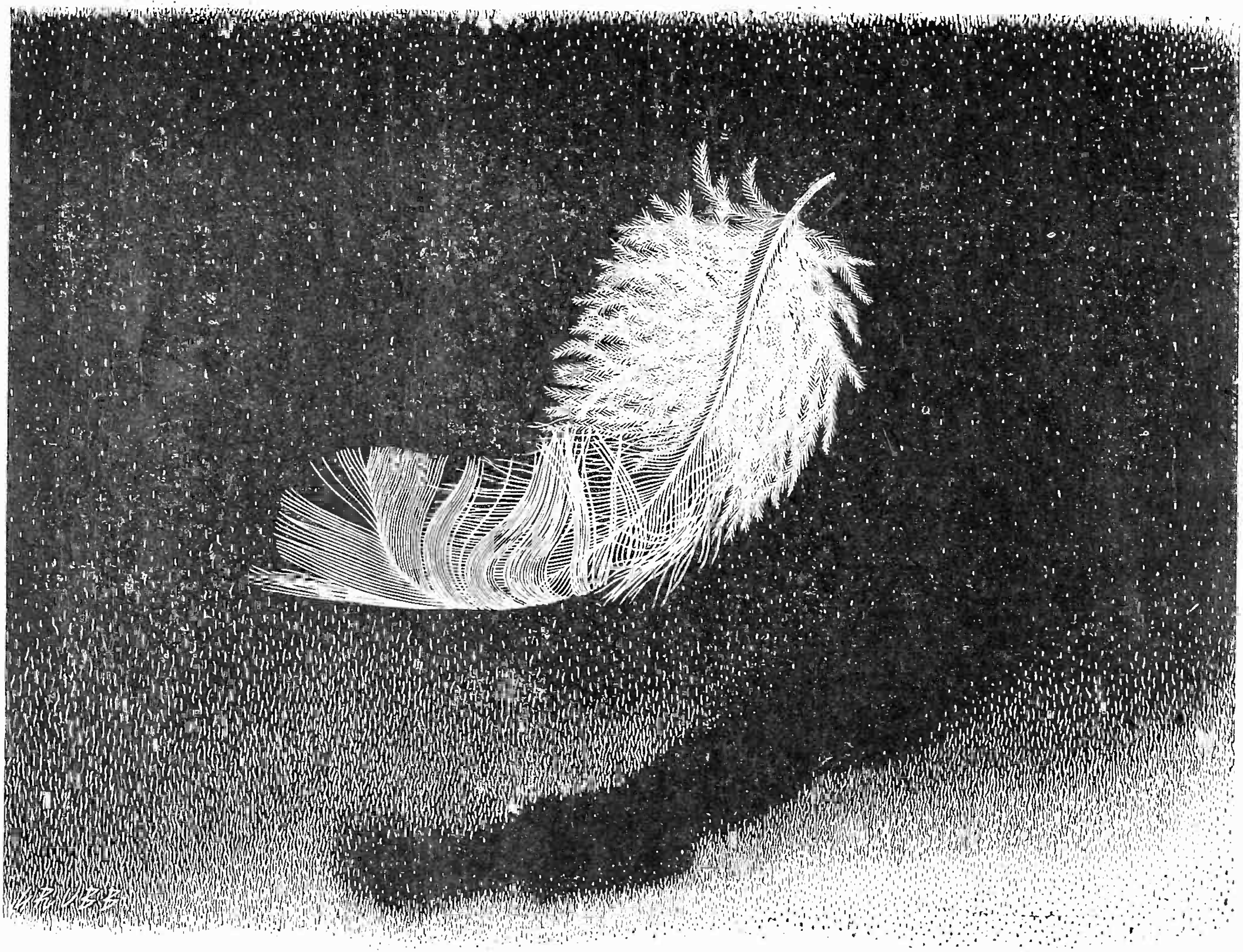
Electronic Engineering

Incorporating ... ELECTRONICS, TELEVISION & SHORT WAVE WORLD

VOL. 20 No. 246 AUGUST 1948 PRICE 2/-



A FEATHER floats to the ground, slowly, effortlessly and, apparently, in silence. But, in actual fact, its fall produces a sound capable of immense amplification. Even a small Philips Amplifier develops power at least 10 million million times greater than that produced by the original sound.

To-day, Philips sound reproducing equipment plays an important role in sport, in entertainment and, above all, in industry. In hundreds of factories Philips sound equipment is helping to speed production and to increase efficiency in the great drive for exports.

The quality and dependability of Philips sound equipment is well known. Yet in this, as in so many other fields of electrical development, Philips scientists and engineers are constantly seeking for further improvements, for new techniques, for new ideas. It is a tradition which has inspired the progress of a great electrical manufacturing organization for over 50 years.

PHILIPS ELECTRICAL
LIMITED

RADIO & TELEVISION RECEIVERS · TUNGSTEN, FLUORESCENT & DISCHARGE LAMPS & LIGHTING EQUIPMENT
INDUSTRIAL ELECTRONIC APPARATUS · HIGH-FREQUENCY HEATING GENERATORS · X-RAY EQUIPMENT FOR ALL PURPOSES · ELECTRO-MEDICAL APPARATUS
ARC & RESISTANCE WELDING PLANT & ELECTRODES · MAGNETIC FILTERS · BATTERY CHARGERS & RECTIFIERS · SOUND AMPLIFYING INSTALLATIONS

CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2.

(P.377U)

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

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagement Order, 1947.

THE QUEEN ELIZABETH HOSPITAL BIRMINGHAM. The Hospital requires immediately the services of a skilled and experienced Laboratory Technician to take charge of the Physics workshop, which designs and prepares apparatus for the Radiotherapy Department and other general physics apparatus for other Hospital purposes.

The workshop equipment consists of lathes and milling machines, including micro-precision lathe and drilling machine. The technician must be a skilled operator of this equipment. Experience in a University or a Hospital Physics workshop is desirable but not essential.

The commencing salary is within the range of £375 to £450 per annum, according to experience.

Applications, which should be sent in at once to the undersigned, should be accompanied by two recent testimonials and the names of two independent referees. G. Hurford, House Governor, Queen Elizabeth Hospital, Birmingham, 15.

DERBY TECHNICAL COLLEGE, Normanton Road, Derby. The Governors invite applications for the post of full-time Lecturer in Mathematics; candidates should be graduates of a British University. Experience in industry would be an added qualification. Salary in accordance with Burnham Scale. Further particulars of the appointment, together with form of application, which should be returned as soon as possible, may be obtained from the undersigned. W. Alfred Richardson, Principal.

SITUATIONS VACANT

ELECTRONIC CIRCUIT ENGINEERS required for research and development work; good academic qualifications and apprenticeship, industrial or research experience essential. Knowledge of any of the following subjects desirable: radar and television pulse techniques, centrimetric components, time-base generators, A.C. and D.C. amplifiers, feed-back amplifiers, servos, especially low power electromechanical stabilised power supply units, data transmission systems, cable form layouts. Some mathematical ability is desirable. Write, with full details of qualifications, experience, age and salary required, to Personnel Manager, Sperry Gyroscope Company Ltd., Great West Road, Brentford, Middlesex.

THE ENGLISH ELECTRIC VALVE COMPANY invites applications for a Valve Engineer for the research laboratory. This is a senior appointment calling for an essentially practical man with wide experience in the design and manufacture of electronic tubes. A Science Degree together with a knowledge of photo-electric processes would be advantageous. The applicant should be a good organiser and capable of controlling staff. Remuneration will be according to age, qualifications and experience. Apply giving full details of age, qualifications and salary required to, Chief of Research, English Electric Valve Co., Ltd., Waterhouse Lane, Chelmsford.

ELECTRIC AND MUSICAL INDUSTRIES LTD., have vacancies for the following drawing office personnel, on electronic, telecommunication and electro-mechanical engineering: (a) Senior Electro-mechanical Designer-Draughtsmen. (b) Senior Mechanical Designer-Draughtsmen. (c) Senior Electrical Designer-Draughtsmen. (d) Detail Draughtsmen. Apply, stating age, fullest details of experience and salary required to Personnel Department, E.M.I. Ltd., Blyth Road, Hayes, Middlesex.

TECHNICAL SUPERINTENDENT required to control inspection and test gear sections of progressive company manufacturing radio components in west London area. Degree or equivalent, with several years practical experience essential. Box 309, E.E.

ENGINEERS REQUIRED for work overseas on installation of meter wave ground radar equipment and instruction of local staff. Good experience in this type of work essential. Reply, quoting Ref. No. 127, to Box 323, E.E.

THREE JOBS OPEN. Applications are invited from suitably qualified men for the positions of Chief Technician, Production Manager and Production Foreman, in a new factory in India, scheduled to commence production in the autumn of 1948. Applicants should have held similar posts in British or U.S.A. factories making domestic radio equipment. Three-year contracts at agreed salaries, plus living allowances, will be offered to successful candidates. Box 324, E.E.

THE UNIVERSITY OF LIVERPOOL. Glass-blower required in the Department of Physics. Experience in hard and soft glasses and glass-metal seals essential. Salary in accordance with age and experience. Applications, which should include particulars as to age, qualifications and experience, together with copies of testimonials, should be received not later than August 21st, 1948, by the undersigned. Stanley Dumbell, Registrar.

WANTED, SENIOR AND JUNIOR DESIGNERS with mechanical, electrical, or tuning coil design experience, for several long-term developments. Positions carry responsibility and applicants should have experience in or specialised knowledge of radio, electrical or communication component design. Write, giving qualifications, experience and salary required, to Messrs. The Plessey Co., Ltd., Vicarage Lane, Ilford, Essex.

RESEARCH LABORATORIES of The General Electric Co., Ltd., North Wembley, Middlesex, require an Engineer or Physicist, preferably aged 25-30, with an Honours Degree or equivalent qualifications, and with experience in circuitry and advanced development work, for research in the field of telecommunications. Apply by letter to the Director, stating age, experience and academic record.

GLASS BLOWER with technical knowledge and wide experience in working hard and soft glass with special reference to glass-metal seals, particularly copper-clad tungsten and Korar wires up to 1 mm. dia. Applications to Barr and Stroud, Ltd., Anniesland, Glasgow.

SOUTH WESTERN Division of a leading company invites applications for the post of Test Foreman. Consideration will be given to applicants who have an intimate knowledge of communications and radar work to Government specifications, are able to assume responsibility and control staff. The salary will be £400/£450, according to experience and ability. Full details, giving age and qualifications to Box 308, E.E.

PYE LIMITED have vacancies in their engineering department in Cambridge for Draughtsmen. Applicants should have served an apprenticeship in mechanical or electrical engineering and should have some drawing office experience in the radio or light electrical industry. Salary in accordance with accepted provincial rates.

PHYSICIST OR ENGINEER, preferably University Graduate, with some knowledge of radar, required as assistant in the laboratory of a west of Scotland factory engaged in the development of scientific instruments. Applicants should be between 20 and 30 years of age, and should give full details of their technical and practical training. If necessary, a house is available. Address, 1861, Wm. Porteous and Co., Glasgow.

APPARATUS ENGINEER (TELECOMMUNICATIONS). Light engineering firm in north London have vacancy for a Telecommunications Apparatus Engineer (B.Sc. or equivalent). Preference will be given to applicants with experience of valve circuits, acoustics, relays, transformers, etc. Graduates direct from any University will be considered. Write, stating age, qualifications, salary required to Box Q 5709, A.K. Advtg., 212a, Shaftesbury Avenue, London, W.C.2.

FIRM IN N.W. LONDON area, manufacturing a wide range of industrial instruments and controls, has vacancies in its engineering laboratory for Assistant Development and Design Engineers. Applicants should, preferably, have a Degree, or equivalent, in Electrical Engineering, Mechanical Engineering or Physics, with a good knowledge of the fundamentals of radio technique. Work would include the development of electronic devices and servo mechanisms for industrial application, and practical design experience is desirable. Initial salary will be between £400 and £600 per annum, according to qualifications and experience. Write Box 311, E.E.

A LARGE VALVE MANUFACTURER (S.W. London) require graduates in Physics or Electrical Engineering as Senior Assistants for their transmitting valve development department. Must have had experience in either receiving or transmitting valve design, preferably the latter, knowledge of cooled anode valves an advantage, and should be capable of originating and supervising development work. Salary £600 plus, according to age, experience, and qualifications. Reply to Box EE586, L.P.E., 110, St. Martin's Lane, W.C.2, and quote reference T'111.

SENIOR ESTIMATOR required for communications division by large established company situated in the London area. Experience to cover extensive knowledge of the light electrical engineering industry. Applicants should write, stating age, qualifications, experience, and salary required, to Box 307, E.E.

ELECTRONIC ENGINEER required in N.W. London district to undertake development of electronic equipment. Applicants should possess a Degree and have had experience in this class of work. Knowledge of optics will be an advantage. Applications should state age, full particulars of experience and salary required. Write Box 523, c/o 7, Coptic Street, W.C.1.

TECHNICAL ASSISTANT required, with experience of transformer and electronic design and manufacture. A knowledge of commercial practice would be an advantage. Excellent prospects. Apply by letter only, giving experience to date, age, and salary required to Savage Transformers, Ltd., 51, Northgate Street, Devizes, Wilts.

DEVELOPMENT ENGINEER required for work on experimental types of cathode ray tubes. Applicants should possess a Physics Degree and have had practical experience in the design, development and manufacture of cathode ray tubes. London area. Applications should include details of qualifications, experience, and salary required, and be addressed to Box 315, E.E.

