also arranged for the lamp current, which is comparatively large, to operate indicators or a recorder. A pair of photo-cells is used to eliminate " drift " and mains voltage variation.

In general, photo-cell temperature devices may be divided into three groups:

1. Those with a single stage of amplification and without any special optical system, light filter or voltage regulator. The range is approximately 1,300° F. to 2,000° F. and the accuracy, although low, is still satisfactory for certain purposes.

2. Those employing two stages of amplification, an optical system and light filter, and also a measure of voltage regulation. Their useful range is about 1,100° F. to 2,000° F. and the accuracy is about ± 10° F.

3. Systems using a number of stages of amplification, together with voltage regulation and elaborate optical systems with filters. The range of these is between 980° F. and 3,300° F. with an accuracy of ±5° F.

In some cases where photo-cells are used for foundry work trouble is experienced from direct daylight or from reflexions. In such cases considerable improvement may be obtained by working entirely with infra red light, since light from this end of the spectrum is poorly reflected by most foundry or machine shop objects. Fig. 2 shows the comparative response curves of the human eye, a typical caesium photocell and an infra red filter. It will be seen from these that the cell can have quite a good output when visible light is cut off by the balancing potentials.

Self-Balancing Potentiometers

The most accurate method of measuring the voltage generated by a thermo-couple is to use a potentiometer, a matter involving a more or less skilled operator, with the consequence that a number of attempts have been made to develop self-balancing potentiometers.

Several of these are highly successful, but space prevents more than three from being described in any detail. Although the specific reference here is to the measurement of temperature, they can be used anywhere where automatic potentiometric measurement could be used with advantage.

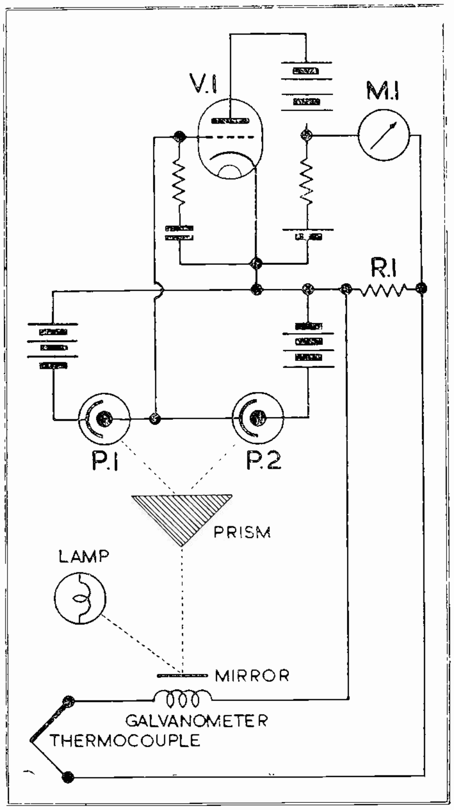


Fig 3. Simplified circuit diagram of the Weston self-balancing Photo-electric Potentiometer

The first instrument described is that of the Weston Electrical Instrument Corporation and differs from most orthodox D.C. potentiometers in that the usual constant current, flowing through an adjustable resistor, is not used Instead, a variable current is passed through a fixed resistor to obtain a voltage equal and opposite to the unknown voltage (or a known fraction of it). This variable current is automatically maintained at the proper value for balance and is used to supply the indicators, recorders or power relays for control purposes. Since the only standard of comparison between the known and unknown quantities is the fixed resistor, a standard cell is not required.

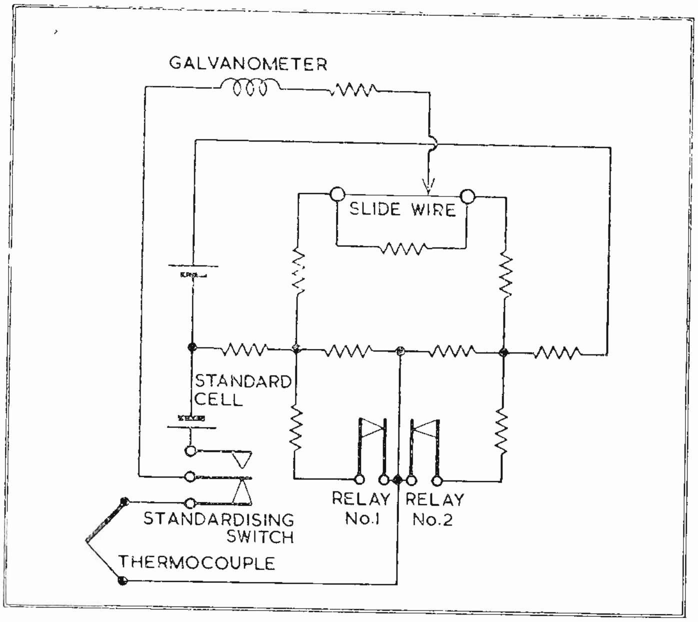
A simplified circuit diagram is shown in Fig. 3. The anode current of valve V_1 is passed through the standard resistor R_1 in opposition to the applied potential from the thermo-couple. When the two P.D.s are balanced, the reflecting galvanometer, which is arranged to have negligible mechanical control, is undeflected. Should unbalance occur the light beam reflects on to one of a pair of photo-cells P_1 and P_1 via a system of prisms. The cells act as variable resistors in the grid circuit of V_1 and vary the grid potential, depending on the direction and amplitude of unbalance. This causes a larger or smaller current to flow through the valve and also through the standard resistor, to rebalance the circuit. As the meter M_1 measures the anode current through R_1 required to balance the input potential by producing an equal and opposite one, M_1 may be scaled in terms of that potential and hence in temperature units. In actual commercial practice a pentode valve is used and the accuracy and sensitivity are independent of circuit elements, within reasonable limits.

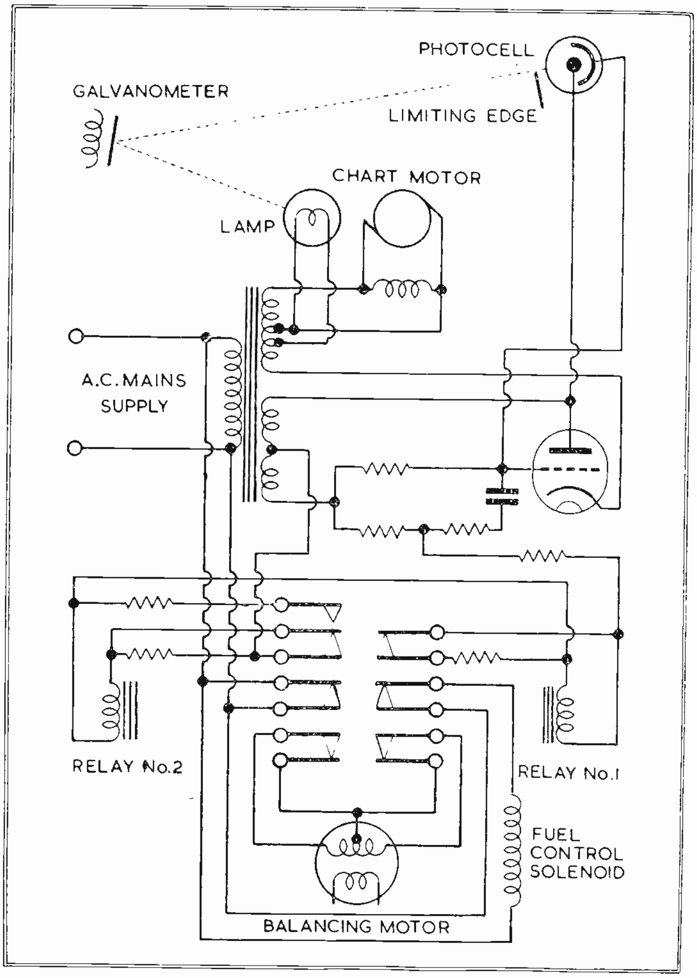
As a sidelight on electronic instruments of this class, where quite a high degree of accuracy is concerned, it is interesting to note that this maker, who is well known for high-class instruments, recommends that the pentode valve should be replaced after 2,000 hours of use and the photo-cells after 5,000 hours.

A somewhat different arrangement is used by the Tagliabue Manufacturing Co., in their recording controller; the temperature measuring and balancing circuits of which are shown in Figs. 4 and 5 respectively.

The starting condition is where a temperature change disturbs the galvanometer balance and deflects the beam away from the photo-cell cathode, which is arranged optically so that it is neither fully covered or fully uncovered. When the beam is off the balance position, relay REL_1 or REL_2 will operate and the balancing motor will drive the slide wire contactor and recording pen to the new balance position.

The balancing circuit operates as follows: As the light beam strikes the photo-cell it causes a sudden change in the current through the grid resistor and so changes the grid voltage of the valve before the capacitor has changed its potential appreciably. As the voltage across the capacitor changes, the grid voltage changes in the same direction, but at a much slower rate. The overall effect is that the anode current suddenly increases when light falls on to the cell and then increases





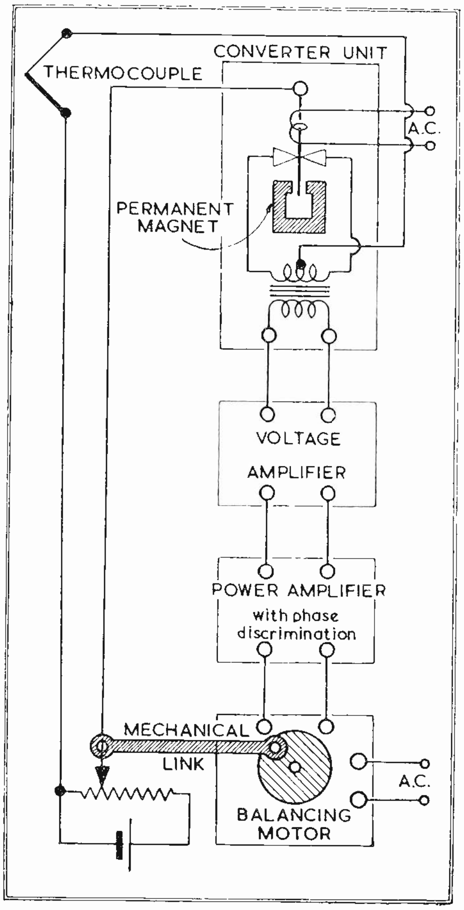
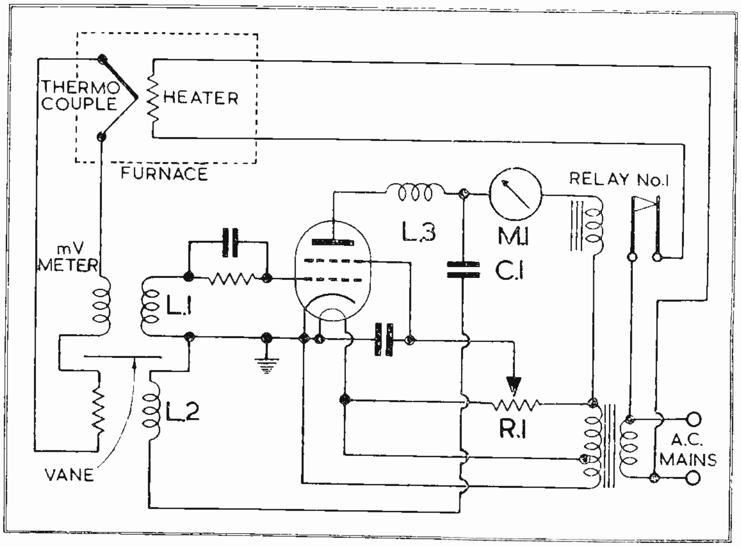


Fig. 4 (*top left*). **Temperature measuring circuit of the Tagliabue Recording Controller**

Fig. 5 (*top right*). **Automatic balancing circuit of the Tagliabue Recording Controller**

Fig. 6 (*left*). **Continuously-balanced potentiometer not requiring a galvanometer**

Fig. 8 (*right*). **Circuit of electronic pyrometer developed by the Bristol Instrument Co**



at a lower rate to a higher value.

The two series relays in the anode circuit are arranged to have their respective operating points above and below the initial increase in current. They are connected so that the motor controlled by them revolves in one direction if both are open, and in the reverse direction if both are closed. If one is open and the other closed the circuit is balanced.

Starting again from the condition when the circuit is unbalanced and the motor is driving the contactor and recorder. The light beam is deflected off the cell and both relays are open. An E.M.F. is applied to the galvanometer so that the beam reaches the cut-off point before the motor achieves balance, to avoid overshooting. When, however, the beam strikes the photo-cell, one of the relays closes and removes the

E.M.F. from the galvanometer, causing it to stop quickly. A braking current is also fed to the motor. If the potentiometer becomes unbalanced in the reverse direction the full beam strikes the photo-cell, both relays close and the motor operates in the opposite direction.

The third method of operating a continuously balanced potentiometer is shown in the block diagram, Fig. 6, and it differs from the previous ones in that there is no galvanometer, often the most delicate part of any potentiometer system. A vibrating reed type of converter is used, followed by a three-stage voltage amplifier giving a total amplification of 12,500 and this in turn is followed by a power amplifier formed by the two triodes, with inputs in parallel and outputs in push-pull. The motor circuit is shown in Fig. 7. Valve V_1 can conduct only during odd half cycles and valve V_2 only during even. Thus a definite phase relationship exists between the control voltage from the thermocouple and the power output to the motor, whose windings are shown in A and B.

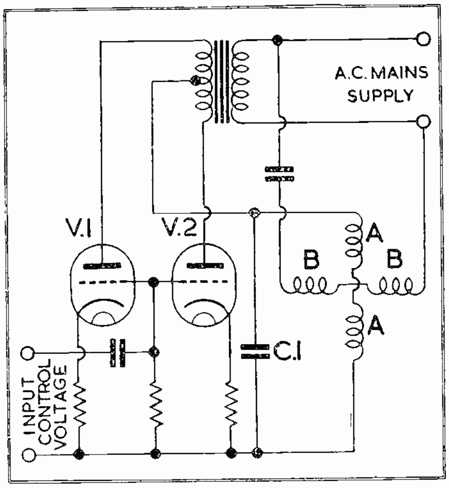


Fig. 7. Motor circuit of the potentiometer shown in Fig. 6

Thermionic Oscillator Relays

The electronic pyrometer controller made by the Bristol Instrument Co. is a good example of this class of instrument, which possesses a number of advantages, not the least being that there is no mechanical link between the initiating mechanism and the responding element. The basic principle is the use of an oscillating valve circuit as shown in Fig. 8—a simple Hartley type oscillator, capacitively coupled through capacitor C_3. Grid coil, L_1, is untuned and the anode coil is split into two parts, L_2 and L_3, the former being degeneratively coupled to L_1 so that the circuit is normally not oscillating and the anode current is at its maximum, say, 10 milliamperes. Heat from the subject being controlled, *e.g.*, a furnace; operates a millivoltmeter, via a thermo-couple and attached to the millivoltmeter pointer is a light aluminium vane, able to move between the coils, L_1 and L_2.

With the temperature below the desired point, Relay 1 is operated and heat applied to the furnace until the upper limit is reached and the vane gradually shields L_2 from L_1. Oscillation starts and builds up in amplitude until the anode current drops sufficiently for Relay 1 to release and so cut off the heat.

A circuit of this type is very stable and a case is recorded of where an equipment was in use for four years of normal industrial work without the valve being changed. Any slow change of emission is indicated on the milliammeter M_1 and can be compensated by adjusting the screen voltage by means of resistor R_1.

A variation of the above principle is to use a circuit in which the frequency is altered by the millivoltmeter element.

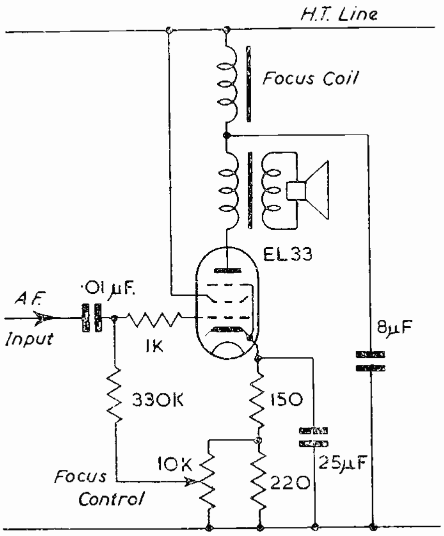
Focus Current Stabiliser for Television Receivers

By C. H. BANTHORPE*

In an electromagnetically focused C.R.T., the current through the focus coil must be variable for optimum focus of the trace, but once set, must remain at that setting within very close limits, regardless of time, temperature and supply variations. In practice, many television receivers need to have the focus control adjusted, some several times, during a transmission. This is quite irritating to a viewer and several solutions to the problem have been found, notably permanent magnet focusing, and current stabilising circuits on the lines of stabilised power supplies.

In the latter method it is usual to feed the coil from a supply which has a very high internal impedance, and therefore resistance changes of the coil, due to temperature variations, have little effect on the current.

Tests have shown that with a coil through which 26 mA passed for optimum focus, a variation of ± 3 mA would make the picture practically



unviewable. It is possible, however, to reduce the current variation due to temperature changes to a negligibly small amount without an increase of cost by taking advantage of the fact that the output impedance of a pentode is high and the valve may, at the same time, provide the power amplification of the television sound channel.

One such arrangement used by the writer is shown in the figure. The focus control varies the bias of the sound output valve, and over the limits needed for focus setting it has no audible effect on the sound output. Considering the small current variation this is to be expected.

If the current needed for focus is higher than the anode current of the sound output valve, the anode current of the line scanning output valve may be used, or the anode current of another valve may be added.

A further advantage of the circuit shown is that a low wattage focus control may be used. In television receivers it is usual to connect the focus coil in series with part, or all, of the circuit, and divert some of the current, by means of a shunt variable resistor, or connect the focus coil across the circuit and reduce the current by means of a series resistor.

* Central Equipment Ltd.