SOUTH WALES. The following vacancies exist in the development laboratories of a modern, well-equipped factory in South Wales: Electronics Division—two Senior Engineers required. Must have wide and varied experience of development work for Government contracts, particularly on telecommunication and radio apparatus. Acoustics Division—one Junior Engineer, aged 20-25, required, with sound technical knowledge and practical experience in development of loudspeakers, microphones, etc. Appliance Division—one Senior Engineer required, with experience in the development of domestic electric appliances. Experience in design of fractional h.p. motors an advantage. For all the above positions applicants must have previous experience of factory development work. Engineering Degree an advantage. Write, giving details of education, age, experience, and salary required, to Box 537, Arthur S. Dixon Limited, 229, High Holborn, W.C.1.

WOOLWICH POLYTECHNIC. A Laboratory Assistant required in the physics department of Woolwich Polytechnic. Previous experience in a physical laboratory is desirable, but lack of it will not disqualify a suitable applicant. Salary £225-£15-£315 per annum. Permanent appointment (after probationary period) with superannuation scheme. Application, by letter, to the Secretary at the Polytechnic, Woolwich, S.E.18.

SENIOR AND JUNIOR DRAUGHTSMEN required in the electronic drawing office of a large manufacturer of radio and allied equipment, situated in the east London area. Suitable applicants should have Higher National Certificate or equivalent qualifications and previous experience. State age, experience and salary required to Box 321, E.E.

MICROWAVE RADIO DEVELOPMENT. A Senior Engineer and a Mathematician are required by a company in the east London area engaged on this work. Technical qualifications to Degree standard are necessary and, in the case of the engineer, previous experience would be an advantage. State details of experience and qualifications, together with age and salary required, to Box 320, E.E.

HIGH FREQUENCY ENGINEER urgently required. Interesting and new development work involving crystal control on frequencies between 40-60 megacycles. Wide experience and ability to tackle difficult problems associated with load matching, automatic tuning and power measurements. Good prospects, salary according to age and experience, degree standard or equivalent. North London district. Apply giving age, qualifications and experience to Box 322 E.E.

INDEX TO ADVERTISERS
SEE PAGE 32

CLASSIFIED ANNOUNCEMENTS (Cont'd.)

RADIO ENGINEER required as foreman of Service Department. Must have first-class technical qualifications and practical experience of modern radio, television and electronic instruments. Reply, giving particulars of qualifications and salary required to Box Q5800, A.K. Advtg., 212a, Shaftesbury Avenue, W.C.2.

SITUATIONS WANTED

CONSULTING PHYSICAL CHEMIST, own laboratory, high academic qualifications, offers services for research and development on physical or chemical problems. Box 313, E.E.

EX-R.A.F. TECHNICAL OFFICER, Higher National Diploma, Electrical Engineering, Radio Group, age 30, seeks interesting vacancy. Box 314, E.E.

WORKS OR PRODUCTION MANAGER, age 41, seeks position with firm in London or home counties. Electronics, radar, television, transmitters, light engineering and assembly. Full knowledge all factory services. Planning, processing, layouts, personnel and welfare. Actual experience 700 employees. Box 306, E.E.

CHIEF ENGINEER, HONOURS GRADUATE, Ph.D., M.Sc., A.M.I.E.E., A.M.I.Mech.E., seeks change of post. Technical Director, Chief Engineer. Twelve years responsible positions telecommunications, electronics. Eight. years engineering training. Box 312, E.E.

YOUNG ARTIST with technical experience and ideas on styling desires position in design studio of radio or electrical manufacturer. Box 317, E.E.

EDUCATIONAL

COMPLETE CORRESPONDENCE COURSE, covering Amateur and C. and G.I. Examinations, consisting of 12 lessons. Students trained for Certificates of the City and Guilds of London Institute. Send for particulars. Orthic-Modern Institute, 72, St. Stephen's House, Westminster, S.W.1.

SERVICE

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

COIL SPECIALISTS. Tuning and oscillator coils, I.F., L.F. and mains transformers rewound and wound to specification. Wavewinding, L.S. repairs. Armature and field rewinding. Rynford Industries Ltd., 17, Arwenack Street, Falmouth, Cornwall.

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.

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.

HAVE YOUR RADIO, electrical and mechanical problems solved by qualified engineers with years of industrial experience. Designs to your specifications and prototypes built. Estimates on request. Box 318, E.E.

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).

COILWINDING. Layer, wave and progressive wave winding to specification. Prototypes or quantity production of units and assemblies. Design and development. Rynford Industries Ltd., 17, Arwenack Street, Falmouth, Cornwall.

PATENTS

PROPRIETOR BRITISH PATENT No. 600,172, unique design moving coil pickup, wishes contact manufacturer interested in marketing on agreed basis. Box 310, E.E.

AUCTION

G. ♛ R.

WITHOUT RESERVE

By Order of the MINISTRY OF SUPPLY

MESSRS. FULLER, HORSEY, SONS & CASSELL have been instructed to offer for sale by auction in Lots at the Royal Hotel, Cumberland Place, Southampton, on Thursday, 12th August, 1948, at eleven o'clock precisely, surplus stores, electrical, wireless and radar equipment at 65, O.S.D. (Don) Lockerley, Nr. Romsey, Hants., including 30 tons new electric cable; 4 tons cadmium and enamelled copper electric wire; 6,000 headgear receivers; 300 telephones loud speakers; 9,500 battery hand lamps; flashlight electric bulbs; neon lamps; hand torches; magneto bells, rotary converters; battery chargers; power transformers; armature assemblies; motorised fans; A.A. gun mountings and fittings; canvas predictor covers; cordage and numerous other effects. Catalogues, 6d. each, admitting two persons on view days and one on sale day, may be had, when ready, of Messrs. Fuller, Horsey, Sons & Cassell, Industrial Auctioneers, 10, Billiter Square, London, E.C.3.

FOR SALE

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.

THE ENOCK PICK-UP is now available in limited quantities. Moving coil (licenced under Patent No. 538,058) with precision made polished diamond stylus. Weight at needle point, ⅝ oz. No resonances within the recorded range. Price, £36 15s. inc. tax. Full particulars from Joseph Enock Ltd., 273a High St., Brentford, Middlesex. EALing 8103.

THE MORDAUNT DUPLEX REPRODUCER, as used in the Enock instrument, is now available separately. Folded horn bass unit and new high note reflector of original design, giving exceptionally smooth response from 40/20,000 c.p.s. Even distribution over a wide angle. Reproduction has an "atmosphere" and realism hitherto unattainable. Price (ex works), 98 gns. (in white wood, skeleton form £88). Please send for particulars or better still, let us demonstrate. Joseph Enock Ltd., 273a, High St., Brentford, Middlesex. EALing 8103.

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

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.

TELEVISION AERIALS. Baldwin Instrument Co., Ltd., have for disposal a limited number of sets of duralumin tubes cut to correct length suitable for television aerials. Price, carriage paid, dipole only 15s., dipole and reflector 25s. Cash with order or C.O.D. Baldwin Instrument Co., Ltd., Brooklands Works, Dartford, Kent.

0 to 350 mA Moving Coil R.F. Meters, 3s. 9d.; generators, ball bearing for 12, 24 and 200 volts D.C. 4s. 6d.; Neon tubes, 1s; American I.F. chokes, 3s. 6d.; American transformers, 2s.; valves from 1s. 6d.; 230/115 transformers, 21s. Thousands of electronic parts in stock. Stamp for list. Jack Porter Ltd., "Radio," 22/31, College Street, Worcester.

TELEVISOR KIT. Complete range of Erie resistors, tolerances and wattage exactly as specified, in stock. T.C.C. condensers and electrolytics, exact, in stock. Belling-Lee components, scanning and focus coils, EHT transformers, etc., in stock. Trade only. Petter Radio Supplies, 203, Forest Road, E.17.

1948 VADE MECUM listing 10,000 valves. Universal Services, 13, Newburgh Street, London, W.1.

ARMOUR PORTABLE WIRE RECORDER, complete with microphone and wire for four hours' recording, all in new condition. £145. Harris, 93, Wardour Street, W.1.

"ELECTRONIC ENGINEERING" July-November, 1940. January - September, 1942. December, 1945. 1946 complete. January-August, October-December, 1947. 30s. 0d. lot. George, 77, Springfield Park Avenue, Chelmsford.

⅛ H.P. UNIVERSAL MOTORS, £1; 1½ KW Alternators D.C. mains in, A.C. mains out, £25; 100 yds. 44/.012 heavy rubber, £1; Twin mains padded and braided, 100 ft., 15s; Loudspeaking intercom sets, new, £10; Wavemeters, 160-220 Mc/s., less 6J5 and 0-1 mA meter, 7s. 6d.; Oscilloscope units, less 2¾-in. C.R. tube, 10s.; 10SB/5 3-valve battery 55-85 Mc/s. signal generators, complete, 25/-; Rotaries, 12 volts D.C., 300 volts 240 mA, and 6 volts 5 amps. out, £1; Pint tins polystyrene solution, 6s.; Autosyn motors, one fitted with scale calibrated in degrees, pair, £3; Co-axial cable, 45 or 72 ohms per yd., 1s.; 100+100 split stators, 1,400 volt, 2s. 6d.; Bulgin toggles, 1s. 6d.; 180 watt vitreous 12K, 100K, also 130 watt 20K, 50K, 5s. ea.; T.C.C. 4 mF 1,000 volt, 5s.; 400 mH L.F. chokes, 5s.; 40 Amp relay/cut-out 9-14 volt coil, 5s.; Postage Carriage extra. Trade lists available. Amateur Radio Service, Canning Street, Burnley.

1 MARCONI STANDARD SIGNAL GENERATOR TF144G, 85 Kc/s.—25 Mc/s. Complete with mains and output leads, £50. 2 Cossor 339 Double Beam Oscilloscope new C.R.T. Recently overhauled and re-valved by Cossor. One green, other blue for photography, £45 each. 1 Cossor 447 V.H.F. Signal Generator. 6.5 Mc/s.—12 Mc/s., and 16 Mc/s.—95 Mc/s., £40. 1 Marconi TF301D/1. 1 Mc/s. Inductance Bridge, 0–50 microhenries, accuracy plus or minus 2 per cent., £30. Tele-Radio (1943), Ltd., 177, Edgware Road, London, W.2. Phone: AMB 5393; PAD. 6116 and 5606.

BRAND NEW Phase Control units, design "E," containing: Mains transformer, input 230 volt 50 cps output, 250–0–250 volts, 75–0–75 volts, 4 volts at 3 amps., 4 volts at 1.5 amps. Valves UU4 rectifier, Thyratron GT1C, condensers, resistances, etc., in super metal cabinet and packed in wooden container. Only £3. New ex-R.A.F. Power Units, containing: 1, 0–1 mA M.C. meter, meter rectifier, 2 by 32 mfd. 600 VDC condensers, 2 by 300 mA 20 henry chokes, 1 heavy duty mains transformer, 230 volts 50 cps. primary, sec. 350–0–350 volts at 300 mA, 2 by 6.3 volts, 5 volts, 20–0–20 volts, 2 by EF50, 1 by EA50, 5U4G condensers, resistances, thermal delay switches, fuses, etc., complete in wooden packing case. Bargain, £6 15s. Brand new ex-R.A.F. Modulator Units, type 76 by ECKO, containing: 9 valves—1 by EF50, 3 by EF39, 1 by EBC33, 2 by EF36, 2 by KT33C, 4 I.F.'s, 5 relays, 4 transformers, approx. 67 resistances and 65 condensers, 1 motor generator 24 volt input, 2 by 250 volts at 200 mA output; many other items, fuses, etc., complete in metal cabinet and packed in wooden packing case, price £4. All the above carried paid. S.A.E. list other interesting items. Cross, Skerries, Newton Lane, West Kirby, Cheshire.

R1155 COMMUNICATION RECEIVERS, unused, guaranteed working, £9 10s. 30, Second Avenue, Stafford.

MAGSLIPS. 3-in. transmitters, 27s. 6d. each. 2-in. transmitters, 30s. each. See also displayed advertisement, page 32. Hopton Radio, 1 Hopton Parade, Streatham High Road, London, S.W.16. STReatham 6165.

15-IN. BAIRD C.R. TUBE. Perfect condition. Has been stored. £12 10s. Box 319, E.E.

R T S RANGE OF PRECISION BUILT

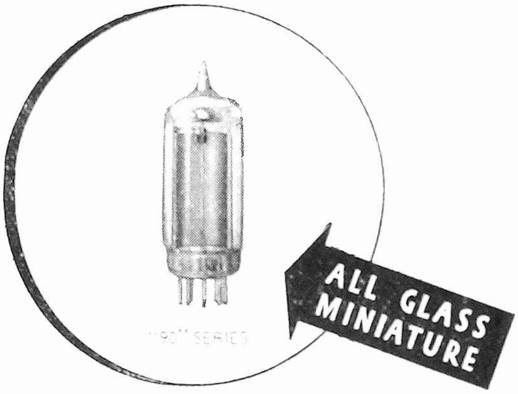
transformers & chokes are specified by engineers who require accuracy and reliability to Tropical Standards.

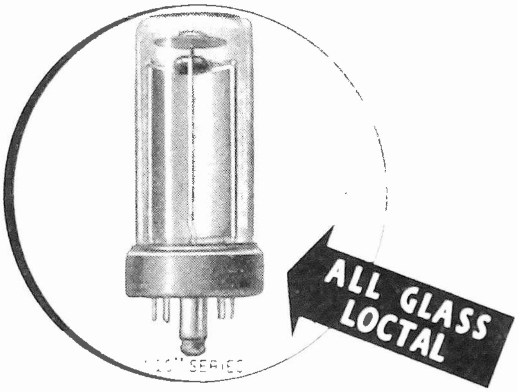
TYPE APPROVED
BY THE ROYAL AIRCRAFT ESTABLISHMENT

Retail stockist: Berry's (Short Wave) Ltd. 25, High Holborn, London, W.1.