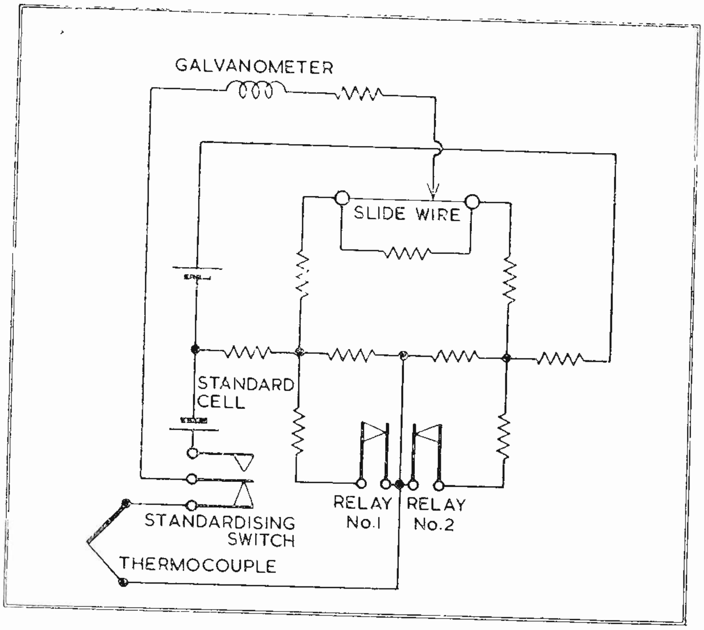


Fig. 4 (*top left*). **Temperature measuring circuit of the Tagliabue Recording Controller**

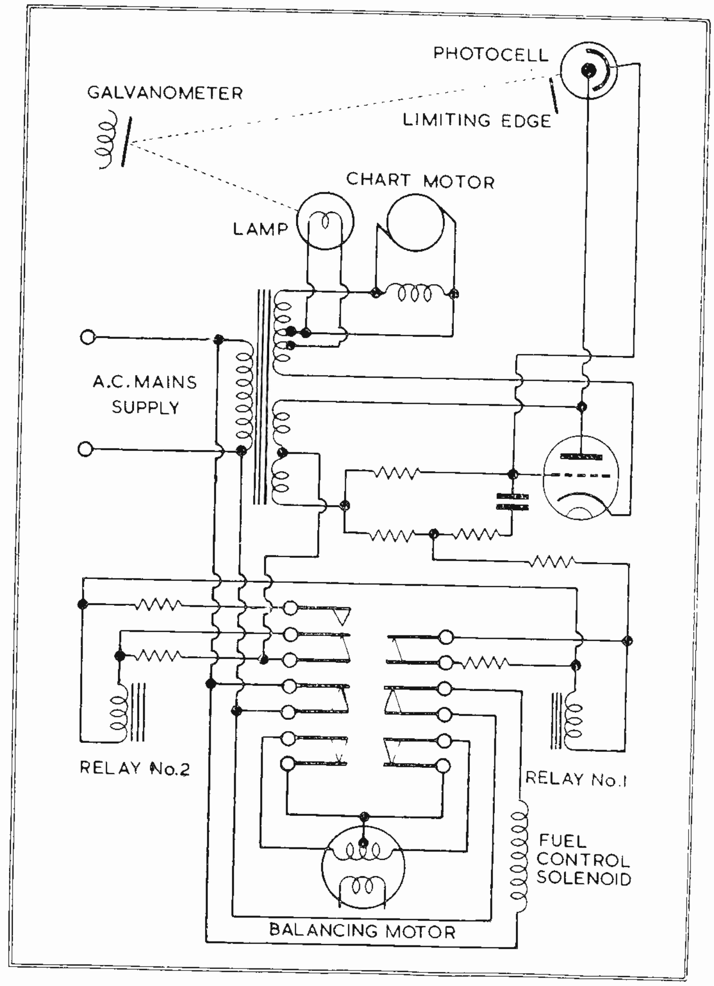


Fig. 5 (*top right*). **Automatic balancing circuit of the Tagliabue Recording Controller**

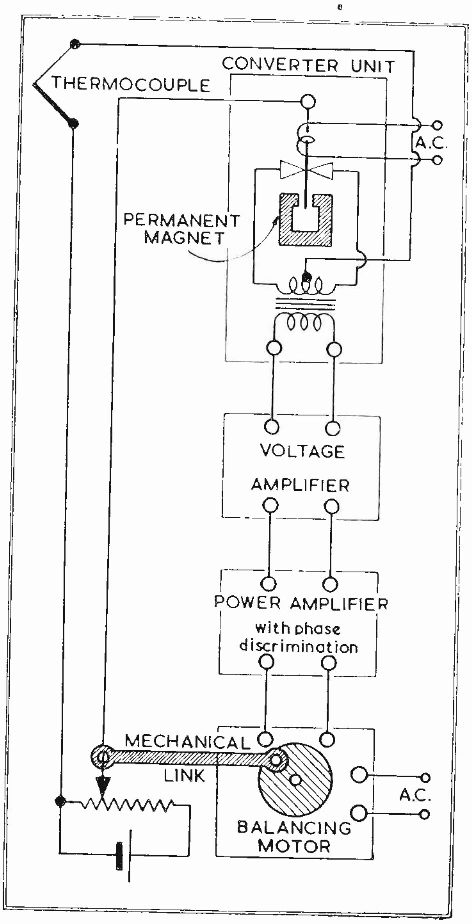


Fig. 6 (*left*). **Continuously-balanced potentiometer not requiring a galvanometer**

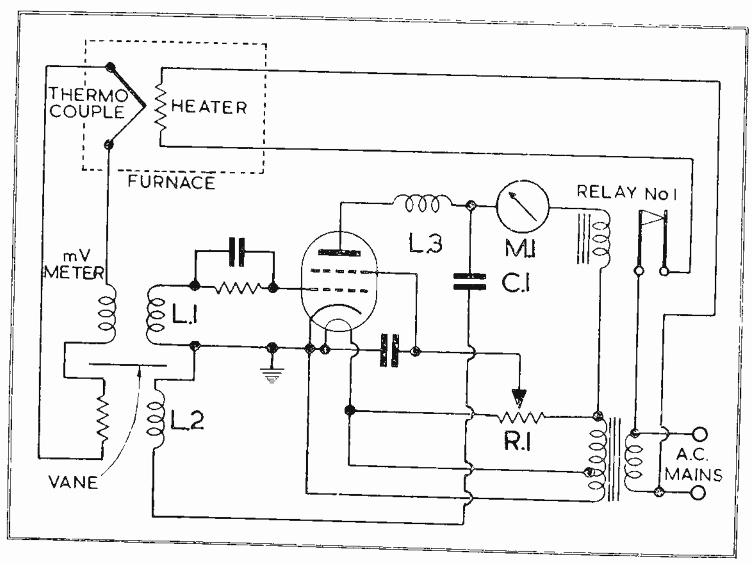


Fig. 8 (*right*). **Circuit of electronic pyrometer developed by the Bristol Instrument Co**

at a lower rate to a higher value.

The two series relays in the anode circuit are arranged to have their respective operating points above and below the initial increase in current. They are connected so that the motor controlled by them revolves in one direction if both are open, and in the reverse direction if both are closed. If one is open and the other closed the circuit is balanced.

Starting again from the condition when the circuit is unbalanced and the motor is driving the contactor and recorder. The light beam is deflected off the cell and both relays are open. An E.M.F. is applied to the galvanometer so that the beam reaches the cut-off point before the motor achieves balance, to avoid overshooting. When, however, the beam strikes the photo-cell, one of the relays closes and removes the

E.M.F. from the galvanometer, causing it to stop quickly. A braking current is also fed to the motor. If the potentiometer becomes unbalanced in the reverse direction the full beam strikes the photo-cell, both relays close and the motor operates in the opposite direction.

The third method of operating a continuously balanced potentiometer is shown in the block diagram, Fig. 6, and it differs from the previous ones in that there is no galvanometer, often the most delicate part of any potentiometer system. A vibrating reed type of converter is used, followed by a three-stage voltage amplifier giving a total amplification of 12,500 and this in turn is followed by a power amplifier formed by the two triodes, with inputs in parallel and outputs in push-pull. The motor circuit is shown in Fig. 7. Valve V_1 can conduct only during odd half cycles and valve V_2 only during even. Thus a definite phase relationship exists between the control voltage from the thermocouple and the power output to the motor, whose windings are shown in A and B.

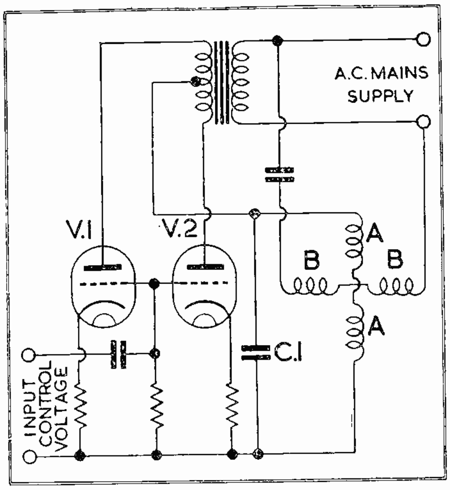


Fig. 7. Motor circuit of the potentiometer shown in Fig. 6

Thermionic Oscillator Relays

The electronic pyrometer controller made by the Bristol Instrument Co. is a good example of this class of instrument, which possesses a number of advantages, not the least being that there is no mechanical link between the initiating mechanism and the responding element. The basic principle is the use of an oscillating valve circuit as shown in Fig. 8—a simple Hartley type oscillator, capacitively coupled through capacitor C_3. Grid coil, L_1, is untuned and the anode coil is split into two parts, L_2 and L_3, the former being degeneratively coupled to L_1 so that the circuit is normally not oscillating and the anode current is at its maximum, say, 10 milliamperes. Heat from the subject being controlled, *e.g.*, a furnace; operates a millivoltmeter, via a thermo-couple and attached to the millivoltmeter pointer is a light aluminium vane, able to move between the coils, L_1 and L_2.

With the temperature below the desired point, Relay 1 is operated and heat applied to the furnace until the upper limit is reached and the vane gradually shields L_2 from L_1. Oscillation starts and builds up in amplitude until the anode current drops sufficiently for Relay 1 to release and so cut off the heat.

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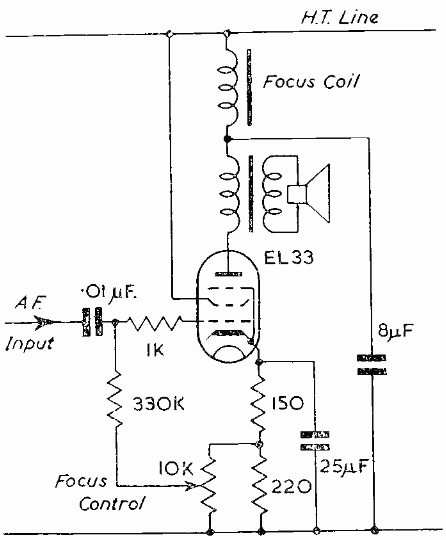
Tests have shown that with a coil through which 26 mA passed for optimum focus, a variation of ± 3 mA would make the picture practically unviewable. It is possible, however, to reduce the current variation due to temperature changes to a negligibly small amount without an increase of cost by taking advantage of the fact that the output impedance of a pentode is high and the valve may, at the same time, provide the power amplification of the television sound channel.



One such arrangement used by the writer is shown in the figure. The focus control varies the bias of the sound output valve, and over the limits needed for focus setting it has no audible effect on the sound output. Considering the small current variation this is to be expected.

If the current needed for focus is higher than the anode current of the sound output valve, the anode current of the line scanning output valve may be used, or the anode current of another valve may be added.

A further advantage of the circuit shown is that a low wattage focus control may be used. In television receivers it is usual to connect the focus coil in series with part, or all, of the circuit, and divert some of the current, by means of a shunt variable resistor, or connect the focus coil across the circuit and reduce the current by means of a series resistor.

* Central Equipment Ltd.

The Patent Office Library and Electronics

By R. Neumann, Dipl. Ing., A.M.I.Mech.E.

Fig. 1. Main Entrance to Patent Office
(From an etching by H. F Gill)

NEARLY every Londoner or visitor to London knows the picturesque half-timbered Elizabethan houses bordering the south side of High Holborn at Chancery Lane Tube Station. But not many have noticed that at the rear of these houses there is a little garden, now tidied up again after having been utterly destroyed together with the XVIth century Hall of Staple Inn during the "Blitz." And only the initiated know that the large grey building on the south of this garden is that of H.M. Patent Office and Library. The main entrance is in 25 Southampton Buildings, just to the right of the garden, but the buildings may also be entered through Quality Court off Chancery Lane or from Furnival Street. Passing through the main entrance (Fig. 1) and the facing swing doors, you find yourself in the vestibule, where you sign the visitors' book and may leave your hat and overcoat at the cloak room. Suitcases, attaché cases, bags and the like, have to be left in the care of a friendly attendant. This is the only restriction, and then the whole library with its collection of official and non-official literature of patents, designs, trade marks, specifications, journals and indexes from all parts of the Empire and foreign countries, its selection of the best textbooks and periodicals of the world, covering all branches of science and technology, is at your disposal. It is a reference library and the public has free and unrestricted access to the shelves. Only very old or a few very modern volumes are kept in special storage and may be ordered by filling in a special slip.

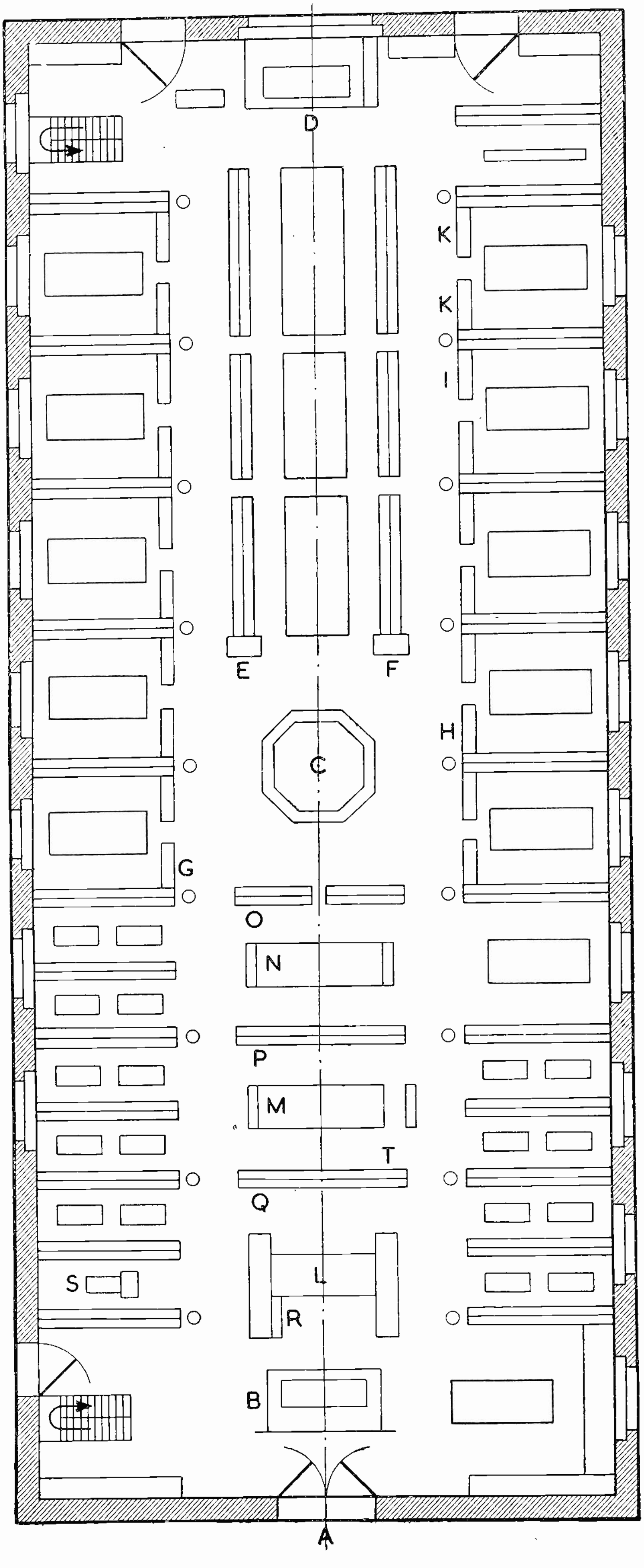
The library was founded in 1852 and opened to the public in 1855. The present building was completed in 1902. It contained:

84,000 volumes in 1901
183,000 volumes in 1920
321,000 volumes in 1945
and at present contains
about 332,000 volumes

The hours of admission are from 10-6 on Mondays-Fridays and 10-5 on Saturdays.

Fig. 2 shows a general view, and Fig. 3 a plan of the reading room. The part near the entrance (A) contains the patent literature. British specifications, registers and card indexes are on the ground floor, the foreign literature on the galleries, two on each side of the hall. Attendants' desks are at the entrance door (B), in the centre (C) (the so-called "dais") and at the opposite end of the hall (D) and also on the two galleries.

The far end of the hall contains the collection of books on high shelves arranged in bays under the galleries on either side of the hall. A collection of current periodicals is on the lower shelves flanking these bays and also running in double-sided rows along a reading table extending lengthwise through the farther part of the hall. The current periodicals are stored in boxes and the bound volumes are



arranged on shelves on the first and second galleries.

Catalogues

In using any kind of library the "know-how" is quite an important matter. If the author and title of a book is known it is an easy matter to consult the catalogue and there to find where to look for it. In the Library the catalogue contains a class mark, and tablets fixed to the columns between the single bays indicate the class marks of the books contained in the bay. The main author catalogue is contained in 15 large volumes lying on the desks surrounding the dais. Additions since 1930 are found in a card index standing near the dais and carrying the indication "Supplement to Author Catalogue" (E). Special symbols added to the class marks in both the main and the supplementary catalogues indicate special locations, *e.g.*, single or double asterisks or "H.R." (Hatch room) or "Pb" (Pocket books) mean that the inquirer must apply for the book at the rear desk with a special slip. A bar behind the class mark refers to the folio collection of books or periodicals, the latter being found on the right side top gallery. The symbol (y) indicates trade catalogues and the symbol (z) pamphlets and these are found in files on the bottom rows of the shelves.