R.T.S. ELECTRONICS, LTD KING STREET, EXETER.
Telephone: Exeter 2132. Cables & 'Grams: "Television," Exeter.

Introducing *the first* *of* a new range of Industrial Photocells





These new Mullard photocells have been specifically developed to meet the exacting requirements of industrial electronics. Both the miniature B7G "90" series and the full size B8G "20" series are of all-glass construction which provides the maximum possible cathode area. The caesium (C type) photocells listed below have high sensitivity to infra-red and incandescent light. Other industrial photocells with special cathodes will be announced in the near future.

DATA

Characteristics	Caesium Vacuum 20CV	Caesium Vacuum 90CV	Caesium Gas-filled 20CG	Caesium Gas-filled 90CG
Sensitivity (μA/L)	25	20	150	125
Max. Anode Voltage (V)	250	100	90	90
Max. Cathode Current (μA)	20	10	5	2
Max. Gas Amplification Factor	—	—	10	10

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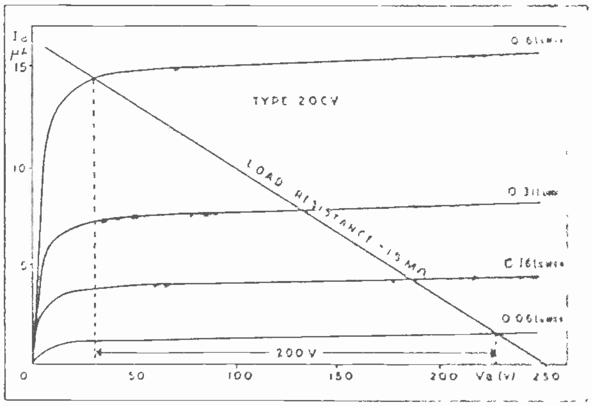


NOTE: 0.048 lumen sq. in. is the light intensity produced by a 60 watt tungsten filament lamp at a distance of 2 ft. 6 in. (Cathode area of Type 20CV = 1·25 sq. in.)

Mullard
THERMIONIC VALVES & ELECTRONIC TUBES

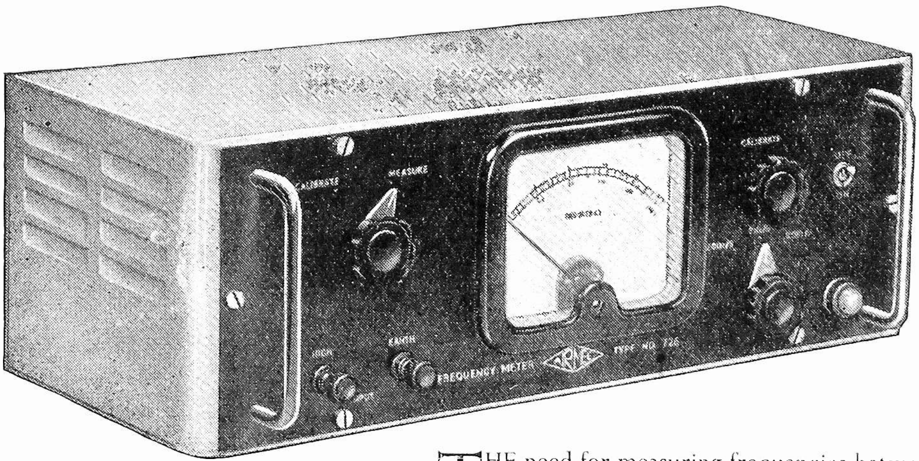
Mullard MULLARD ELECTRONIC PRODUCTS LIMITED, Century House, Shaftesbury Avenue, London, W.C.2

AIRMEC

FREQUENCY METER

(ELECTRONIC TACHOMETER)

for Research and Industrial use



FREQUENCY METER. TYPE No. 726.

Will provide direct measurement of frequency from 0 to 20 Kc/s. Most suitable instrument for measuring frequency source containing noise components, interference or harmonics. Reading accuracy of better than 1% of full scale and unaffected by mains voltage variations of 10%. Input Signal Voltage of 0·1 V. to 20 V. peak to peak. Wave form may be of any contour provided it does not pass through zero more than once every cycle.
For use on power supply of 50 cycle A.C. mains, 100-130 volts, 200-250 volts.

THE need for measuring frequencies between the range of 0 and 20,000 cps. has become not only very common but also an extremely important problem in Research Laboratories and Industrial testing; in almost every industry whether the application is concerned with mechanical effects (such as in tachometry or vibration studies) or in acoustic and audio work. In electrical and audio work the voltage examined is applied directly to the instrument. In the case of a mechanical effect it will be necessary to convert it into an equivalent voltage change by the use of an electromechanical pick-up device, in particular the Airmec Photocell Unit Type 724 designed for use with this instrument.

Works: High Wycombe, Bucks.

AIRMEC LABORATORIES LTD.
19 CHARTERHOUSE ST., LONDON, E.C.1
Telephone: Chancery 7843

MEASURE YOUR COMPONENTS
ON THE
MUIRHEAD IMPEDANCE BRIDGE

It gives answers without ambiguity

TYPE D-197-A

RANGES:

D.C. RESISTANCE:

0·001 ohm to 1·11 Megohms.

CAPACITANCE: 1 μμF to 100 μ.F

DISSIPATION FACTOR: 0-1·2.

INDUCTANCE: 1 μH to 1000 H.

MAGNIFICATION FACTOR: 0-60.

FEATURES:

BUILT-IN
- Resistance and reactance standards.
- 1 kc/s oscillator and bridge amplifier for A.C. measurements.
- Rectified A.C. source and sensitive centre-zero galvanometer for D.C. resistance measurements.

PROVISION FOR USE OF EXTERNAL GENERATOR FOR A.C. MEASUREMENTS UP TO 10 KC/S.

PROVISION FOR USE OF EXTERNAL GALVANOMETER.

MECHANICAL INTERLOCK BETWEEN DIALS DISPLAYS ONLY ONE ANSWER.

ELECTRONICALLY OPERATED WAGNER EARTH.

ALL - MAINS OPERATION.

Full details in publication C-104-A—which will gladly be sent on request

Muirhead & Co. Limited, Elmers End, Beckenham, Kent. Tel: Beckenham 0041-2

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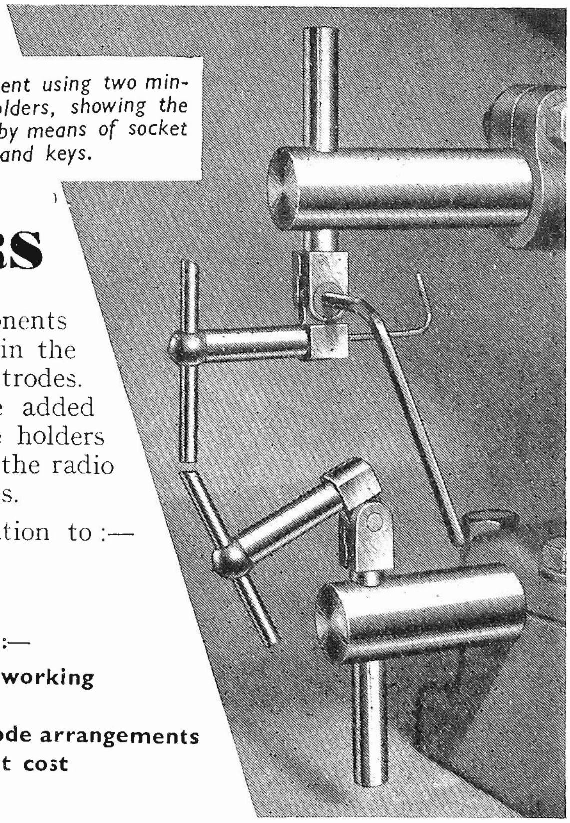

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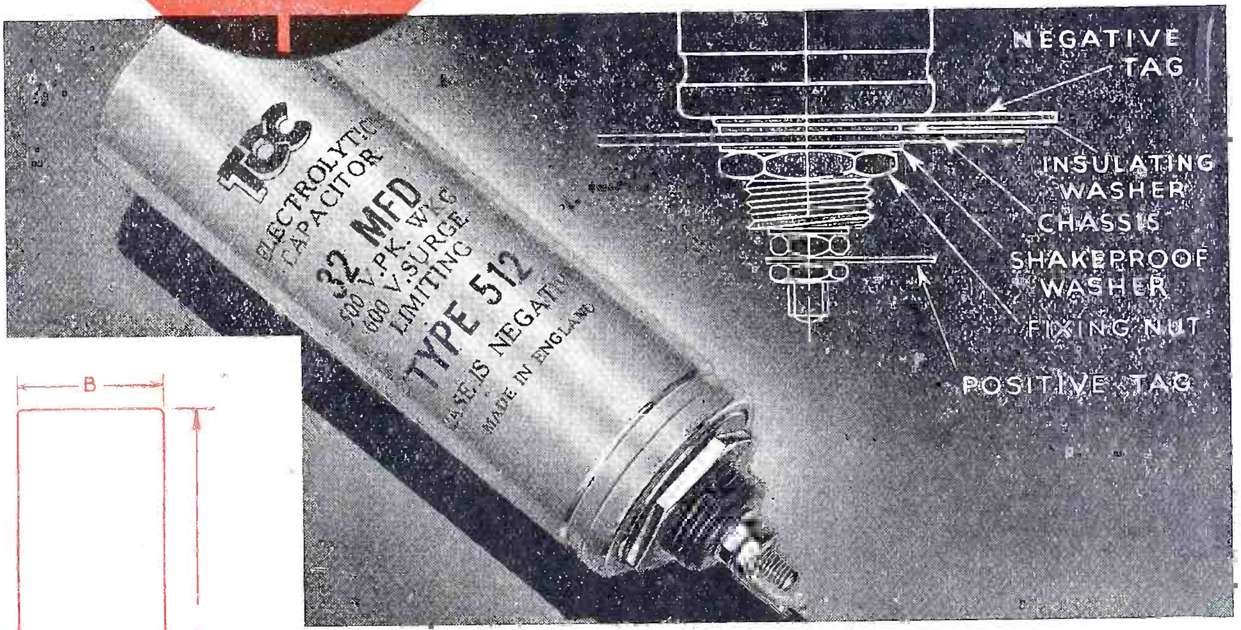

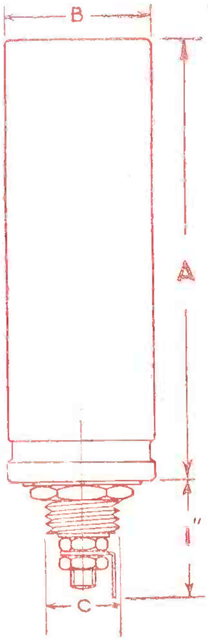

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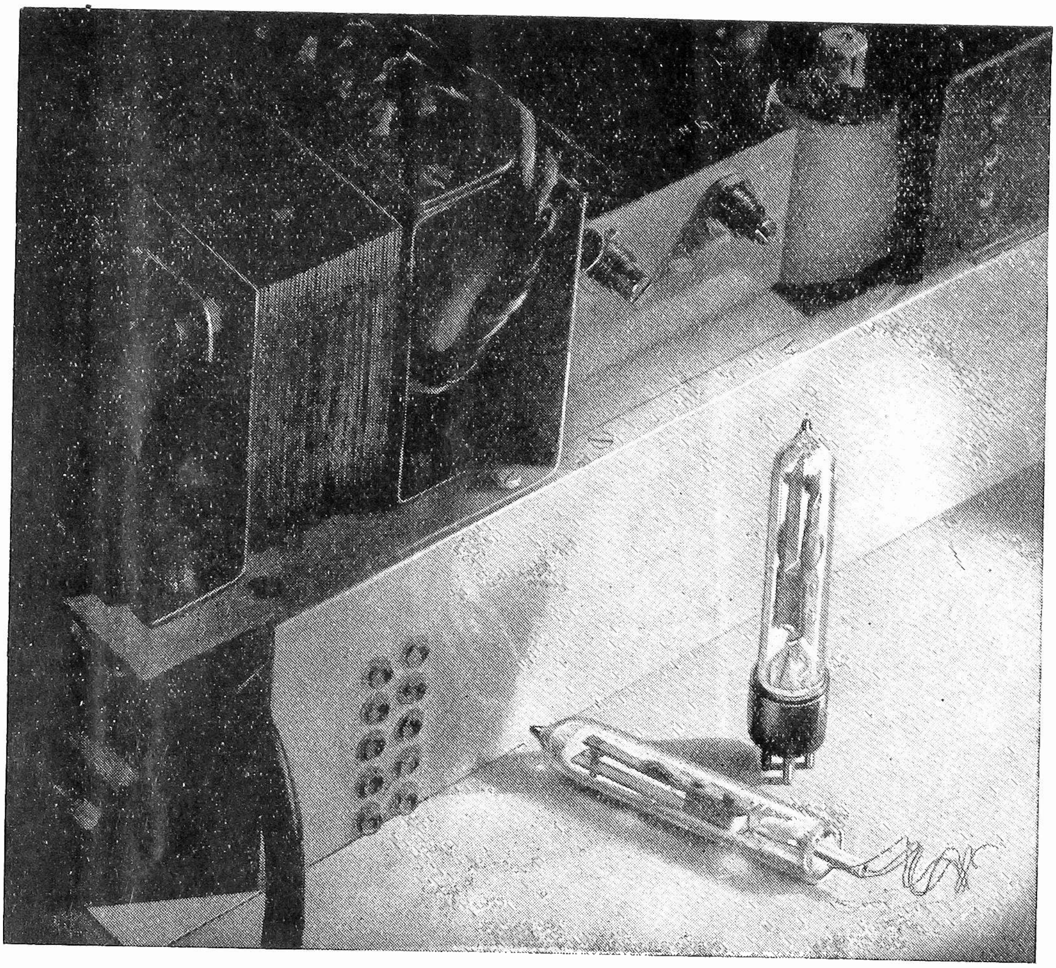

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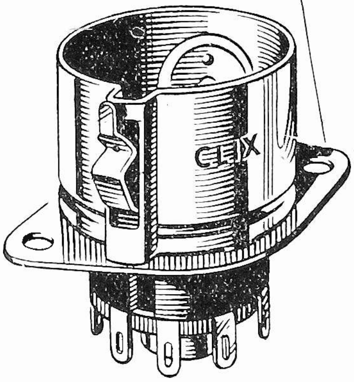

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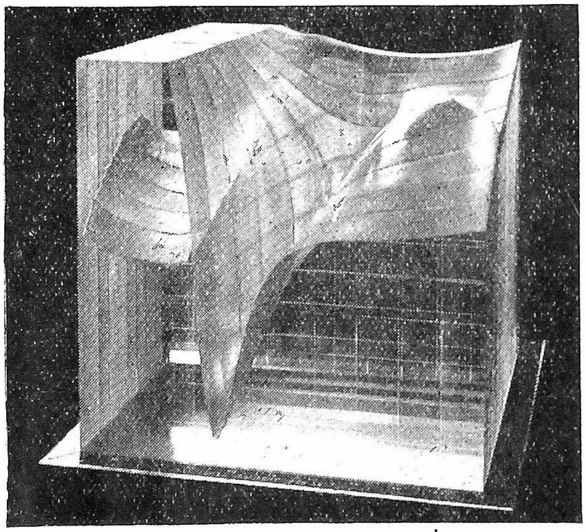

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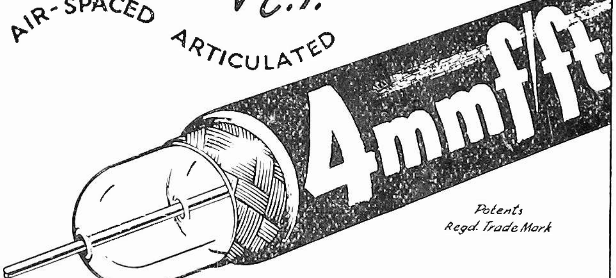

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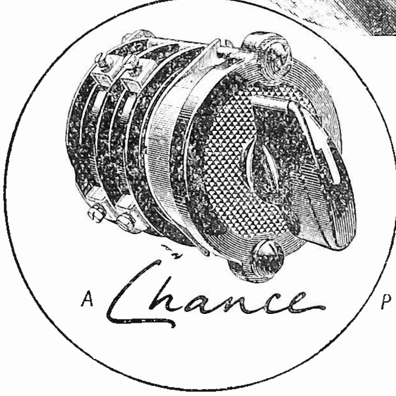

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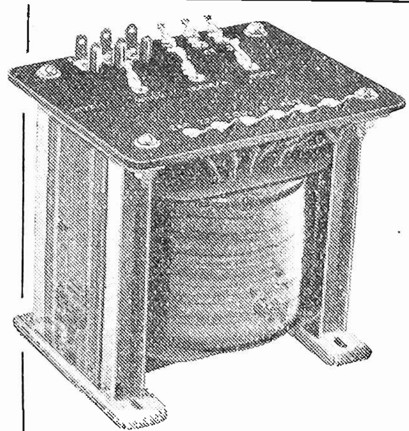

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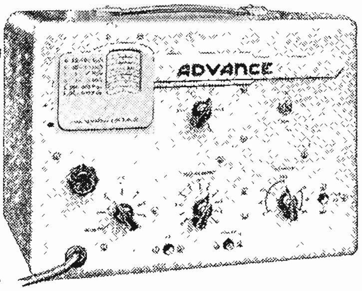

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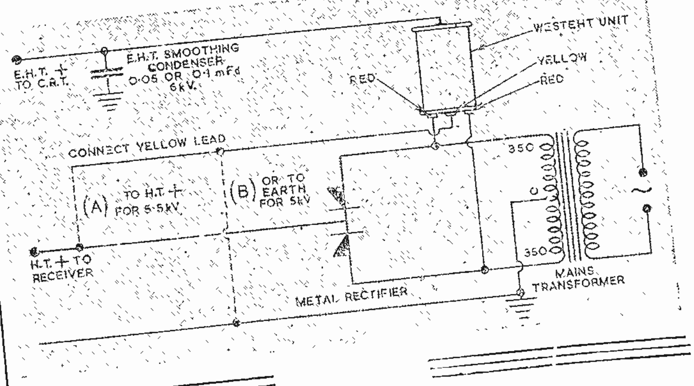

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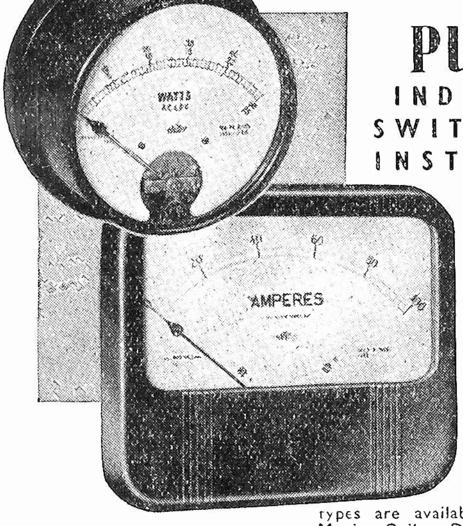

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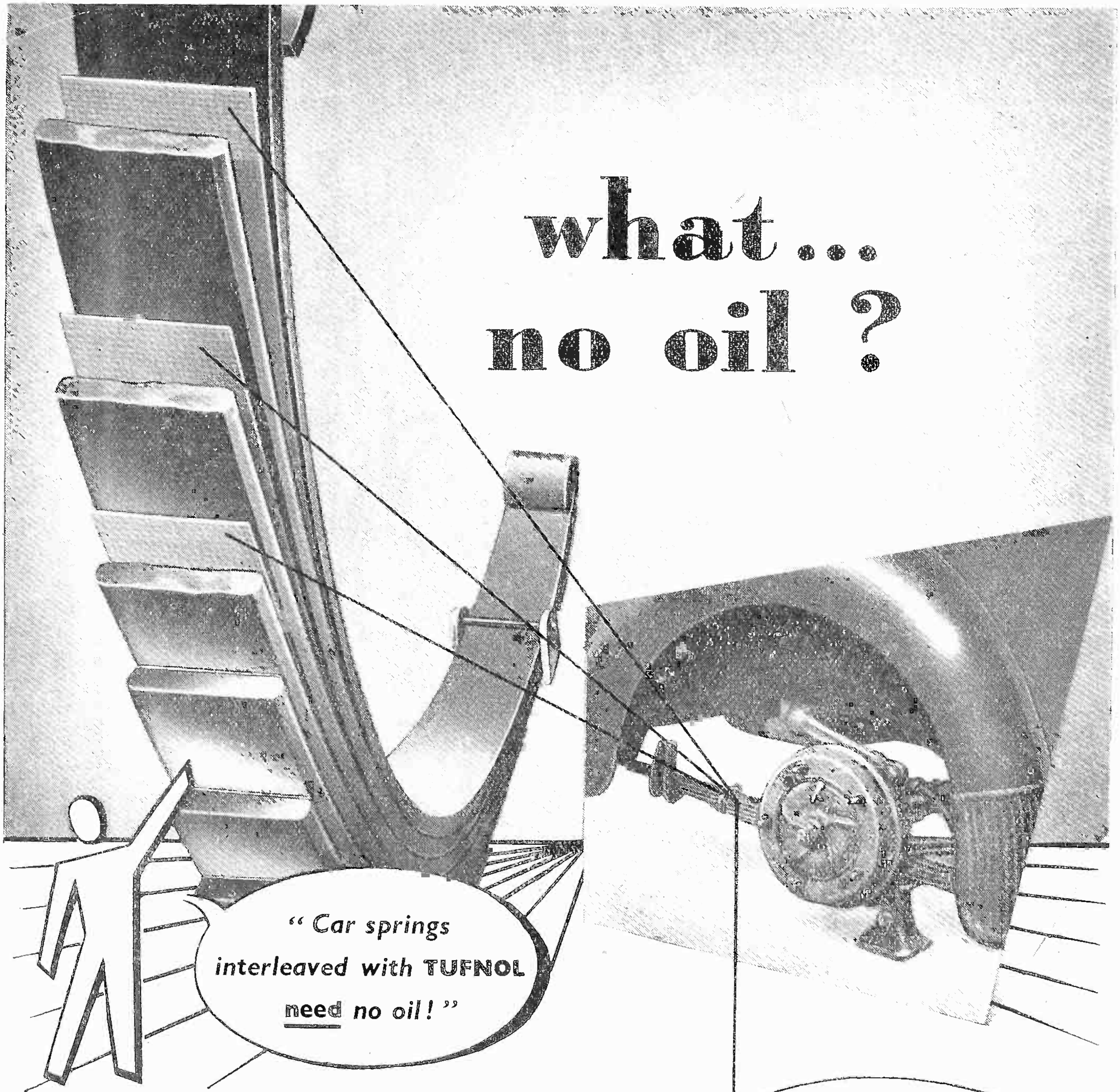

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Vol. 20. No. 245

CONTENTS

August, 1948

Scientific Information

IT is probable that the Royal Society's Conference on Scientific Information, reported on page 248, would have received less notice from technical workers had it not been for the prominence given by the daily Press to Prof. Bernal's proposal for a central Publications Board which would determine what material was suitable for issue in the form of printed papers.

As this proposal was not finally put to the Conference, no more need be said than has already appeared in *The Times* leader and other commentaries.* It has been said before, in this and other technical journals, that the scientific worker finds very quickly by experience the type of publication most likely to be useful to him and concentrates on the few that give him the best return for his trouble in reading through them.

It is inevitable that some original published material will be overlooked by even the most exhaustive search. It may appear in one of the more obscure journals (as, for example, Röntgen's announcement of the discovery of X-rays), or its significance may not be apparent for some years after is appearance. These conditions may lead to duplication of work or neglect to acknowledge a prior claim, but they would not be remedied by restricting the channels of publication. On the contrary, the provision of more specialist publications would tend in the course of time to simplify the task of searching.

One of the difficulties which the present-day worker meets is the restricted circulation of technical journals. One has only to look through the bibliographies of some technical articles to see how limited is the scope of the author's search. Continental publications are seldom mentioned in either British or American references, and it would be absurd to conclude from this that no original work had been done in Europe since 1939.

Paper shortage is certainly an important factor, but it is not the deciding one, and its effect could be minimised by an increase in publication of short summaries and abstracts. One of the points stressed at Conference was the importance of improving existing abstracting services and making their work more widely known. Lecturers in technical colleges and universities could help materially if they instructed students in the existing sources of information and where to find them. There are still too many entering research establishments who are unfamiliar with the contents of the principal scientific libraries and how to set about finding references, and the knowledge of where to acquire information is often of greater value than the storage of the information itself.

* *The Times*, June 21st., 1948.
The Observer, June 27th. 1948.

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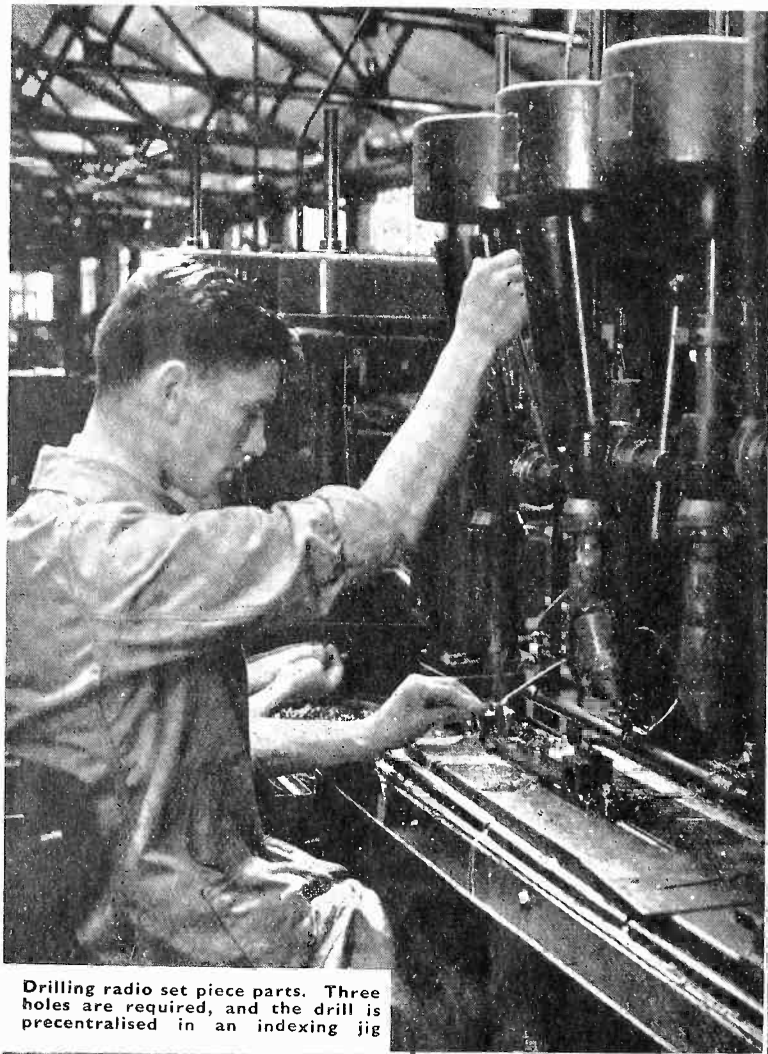
These photographs, reproduced from a booklet of this title, issued by the National Institute for the Blind, show how blind workers can be usefully employed in various branches of the radio industry.