On the opposite side to the supplementary author catalogues on the left there is a subject card index on the right (F). Its upper row of drawers contains a very elaborate index of the class marks and the rows of drawers below this contain the single books arranged according to class marks from 1927 onwards. For older selected groups of subject indexes which were published in book form till the outbreak of the first world war the main author catalogue may be consulted under the heading "Patent Office Great Britain, etc., Library." Two special catalogues to be found on the low shelves near the dais will also prove very helpful. One of them (G) contains an index of all dictionaries and glossaries available in the library, the other (H) a card index of bibliographies which, in addition to some bound volumes of the American "Bibliographic Index", help in tracing the most modern literature of any subject.

Fig. 3. Plan of Reading Room
For explanation of reference letters see text

Periodicals

The catalogues thus far mentioned refer to the book literature. For the periodicals there exists a loose-leaf subject-matter list (I), also containing a key to the classification of headings and a detailed card index (K) with numerous cross references, containing the titles and class marks, as well as the special location symbols mentioned above. These catalogues are found on the right-hand low shelves at the rear end of the hall.

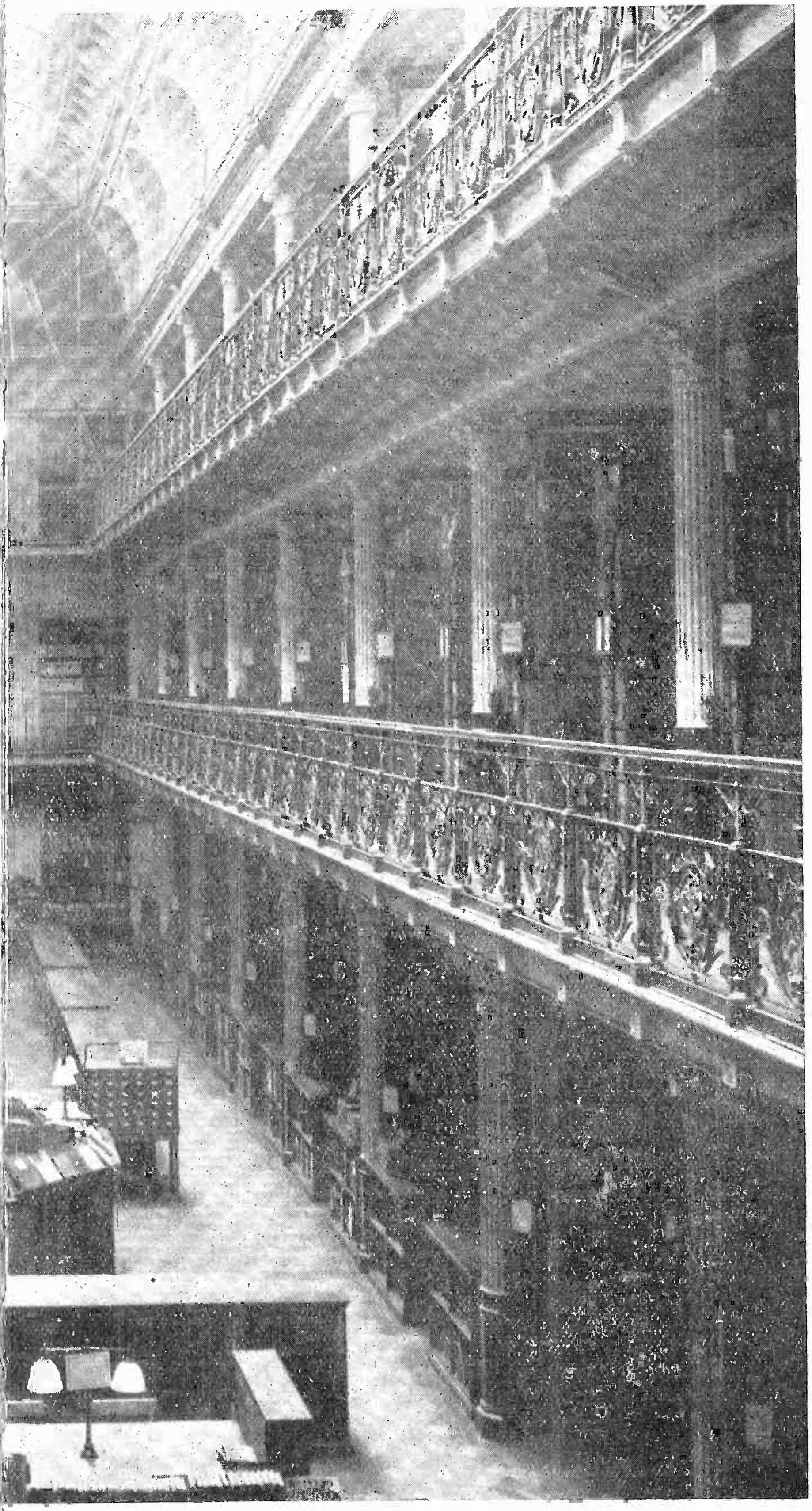
In searching for modern literature on a special subject, use will frequently be made of the special indexes partly containing the titles only and partly brief abstracts. They are published either in yearly volumes like the American publication "Industrial Art Index"—to be found in one of the bays under AB15—and "Engineering Index" (M00), or in monthly instalments like "Science Abstracts Sections" A (Physics) and B (Electrical Engineering) published by the Institution of Electrical Engineers (FY 02). These last-named volumes will be found on the shelves surrounding the dais. The "British Abstracts" (ZE05) mainly concerned with general, physical, inorganic and organic chemistry, physiology, biochemistry, anatomy, chemical engineering, industrial chemistry, agriculture, foods, sanitation, analysis and apparatus, will also prove helpful.

Patent Literature

Although the general reader is usually less interested in the patent literature, the research worker will occasionally want to seek information from this source, and therefore a brief guide to this section of the library follows. As was mentioned before, this section is located in the part of the hall nearest to the entrance. Three readers' desks (L,M,N) running across the hall are separated by low shelves (O,P,Q) containing the illustrated abridgments of all British patents since 1855. Name and subject indexes are on top of the second shelf and volumes containing a register of renewal fees and voids (from which may be ascertained whether a certain patent is still valid), a register of "stages of progress" and an "application register," are on the shelf nearest the entrance (Q).

At present the bound volumes of the name indexes extend from 1617

Fig. 2. General View of Patent Office Reading Room. (Figs. 1 and 2



rtesy of Sir Harold Saunders, Comptroller-General of the Patent Office)

to 1939 and if a name search must be made for a later date the card indexes arranged around the readers' desk (L) nearest to the entrance must be consulted. More important for the research worker, and less easily performed, is a subject matter search. For carrying out such a search over the whole period during which abridgments have appeared or are due to appear it is useful to know that the volumes from 1855 till 1930 are arranged according to *classes*, from 1931 onwards according to *groups*, and that the lists containing the numbers of specifications not yet abridged are arranged according to *classes* again, but that the so-called "press marks" given in these lists considerably facilitate the work of searching for a very specialised subject.

The original 146 classes were arranged in alphabetical order and the abridgments appeared in 146 volumes for each of nine periods (Series A). For the years starting with 1909 there are 271 volumes for each of four periods, as a number of sub-classes had been added to the original classes (Series B). The last-mentioned period ends with 1930 and with specification No. 340200. It should be mentioned that the numbering of the specifications also underwent a change in that till 1915 the numbers started with one each year, and the year was indicated in giving the number of a specification. From 1916 onwards the specifications are numbered consecutively, starting from 100001.

From 1931 onwards the abridgments are sub-divided into 40 groups. Tables comparing the groups and the corresponding classes and sub-classes are found in Volume II of the "Abridgment Class and Index Key" on the first readers' table (L) near the entrance, as well as at the end of each volume of the abridgments.

With increasing specialisation in many fields of manufacture, a further refinement of the classification proved desirable. A new index key was therefore started in 1937, and this is to be found in four loose-leaf volumes on the high desk (R) at the left of the first reader's table. Here the "press marks" mentioned above are given in italics at the right side of every sub-heading and sub-division. From specification 440006 onwards these press marks are also given in the indexes of abridgment volumes and from specification 60001 onwards they are also

Subject	Universal Decimal Classification	Library Class-mark	Patent Specifications		
			Group	Class	Press-mark
Electronics	621.38	HD 70-72, 80	XL	39 (I)	various
Photocells					D 6, L 7$_e$, D 36.
and photomultipliers	621.383	HE 24-26	XL	39 (I)	D 15 [D 402$_e$
Particle accelerators	621.385.83	FW 32, FY 00			
Cyclotron	621.384.6	ZI 85	XL	39 (I)	D 4. . . D 10. . .
Betratron synchrotron	621.385.83	FW 32, FY 00			D 10$_e$
van de Graaf	621.319.339	,, ,,	XXXV	35	D I
Thermionic tubes	621.385	HD 24, 25, 84	XL	39 (I)	various. Chiefly D I
Magnetrons	621.385.16	,,	,,	,,	D 10 b, D 10$_f$
Klystrons	621.385.1.029.6	,,	,,	,,	D 16
Thyratrons	621.385.38	,,	,,	,,	D I j
Ignitrons	621.314.653	,,	,	,,	D 3 i
Cathode ray tubes	621.385.822	HB 04-08, HE 66	,,	,,	D 4 a-x D 10 a, b
Oscillographs	621.317.755	HE 62, 66	XXXVL	37	A 5 i I
Ionisation chambers	537.56	HD 82, FW 32	XX	97 (III)	W
Point counters	537.542	FW 32, HD 83			
G.M. counters	621.385		XL	39 (I)	D 8
X-rays	621.386	FW 32			
X-ray tubes	621.386.1	HD 88, 89	XL	39 (I)	D 2, D 32
X-ray apparatus	621.386.8	,,	XX	98 (I)	A I v
Radiography	778.33	HD 86, 87, 89, 90	III	I (I)	F 12, 0
Parts, operation and properties of cells and tubes	621.385.03	HD 24, 25	XL	39 (I)	D I. . . 46
Cathodes	621.385.032.21	,,	,,	,,	,,
Anodes	621.385.032.22	,,	,,	,,	,,
Grids	621.385.032.24	,,	,,	,,	,,
Fluorescent screens	621.385.832	JA 42	,,	,,	D 4 f 2, 5
Electron optics	621.385.83	HE 42	,,	,,	D 4. . , D 10. . .
,, microscope	621.385.833	HE 45	,,	,,	,,
,, diffraction	,,	FW 32	,,	,,	,,
Applications :					
Rectifiers	621.314.67	GX 45	XXXV	38 (II)	F 3 d . .
			XL	39 (I)	D 3 . . . D I
Telegraphy	621.394	HA 44, HC 95 and others	XL	40 (III)	various
Telephony	621.395	HA 44, HC 95 and others	XXXIX	40 (IV)	various
Radio	621.396	HC 65-99	XL	40 (V)	various
Aerials	621.396.67	HD 23	XL	40 (V)	L 12 AE
Transmitters	621.396.61	HD 20	XL	40 (V)	W 2. . , W 8. .
Oscillators	,,	HD 96	XL	39 (I)	D 4
			XL	40 (V)	W 2. . , W 8. .
Receivers	621.396.62	HD 32, 34	XL	40 (V)	Q I . . - Q 4. .
Amplifiers	621.396.645	HD 34	XL	40 (V)	W I. . - W 7. .
Radar	621.396.96	HD 15	XL	40 (V)	L 12 t
	before spec.	580001 also	XXXVI	37	A I. . 8 DS, DF, DP
Television	621.397	HB 04-08	XL	40 (III)	F. . . .
Depositing substances by electric discharges	621.793	ZL 46	XL	39 (I)	M
Gas discharge lamps	621.327	GY 67-70	XL	39 (I)	D 5
Fluorescent materials	535.37	JA 42	XL	39 (I)	S
High frequency heating	621.36	GZ 02-10	XI	39 (III)	H 2. . .
dielectric	621.365.92	ZL 65	,,	,,	H 2 d 2
inductive	621.365.5	,,	,,	,,	H 2 d I
Radioactivity	539.16/.18	ZI 58	III	I (I)	F 12, 0
Electromedical devices	61	SY 16	VI	81 (II)	B 19
Resistors	621.316.8	HD 07	XXXVI	37	C
Chokes	621.318.42	,,	,,	,,	
Dust cores	621.318.042.15		XXXV	38 (II)	
Capacitors	621.319.4	,,	,,	37	D
Conductors	621.315.5/.6	GX 69-82	XXXVI	36	various
Insulators	621.315.61	GY 06-10	XXXVI	36	,,
Glass	666.1/.2	CH 03-06	XXIII	56	,,
Ceramics	666.3/.7	CD 17-18	X	87 (I)	,,
Textiles	677	CR 97-99	VIII	96	,,
Paper	676	YV 03-64	,,	140	,,
High vacuum	533.5	JF 22	XXXIII, XXVI, XIX		various
,, ,, pumps	533.51/.57	,,	XXVIII, XXVI	8 (I), 71, 110 (II)	,, ,,
,, ,, gauges	531.788	,,	XIX	106 (II)	,,
Photography	77	CA 95-CC 59	XX	98 (II)	,,

to be found printed on the specification. They are of special value for subject matter searches of recent specifications, the more so since at present the latest printed abridgments refer to specifications till 1943 only. Numerous cross-references are given, easing the search work considerably. For more detailed information concerning this subject the reader may be referred to E. M. Bennett: "The classification of inventions disclosed in United Kingdom Patent Specifications," *Proc. Brit Soc. Internat. Bibliogr.* 7, 1-9, Feb. 21, 1945.

There may still be cases in which the tracing of the class or sub-class under which a particular subject is classified is doubtful. In these cases it is useful to know, *e.g.*, from the book or periodical literature, one specification number referring to that subject. Then the respective sub-class or press mark may be found by consulting the "Group Allotment Index" in the shelf (R) below the 1937 Index Key and contained in loose leaves stored in boxes in the adjacent bay (S).

The very latest specifications may be found in the files containing the "Official Journal (Patents)," appearing weekly and laid out for inspection on the readers' desks. Here the subject matter index gives the headings alphabetically. The sub-division according to groups, classes and shelf marks respectively is found in the boxes forming the continuation of the bound volmes of abridgment groups and in the Class Lists stored in separate boxes to be found in the first shelf facing the second reader's table (T).

As will have been noticed, the classification of the patents and of the library are different and it has frequently been asked why a single system, *e.g.*, the Universal Decimal Classification, has not been used for both. Of course, it must be taken into account that the patent classification originated long before the Dewey system (which forms the basis of the U.D.C.) had been devised. Further, the requirements of a patent classification and a library classification differ in themselves to a large extent. The former must be far more specialised and must be easily further sub-divided if the necessity arises without having to wait for international agreement on extensions. The same applies, although perhaps not in every respect, to the Patent Office Library classification. This was due to the work of two former librarians, Messrs. E. W. Hulme and H. V. Hopwood, in the first decades of this century. The class marks consist of two letters and usually a two-digit number. When the number has more than two digits, the same principle is used as in the decimal classification, *e.g.*, HA 1462 ranges before HA 147 and this before HA 15. It may be said that both the patent classification and the book classification fulfils in a general way the two requirements to "provide a range of categories sufficient to accommodate any possible item that may need to be classified" and that "the definitions of the categories are mutually exclusive, so that only one home is possible for any one item and a searcher is bound to look for this in the same place as the classifier has put it" (J. E. Holmstrom). But this is an ideal state and cannot always be actually fulfilled in practice. That the second requirement cannot be satisfied in all cases may be shown by the fact that there are about 1,500 headings in the present patent classification key, but that a specification is allotted to 2-3 or even more headings, and the respective abridgment appears in the class and group volumes of the heading to which the correspondin specification is allotted.

Electronic Engineering

The leading periodicals and books in this field may be found on the library shelves. Most of the journals on electronics are kept under class number HD 72, but ELECTRONIC ENGINEERING is marked HB 05. This is due to the fact that this journal was founded in 1928 under the name of *Television.*

Besides the bibliographies and abstract journals mentioned above, the abstracts published monthly in the *Bulletin of the British Scientific Instruments Research Association* (FW 30) and in the *Wireless Engineer* (HC 68) will be helpful. The technical dictionaries contained on the shelves AA 98 are in general not modern enough to be of any use for electronic engineering. The modern illustrated *Electronics Dictionary* by Cooke & Markus (HD 76 H.R.) is kept in the hatch room, and the Russian-German-French English *Dictionary of Radio Terminology* by Litvinenko (HC 98) is obtainable at the dais. The "Radar Glossary" which appeared in ELECTRONIC ENGINEERING in October, 1945, The British Standards Institution's *Glossary of Terms used in Telecomunication* (BS 204:1943) (MD 100) and the *Universal Decimal Classification* (*Vol.* 4, *Part* 2 *Electrical Engineering* (AN 41 H.R.) may be mentioned in this connexion. Petraglia's *Electronic Engineering Master Index* 1925-1945 may be found under HD 73 among the bound volumes of periodicals on the gallery.

The table opposite contains a survey of several classifications of the principal subjects in electronic engineering. The decimal classification is given mainly because it has been adopted by *Science Abstracts* which are indispensable for every search in physical and electrotechnical literature.

Finally a few general remarks may be added on the relations between fundamental research and literary and patent search. There can be no doubt whatever that fundamental research, be it of a theoretical or experimental nature, plays the most important part in promoting pure and applied science.

But it might be well also to add a word of warning concerning the value of literary and patent search. It refers specially to publications in the field of applied sciences. It must be borne in mind that reports in this field are written in the great majority of cases only with the consent and in the interest of the companies for which the author is working. So it may be true to some extent that "company employees frequently may not, or cannot, report truthfully and extensively . . . and usually after a delay of several years" (Dr. P. Schwarzkopf). As a matter of fact the Patent Office Library favours the periodical rather than the text book because the periodical literature is in general more up to date, especially at the present time when long delays in the publication of books are unavoidable due to the paper shortage. That "patents are only partly useful as sources of information about technical development" will be generally admitted. The fact that a patent has been granted is by no means a proof that its subject matter is of any value.

All these considerations do not impair in the least the enormous value of such a collection of most important information that is to be found in the Patent Office Library.

3-Phase from 1-Phase

Constant Phase Difference With Variable Frequency

By W. BACON, B.Sc., A.M.I.E.E.*

A PROBLEM sometimes encountered in electronic engineering is that of obtaining a 3-phase output from a single-phase input. If the frequency of the input is constant, the problem is straightforward. Where power loss is unimportant, a simple resistance capacity phase shifter is sufficient. The problem of transforming a single-phase 50 c/s. power supply to 3-phase has also received attention. Where, however, it is necessary to transform a single-phase input to 3-phase when the input varies over a range of frequencies the problem becomes more difficult. Such a problem arises, for example, in designing a ripple control outfit for operation over a 3-phase system.

Below is described a method for designing a suitable network which gives an accurate conversion of single phase to 3-phase at two frequencies any distance apart, and at intermediate frequencies gives a conversion in which the phase voltages are of the correct magnitude, but in which the angles between the phases vary slightly with frequency. A method is given for calculating the maximum value of this error.

A general calculation is first given for obtaining a 2-phase system in which the phases are any number of degrees apart. This is then applied to the particular case of a 2-phase output in which the phases are 90° apart, from which a 3-phase system may be obtained. Charts are given for the calculations in this latter case.

General Calculation

Consider the circuit shown in Fig. 1. *AOB* is the centre-tapped secondary of a transformer, *RC* is a resistance capacity and *RL* a resistance inductance network. All the components are, of course, assumed perfect. Single-phase voltage is fed into the primary of the transformer and the two phases are obtained from *OC* and *OD*. The vector diagram is shown in Fig. 2.

Let us calculate the angle *COD* between *OC* and *OD*. Since angles $B\hat{C}A$ and $B\hat{D}A$ are right angles, a circle can be drawn with centre *O*

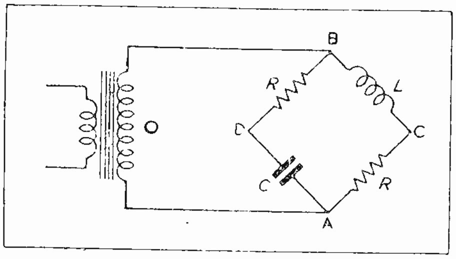


Fig. 1. Centre tapped transformer with *R-C* and *R-L* networks

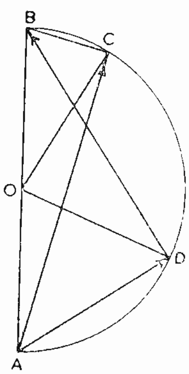


Fig. 2. Vector diagram for Fig. 1.

passing through *B*, *C*, *D*, and *A*. Then since the angle at the centre equals twice the angle at the circumference.

$$\text{Angle } B\hat{O}C = 2 \times B\hat{A}C = 2\tan^{-1}\frac{\omega L}{R}$$

Similarly

$$\text{Angle } A\hat{O}D = 2 \times A\hat{B}D = 2\tan^{-1}\frac{1}{\omega CR}$$

$$\therefore \text{angle } C\hat{O}D = 180° - (B\hat{O}C + A\hat{O}D)$$

$$= 180 - 2\left(\tan^{-1}\frac{\omega L}{R} + \tan^{-1}\frac{1}{\omega CR}\right)$$

$$\text{Let } \theta = \frac{180 - C\hat{O}D}{2}$$

$$\text{Then } \tan^{-1}\frac{\omega L}{R} + \tan^{-1}\frac{1}{\omega CR} = \theta$$

$$\therefore \tan\theta = \frac{\dfrac{\omega L}{R} + \dfrac{1}{\omega CR}}{1 - \dfrac{\omega L}{R}\cdot\dfrac{1}{\omega CR}}$$

$$\text{Let } \frac{\omega L}{R} = x \text{ and let } Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$\text{Then } Q^2 = \frac{L}{CR^2} \quad \text{and} \quad \frac{1}{\omega CR}$$

$$= \frac{1}{\omega\cdot\dfrac{L}{R}\cdot\dfrac{1}{Q^2}} = \frac{Q^2}{x} \text{ or } \frac{1}{\dfrac{1}{Q^2}\cdot x}$$

$$\therefore \tan\theta = \frac{x + \dfrac{Q^2}{x}}{1 - x\dfrac{Q^2}{x}} = \frac{x + \dfrac{Q^2}{x}}{1 - Q^2}$$

Solving this for x gives:

$$x = \frac{(1 - Q^2)}{2}\tan\theta \pm \sqrt{\frac{(1 - Q^2)^2\tan^2\theta}{4} - Q^2} \quad \ldots (1)$$

Thus, for one value of θ, there exist two values of x, *i.e.*, the phase difference is the same for two values of frequency. Let the corresponding values of x be x_1 and x_2 and let $x_2 = nx_1$ where n is greater than 1. Then

$$\frac{1 - Q^2}{2}\tan\theta + \sqrt{\frac{(1 - Q^2)^2\tan\theta}{4} - Q^2}$$

$$= \frac{n(1 - Q^2)}{2}\tan\theta - n\sqrt{\frac{(1 - Q^2)^2\tan^2\theta}{4} - Q^2}$$

Solving this for $1/Q^2$ gives:

$$\frac{1}{Q^2} = \left(\frac{(n+1)^2 + 2n\tan^2\theta}{2n\tan^2\theta}\right) \pm \sqrt{\left(\frac{(n+1)^2 + 2n\tan^2\theta}{2n\tan^2\theta}\right)^2 - 1} \quad \ldots (2)$$

This enables the value of Q to be calculated for any value of n and any value of θ, the supplement of the phase difference divided by 2.

Calculation for 90° phase shift

Where a 3-phase system is required, it is necessary to make $\theta = 45°$, *i.e.*, the phase difference 90°, and the expression then simplifies to:

$$\frac{1}{Q^2} = \left(\frac{n + 4 + 1/n}{2}\right) \pm \sqrt{\left(\frac{n + 4 + 1/n}{2}\right)^2 - 1}$$

But $\dfrac{1}{Q^2}$ must be greater than unity, or the expression for $\tan\theta$ would be negative. The negative sign is therefore inadmissable, and hence $1/Q^2$

$$= \left(\frac{n + 4 + 1/n}{2}\right) + \sqrt{\left(\frac{n + 4 + 1/n}{2}\right)^2 - 1} \quad \ldots (3)$$

* Municipal College, Portsmouth.

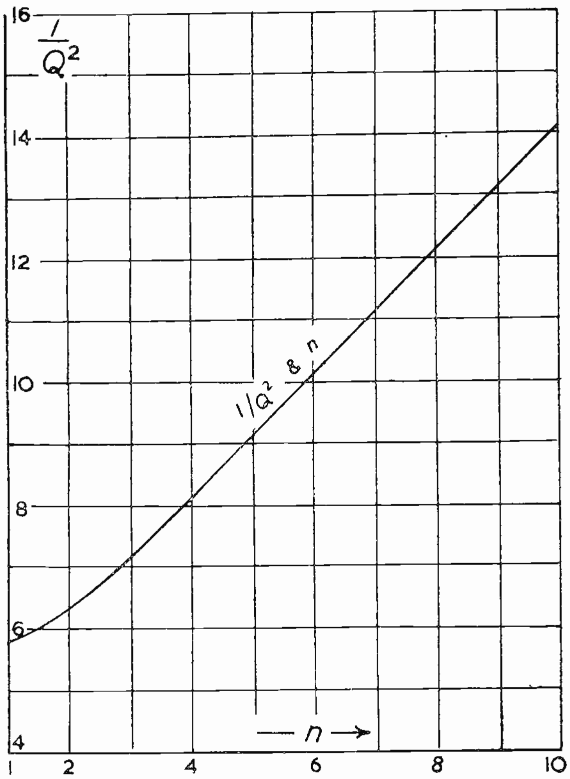


Chart 1. Plot of $1/Q^2$ and n

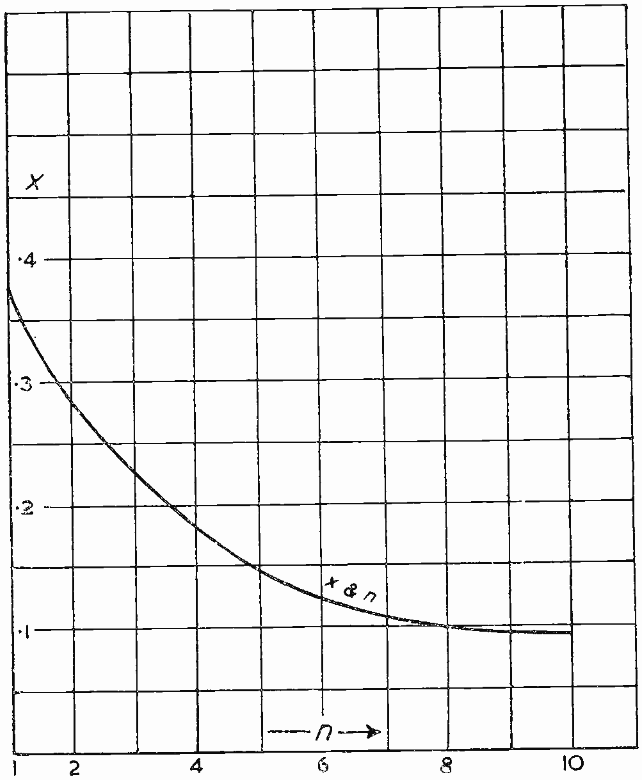


Chart 2. Plot of x and n

Chart 1 shows the plot of $\frac{1}{Q^2}$ against n. The equation for x becomes:

$$x = \frac{(1 - Q^2)}{2} \pm \sqrt{\frac{(1 - Q^2)^2}{4} - Q^2}$$

Taking $x = x_1$ as the lesser value of x,

$$x_1 = \frac{(1 - Q^2)}{2} - \sqrt{\frac{(1 - Q^2)^2}{4} - Q^2} \quad \ldots (4)$$

Since Q is a function of n, x_1 may be plotted against n.

Chart (2) shows plotted as a chart the values of x_1 against n.

$$\text{Now } x_1 = \frac{\omega . L}{R} \text{ whence } L = \frac{x_1}{\omega} R \ \ldots (5)$$

$$\text{and } \frac{1}{Q^2} = \frac{CR^2}{L} \text{ whence } C = \frac{1}{Q^2} \frac{L}{R^2} \quad \ldots (6)$$

Thus if the value of R be chosen, the value of L and C are determined.

Derivation of 3-Phase System

From Fig. 3 it will be seen that to obtain a 3-phase system from the 2-phase system COD calculated as above it is necessary to add another vector OE equal to and in opposite phase to OD, and to make OC' equal to $\sqrt{3}$ times OD. Then C', D and E are at the corners of an equilateral triangle and hence give a 3-phase system.

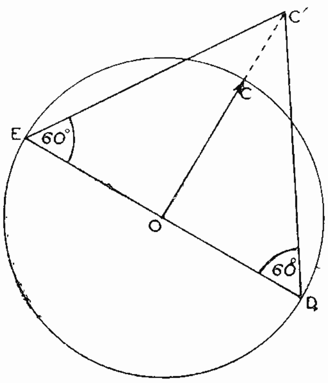


Fig. 3. Vector diagram for 3-phase from 2-phase

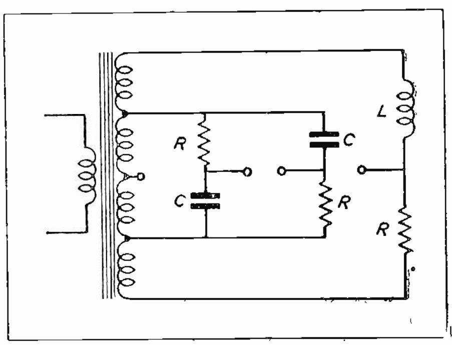


Fig. 4. Additional R-C network for a 3-phase system

This may be effected very simply by adding another RC network similar to the first one (Fig. 4) but in which the resistor and capacitor have been interchanged, and tapping the R-L circuit up on the transformer so that the voltage applied to it is $\sqrt{3}$ times that applied to the two RC circuits.

Design Procedure

The design procedure thus consists in choosing the value of R, obtaining the value of $\frac{1}{Q^2}$ and x either from Equations (3) and (4) or Charts (1) and (2) and hence obtaining the values of L and C from the equations:

$$L = \frac{Rx_1}{\omega} \text{ and } C = \frac{L}{Q^2} \frac{1}{R^2}$$

If the values thus obtained are not practical they can be varied by simple proportion using a different value of R, L being proportional to

R and C to $\frac{1}{R}$. Since the important factor is $\frac{L}{R}$, it is also possible to vary L and its associated R proportionately without changing the result.

Where a value of θ other than 45° is required, x and $\frac{1}{Q^2}$ may be calculated from Equations (1) and (2).

Calculation of Error

The maximum error which occurs may be calculated by finding the value of tan θ where the tan θ – x curve is at a turning point between x_1 and x_2 and subtracting from this the value of tan θ at x_1 or x_2.

$$\text{Now } \tan\theta = \frac{x + Q^2/x}{1 - Q^2}$$

$$\therefore \frac{d}{dx}(\tan\theta) = \frac{1 - \frac{Q^2}{x^2}}{1 - Q^2}$$

and this must be zero at the turning point.

$$\therefore 1 - \frac{Q^2}{x^2} = 0 \text{ or } x = Q$$

the value of tan θ at the turning point is thus given by:

$$\tan\theta_m = \frac{2Q}{1 - Q^2} \text{ or } \theta_m = \tan^{-1}\frac{2Q}{1 - Q^2}$$

The error then equals

$$\theta_m - \theta_{x1} = \tan^{-1}\frac{2Q}{1 - Q^2} - \theta_{x1} \quad \ldots (7)$$

where θ_{x1} is the value of θ at $x = x_1$, *i.e.*, the nominal value of θ.

In the case where $\theta = 45°$, *i.e.*, that suitable for a 3-phase conversion, then

$$\text{Error} = (\theta_m - \theta_{x1})$$

$$= \tan^{-1}\frac{2Q}{1 - Q^2} - \tan^{-1} 1$$

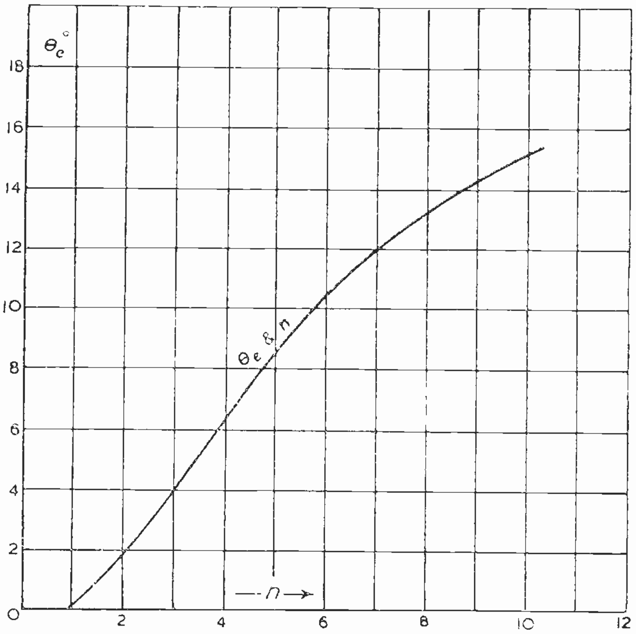
$$\text{Hence } \tan(\theta_m - \theta_{x1}) = \frac{\frac{2Q}{1 - Q^2} - 1}{1 + \frac{2Q}{1 - Q^2}}$$

and if the error $\theta_m - \theta_x = \theta_e$

$$\text{then } \theta_e = \tan^{-1}\left(-\frac{Q^2 + 2Q - 1}{Q^2 - 2Q - 1}\right) \quad (8)$$

This may be calculated if the value of Q is known. Alternatively, since Q is a function of n, a curve of θ_e against n can be plotted and this is shown in Chart 3.

Chart 3. Plot of θ_e against n



Summary of Design

For convenience the various design formulæ are listed below:

(1) *For any angle between the phase.*

$$\frac{1}{Q^2} = \left(\frac{(n+1)^2 + 2n\tan^2\theta}{2n\tan^2\theta}\right) + \sqrt{\left(\frac{(n+1)^2 + 2n\tan^2\theta}{2n\tan^2\theta}\right)^2 - 1} \quad \ldots (2)$$

$$x_1 = \frac{1 - Q^2}{2}\tan\theta - \sqrt{\frac{(1 - Q^2)^2}{4}\tan^2\theta - Q^2} \quad \ldots\ldots (1)$$

$$C = \frac{1}{Q^2} \times \frac{L}{R^2} \quad \ldots\ldots\ldots\ldots (6)$$

$$L = \frac{x}{\omega_1} \cdot R \quad \ldots\ldots\ldots\ldots (5)$$

$$\theta_e = \tan^{-1}(2Q/1 - Q^2) - \theta_x \quad \ldots (7)$$

$$\theta = \frac{180° - \text{phase difference}}{2}$$

(2) *Where the required phase angle* = 90° (*e.g., for a 3-phase system*). The formulæ for C and L are, of course, unchanged, and:

$$\frac{1}{Q^2} = \left(\frac{n + 4 + 1/n}{2}\right) + \sqrt{\left(\frac{n + 4 + 1/n}{2}\right)^2 - 1} \quad \ldots (3)$$

and may be found from Chart 1.

$$x = \frac{(1 - Q)^2}{2} - \sqrt{\frac{(1 - Q^2)^2}{4} - Q} \quad (4)$$

and may be found from Chart 2.

$$\theta_e = \tan^{-1}\left(-\frac{Q^2 + 2Q - 1}{Q^2 - 2Q - 1}\right) \quad (8)$$

and may be found from Chart 3.

Application in Practice

As is usually the case, practical results may show some apparent discrepancies from the theory unless care is taken. When a single phase system is being split into two phases, the common point of the two phases would appear to be the centre tap O of the transformer. If this is taken as such, however, the leakage inductance and self-capacitance of the transformer are introduced in series with the phase-shifting network, the properties of which are thereby altered. This may be overcome by taking the junction of the two phases as the junction of two equal resistances connected in series across the transformer.