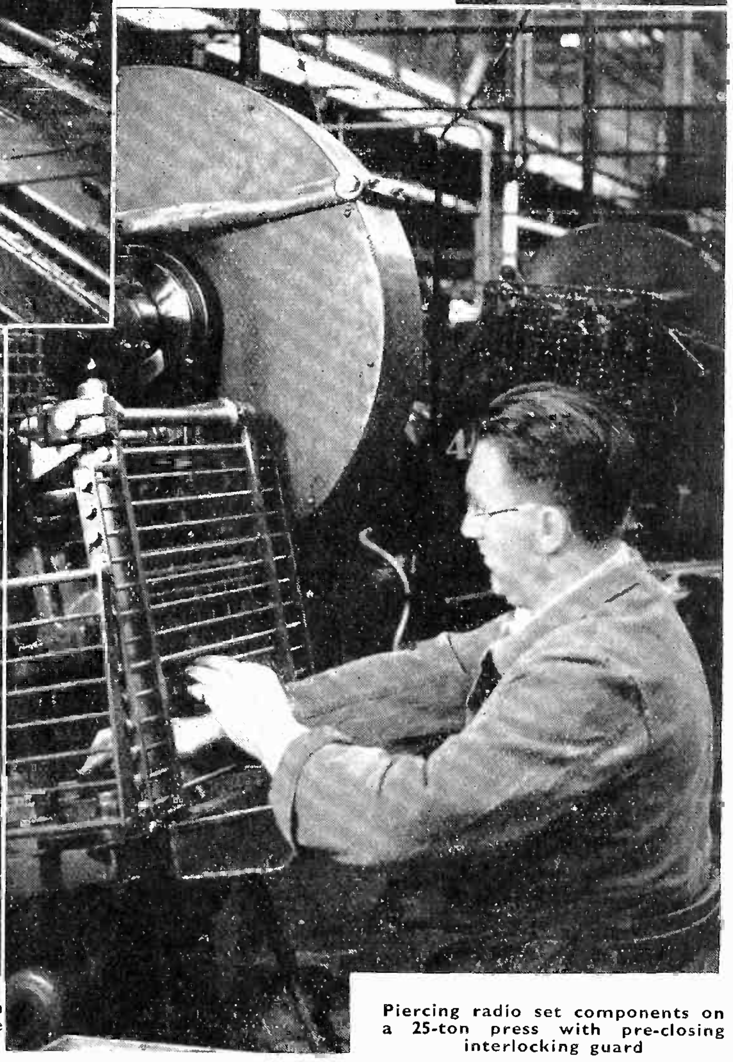
Photos taken at Philips Lamps Ltd.



Drilling radio set piece parts. Three holes are required, and the drill is precentralised in an indexing jig

Glass cane cutting on a serrated cutting wheel

Annealing radio valve 'pins in an open gas flame, shielded from the operator



Piercing radio set components on a 25-ton press with pre-closing interlocking guard

The Miller Integrator

By B. H. BRIGGS, M.A.*

The first of a series of three articles dealing with the basic theory of the Miller Integrator and its application to circuit technique. The properties of this circuit were first investigated by the late A. D. Blumlein, and it has been suggested that the term "Blumlein Integrator" is more appropriate, but the name "Miller Integrator" is now firmly established owing to its derivation from the Miller Effect.

A MILLER Integrator[1,2] is a circuit in which a form of feedback is applied to an amplifier, the effect being to constrain the output voltage to be proportional to the integral of the input voltage with respect to time. Fig. 1 shows the basic feedback circuit. The amplifier must have a high gain, be phase-reversing, and have a high input impedance. The input voltage V may be an arbitrary function of time, all the voltages in Fig. 1 being instantaneous values. The integrating property of the circuit can be demonstrated at once if two assumptions are made:

(i) The changes in V_g required to produce a finite output are negligibly small, owing to the high gain of the amplifier, and so V_g can be neglected in comparison with V and V_a.

(ii) The current in R is equal to the current in C, *i.e.*, no current flows into the amplifier input terminal (owing to the high input impedance).

From (ii) we have

$$\frac{V - V_{g1}}{R} = C\frac{d}{dt}(V_g - V_a) \quad \ldots\ldots (1)$$

and, making the approximations in (i), this becomes

$$\frac{V}{R} = -C\frac{dV_a}{dt} \quad \ldots\ldots (2)$$

$$\text{or } V_a = -\frac{1}{CR}\int_0^t V dt + v_0 \quad \ldots\ldots (3)$$

where v_0 is the anode potential at time $t = 0$.

This type of feedback is often applied to quite complicated amplifiers, containing several valves and possibly also transformers. In such cases there is the possibility of oscillation round the feedback loop, due to phase shifts, stability being determined by the Nyquist criterion for feedback amplifiers.

The rest of this article, however, is concerned only with the most common case, in which the amplifier consists of a single pentode

	SYMBOLS USED
A	D.C. Amplification $= g_m R_L$
C	Value of "Miller" Capacitance from anode to grid
g_m	Slope of valve in A/V.
I_a, I_{g1}, I_k, I_L, I_R I_{g2}	See Fig. 3
R	Value of "Miller" resistance (grid leak)
R_L	Anode load resistance
t	Time
T_1	Total duration of "run-down," or time base length in secs.
V	Voltage applied to grid leak R
V'	$=(V+V_0)=$the corrected value of V to allow for the fact that the mean grid potential is negative with respect to earth by an amount V_0.
V_a	Anode potential, or output voltage
V_b	H.T. potential
V_c	Cut-off bias
V_{g1}	Control-grid potential
V_{g2}	Screen-grid potential
V_{g3}	Suppressor-grid potential

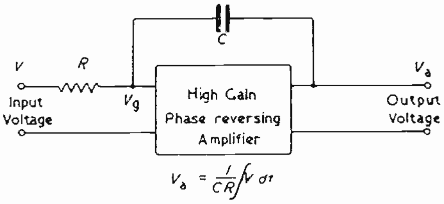


Fig. 1. Basic "Miller feedback" circuit

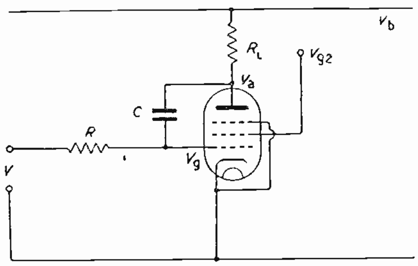


Fig. 2. "Miller Valve" circuit, using single pentode

valve. Fig. 2 shows the circuit, which is always stable. The arrangement is often referred to as a "Miller Valve." A resistance R_L is shown in the anode circuit, but other types of anode load are quite common. In normal operation the grid potential is slightly negative with respect to cathode,† so that the effective input voltage is $V + V_0$, where V_0 is a small positive constant of the order of a few volts. (We are neglecting here the actual *motion* of the grid; V_0 is the *mean* negative grid potential). A better approximation to the output voltage is therefore

$$V_a = -\frac{1}{CR}\int_0^t V'dt + v_0 \quad \ldots\ldots (4)$$

where $V' = V + V_0$

An important case arises when V is *constant*. The anode potential change is then *linear* with time

$$\frac{dV_a}{dt} = -\frac{V'}{CR} \text{ volts/sec.} \quad \ldots\ldots (5)$$

$$\text{or } V_a = V_b - \frac{V't}{CR} \quad \ldots\ldots (6)$$

if V is positive and the integration is started at $t = 0$, when the anode is at H.T. potential V_b. The anode potential falls linearly from V_b, an effect referred to as a "Miller rundown" of the anode or simply a "run-down."

Considering now the fact that the gain of the valve is finite, it will be seen that this will cause two modifications to the reasoning used above. In the first place, the current in R will no longer be constant, owing to the changing grid potential, and so the anode potential variation will no longer be exactly linear. In principle this departure from linearity can be avoided by letting V and R tend to infinity, while keeping V/R constant. This point will be neglected for the time being and taken up again in Part II. The second effect of finite gain is to change the scale of the anode waveform. This is because (6) really represents the total potential variation across C, and a fraction $A/(1 + A)$ of this appears at the anode, and a fraction $1/(1 + A)$ at the grid.

Thus,

$$V_a = V_b - \left(\frac{A}{1+A}\right)\frac{V't}{CR} \quad \ldots\ldots (6')$$

In this equation it is legitimate to

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† The manner by which the correct "biasing" of the valve is obtained varies in different circuits, and is explained in detail later.

take the gain of the valve, A, at its D.C. value $g_m R_L$ in spite of the presence of C, because the current in C is constant (or very nearly constant), so that *changes* in grid potential are reflected as *changes* in the current in R_L, exactly as if C were absent.

Equation (6′) is the basis of several time-base circuits, the principle being equally applicable to triggered and self-running time bases. The circuits differ only in the way in which the run-down is started, and the arrangement used to "flash-back" to the starting point at the end of the linear sweep.

It should be noted that the time base speed (rate of change of anode potential during the run-down) depends mainly on the accurately known values of V, C, and R, and only slightly on the more uncertain and more variable quantities A and V_o. This relative independence of valve characteristics, H.T. potential, etc., is one of the main advantages of the circuit and is due fundamentally to the use of negative feedback. The feedback also tends to maintain the linearity, even if the amplifier characteristic is curved.

In a second class of circuit the same linear "run-down" is used, but it is the *time* taken for the anode to fall through a known potential which is important. The applications of this principle to the production of delayed marker pulses, timing circuits, etc., will be obvious, and again the circuits have advantages similar to those mentioned above, over circuits in which feedback is not used.

For the remainder of Parts I and II only the linear run-down case (V_b a fixed positive voltage) will be considered.

The problem, then, is to control the Miller valve in such a way that the anode potential falls linearly for a certain length of time and is then returned to its starting point as rapidly as possible. Three methods of achieving this will now be described under the headings "Suppressor Switching," "Grid Switching" and "Grid-leak Switching." (Figs. 3, 5, 6 respectively). It will be assumed for the present that an independently generated square waveform is provided, by means of which the time base is to be controlled. It should be understood, however, that these basic methods of switching also occur in more complex self-operating circuits of various types, in which the square wave is produced internally by the circuit itself.

The currents and voltages at all points in the circuits will be investigated in considerable detail. This assists in obtaining a clear physical picture of the operation. It will be convenient at some points to give numerical values, which will be appropriate to a valve of the EF50 class.

Suppressor Switching

The circuit, notation and waveforms are given in Fig. 3. A square wave of about 100 V amplitude is passed to the suppressor via C_1, and is D.C. restored by the diode so that its upper level is at earth potential. During the negative portion AB, therefore, the suppressor is below cut-off potential, and no anode current can flow, while during the period CD the suppressor is at earth potential. The operation is best described in stages:

(I) Quiescent Condition

Immediately before the point marked B the circuit is completely quiescent. The anode is at H.T. potential V_b, anode current being zero, because the suppressor is below cut-off; the whole cathode current is flowing to the screen grid. Grid current of amount V/R is flowing, the grid being very nearly at earth potential.* The condenser C is charged to potential V_b. The current conditions are

$$I_a = I_L = I_K = 0,$$
$$I_R = I_{g1} = V/R$$

(II) Initial Drop (BC)

At B the suppressor is suddenly brought to earth potential, so that anode current is able to flow. There will be an instantaneous drop in anode potential, ΔV, and an equal drop must occur at the grid, owing to the condenser C connecting anode

* The grid cannot, of course, rise appreciably above earth potential in spite of the presence of the positive voltage V, as this would necessitate a large grid current flow through R, which is a high resistance; The actual grid potential can be found by means of a load line on the characteristic in the usual way. See footnote on previous page.