In the 3-phase case this problem does not arise in the same way, but care must be taken that the loading on the network is sufficiently light not to disturb its properties. For this reason the value of R will normally be taken to be as low as possible.

It will be seen that the curve of $1/Q^2$ against n tends to become a straight line. At large values of n the corresponding equation simplifies to $1/Q^2 = n + 4$.

The Van De Graaff Generator

(*Continued from p. 47*)

it is necessary to have a particle source and a means of directing and focusing such particles on to a target. This is achieved by using an accelerating tube consisting of a number of ceramic tubes connected together by means of annular metal rings, which are connected to adjacent plates of the H.V. electrode supporting column, thus giving a uniform voltage gradient down the tube. At the top end is a particle supply in the form of a tungsten hairpin filament, and at the bottom is the focusing assembly and target. The accelerating tube is evacuated to a very high degree to prevent particle energy loss owing to collision with gas molecules. Fig. 8, right hand side, shows the top of the filament assembly. This filament is supplied by a 2,000 c/s. generator (top centre of Fig. 8) which is belt-driven from the top conveyor belt roller.

Emission from the accelerator tube filament is controlled by Selsyn motors at the bottom of the column and these are controlled by a similar unit on control panels. The meters which record ion-source voltage and current are read by means of an optical system. The small hole through which these meters are viewed passes right through the supporting columns and is shown in Fig. 4.

The particle energy achieved may be as high as 5 MEV and can be used for radiographic, therapeutic and nuclear research.

One of the most important applications of this generator is in the treatment of cancer by means of deep therapy treatment.

The high particle energy produces very hard X-rays which are extremely suitable for deep tumours. These rays, in addition to having a high penetration, are sharply defined. This means larger depth doses are possible and there is less change of damaging surrounding healthy tissues as was the case with the lower voltage X-ray machines. Again, owing to its high definition, the beam possesses better directive properties which enables multiple doses from various directions to be concentrated on to one point.

Even if this generator can never be applied to anything other than nuclear and cancer research, success in the latter field alone would fully warrant any time, money and energy spent on its development.

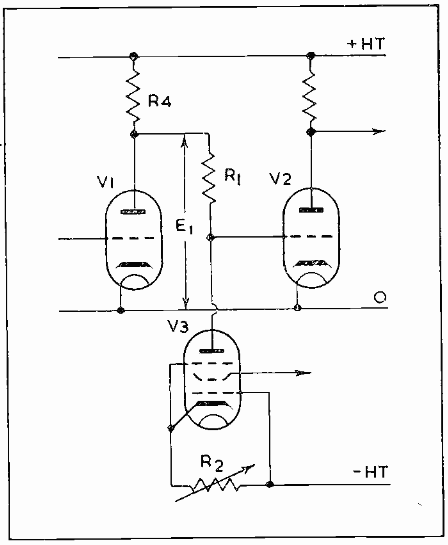
A Note on Interstage Coupling for D.C. Amplifiers

By P. O. BISHOP, M.B., B.S.*

IN multi-stage D.C. amplifiers simple cascading (*i.e.*, direct coupling between anode and grid) requires a relatively high potential source for the later stages and means that the output is at a high positive potential with respect to earth. Many circuit arrangements have been suggested to avoid this difficulty. One of the most recent is that of Mezger† in which a triode is used in the inter-stage coupling. The high differential impedance of a pentode can be used to obtain a high impedance for a relatively small voltage drop across it. It has been used in this way in both the anode and cathode circuits of an amplifier to give large anode and cathode loads without the necessity of having large positive and negative high tension supplies. It is particularly useful as a common cathode load in balanced amplifiers to obtain a high discrimination against in-phase signals. So far as the writer is aware, however, its use in inter-stage coupling for D.C. amplifiers has not been described.

If in the diagram shown the valve (V_3) is replaced by a resistance (R_3) the method of interstage coupling becomes the common one of a potential divider with negative bias.

For minimum attenuation of the signal R_3 must be made very much greater than R_1. The practical limit is set by the available negative supply. By using a pentode to replace the resistor R_3 the effective value of R_3 can be greatly increased without increasing the negative voltage.



The coupling pentode V_3 is self-biased and the biasing potentiometer R_2 can be used in setting up to bring the anode potential of V_3 to the appropriate level for the grid of V_2. The screen potential is obtained from a suitable source depending upon the operating potentials of the valves V_1 and V_2. In many situations it is convenient to earth the screen. It can be seen that the anode current of V_3 must flow through the anode load (R_4) of V_1. This reduces the allowable value of the anode load (R_4) for a given high tension voltage and limits the value of this coupling arrangement in the early stages of an amplifier where small anode currents are used. However, the use of valves and neons in coupling the early stages of a high gain D.C. amplifier is undesirable because of the noise arising in them. Valves are much better than neons in this respect. Furthermore, the early stages can be operated with relatively low voltages across the valves and the high tension requirements only become a serious difficulty in the later stage. As it is desirable to use a high impedance pentode for coupling, the anode current can be made less than a milliampere.

The impedance of a pentode looking into the anode is given by $R_a + (\mu + 1) R_2$. The attenuation of the signal is thus given by the ratio

$$\frac{R_a + (\mu + 1) R_2}{R_a + (\mu + 1) R_2 + R_1}$$

The following values are typical:

Negative supply line − 100 V

$E_1 = 100$ V

Cathode of V_2 − earth potential

$R_1 = 100$ K

$R_a(V_3) = 1\ \text{M}\Omega$

$\mu(V_3) = 1000$

$R_2 = 1000\ \Omega$

The ratio

$$\frac{R_a + (\mu + 1) R_2}{R_a + (\mu + 1) R_2 + R_1}$$

becomes 0.5.

Using a potential divider to obtain the same potential drop would have resulted in the signal being reduced by a half.

* Department of Anatomy, University College, London.

† G. R. Mezger, ELECTRONICS, *15*, 106, 1944.

CORRESPONDENCE

Design for a Brain — *Discussion*

The interest which Dr. Ashby's article aroused has been reflected in the number of letters, some sarcastic, some complimentary, which we have received. It is regretted that space permits publication of only a limited cross-section of the correspondence.—Ed.

Dr. W. Grey Walter (*Burden Neurological Institute*)

The publication of the article by Dr. Ashby was a brave and commendable step towards solemnisation of the union between brain physiology and electronic engineering. Their relations, though intimate, have so far had both the excitement and the dissatisfaction of an irregular liaison; they have gained mutual stimulation but now one may assert that they are one flesh.

Those of us who have seen Dr. Ashby's larval homeostat at work can vouch for the accuracy of his description of its behaviour and perhaps add some impressions of our own. Its most convincing performance is to adapt to a reversal or arbitrary linkage of its components in order to achieve its standard of stability. In reaching this goal it sometimes seems to exhibit the familiar signs of frustration and disappointment; it may sulk inactively for a while, then display hysterical over-action and frantic over-compensation. Furthermore, the imposition of an external control may make a stable arrangement unstable for a long period. When adaptation to the new rule is complete, removal of the control will again produce instability, and if one came on the device for the first time just before the control was removed, one would imagine that the external force was essential to the system.

It is easy to dismiss this contrivance as a crude analogy, but its resemblance to a simple nervous system may not be a superficial one. Just as in the Homeostat certain connexions must be made correctly at the outset—the valve heaters for example—and others left random, so in a nervous system certain structures develop in a standard form and others acquire connexion only with use and trial. As Dr. Ashby says, vertebrate and particularly human brains are so complicated and above all so super-miniaturised, that it needs a real effort to see their resemblance to any mechanism. The human brain may have of the order of 10^{100} as compared with the homeostat's 10^5 combinations of feedback but the onus of proving that their basic principles of operation are different is now with the supporters of non-mechanistic hypotheses.

As the homeostat or its collateral descendants evolve, the other properties of nervous function will be incorporated.

The nervous system includes devices for integrating, differentiating, frequency modulation and discrimination, wave synthesis, storage and scanning, and makes elaborate group transformations of signals from one co-ordinate system to another; signals arriving as a spatial pattern are displayed on a time base, others containing data on frequency differences are projected on spatial co-ordinates, and so forth. When all these have been reproduced electronically, as individually they easily can be, and combined in a homeostatic individual, we shall certainly have something—or it will have us.

Dr. Ashby chose one rather unfortunate example of acquired discrimination—a kitten would take more than nine lives to distinguish between the redness of meat and that of fire—cats are colourblind! All the same his article was a great encouragement to those who are learning to think of the brain more as the supreme device for handling signals than as mysterious electric jelly.

Dr. W. Summer (*Bournville*)

Certainly, the homeostat is a mechanism that out of a variety of possible combinations of primary information (either designed into, or received from the world surrounding the machine) chooses by selection, i.e., by the primitive method of trial and error. Even on the relatively low level of purely instinctive behaviour it is difficult to see what action the homeostat would take in order to prevent or repair damage (from exterior or interior causes) to any of its parts. A fox, when caught in a trap, sometimes maims himself by biting off the leg trapped in order to save the rest of the organism and get away safely. The instinct, in the bid for survival and preservation of the entire organism, directs the actions of the animal so that self-amputation results in achieving this end, namely, preservation of the individual. How, for instance, would the homeostat react to one of its magnets being broken or arrested or destroyed?

Mr. H. F. Sheppard (*Birmingham*)

The significance of work like this may lie most in the gradual clarification of our knowledge of complex stable organisation such as living matter. If self-determination, free will, purposiveness and the ability to adjust to master new difficulties, can be shown by a non-biological device, they are removed from the ever-narrowing field of biological mystery and theological worship and their implications can be formulated philosophically and even mathematically. Just as research upon mechanical vibrations often uses "equivalent circuits" to aid mathematical solution, so the mathematics of self-stabilising systems may have a vast application. Dr. Ashby's device is not a "machine" in the mechanical sense: it does not use a force at a point of application to provide a force different in position, direction and/or magnitude upon the load: and stable machines may include administrative or governmental machinery, which demands far greater understanding than we have yet achieved. The machinery for the distribution of goods having created slums, we are faced with the need to re-orientate it in this generation: in some countries individuals are all the slaves of the machine of government, and in most humanity has by it been sacrificed in war: for centuries every religious reformer has tried to redirect the activities of some church or religious organisation away from the service of its own ends and towards the service of God. It was even whispered at one time that the B.B.C. was going to cease broadcasting and devote its whole attention to the administration of the B.B.C. In all such matters, a proper analysis of the stability of complex organisations would transfer many of the problems from political controversy to ordered design.

Mr. A. Greenwood-Wilson *(Sale)*

May a student of philosophy protest against the paper by Dr. Ashby which you published in your December issue. Writings such as this could be dismissed as just funny, were they not indicative of the dangerous muddle headedness which is prevalent in certain scientific circles. In this paper what strikes the reader most forcibly is not the lack of logical thought, but rather the shocking lack of wisdom and *pietas* which such writing betrays.

To discuss Dr. Ashby's paper in more detail—he fails entirely to make his point concerning the difference between electronic and other machines. There is no difference in principle between the governor of a steam engine and his feed back circuits. When he goes on to talk of the brain as an " acting machine " he gives the whole show away. It now becomes clear what he intends to make: a machine which is capable of choosing, according to some principle, one from a number of possible choices; the choice being made according to the " will " of the machine and not according to the will of the mechanic. The fallacy is here patent. The principle is given by the mechanic; in the case of Dr. Ashby's machine the maintenance of electrical stability. This is the only act of will involved. The machine merely conforms to the imposed law of its being.

Concerning the final or prophetic section: if Dr. Ashby wishes to rival Dean Swift he must learn control. The satirist should keep within the bounds of possible credulity or the effect is lost.

" The most serious danger of such a machine would be selfishness."

" Matters like the supplies of power and the price of valves affect it directly, and it cannot, if it is a sensible machine, ignore them."

When a contributor writes like that in a periodical of high scientific repute, then one is only cheered by the thought that after all there is something to be said in favour of a life devoted to the study of academic philosophy.

I beg you, sir, to print this letter, if only in vindication of the good name of your publication. Let us at least be rational.

Mr. P. T. Hobson *(Mill Hill)*

There would seem to be little doubt that many of the functions of the human brain are explainable in " automatic " terms and that equipment can be built to demonstrate the principles involved. I believe that such mechanics can be used as analogies to help us to understand the mechanism of the brain; but the complexity of the problem demands the use of equipment as closely analogous to that of the brain as possible. There is nothing remotely resembling swinging magnets in the brain; but there are billions of synapses and their interconnecting neurons whose action is surprisingly similar to that of chains of relays or impulse operated valves.

Rashevsky *et al** has given a mathematical analysis showing quite complete examples of behaviour resulting from simple interconnexions of neurons and synapsis.

Here therefore is a challenge to the electronic engineer and the medical man to co-operate in an investigation which could do much to benefit humanity.

Dr. Ashby replies

May I thank the many correspondents for their interesting and stimulating letters. The many criticisms which have been directed at my article have established, so far as I can judge, only one factual error, and that was noticed by only one correspondent. Dr. Grey Walter kindly informs me that the cat is colourblind, so a modification, not affecting the main argument, should be made in that example.

* Rashevsky, N. *Mathematical Biophysics*. University of Chicago Press, 1938.
Householder and Landahl. *Mathematics of the Nervous System*. University of Chicago Press.

Dr. Summer raises the question of how the homeostat would behave if one of the magnets was broken, arrested, or destroyed. A direct test on the machine showed that it treated this complication (an arrest) as it has treated the others: it just hunts till it finds a new combination which, in conjunction with the new circumstances or constraint, is stable. In several trials it took an average time of a few seconds.

In the paper, I tried to distinguish with care between the purely factual description of the homeostat's behaviour and the purely speculative description of how it might develop in the future. The first part seems, apart from Dr. Grey Walter's correction, to have been accepted almost *nem. con.* The second part, however, has aroused some opposition. Nor is this surprising. The Editor had suggested that the final section might be more stimulating if made provocative. Not unwilling, I reached for my most purple ink, dipped deep, and wrote. Nor do I apologise. In any exploration, it is good at times to survey the country ahead, even to the most distant horizon. Mistaken identifications may be made, but they will inevitably be corrected on closer approach, and the gain in orientation may be invaluable.

Most of the criticisms were directed against my " implication that the brain is only a machine." All these criticisms are answered by the simple reply that a working hypothesis and an ultimate truth are different and should be carefully distinguished. That the brain is mechanistic in part cannot now be doubted. It also seems clear that the mechanistic possibilities of the brain are by no means exhausted. This being so, the practical worker can hardly do better than to go on working under the guidance of the hypothesis that the brain is " only " a machine, in the hope that this working hypothesis will continue to be as productive in the future as it has been in the past. The homeostat seems to suggest that the hypothesis, far from being an exhausted mine, is only beginning to yield its riches.

Ultimate truths are best left to the ultimate future. The workers of this decade cannot do better than follow the programme so clearly stated by Dr. Grey Walter.

Electronic Equipment

A monthly record of British electronic apparatus, components, and accessories, compiled from information supplied by the manufacturers.

Press-button Single Record Player

A SINGLE record player for 10-in. or 12-in. records, operated by press-button which automatically places the pick-up on the record and starts and stops the turntable, has been developed by The Plessey Company Ltd., Ilford, Essex.

Two buttons are incorporated, one for 10-in. and the other for 12-in. records. When either is depressed the pick-up arm is lifted over the playing groove of the selected record and the turntable is set into motion. Upon release of the pressure on the button, the pick-up is lowered on to the playing groove, the record is played through, and the turntable stops.

Since the user does not have to place the needle on the track, visibility of the playing-table and its height are no longer of primary importance; the cabinet manufacturer is, therefore, allowed much greater freedom of design. Damage to records is also reduced, as the automatic device ensures that the needle is placed accurately on the track.

The turntable is rim driven by an A.C. electric motor, at a constant speed, and the pick-up is a high-class moving iron unit housed in a moulded case.

Weight approximately 4½ lbs.

The Plessey Company Ltd.,
Ilford, Essex.

"Compact" Television Aerial

A DIPOLE aerial inductively loaded to reduce the overall physical length to approximately ¼ wavelength. This is combined with a low impedance stub section, the characteristics of which are so arranged that the variation of input reactance tends to cancel the variation in aerial reactance. The resulting input impedance of the complete aerial is substantially resistive over the television waveband, and is adjusted to a value of approximately 70 ohms.

The aerial can be fitted behind the receiver or in any recess in the room, and as the polarisation of the television signal is very often not vertical inside buildings, provision has been made so that the "Compact" can be fixed at any angle.

Satisfactory reception is obtained under average conditions within a 10-mile radius of Alexandra Palace, and a special feature is that in areas where reception conditions are below average an alternative terminal connexion is provided to allow for a greater signal input with a slight reduction of definition.

Overall length is 5 ft. 6 in. List price is 50s.

Antiference Ltd.
Plender Place, Plender Street, London, N.W.1.

4-Dial Vernier Potentiometer

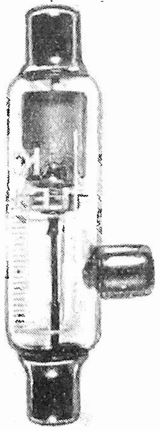
THIS precision potentiometer is capable of reading to 1 part in 1,000,000 of the 1 volt setting, the main dial giving 18 steps of 0.1 V each. A second vernier dial has 100 steps of 0.001 V with an "off" position between the 100 and 00 settings. In parallel with this is a third dial having 101 steps of 0.00001 V each, and the fourth dial has 15 steps of 0.000001 V.

On the high range the instrument measures from this value of voltage to 1.90105 V, and on the low range to 0.1901015 V in steps of 0.1 μV.

A 5-position selector switch is provided to connect a standard cell and any one of four "unknown" circuits. The galvanometer circuit is fitted with a 4-position series resistance switch, and the galvanometer key is capable of being locked in the "on" position.

All insulation is of keramot and the resistors are of best quality manganin. The complete instrument is housed in a polished wooden box with all contacts and insulation protected. Type 4363C is shown below and Type 4363D has a standard cell dial incorporated for standardisation independent of main dial settings.