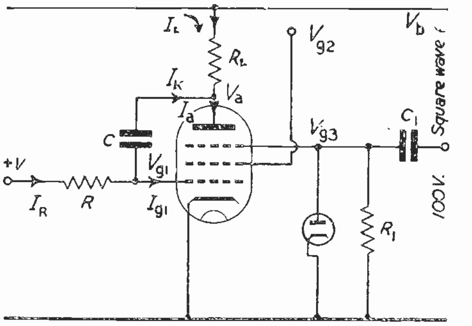
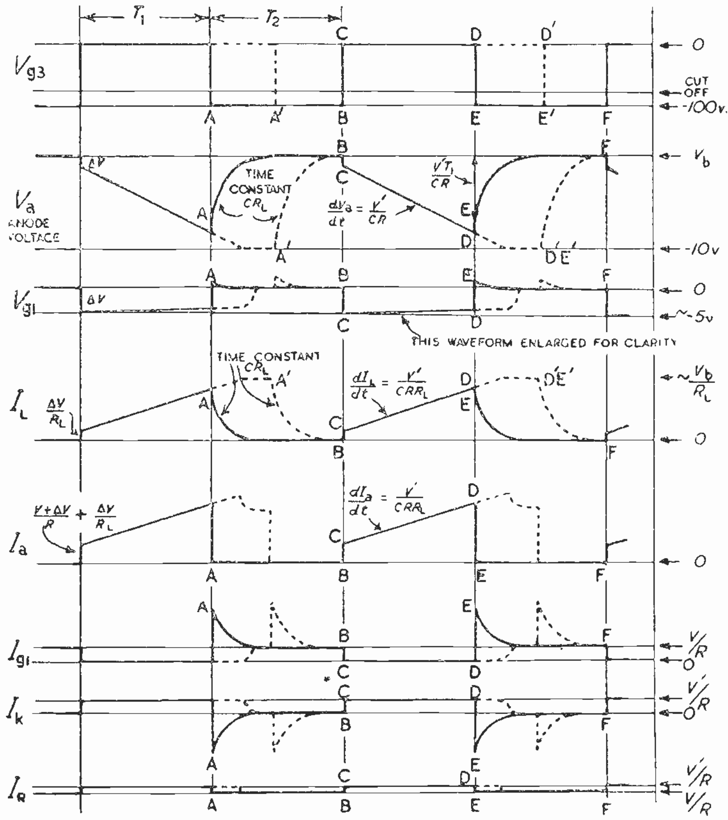


Fig. 3. Control of Miller valve by suppressor switching. The waveform at the various points in the circuit is shown in the diagram below



and grid.* ΔV cannot, therefore, be large, as might be expected at first sight if the feedback is overlooked, but must be less than the grid base of the valve, and such that the circuit is instantaneously in equilibrium immediately after it has occurred. The anode current at all times is uniquely determined by the grid potential by virtue of the valve characteristic, so that if the anode current immediately after the initial drop is determined the corresponding grid potential can be found. This anode current is made up of two parts. Firstly there will be a current $\Delta V/R_L$ flowing in R_L. Secondly, there is now a current flowing in C. This current must be equal to the current in R, because there is no longer any grid current; and the current in R is now $(V+\Delta V)/R$. Thus the anode current immediately after the initial drop is

$$\frac{V+\Delta V}{R} + \frac{\Delta V}{R_L} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

If the valve characteristic is taken to be $I_a = g_m(V_{g1} + V_c)$ (a linear characteristic with cut-off at $-V_c$ volts) then

$$\frac{V+\Delta V}{R} + \frac{\Delta V}{R_L} = g_m(-\Delta V + V_c)$$

Solving for ΔV gives

$$\Delta V = \left\{ \frac{V_c - V/Rg_m}{1 + \left(1 + \frac{R}{R_L}\right)/Rg_m} \right\} \ldots (8)$$

$$\approx V_c$$

In a typical case the product Rg_m will be of the order of 1,000, and R and R_L will be of the same order. Thus the approximation $\Delta V \approx V_c$ is justified. This simply means that the anode current immediately after the initial drop is very small, so that the grid falls nearly to cut-off.

If ΔV is required more accurately, the actual valve characteristic must be used, and successive approximation, or a graphical construction, will be necessary.

(III) The Run-Down (CD)

The equilibrium reached after the initial drop is only instantaneous, because the current flowing in C at once begins to discharge it. The potential across C therefore decreases.

The change in potential is shared between the two plates, the lower plate (grid) rising and the upper plate (anode) falling. Owing to the amplification of the valve, however, the motion of the upper plate will be much greater than the motion of the lower plate. If the motion of the lower plate is negligible, the current in C will be constant at the value.

$$I_K = I_R = \frac{V+\Delta V}{R} = \frac{V'}{R}$$

The potential across C therefore decreases at a constant rate V'/CR volts/sec., and this change all occurs at the anode, which falls linearly in potential at this rate (Equation 6).† The anode current consists of two parts, the initial value given by (7), plus a linearly increasing part equal to the current in R_L:

$$I_a = \frac{V+\Delta V}{R} + \frac{\Delta V}{R_L} + \frac{V't}{CRR_L}. \quad (9)$$

The grid potential must actually rise during the run-down by just the amount required to produce this increasing anode current. If the valve characteristics were perfectly straight (g_m constant), the rise in grid potential would be linear, but this will not in general be the case. If R_L is increased, the required change of grid potential will be decreased, the current in R will be more nearly constant, and the linearity will be improved. Thus values of R_L much higher than would be used in a normal amplifier are common. In a normal amplifier, increase of R_L beyond a certain stage gives very little improvement in gain, because the anode current has to be decreased, and g_m falls almost in proportion to the decrease in anode current. In the present case this does not apply, because there is a constant anode current flowing into C (first term in Equation (9)) and this enables the slope to be maintained even if the current in R_L is negligible.

To remove any possibility of confusion, it may be desirable at this point to discuss the relation between V_c, ΔV, and V_o. It has just been shown that ΔV is in many cases very nearly equal to V_c, though it may be appreciably smaller, particularly when $R<R_L$. V_o is the mean negative grid potential during the run-down: it is relevant because the *mean* rate of the run-down is usually more important than the initial rate. The initial rate is $(V+\Delta V)/CR$, and if the gain was sufficiently high for grid motion to be negligible, this rate would be maintained throughout the run-down, and we would have $V_o = \Delta V$. As, however, the grid actually rises in potential during the run-down, $V_o < \Delta V$; with linear valve characteristics V_o is obtained by subtracting half the grid motion from ΔV. The fact that these distinctions have been made should not be taken to suggest that in practice either ΔV or V_o can be precisely calculated in advance, since in any case they depend ultimately on individual valve characteristics.

The run-down continues until it is terminated either by the action of the original square wave, or by the anode falling to cathode potential. The former alternative will be taken first.

(IV) The Flashback (DF)

At D the suppressor is returned to −100 V by the square wave, and anode current is cut off. The anode tries to shoot positive, and carries the grid with it until grid current flows; the grid is then prevented from rising any further and the anode motion becomes an exponential recovery of time constant CR_L to V_b, as C charges through R_L. The current conditions are

$$I_L = -I_K = I_{g1} - I_R = I_{g1} - V/R.$$

When the recovery is complete, and I_L and I_K have decayed to zero, we have $I_{g1} = V/R$, and are back at the quiescent condition. Thus one complete cycle of the operation has been described.

We must now consider what happens if the period CD of the square wave is lengthened to D', so that the anode falls to earth potential and remains there for some time, before it is flashed back by the square wave. The situation is then as shown by the dotted waveforms in Fig. 3. When the anode approaches earth potential the gain begins to fall, owing to the knee in the characteristic being reached. The rate of rise of grid potential therefore increases, and the rate of fall of anode potential decreases. Eventually the gain becomes zero, anode motion ceases, and the grid rises rapidly, owing to the lack of feedback, until grid current begins to flow. As no further current can flow to the anode, the extra cathode current all flows to the screen. There is then a quiescent condition, in which the anode is said to be "bottomed." With usual valves of R_L (order of 100,000 ohms) bottoming takes place when the anode falls to about 10 volts.

* The initial drops at grid and anode are no longer equal if there is appreciable capacity from grid to earth. This effect is discussed in the section on the Sanatron circuit, in Part III.

† Here and for the rest of the article, the factor $A/(1-A)$ of equation (6') is omitted.

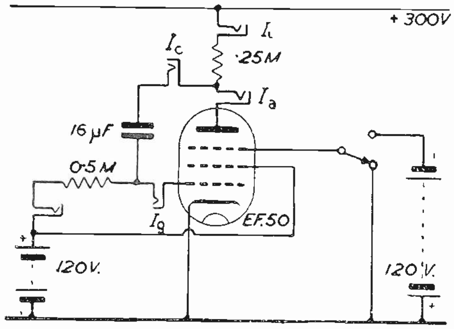


Fig. 4. Demonstration circuit for a suppressor-switched Miller valve

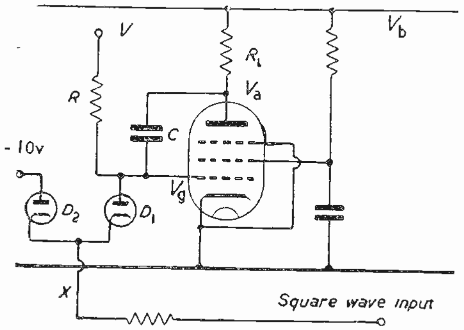
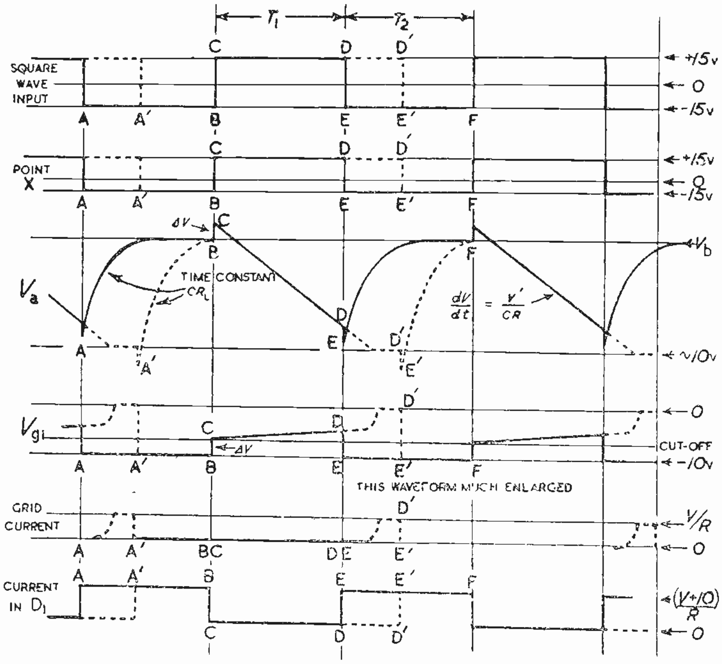


Fig. 5. Control by grid-switching. The waveforms at various points are shown on the right



The bottomed state continues until the point D', when anode current is cut off, and the usual exponential recovery takes place. (There is no positive jump in this case, because the grid is already at earth potential, and drawing grid current).

The most important waveform in Fig. 3 is, of course, the anode waveform, which is obviously suitable for use as a time base, the speed of which can be controlled by changing the potential V, or the valve of R, while C may be switched in steps.

Suppressor switching is probably the most common method of controlling a Miller valve, and has been described very fully for that reason. From the instructional point of view, it is easy to examine the voltage waveforms with an oscilloscope, but the current waveforms are not readily observable. Fig. 4 shows a very slow running circuit, in which the voltages and currents at all points can be measured with ordinary meters, and plotted as functions of the time with a stop watch. The values are chosen to give a run-down time of 24 secs. and a flashback time constant of 4 secs. Some selection may be necessary in order to find a condenser of sufficiently low leakage.

With this circuit it is possible to reproduce all the waveforms of Fig. 3 experimentally.

Grid Switching

Again a square wave is used to control the Miller valve, but this time it must swing both positively and negatively about earth potential. Only a small amplitude is required, in this case, shown in Fig. 5 as ±15 volts (the exact amplitude is unimportant). The waveform at point X will be as shown; during the period AB its negative excursion is limited by the diode D_2 to a value just greater than the cut-off bias of the valve (say −10 volts). The cathode of D_1 will be at −10 volts during this period, and so the grid of the valve will also be held at −10 volts by current flow in D_1 (the diodes are asumed to be low impedance, so that there is negligible voltage drop across them). Such an arrangement is often called a "clamping circuit," and its action can be summarised by saying that during the period AB the grid is clamped at −10 volts, while during CD it is released, and free to take up any potential as determined by the rest of the circuit. With this brief explanation of the grid clamping circuit, the rest of the operation should be obvious from the waveforms in Fig. 5, most of the features being similar to those already explained in Fig. 3. The chief difference is that there is now an *upward* jump at grid and anode immediately before the run-down, the magnitude being in the present case $(10 - V_b)$ volts, approximately. Similarly there is a downward jump coinciding with the back edge of the square wave. The object of limiting the negative excursion of the point X to a potential only slightly greater than V_b is to keep these jumps as small as possible. Only two current waveforms are shown; grid current, and current in the diode D_1, the rest of the current waveforms being similar to those in Fig. 3. It will be noted that it is only if the anode is allowed to bottom (dotted curves) that grid current ever flows in this circuit.

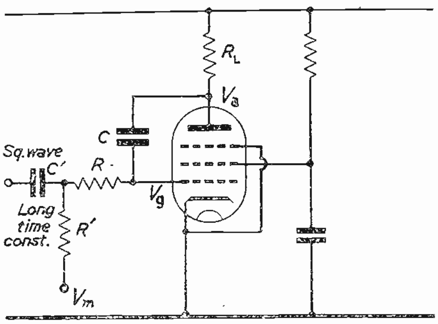
An advantage of grid switching is that the cathode current is zero in the period between the linear sweeps, whereas in the suppressor-switched circuit there is a large cathode current, all of which flows to the screen grid. In the latter case the permissible screen grid wattage is often a limiting factor, particularly when the linear sweep occupies only a small fraction of the total repetition period.