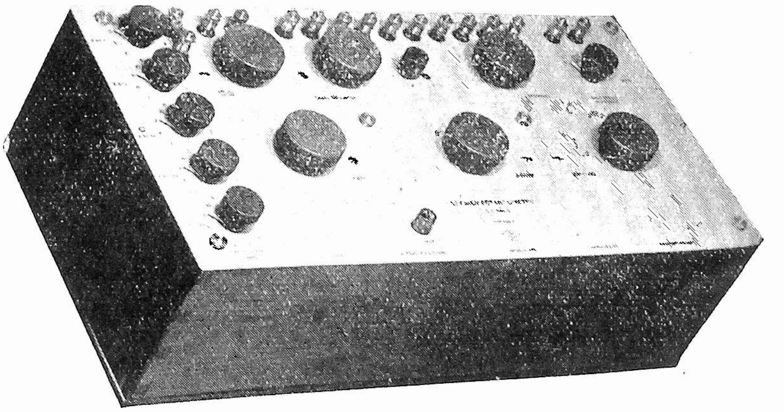
H. Tinsley and Co.,
Werndee Hall, S. Norwood, S.E.15.

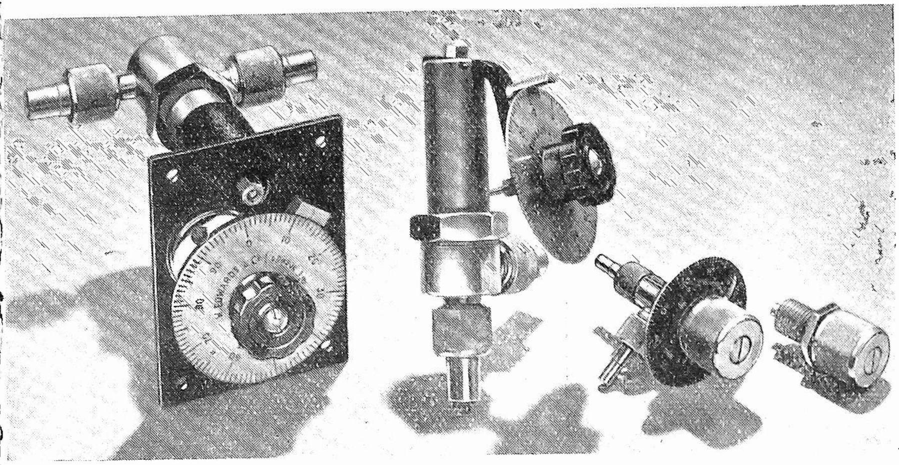


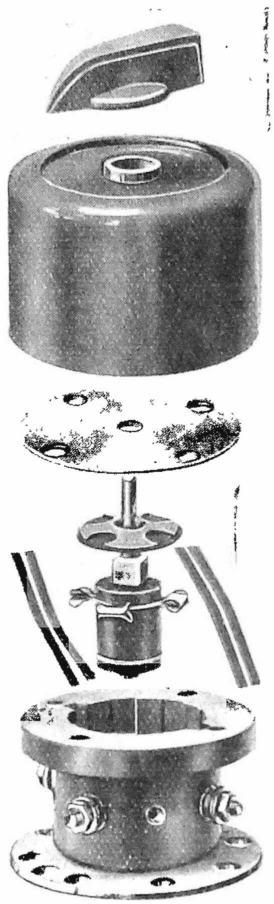
Neon Stabiliser KD.60

THE Ferranti cold cathode stabiliser KD.60 is designed as a miniature stabiliser for low current work and runs at 63 V max. It can also be used as a visual indicator. The report from the Electronic Applications Research Laboratory (Exeter) on an average sample tube says: "The current range is 0.1-2.5 mA, and the nominal voltage level 61 ± 1 V. Random variations do not exceed 0.02 V, and the accuracy of the voltage reference obtained was better than 1 part in 3,000 over the 0.5-2.5 mA range." Photograph is approximately full size.

Ferranti Ltd.,
Moston, Manchester, 10.







New Vacuum Valves

THE vacuum control valves described are high grade instrument finished components designed for dependable high vacuum service. Four types are illustrated in the photographs and are as follows :—

Fine Control Needle Valve Type L.B.1.—A bellows sealed needle valve having a lever reduction movement for fine control. Flow control per degree of dial revolution approx. 0.5 c.c./min. (N.T.P.) with atmospheric pressure differential. List No. C.240. Price, complete with vacuum unions, £5 12s. 6d.

Fine Control Needle Valve Type L.B.2.—The body assembly is similar to Type L.B.1, but arranged for panel mounting. List No. C.250. Price, complete with vacuum union, £9 5s. 0d.

Needle Valve Type W.S.1.—A compact vacuum sealed needle valve having an elastomer-type spindle seal. Flow control per degree of dial revolution approx. 2 c.c/min. (N.T.P.) with atmospheric pressure differential. List No. C.230. Price, complete with vacuum unions or B.14 connexions, £3 15s. 0d.

Air Admittance Valve Type R.S.1.—A small chromium-plated brass air admittance or "vacuum break." List No. C.520. Price, complete with back nut and vacuum union, £1 5s. 0d.; with sealing washer only, £1 1s. 0d.

W. Edwards and Co (London), Ltd.
Kangley Bridge Road,
Lower Sydenham, London, S.E.26.

Industrial Photocells

A SERIES of new Mullard photo-cells is now available in two sizes, the large "20" series on a loctal base and the "90" (miniature) series on a button B7G base.

In types 20CV, 90CV, 20CG and 90CG, high sensitivity to infra-red and incandescent light results from the use of caesium (C) type cathodes. Type 20CV has a sensitivity of 25 μA. per lumen, and the maximum permissible cathode current is 20 μA. The 90CV has a sensitivity of 20 μA per lumen, the maximum permissible cathode current being 10 μA. Types 20CG and 90CG are gas-filled versions.

Types 20AV and 90AV are caesium-antimony photo-cells for highest possible sensitivity to daylight and blue light. The total sensitivity to daylight of these cells is approximately 40 times greater than that given by photo-cells having "C" type cathodes.

List prices are as follows :—

20CV and 20CG ...	£3 0s. 0d.
90CV and 90CG ...	£2 10s. 0d.
20AV	£3 10s. 0d.
90AV	£3 0s. 0d.

Mullard Electronic Products Ltd.,
Century House, Shaftesbury Avenue,
London, W.C.2.

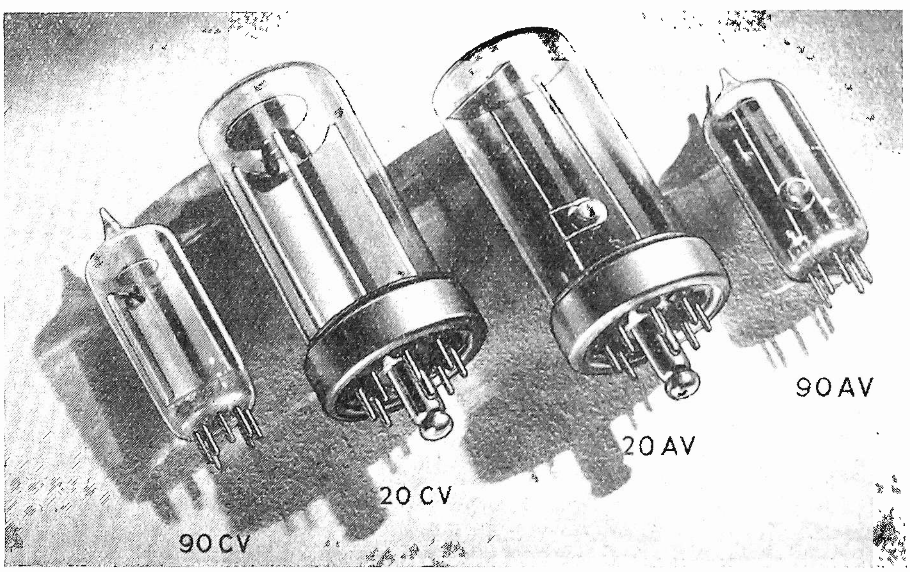
Rotary Mains Switches

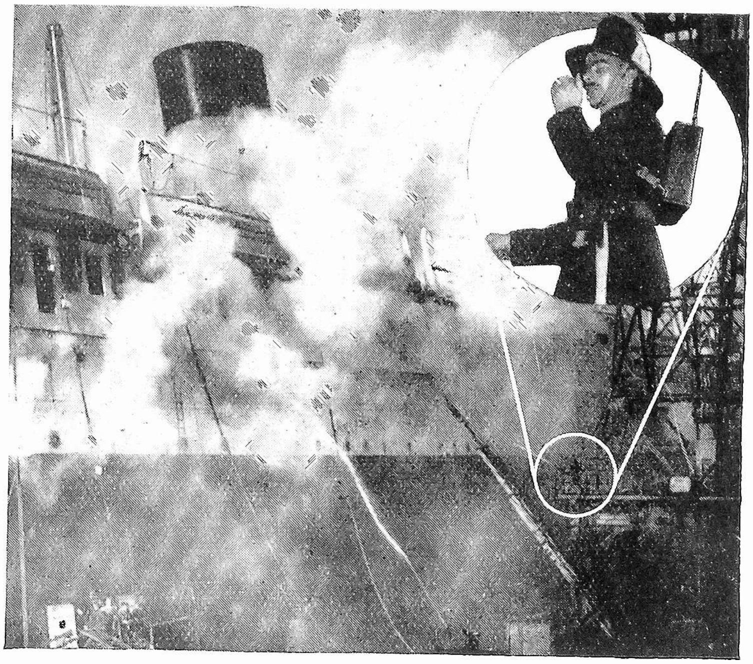
"CRATER" rotary switches can be supplied in either panel or surface mounting for A.C. or A.C./D.C. use, and can be fitted into a standard conduit switch box for control of multi-circuit lighting.

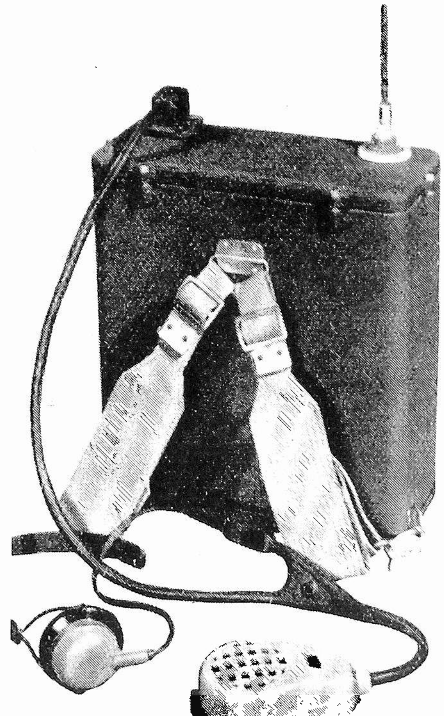
The exploded view shows the simple and robust construction, the main body of the switch being a heavy plastic moulding in which the contacts are inserted. The flat springs on each side of the square on the shaft ensure positive "click" action.

In addition to the normal switching action, the range includes semi-rotary changeover switches for use on small appliances. The body can be supplied in various colours as well as black.

Crater Products Ltd.,
The Lye, St. Johns, Woking, Surrey.







The portable transmitter in action at a fire. On the right is a view of the set with microphone and earpiece. (Fox Photo.)

Portable Two-Way Radio

EXPLOITATION of the V.H.F. waveband for two-way radio communication by light compact equipment was so successful during the war that considerable attention has been given to its possibilities for civilian uses. Official services such as police and fire-fighting offer obvious scope; and the granting of licences for private or " business " use in Britain and some other countries has given an impetus to developments of this kind.

The only A.M. equipment which, at the date of writing, has satisfied the British licensing authorities is that designed and manufactured by British Communications Corporation, Ltd.* It comprises a rectangular metal case 11 in. by $9\frac{1}{2}$ in. by 4 in. containing the transmitter, receiver, and batteries, which can be worn on the back as a pack. Projecting from it is a quarter-wave whip aerial; and the only external items are the plug-in earphones and microphone.

The container has been designed to be proof against any weather. Where the top and bottom are removable to get at valves, crystals, and batteries, they are sealed by rubber gaskets; and the connecting sockets are watertight.

* Gordon Avenue, Stanmore, Middlesex.

The case is also proof against any leakage from batteries. The microphone—a push-pull carbon type—is contained in an unbreakable polythene moulding, connected to the plug by a specially moulded rubber cable. To prevent the aerial hindering progress in congested situations it is a completely flexible structure of silver-plated phosphor-bronze.

The transmitter circuit is fairly straightforward. The controlling crystal oscillates at one-sixth carrier frequency and works into a tripler stage which in turn drives the combined doubler and output stage. Amplitude modulation is effected by a Class AB push-pull stage, transformer-coupled to the anode of the R.F. output valve.

The receiver circuit, on the other hand, is rather unusual, and has been devised to avoid a large number of frequency-multiplier stages. The third harmonic of the crystal-controlled oscillator is taken direct to a first mixer, where it generates a difference frequency, and the third harmonic then pass into a second mixer, where the 1.6 Mc/s. difference frequency is generated. This I.F. is amplified by three stages before being passed to a unit containing three germanium crystals for A.G.C. detection, and noise limiting. The limiter is adjustable and of the type which has compared so successfully with F.M. systems in British Home Office service. Crystals have been found to be more uniform than diodes as well as more adaptable in battery circuits, and, of course, more compact. In addition to the receiver stages mentioned there are a preliminary R.F. and a final A.F. stage. The frequency response is rated as flat within ± 3 db. from 300 to 3,000 c/s., and the sensitivity as 5 μV at 30 per cent modulation to give an output not more than 10 db. below that required to load the earpiece fully. Signal/noise ratio with this input is given as better than 10 db.

From the foregoing description it can be deduced that the frequency of the receiver crystal is $f_r - 1.6/6$, where f_r is the receiver frequency. To make a numerical example, suppose that the receiver had been allotted a frequency of 88.6 Mc/s., the fundamental crystal frequency from the above being 14.5 Mc/s., the third harmonic would be 43.5 Mc/s. This, combining with the carrier in the first mixer, would yield 88.6 − 43.5 = 45.1 Mc/s., which, combining with 43.5 Mc/s. in the second mixer, would give the 1.6 Mc/s. I.F.

To prevent the third harmonic from being radiated, there is a rejector wave-trap in series with the aerial.

Transmitting and receiving frequencies are not necessarily the same, and can be anywhere in the band 75-100 Mc/s. Aerial change-over is effected by thumb control on the microphone, energising a contactor by means of current from the 2-volt filament battery. The coil is in series with the transmitter filaments, serving the additional purpose of reducing the battery voltage to 1.4; but to ensure reliable action the filaments are initially short circuited, and are unshorted by the change-over.

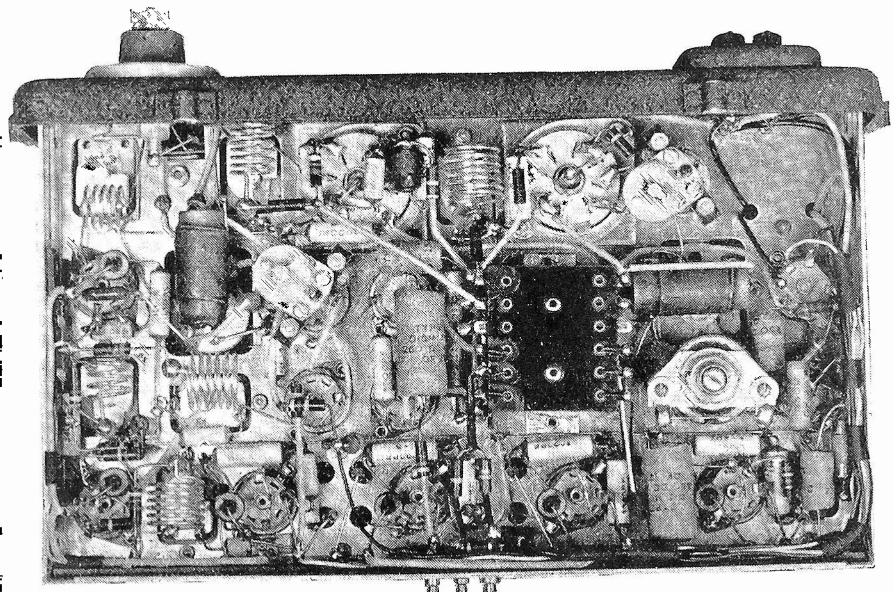
One of the most important considerations in V.H.F. communication is frequency stability. The tolerances and temperature coefficients must be small enough to ensure, under all working conditions, (a) complete separation of 100 Kc/s. channels, and (b) frequency alignment of the two or more sets using the same channel. The bandwidth of the receiver must be chosen to comply with these opposing requirements. When the crystals are plugged into the B.C.C. sets their frequencies are initially set accurately to the centre of the channel at normal temperature by adjusting the parallel capacitance. To ensure that the receivers of a pair of communicating stations accept the incoming carrier waves, even though their temperatures may differ by up to 40° C., the I.F. stages have been carefully designed for electrical, mechanical and thermal stability. Instead of the usual inductively-coupled transformers, whose tuning is liable to be excessively upset by small mechanical displacements within the screening can, primary and secondary coils are here shrouded by separate iron cores, and critical coupling is provided by a few closely-coupled link turns. Tuning adjustments by axial movement of the internal part of the core are held mechanically by a spring tension device. Temperature compensation is provided by appropriate parallel capacitors. A tiny R.F. choke in one leg of each filament prevents stray feedback between the receiver stages via the filament leads.

A valuable feature for servicing is a 7-hole socket into which a test instrument can be plugged, displaying the most significant readings of transmitter and receiver.

Power is provided by three 45-volt dry batteries. The discharge characteristic shows that with a constant receiver drain of 18 mA at 90 V and a 36 mA transmitter drain at 135 V intermittently for one-third of each hour, satisfactory service can be maintained continuously for 24 hours. There is a fairly steep fall during the final hour or two, so it is interesting to note that the rated transmitter output—not less than 0.25 watt—is reckoned after 10 hours continuous communication on the above schedule. Alternatively a Vibrapack can be provided in place of the dry batteries.

The standard construction of the equipment is semi-tropical; but where conditions warrant it fully tropical equipment, with desiccator, can be supplied. The total weight of the complete equipment is not more than 16-lb.

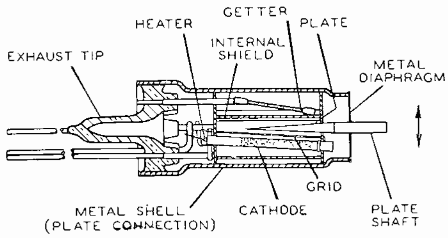
Those with experience of portable communication equipment will agree that its range depends so enormously on the sites that an unqualified range figure is meaningless, and only prolonged tests under a great variety of conditions can show. So approval of the B.C.C. sets by the British Post Office and Home Office, among others, is a more reliable indication than a mileage. But to give a rough idea it may be said that a range of half a mile can be obtained in very unfavourable city conditions, a mile or more in severe city conditions, and ten miles in open country.



Underneath view of the chassis showing the compact layout

Mechano-Electronic Transducer

RCA-5734 is a triode transducer intended to provide a method of translating mechanical vibration into electrical current variations which can be observed and measured. It has a deflection sensitivity of 40 volts per degree deflection of the plate shaft. The part of the plate shaft within the tube has a minimum free cantilever resonance of 12,000 cycles per second permitting, with suitable mechanical coupling to the external end of the plate shaft, measurements of vibration up to 12,000 cycles per second. The moving element of the 5734 is designed to have very low inertia.



The 5734 weighs but a 1/16 of an ounce (1.75 grams), has a length of only 1-9/32 in. and a diameter of 5/16 in. Its small size and light weight provide flexibility of installation.

The R.C.A. London office are able to import limited numbers of these transducers under licence for special experimental work.

BOOK

Photoelectric Cells in Industry

By R. C. Walker, (Pitman and Sons, Ltd.) 501 pages. 239 Figs. Price 40s.

THE object of this book, as the author states in his preface, is to present a representative selection of the industrial uses of light sensitive cells with a very superficial explanation of the theory of operation of these devices sufficient to make the text readable to the practical man whose purpose is to employ electrons rather than to theorise about them.

In this, the author largely succeeds and the practical man with a reasonable background of electronics should have no difficulty in overcoming his own problems in the design, operation and maintenance of industrial photoelectric equipment.

The theoretical side is very superficially explained but the practical aspect is treated with a wealth of detail obviously acquired by long experience in photocell applications.

The thirteen chapters of the book are each complete with a comprehensive list of references and it is encouraging to read of the many British contributions to industrial applications.

Chapters 1 to 4 deal with the fundamental properties of photoelectric cells and their construction, with particular reference to the caesium silver oxide type together with such associated apparatus as thyrations and relays.

Chapter 5 is entitled "The Source of Light" and serves no more than a reminder to those who have forgotten School Certificate Physics.

Chapter 6 is a very useful one on counting and covers such important aspects as rate of counting and selective counting with uniselector switches. The problems of high speed counting are also discussed.

Chapter 7 is devoted to the application of photocells to machine control with particular reference to printing and textile machinery and illustrates the wide range of application and control. This is amplified further in chapter 8 which describes the familiar smoke detection gear and such miscellaneous control devices as fire and burglar alarms.

Chapter 9 covers ancillary measuring equipment which employs photocells and includes illumination meters and calorimeters.

Chapters 10 to 12 deal with applications such as picture transmission and television which it might be argued are not strictly within the scope of the book and these chapters might with advantage have been omitted since their subject matter is adequately dealt with elsewhere.

The final chapter covers miscellaneous applications, many of which are novel in character. The reviewer suggests, however, that some of these could never have worked and their descriptions read like over-enthusiastic patent applications.

The book is largely descriptive and non-mathematical in its treatment but is nevertheless a valuable addition to the not too extensive British literature on industrial electronics. A little more space could have been given to the problems of amplifiers associated with photocells and would have been helpful to the practical man if values of components were included in the circuit diagrams. There is too the impression that the author is not familiar with some of the latest electronic methods but since the subject is developing so rapidly this is scarcely a criticism.

H. G. FOSTER.

Microwave Receivers

By S. N. van Voorhis. Volume 23 in the Massachusetts Institute of Technology, Radiation Laboratory Series. 618 pages, price 48s.

THE qualified title "Microwave Pulse Receivers" would be better for this book but even this does not truly permit excursion down to the Mc/s. band. "Pulse Receiver Technique" most adequately defines its scope.

The introduction deals with the fundamental concept of noise factor—a concept which is not even yet as widely understood and utilised as it ought to be. This is further developed and practical considerations are introduced, in the chapters on I.F. amplifiers and input circuits. These comprehensive and lucid chapters are very well written. AFC systems receive considerable attention and the chapter indicates the frequency stabilities which can be achieved at microwaves. Instance is given of two 10,000 Mc/s. oscillators with AFC beating to give a reasonably pure tone.

A curious omission occurs in the chapter on VHF amplifiers, mixers and oscillators. In the section on mixers, thermionic valve mixers are dealt with, but there is no comparative treatment of the crystal mixer. Although another volume in the series takes crystal mixers as its title, a direct comparison of merits would seem desirable in view of the wide use of this type of mixer.

Other chapters on the receiver proper include one on microwave duplexers, mixers and oscillators, which outlines the subject, but refers to the appropriate volume in the series for fuller treatment; one on video amplifiers; and one on gain control circuits.

Leaving the more normal superheterodyne receiver, the particular

REVIEWS

cases of crystal-video and super-regenerative receivers operating in the linear and logarithmic modes are treated in separate chapters. The special problems involved in the design of wide band F.M. and beacon receivers, and receivers for moving target indication all receive attention.

Almost one third of the book is given up to detailed consideration of specific receivers, the examples chosen being an airborne receiver with anti-clutter circuits; an automatic tracking radar receiver; a wide band F.M. receiver; and various types of beacon superheterodyne receivers. In addition, each chapter refers to numerous examples drawn from existing equipments.

A short, but useful chapter on the construction of the receiver cabinet could well have been elaborated and extended to cover the mechanical aspects of ultra-high frequency engineering. Many radio engineers are vague on vital points where mechanical and electrical performances are closely linked, as, for instance, in the case of sliding contacts or surface finishes.

Specialisation is today so universal that much of the value of a book on technique lies in its ability to open up new fields, rather than in its direct application to individual problems; and no single book can hope to present in itself, without losing point, all the aspects of its subject. On this account, a bibliography of fundamental and companion literature becomes almost essential. For some reason this feature is lacking in a book which is otherwise comprehensive within the scope mentioned earlier. It is a valuable and readable contribution to the ever-increasing literature on modern radio method.

R. E. FISCHBACHER

Guide to Broadcasting Stations

Fourth edition. Compiled by Wireless World. (Iliffe & Sons, Ltd.) 1s.1d. post free.

THE demand for this booklet, first published in 1947 as "Broadcasting Stations of the World," has been such that a fourth completely revised and enlarged edition has been produced.

Details of nearly three hundred European medium- and long-wave broadcasting stations and eleven hundred short-wave stations of the world are given in tabular form, both geographically and in order of frequency. As in the previous edition all entries have been checked against the frequency measurements made at the B.B.C.'s receiving station at Tatsfield.

Practical Disk Recording

By Richard H. Dorf. Pp. 96 with 80 diagrams and photographs. (Gernsback Library, No. 39. Radcraft Publications, Inc., 25 West Broadway, New York 7, U.S.A.) Price 75 cents.

IN fourteen chapters the author covers a certain amount of theory, or, more accurately, technique of the subject, and provides some constructional information. Unfortunately, the rather limited treatment of both technique and practice does not provide enough basic information to enable the reader to grasp the fundamentals properly or to construct a high-grade disk recording channel from the beginning.

A few comments on specific points. The photograph of the Presto electro-magnetic cutting-head on page 26 is inverted. On page 36 the modified constant-velocity recording characteristic in electro-magnetic cutting-heads (i.e., bass fall-off) is stated to be "built into most commercial cutters by means of mechanical adjustments and rubber dampers." This is not usually the reason, as it is mainly due to the L/R ratio of the cutting-head.

In the discussion of the cutting-stylus in Chapter 7, it is explained that the steel stylus is flexible at high frequencies and, instead of following armature movements, it sways and bends slightly. This is responsible for a reduced recorded response at the higher frequencies, compared with that recorded by a sapphire cutting stylus. But why should a steel stylus flex more than a sapphire in a duralumin shank, unless the former is much too long?

On page 67 some confusion about high-frequency loss being due to "pinch effect" seems to have arisen, because such loss is more attributable to the recorded wavelength in the groove becoming smaller than the playback needle tip radius.

Chapters 6 and 11 deserve special mention and praise as the former expounds with lucidity the important topic of constant amplitude and constant velocity characteristics, and the latter deals with equalisation, including frequency run tests and interpreting light patterns on disks. A short glossary of technical disk recording terms concludes this book.

The standard authoritative work on disk recording has yet to be published, but this present book should prove of great interest and usefulness to beginners and amateur enthusiasts in the sound recording world, to whom it is recommended.

DONALD W. ALDOUS

BOOK REVIEWS *(continued)*

Microwave Magnetrons

Edited by George B. Collins, Radiation Laboratory Series, volume 6, xviii, + 806, McGraw-Hill, 1948.

THIS, one of the most important of the M.I.T. Radiation Laboratory Series, amply fulfils the promise of the volumes already published. The "five-foot shelf" bids fair to become a classic in the factual reporting of a five year period of research and development.

Those who were concerned intimately or incidentally with magnetrons during the war will remember, perhaps with a wry smile, the wealth of material which passed across the Atlantic in the form of reports. The flow was not all one-way, as is very gracefully acknowledged by the several authors, but one must admit that the volume of results produced by U.S.A. laboratories, particularly during the later years of the conflict, was immeasureably greater than that produced in Britain. Despite this, the earlier and more fundamental work of Hull (U.S.A.), Randall, Boot and Hartree (Britain) has been given its proper place, and an almost coherent picture has been painted from a very large number of bold and faint lines contributed under stress by a very large number of artists. That the picture is not so complete as that painted in the succeeding volume of the series on klystrons is due first to the greater complexity of the magnetron problem and second to the fact that a much more detailed investigation of magnetron design and operation was necessary. These two factors do not, as might be expected at first sight, cancel one another. Rather may we say that klystron theory is more complete, *so far as it goes*, while magnetron theory, having been taken much further, still falls short of adequate quantitative prediction.

Of the volume as a whole there can be little criticism. Faced with a difficult task, the editor has chosen to divide the subject into five parts, entitled "Resonant Systems," "Analysis of Operation," "Design," "Tuning and Stabilisation" and "Practice." The division is not completely logical, but it succeeds in focusing attention on certain aspects of the subject on certain pages. In a complex electronic device, where each factor interacts with almost every other factor, any division must be subject to continual cross-reference. The method adopted has one happy result. It has enabled the authors to give a good account under "Practice" of the techniques of magnetron construction. This is one of the most interesting and satisfying parts of the volume. Part IV, which is shorter than the others, is on "Tuning and Stabilisation," and has obviously been introduced to assist the post-war designer, since the need for stabilised magnetrons has become more urgent in peace. One would have liked to read more of cathode construction and behaviour in the part on "Design," but perhaps the editor felt that only those results should be featured which were fully authenticated and of precise significance. This chapter fails to convey the impression that much remains to be discovered with regard to thermionic emission, and that this subject is one of the most fruitful fields for immediate research.

In spite of that, the book is perhaps weighted a little too heavily in the direction of physics, and too little towards engineering. It is implicit throughout that precision engineering is a prerequisite to a successful magnetron, but the influence which this has had on the electrical design is not brought out clearly. On the other hand, the importance of each physical factor is discussed in a very direct manner. On such questions as "how to scale" and "when to strap, or when to use a rising sun" the reader is left in no doubt whatsoever. From the point of view of the physicist advising the valve engineer, the book is a mine of useful information; but it is only in the excellent Part V that the constructional engineer will feel really happy.

The volume maintains the high standard of technical excellence displayed by all the books of the series. The many diagrams and photographs are of high quality. There are very few errors in the text, and those noted by the reviewer are not serious.

Page 623 contains the rather surprising statement that "the (electronic) A.F.C. system . . . acts to eliminate completely the errors in frequency rather than merely to reduce them in some constant proportion." Professor Rieke cannot mean this, for, of course, all A.F.C. systems, whether dependent on discriminator action or not, simply "reduce the errors in a constant proportion." Despite the best efforts of a most distinguished team of authors, it is not possible to obtain a clear picture of the wood: we are still too close to the trees. On the other hand, it can be recommended wholeheartedly not only to those who are concerned with magnetron design and operation but to all physicists and electrical engineers who are interested in microwave techniques. The special discussion of output coupling, frequency pulling, waveguide transformers and multi-segment resonators have an intrinsic value far beyond their immediate application to magnetrons.

J. THOMSON

FEBRUARY MEETINGS

The Institution of Electrical Engineers

All meetings, unless otherwise specified, are held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Ordinary Meetings

Date: February 16. Time: 6.30 p.m.
Held at: Central Hall, Westminster, S.W.1.
Faraday Lecture on: "Television."
By: Sir Noel Ashbridge, B.Sc.(Eng.), and H. Bishop, C.B.E., B.Sc.(Eng.).
Date: February 24. Time: 7 p.m.
Held at: Connaught Rooms, Great Queen Street. W.C.2.
Annual dinner.

Measurements Section

Date: February 8. Time: 5.30 p.m.
Lecture: "The Measurement of Light and Colour."
By: G. T. Winch.
(This is a joint meeting with the Utilisation Section.)

Radio Section

Date: February 2. Time: 5.30 p.m.
Lecture: "Direction Finding Site Errors at V.H.F."
By: H. G. Hopkins, B.Sc., Ph.D., and F. Horner, M.Sc.
and
"Scattering of Radio Waves by Metal Wires and Sheets."
By: F. Horner, M.Sc.
Date: February 15. Time: 5.30 p.m.
Discussion: "Water Cooling v. Air Cooling for High Power Valves."
Opened by: J. Bell.

Informal Meeting

Date: February 21. Time: 5.30 p.m.
Discussion on: "Industrial Design in Engineering."
Opened by: N. E. Kearley.
The Secretary: The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Cambridge Radio Group

Date: February 22. Time: 6 p.m.
Held at: The Cambridge Technical College.
Lecture: "Television."
By: D. Jackson.
Hon. Secretary: G. E. Middleton, University Engineering Laboratory, Cambridge.

North-Western Radio Group

Date: February 23. Time: 6.30 p.m.
Held at: The Engineers' Club, Albert Square, Manchester.
Lecture: "Aids to Training—The Design of Radar Synthetic Training Devices for the R.A.F."
By: G. W. A. Dummer, M.B.E.
Hon. Secretary: A. L. Green, 244 Brantingham Road, Chorlton-cum-Hardy, Manchester 21.

The Institute of Physics

Electronics Group

Date: February 15. Time: 5.30 p.m.
Held at: 47 Belgrave Square, S.W.1.
Lecture: "Cold Cathode Discharge Tubes."
By: A. L. Chilcot.
Secretary: G. W. Warren, Research Laboratory, The G.E.C., Wembley.

Midlands Branch

Date: February 17. Time: 6.30 p.m.
Held at: The Grand Hotel, Birmingham.
Lecture: "Bio-Physics."
By: Professor J. T. Randall.
Secretary: Dr. J. H. Nelson, Messrs. Joseph Lucas, Ltd., Gt. King Street, Birmingham.

Industrial Radiology Group

Date: February 18 and 19: 6.30 p.m.
Held at: 47 Belgrave Square, S.W.1.
Spring meeting and exhibition of radiographs.
Secretary: H. F. Tasker, Messrs. Ilford Ltd., 134 St. Albans Road, Watford.

Television Society

Date: February 23. Time: 7 p.m.
Held at: The Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Lecture: "Short Wave Aerials with Scale Model Demonstrations."
By: F. J. Charman, B.E.M.
Lecture Secretary: T. M. C. Lance, 35 Albemarle Road, Beckenham, Kent.

Constructors Group

Date: February 11. Time: 7 p.m.
Held at: The C.E.A. (as above).
Lecture: "Television Receiver BC2." This is a television receiver design developed by the Mullard Electronics Research Laboratories for the assistance of receiver manufacturers.
By: E. Jones, B.Sc., A.M.I.E.E.
Hon. Secretary: A. E. Sarson, 22 Union Road, Bromley, Kent.

Midland Centre

Date: February 3. Time: 7 p.m.
Held at: Room 6, The Chamber of Commerce, New Street, Birmingham.
Lecture: "Clearing the Air for Television."
By: E. M. Lee.
Lecture Secretary: Dr. W. Summer, 169 Mary Vale Road, Bournville, Birmingham, 30.

Programme Group

Date: February 3. Time: 7 p.m.
Held at: The Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Lecture: "Producing a fast-moving multi-scene musical show."
By: W. Anderson.
Hon. Secretary: N. E. B. Wolters, 10 Birkbeck Avenue, W.3.

British Sound Recording Association

Date: February 25. Time: 7 p.m.
Held at: The Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.
Lecture: "Disk Recording and Reproducing Styli."
By: S. R. Lance.
Hon. Secretary: R. W. Lowden, "Wayford," Napoleon Avenue, Farnborough, Hants.

R.S.G.B.

Date: February 25. Time: 6.30 p.m.
Held at: The Institution of Electrical Engineers, Savoy Place, W.C.2.
Lecture: "Impedance Matching."
By: H. A. M. Clark, B.Sc.(Eng.), A.M.I.E.E.
The Secretary: New Ruskin House, Little Russell Street, W.C.1.

Society of Instrument Technology

Date: February 21. Time: 7 p.m.
Held at: The Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, W.1.
Lecture: "Standardisation of Instruments."
By: G. P. Clay.
Secretary: L. B. Lambert, 55 Tudor Gardens, London, W.3.

Brit. I.R.E.