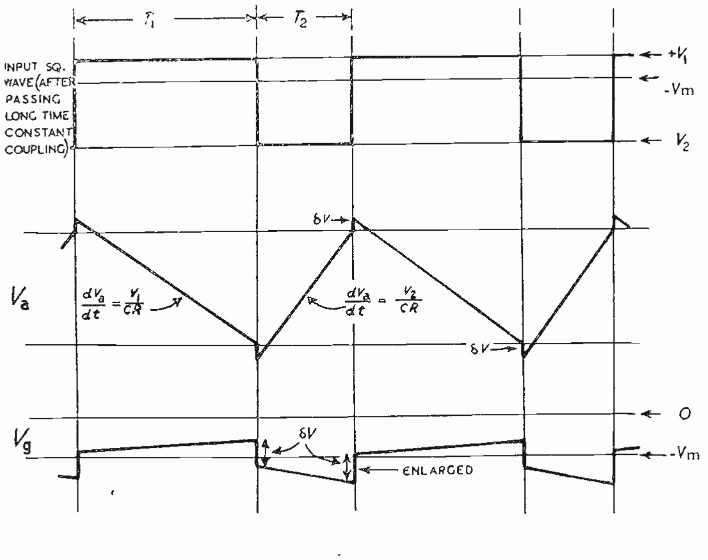
Grid Leak Switching

This example is different from the two previously considered, in that there is no discontinuous "switching-off" of current in the valve, which operates as an integrator for the whole of the time. The square wave is applied at the end of the grid leak, and the anode waveform is the integral of the square wave, *i.e.*, a saw tooth waveform (Fig. 6). An important condition should be noted here. We can only integrate a waveform continuously if the mean value of its integral is zero, otherwise the excursion of anode potential would increase without limit. Fortunately, it is very easy to satisfy this condition; it is only necessary to pass the waveform through a *CR*-coupling, of time constant sufficiently long to impose negligible distortion. In Fig. 6, the resistance R' is returned to a potential $-V_m$ to provide grid bias for the valve, and the square wave after passing the coupling $C'R'$, will swing between potentials V_1 and $-V_2$ such that the mean departure from $-V_m$ is zero. V_1 and $-V_2$ are easily calculated if the total amplitude of the square wave (V_1+V_2), and its mark-to-space ratio, T_2/T_1, are given. The rates of the two linear portions of the anode waveform will then be V_1/CR and $-V_2/CR$ volts per second, (neglecting the grid base correction to V_1 and $-V_2$). A jump of δV in anode potential occurs at each transition, as the current in C has to change discontinuously from V_1/R to $-V_2/R$, which requires a change of anode current

$$\delta I_a = \frac{V_1}{R} - \left(\frac{-V_2}{R}\right) = \frac{(V_1 + V_2)}{R}$$

Fig. 6. Grid-leak switching, with the waveforms at the various points shown in the diagram below





Wave-forms of circuit shown above

The jump in grid potential required to produce this will be

$$\delta V = \frac{(V_1 + V_2)}{g_m R} \qquad (10)$$

(The small current changes $\delta V/R$ and $\delta V/R_L$ in R and R_L respectively have here been neglected in comparison with the current change in C).

The true integral of the input waveform would not contain the jumps δV, and it may be asked why the integration breaks down at these points. The answer is that the circuit behaves as an integrator only if the gain of the valve is high at all instants in the duration of the input waveform concerned, and for sudden changes of input voltage the gain is zero, owing to the presence of C.

With this circuit the valve must be biased to the middle of the straight part of its characteristic, and the anode load chosen to allow the required positive and negative excursions from the mean level. This should be contrasted with the two previous circuits, in which no grid bias is necessary, and in which the anode load can be made much larger than for a normal amplifier. The reason for this is simply that the present circuit is required to integrate in both directions, where previously the integration is in one direction only, *viz.*, decreasing anode potential.

(*To be continued*)

References.

[1] F. C. Williams. "Introduction to Circuit Techniques for Radiolocation." *J.I.E.E.*, Part IIIA, No. 1.

[2] F. C. Williams and N. F. Moody. "Ranging Circuits, Linear Time Base Generators, and Associated Circuits." *J.I.E.E.*, Part IIIA. No. 7.

The Work of the N.P.L.

At a recent "open day," visitors to the National Physical Laboratory at Teddington had an opportunity of seeing the progress made during the past year in various branches of research, as well as inspecting the Laboratory's equipment for precision measurements of all kinds.

The importance of aerodynamical research at speeds approaching the velocity of sound is fully appreciated, and until recently the N.P.L. possessed the only high speed wind tunnels outside Farnborough capable of fundamental research on a reasonable scale. A new small tunnel has been constructed for supersonic investigation and to serve as a scale model for future projects.

In the engineering section, the study of lubrication of machine components has been helped by the use of strain gauges in conjunction with a C.R.O. to obtain continuous records of frictional force. An electronic circuit is arranged to stop the test machine should the increase in friction indicate that seizure of the bearing is imminent. The principle of this device should have a wide application where the approach to an unsafe condition is accompanied by an increase in linear strain in one element of the machine.

Frequency standards for centimetric waves have been devised by multiplication from a quartz frequency standard, and controlled frequencies are now obtained from 350 Mc/s. to 8,000 Mc/s. at intervals of about 1 per cent. One of the applications of this equipment is the study of the R.F. spectra of atoms and molecules. The spectrum of the ammonia molecule, for example, has been found to have lines in the region of 23,000 Mc/s., and the frequencies of these have been measured to an accuracy of 1 part in 10^4. Such lines can be used as standards of frequency and the possibility of obtaining molecular standards of this kind is exciting considerable scientific interest.

The Director of the Laboratory, Sir Charles Darwin, points out that one of its primary functions is to assist industry to solve scientific and technical problems which come within its scope. He would be pleased to receive suggestions for research items of major or immediate importance which would be of help to manufacturing organisations.

The Royal Society's Conference On Scientific Information

Held at the Royal Society and the Royal Institution, June 21—July 2, 1948

THE Empire Scientific Conference called by the Royal Society in 1946 recommended that a conference should be convened to examine the possibility of improvement in existing methods of collection, indexing and distribution of scientific literature and the extension of existing abstracting services. The recent meeting in London, which was attended by representatives of libraries, societies and institutions responsible for publishing, abstracting and information services, as well as by representatives of Commonwealth scientists and observers from the U.S.A. was the sequel to this recommendation. Some limitation of this enormous field was imposed by considering the subject mainly from the user's point of view.

An immense amount of preparative work had been carried out before the conference began, and some of the papers laid before it will be of permanent interest. The work was divided into four sections, in each of which a number of working parties were set up with specific terms of reference.

Throughout the conference every effort was made to draft recommendations in such a way that action was required by a particular body. To this end it was proposed that where no existing body could appropriately take the required action, the Royal Society be invited to convene a number of standing committees. Of these the most important is a committee, representative of the interests present at the conference, which will have the primary task of initiating operational research into the ways in which scientific literature and information services are used. The preliminary analysis of a pilot questionnaire on the reading habits of some 200 scientists was before the conference, and from the results obtained it was clear that much more could usefully be done on similar lines. Standing consultative committees were proposed on the question of subject classification and indexing and on abstracting. The latter is primarily charged with fostering co-ordination and co-operation between abstracting agencies in order to reduce unnecessary duplication and to fill in the gaps in the present abstracts. It was also proposed that standing consultative committees of editors of scientific journals covering related groups of science should be convened to consider common editorial problems, including the allocation of papers to the most appropriate journals.

At the opening session Sir Henry Tizard, chairman of the Government Advisory Council on Scientific Policy, indicated that the Government would listen sympathetically to requests for funds for carrying out the recommendations of the Conference, and during the closing session Dr. D. W. Bronk, of the National Academy of Sciences, U.S.A., said that America would be willing to make a similar contribution.

Section I was concerned with the publication and distribution of original papers. The most important concrete recommendation which it made was the suggestion that "precis journals," such as that issued by the I.E.E., containing extensive summaries of papers which are published in full elsewhere, should be investigated. The purpose of such journals is to enable the scientist to keep in touch with developments in fields outside but related to his own, without having to read all the papers in full. It is claimed that they would be of special value to scientists in the Commonwealth and colonies who have no easy access to comprehensive libraries. Other points discussed in Section I were the need for great improvements in the style of writing and presentation of papers before submission for publication, the desirability of some standardisation of the format and make up of scientific periodicals, and the provision of means for making available copies of scientific documents which are unsuitable for publication in full. The importance of reprints or separates and ways of increasing their distribution and the need for increased support by governments of central scientific libraries such as the Service Library were also considered. It is hoped that all those who are concerned at any stage with the publication of the results of research will read the conclusions and recommendations of this section in full.

Section II dealt with abstracting services. The question which caused most discussion here was whether author's summaries could be used as the basis of abstracts. While it was generally agreed that at present very few authors' summaries were good abstracts, it was pointed out that their use would not only reduce the cost of publication of abstracts, but would also minimise the delay between the appearance of a paper and of its abstract. On the other hand, some of the more specialised abstracting agencies would never be able to rely completely on author's summaries, however much they might be improved. It was recommended that the editors of journals should be invited to co-operate with the abstracting agencies by providing factual summaries of all papers in a form suitable for use as the basis of an abstract. If possible these summaries should be distributed when the paper is sent to the printers. Many minor reforms in the presentation of abstracts were proposed, nearly all of which are already practised by one or other of the abstracting agencies. It will probably surprise many that there are over 100 different journals containing abstracts published in the United Kingdom alone, in spite of which some fields of science and technology are very inadequately covered. This situation will provide the main task of the proposed standing committee.

Section III was concerned with indexing and other library services. In this section it was clear that much more research was needed before useful recommendations could be made. While, for instance, the potential value of the Universal Decimal Classification was recognised strong criticism of certain details of its application and of the inevitable time lag between the development of new subjects and the publication of their decimal classification numbers was voiced. Research into this and other

(*Continued on page 267*)

A Fifteen-inch Glass Betatron Toroid

By

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S. J. MORRISON, B.Sc., A.M.I.E.E.*
and J. G. BRETT*

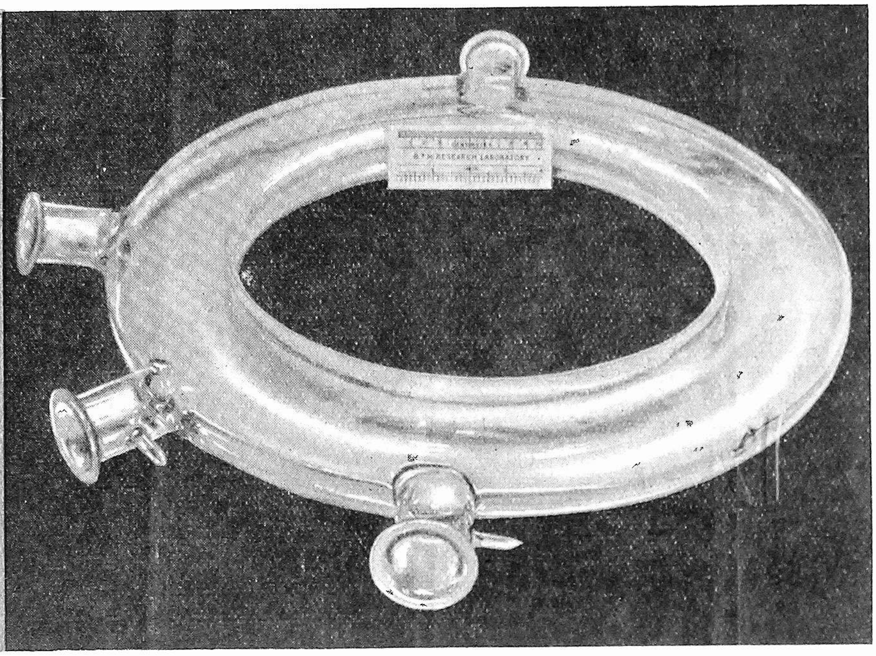


Fig. 1. The glass toroid

THE betatron or induction accelerator is one of the lesser-known electronic devices now being used in research by nuclear physicists for the generation of X-rays at extremely high voltages. By employing acceleration of electrons spinning in a circular orbit, a high electron velocity can be attained without the necessity of equipment operating at more than a fraction of the equivalent electron voltage. The construction of a 2.3 Mev betatron has been described by Kerst[1] and the same author has described a 20 Mev unit built for use in the University of Illinois.[2] A concise description of the betatron has also been given by Wilson.[3]

In common with other electronic devices, the betatron requires a high vacuum envelope in which an electron stream produced by thermionic emission can be accelerated and moved about under control. This envelope takes the unusual form of a hollow toroid (popularly called a "doughnut") with a number of side tubes into which electrode and target systems may be fitted. The cross-section of the chamber may be circular, but in the larger betatrons it is more usual to employ an elliptical or rectangular cross-section in order to reduce the magnet gap. The material of which the doughnut is made must be an electrical insulator as it forms a complete turn in a magnetic field and must also be vacuum tight. Low expansion borosilicate glass has been used successfully in built-up toroids and the one-piece all-glass toroid described below was made in B.T.H. C.9 glass. Glazed ceramic has also been proposed as a suitable material and may have certain advantages in the construction of very large toroids which are usually built up from hollow segments.

The all-glass one-piece toroid shown in Fig. 1 is to be used in a 20 Mev betatron similar to that described by Kerst. This toroid is of rectangular cross-section with an unusually thick wall which is necessitated by the vacuum loading on the non-circular section. The principal dimensions are:

Orbit diameter	15 in.
Dept of section	2 in.
Radial width of section	3 in.
Wall thickness	3/16 in.

Method of Construction

The toroid was constructed from glass channel rings which had been blown in a special bulb mould. A pair of channels were sealed together to form a hollow ring and radial side arms were added at a subsequent operation. The same general principle was followed at both stages, namely, to maintain the whole of the glass at a temperature within the annealing range, while carrying out local sealing operations using a hand torch. In this way the shock of applying an oxy-coal gas flame to a thick-walled vessel is minimised and stresses resulting from the sealing operation are relieved in the surrounding glass.

Specially-constructed equipment was required comprising two ovens both arranged so that a limited amount of the glassware was exposed for hand-sealing operations, the remainder being wholly contained in the oven. The internal arrangements were such that the glassware could be rotated slowly by hand for sealing and then motor-driven continuously for annealing.

The principal difference between the two ovens is in the plane of rotation of the glass, which is horizontal for sealing the channels together and vertical for sealing the side arms in position. The horizontal sealing oven is shown set up for use in Fig. 2.

A simple form of oven construction was employed as the number of doughnuts to be made was small, but the relatively crude nature of the equipment was in itself a great advantage when experimental modifications had to be made.

Glass-blowing Operations

The sequence of operations is represented diagrammatically in Fig. 3. First the inside edge of the ground surfaces of the channels was rounded off by fire polishing, using the horizontal oven. Earlier

* The Research Laboratory, British Thomson-Houston Co. Ltd., Rugby, England.