London Section

Date: February 17. Time: 6 p.m.
Held at: The Royal Empire Society, W.C.2.
Discussion: "Electronic Equipment for the Engineer."
The Secretary: 9 Bedford Square, London, W.C.1.
(This is a joint meeting with the Institution of Production Engineers.)

Merseyside Section

Date: February 2. Time: 6.45 p.m.
Held at: The Incorporated Accountants' Hall, Derby Square, Liverpool, 2.
Lecture: "The Design and Characteristics of Marine Radar Equipment."
By: A. Levin and A. C. D. Haley, M.A.
Secretary: J. Gledhill, 123 Portelet Road, Liverpool 13.

The Institution of Post Office Engineers

Date: February 7. Time: 5 p.m.
Held at: The Institution of Electrical Engineers, Savoy Place, W.C.2.
Lecture: "Improvements in Telephone Signalling."
By: S. Welch, M.Sc., A.M.I.E.E., and C. H. J. Fleetwood, A.M.I.E.E.
Secretary: W. H. Fox, Engineer-in-Chief's Office (T. P. Branch), Alder House, E.C.1.

ABSTRACTS OF ELECTRONIC LITERATURE

THEORY

New Getter Materials for the High-Vacuum Technique

(W. Espe)

This review is mainly concerned with getter materials and techniques developed and commercially used, particularly in Germany during the war. An account of the following getters is given: tantalum, zirconium, thorium, and "Ceto". Flash getters are widely used in the radio industry and details of a new type that contains thorium as one of the active ingredients, known as the "Batto" getter, is described. Manufacture of the various types of getter is discussed and their respective advantages are mentioned.

—*Powder Metal Bull.* October, 1948, p. 100.*

The Efficiency of the Barrier Layer Photo-cell

(R. A. Houston)

An investigation was made to test the truth of the statement that "the conversion of light into electrical energy takes place at the remarkably high efficiency of approximately 50 per cent". The highest efficiency found during this investigation for approximately monochromatic light was 6.4×10^{-8} W/ft.-candle; the highest efficiencies recorded for white light by two different arrangements were 2×10^{-6} and 6.2×10^{-5} W/ft.-candle respectively. When large E.E.L. photo-cell was connected to a milliammeter of 5 ohm resistance and pointed towards the sky, the maximum current obtained on a January afternoon was 4 mA. It is concluded, therefore, that the photo-cell does not promise well as a source of energy.

—*Phil. Mag.* November, 1948, p. 902.*

The Photo-Voltaic Effect

(K. Lehovec)

The Schottky-Mott theory of the barrier layer rectification is extended with respect to the action of light absorbed in the barrier layer. A number of essential physical assumptions which have to be made in this study are discussed. An "equation of state," connecting photo-voltage, photo-current, light intensity, wavelength, and external resistance, is then derived. Among other factors the regularities of short circuit current, open circuit voltage, photo-characteristic, dark characteristic (barrier layer rectification), power output, and spectral distribution of the quantum yield are involved.

—*Phys. Rev.* 15/8/48, p. 463.*

MEASUREMENT

A Recording Photometer and its use in Studies of Cathode-Ray Screen Displays

(F. Hamburger and E. J. King)

The photometer described permits the determination of brightness at any instant at a selected point on a radar screen. The apparatus consists of a 931-A photo-multiplier tube combined with suitable optical and electronic auxiliaries; it is claimed to respond faithfully to rapid light transients for peak brightness determinations. In addition the apparatus will provide data for slow brightness changes associated with phosphor decay characteristics. The photometer has a wide range as it incorporates sensitivity controls and may be used down to 0.005 lamberts when examining a circular area of 0.025 in. in diameter; it has many photometric applications apart from radar screen measurements.

—*Jour. Opt. Soc. Am.* October, 1948, p. 875.*

Cathode-Ray Magnetisation Curve Tracer

(M. V. Scherb)

An instrument developed to measure the magnetic properties of materials in a variety of forms by oscillographic techniques is described. Magnetic hysteresis loops can readily be obtained for specimens in rod, powder, tape, or wire form having cross-sectional areas as small as 10^{-5} sq. cm. or as large as 0.3 sq. cm. ($\frac{1}{4}$ in. rod). With slight modifications, the instrument can be adapted to magnetic measurements of materials as a function of frequency, temperature, torsion, tension, or pressure using the appropriate set-up.

—*Rev. Sci. Inst.* July, 1948, p. 411.*

Electronic Megohmmeters

(H. G. M. Spratt)

The D.C. measurement of resistance, using portable non-electronic meters or galvanometers, becomes increasingly difficult as the order of the resistance value increase. Characteristics of the normal triode valve, however, are such as to enable some of the conventional methods to be used for resistance measurement up to 10^{12} megohms. Circuits for a grid-current megohmmeter and for an instrument based on the substitution method are shown. Means for preventing leakage and for measuring ultra-high resistances are also studied.

—*Wireless World.* October, 1948, p. 354.*

* Abstracts supplied by the courtesy of Metropolitan-Vickers Electrical Co. Ltd. Trafford Park, Manchester

CIRCUITS

The Development of a High-Frequency Cathode-Ray Direction-Finder for Naval Use

(S. de Walden, A. F. L. Rocke, J. O. G. Barrett and W. J. Pitts)

The operation of the direction-finder described in this paper is based on the familiar principle by which two balanced amplifiers, connected to Bellini-Tosi crossed loops, operate the appropriate deflecting plates of a cathode-ray tube. The bearing is displayed as a trace on the c.r.t. fluorescent screen, providing a direct instantaneous reading. The sense of the bearing is obtained by combining the signals from an omni-directional sense aerial with the signal from either of the loops. The sense signal modulates the intensity of the electron beam, which is being swept, either vertically or horizontally, by the signal provided by the respective loop. The relative phase of the two signals is such that one or other end of the fluorescent trace is blacked out, depending upon which of the two lobes of the figure-of-eight loop characteristic is effective for a given wave-direction.

The first experimental equipment, designed for surface vessels, was already in operational use at the end of 1941, but the development proceeded until 1944, when the equipment reached its final form. With small modifications the same equipment was adopted for use at naval shore-stations, operating with an Adcock aerial system.

The paper describes the latest design of the shipborne equipment and also discusses, more generally, some of the problems of the twin-channel receiving technique encountered during the development.

—*Jour. I.E.E.*, March-April, 1947. p.823.

Symposium on Ultrasonics

This symposium on ultrasonics comprises the following five articles: (1) "Some Background History to Ultrasonics", by E. Klein; (2) "Biological and Physiological Effects of Ultrasonics" by H. Davis; (3) "Ultrasonic Absorption in Water in the Temperature Range 0°—80°C.", by M. C. Smith and R. T. Beyer; (4) "100 Kc. Underwater Magnetostrictive Transducer", by L. Camp, R. Vincent and F. du Breuil; and (5) "Lamination Designs for Magnetostrictive Underwater Electroacoustic Transducers", by L. Camp.

—*Jour. Acoust. Soc. Am.* September, 1948, p. 601.*

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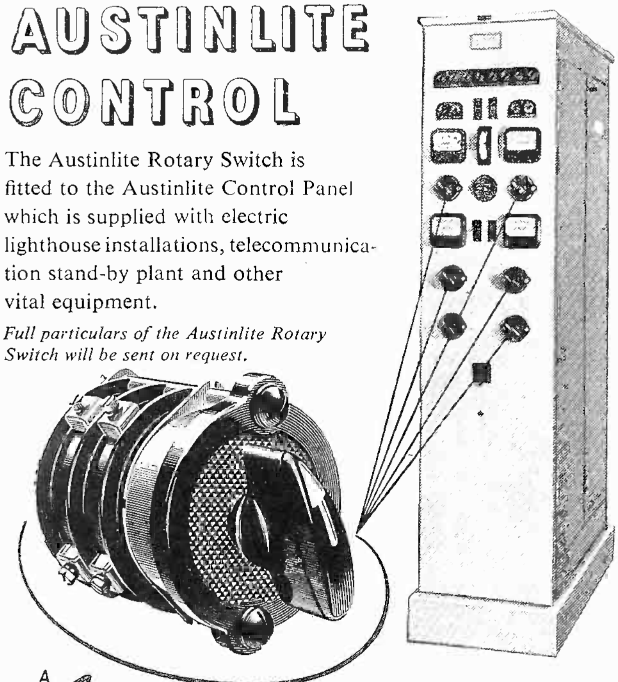

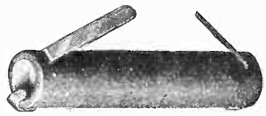

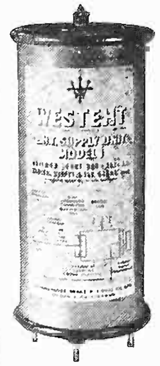

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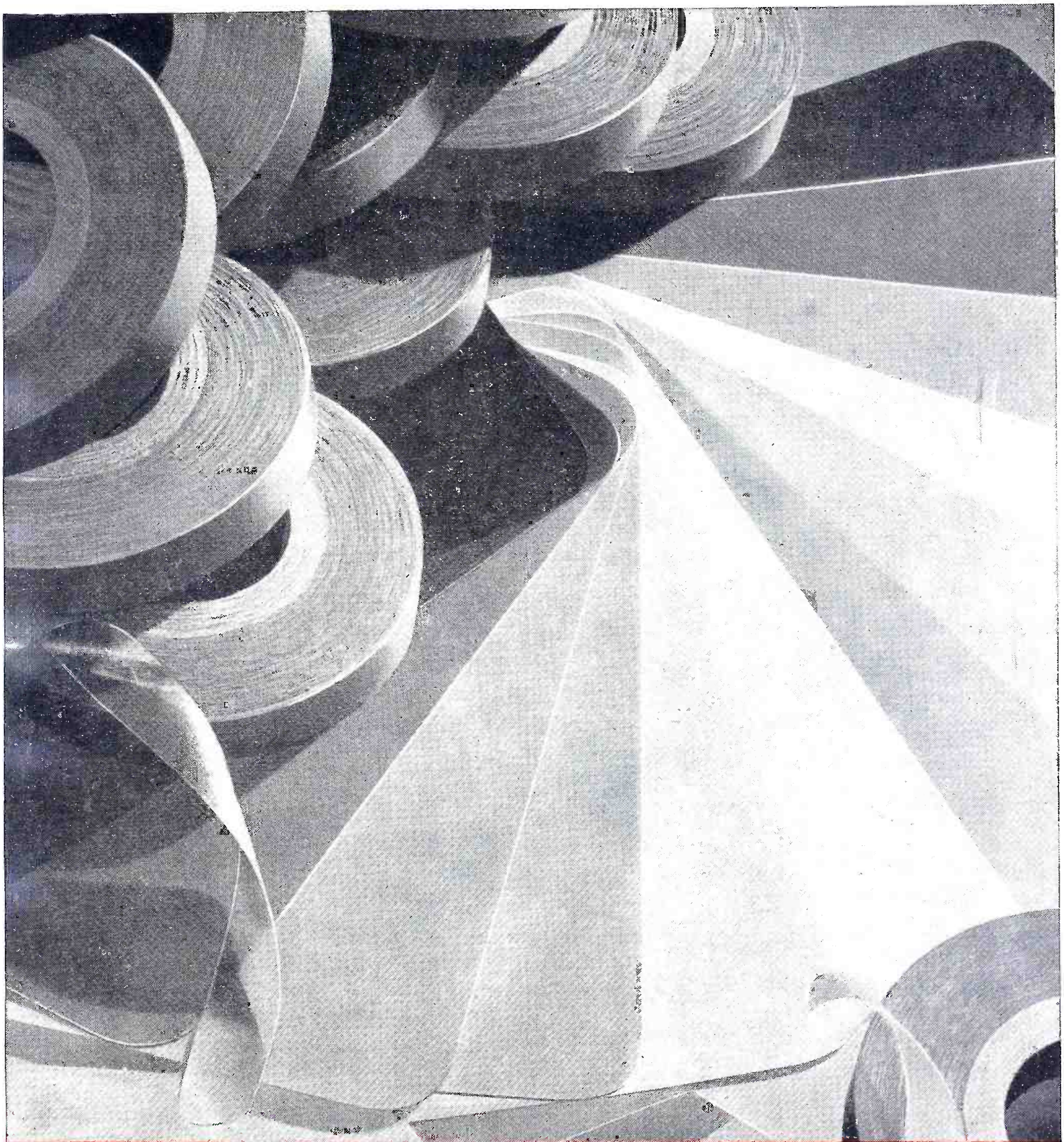

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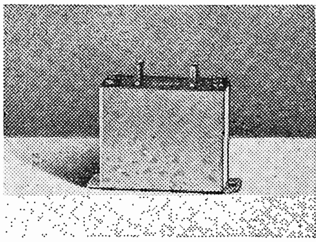

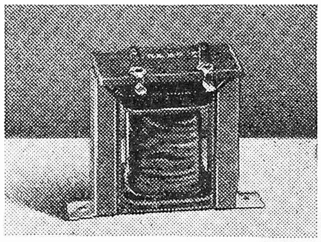

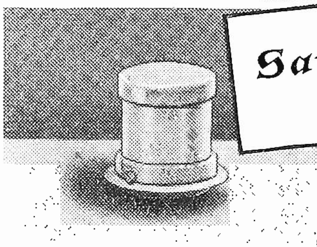

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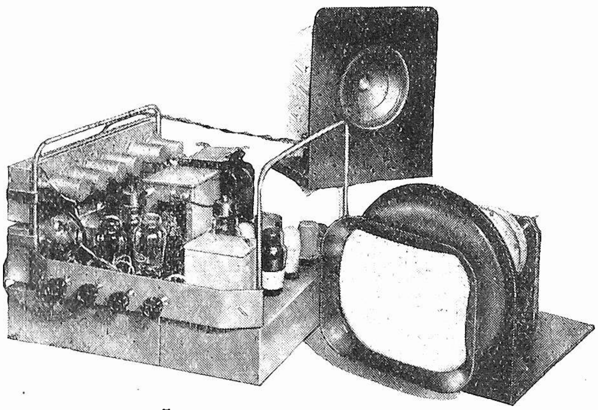

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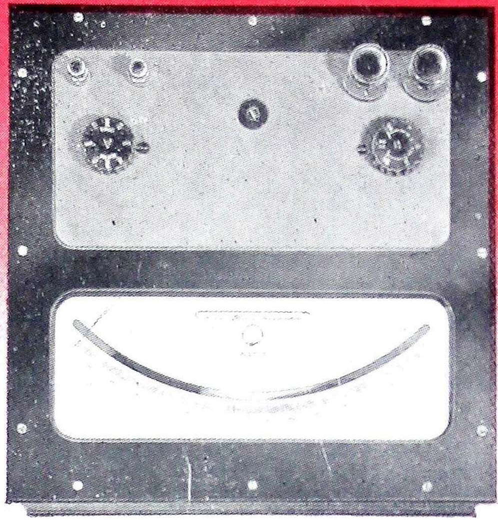

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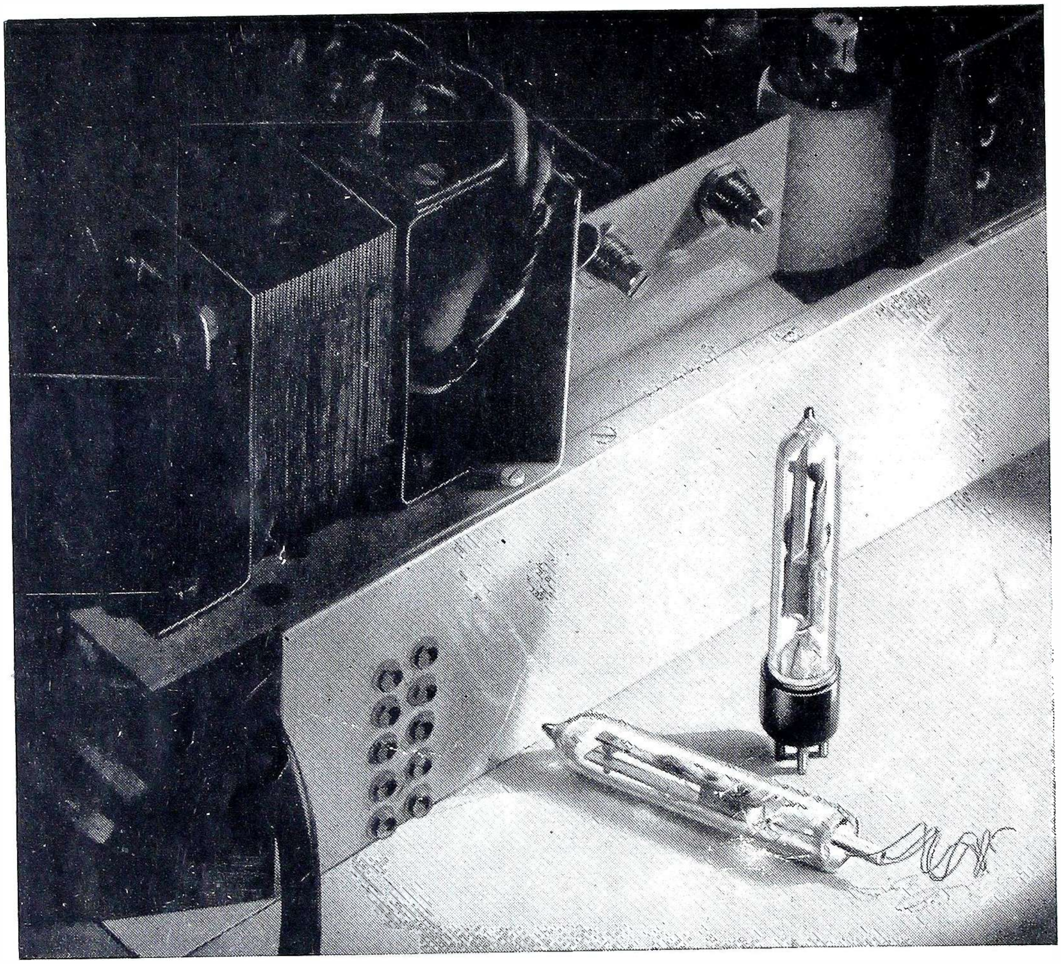

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