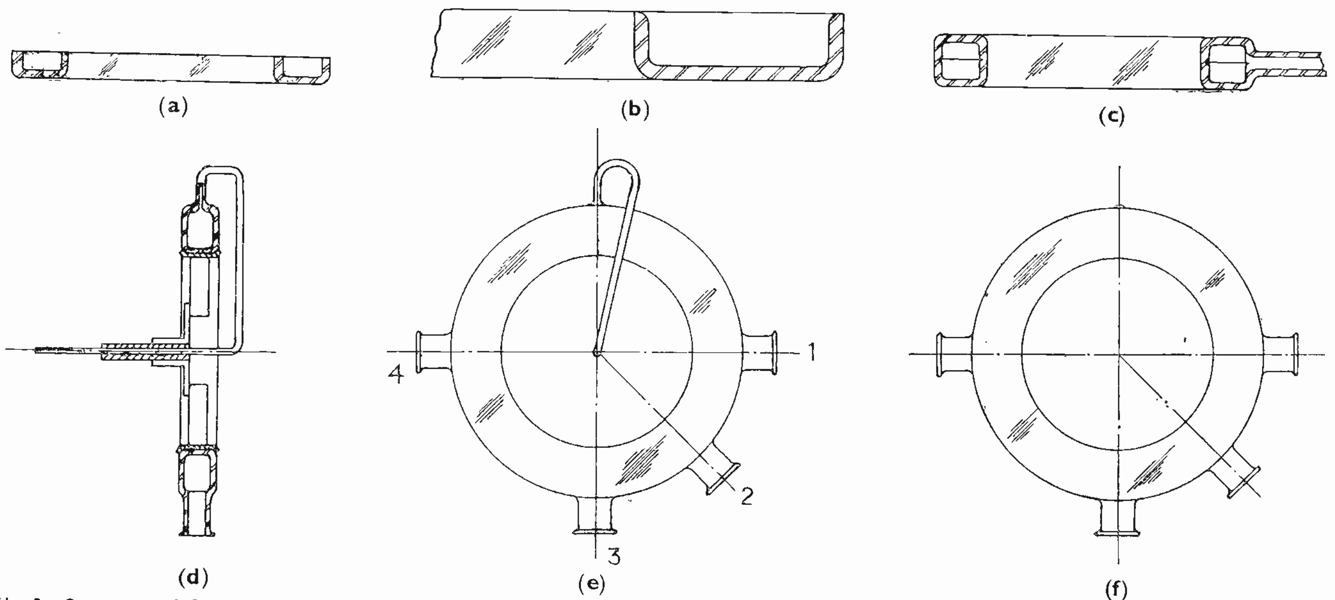
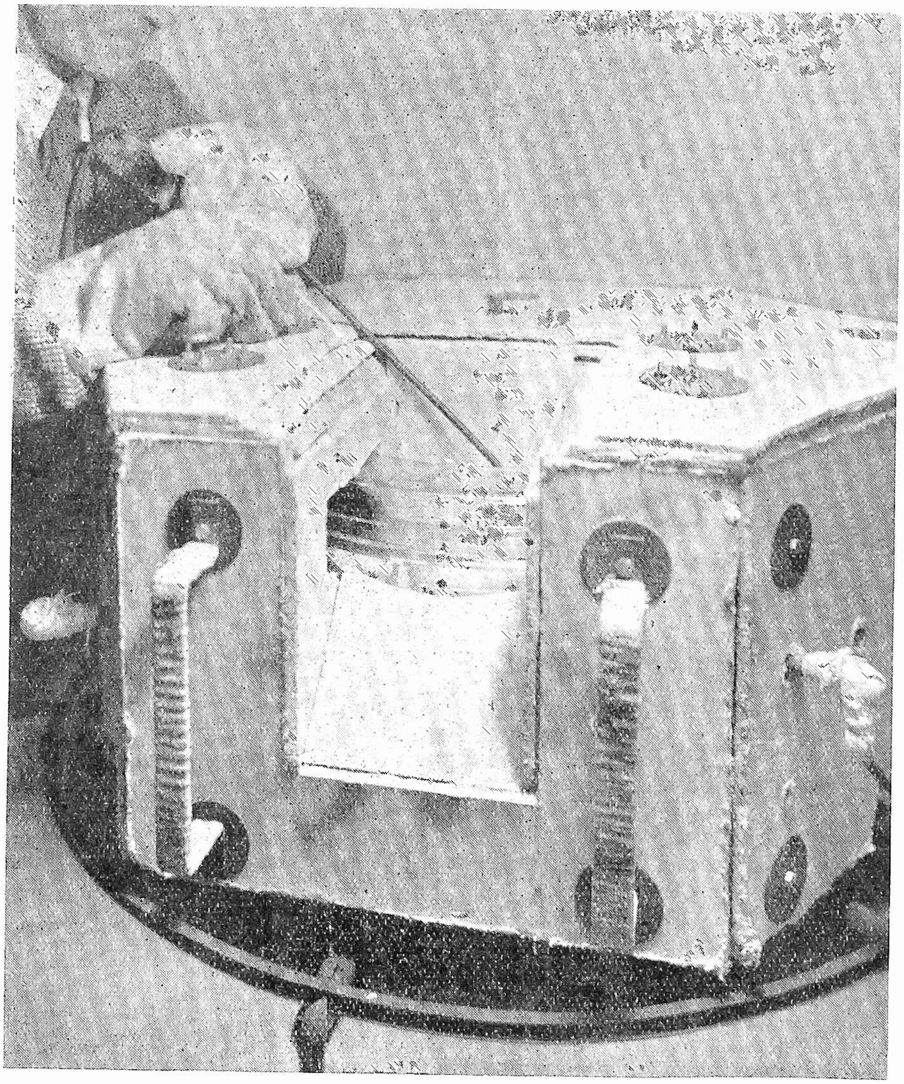


Fig. 3. Sequence of Operations. (a) Channels as supplied (b) Flame polish inside edges (c) Channels sealed and blowing tubulation added (d) 'Doughnut' mounted in vertical oven and blowing tube attached (e) Side arms sealed on in order shown (f) Blow tube sealed off



attempts to seal disks together had demonstrated the impossibility of sealing the ground surfaces together with a hand torch to a greater depth than 3/32 in. The remaining unsealed portion of the ground surfaces, forming a sharply re-entrant inner surface on the doughnut, was a weakness which led to cracking. By rounding off the inside edge of the ground surfaces it is possible to seal through the reduced thickness of glass to produce an inner surface which is still re-entrant, but which has a small internal radius. It is essential to retain approximately 1/16 in. of ground surface, so that the channels will rest one on top of the other during the sealing operation.

The pair of channels was then sealed together by hand torch in the horizontal oven. The seal on the inner circumference was done first and a small diameter tubulation, required for subsequent operation, was put in as part of the outer seal. Each seal had to be initiated by bridging the gap with a small addition of glass rod, but thereafter the edges ran together on heating by the torch.

The side arms were prepared by flanging thick-walled tubing, and grinding the flanged faces. Tubulations for probe wires were sealed on and a special hand chuck assembled on each side arm. The clamping screws were smeared with

Fig. 2. Horizontal oven for sealing channels together

graphite before assembly so that they would come apart easily after baking.

After cooling, the doughnut was transferred from the horizontal oven to the vertical oven. A blowing tube of glass was passed down the hollow spindle, bent outwards alongside the doughnut, and sealed to the auxiliary tubulation. The outer end of the tube was left projecting just clear of the spindle, which was packed with asbestos paper at each end to support the tube.

When the doughnut had been brought up to temperature and soaked for about 45 minutes, the driving motor was disconnected and the spindle locked in position for the first side arm. A patch of glass on the wall of the doughnut was softened by local heating with the hand torch, and a hole blown and opened out to approximately the diameter of the side arm. The flanged tube was then sealed on, the joint being worked by blowing and paddling until it was well shaped.

The process was repeated for all four side arms, each seal being followed by 15 minutes soaking at the annealing temperature, during which the doughnut was driven round by the motor. After the last side arm had been sealed, the auxiliary blowing tube was constricted close to the doughnut and drawn away. The remaining projection was softened and allowed to sink down into the wall of the doughnut.

The second of the completed doughnuts made in this way was exhibited at the Physical Society's exhibition in April this year.

Throughout the work described, the authors have had the most helpful co-operation of Mr. J. E. Stanworth, glass technologist, of the Research Laboratory, and Mr. A. E. Hill, manager of the Chesterfield Glassworks, and would also record the splendid work done by Mr. F. Pegg and his assistants in making the glass channel sections in the hand bulbs department of the B.T.H. Co., Ltd., glass works, at Chesterfield.

The authors thank Mr. L. J. Davies, Director of Research, the British Thomson-Houston Co., Ltd., for permission to publish this account of their work.

References.

[1] Kerst, D. W., *Phys. Rev.*, 1941, *60*, p. 47.
[2] Kerst, D. W., *R.S.I.*, 1942, *13*, p. 387.
[3] Wilson, W., *Journal I.E.E.*, 1947, *94*. Part I, p. 150.

An Electronic Shutter Tester

By D.T.R. Dighton*

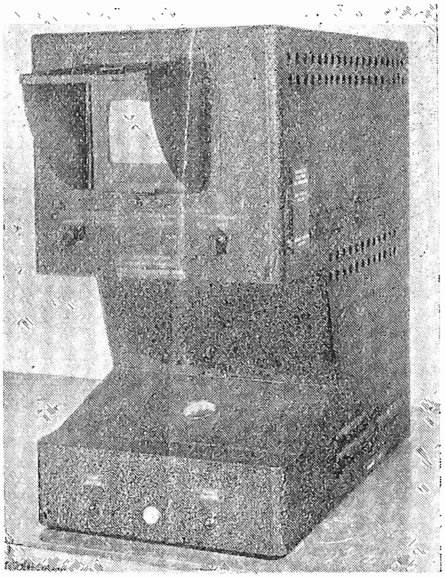


Fig. 1. An electronic shutter testing instrument

THE growing use of colour and flash photography requires greater accuracy in the operation of camera shutters, and conformity with the marked speeds.

An instrument intended for research and development on shutters† has recently been modified to make it more suitable for testing performance on the production line where the time taken is important. This modified instrument is shown in Fig. 1.

This instrument gives a characteristic curve of the shutter, *i.e.*, the curve of light transmitted against time. The total time of opening is read from a calibration trace on the base line which has a series of timing marks at predetermined intervals. For production work, the calibration trace is replaced by a glass graticule in front of the C.R.T. screen, on which is marked the testing tolerances for the particular shutter under test. In cameras with built-in flash contacts, the closing of the contact is indicated on the curve. Fig. 2 is an example of the pattern obtained from a Brownie Reflex shutter.

By incorporating a non-linear time base with an exponential decay of voltage, the spot slows down as it approaches the right-hand side of the screen. This results in patterns for the higher shutter speeds being measurable without those for the slower speeds extending beyond the screen. Further, the logarithmic nature of the time base makes the reading accuracy constant for all speeds, and the tolerance rectangles of equal width for all speeds. The composite photograph of Fig. 3 shows the type of pattern obtained with this time base. The degree of the logarithmic action may be seen from the spacing of the 10-millisecond timing marks. Although this figure only shows the traces for three shutter speeds, it is possible to get sufficiently accurate measurements with five or six speeds on a four-inch time base.

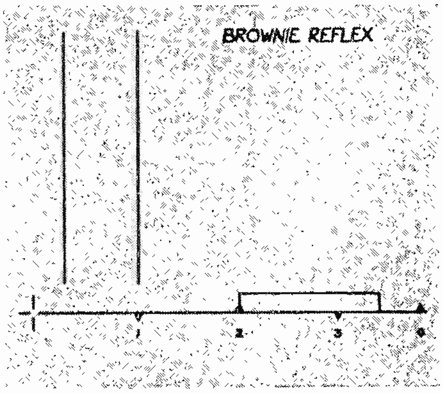


Fig. 2. Test on Brownie reflex shutter (speed 1/50th sec.). Units 10 m/sec. each

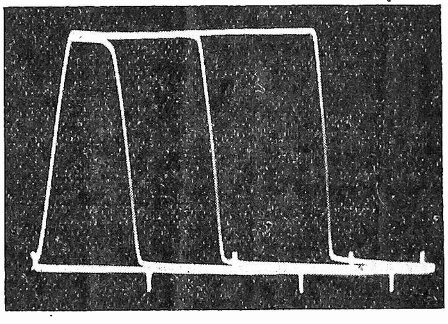


Fig. 3. Composite photograph of curves of a three speed shutter, using logarithmic time base. (1/25th, 1/50th and 1/100th)

* Kodak, Ltd., Harrow.

† D. T. R. Dighton & H. M. Ross. Instrument for Investigating the Operation of Camera Shutters. *Photo Jour.* 86B. 1946, p. 100.
[D. T. R Dighton & H. M. Ross. Cathode Ray Tube Shutter Testing Instrument. *Jour. Sci. Instrum.* 24, 1947. p. 128.

Distortion Correction in Television Waveforms

By H. B. RANTZEN, B.Sc. (Eng.), M.I.E.E.*

IN all systems where signals are identified by the shape of a received pulse, distortion can occur for a number of reasons during transmission, of which the following are generally the most important.

(1) Amplitude distortion: absence or incorrect amplitude of one or more of the signal components.

(2) Phase distortion: difference in the time of propagation of one or more signal components relatively to the other signal components.

(3) Generation of spurious components.

In television and other picture transmission systems, we are frequently compelled to attempt to transmit pictures which contain signals of a frequency greater than that which can be carried without distortion by the line or other transmitting medium. In such cases distortion of the first two types often becomes particularly serious towards the top end of the frequency band of the transmitting medium.

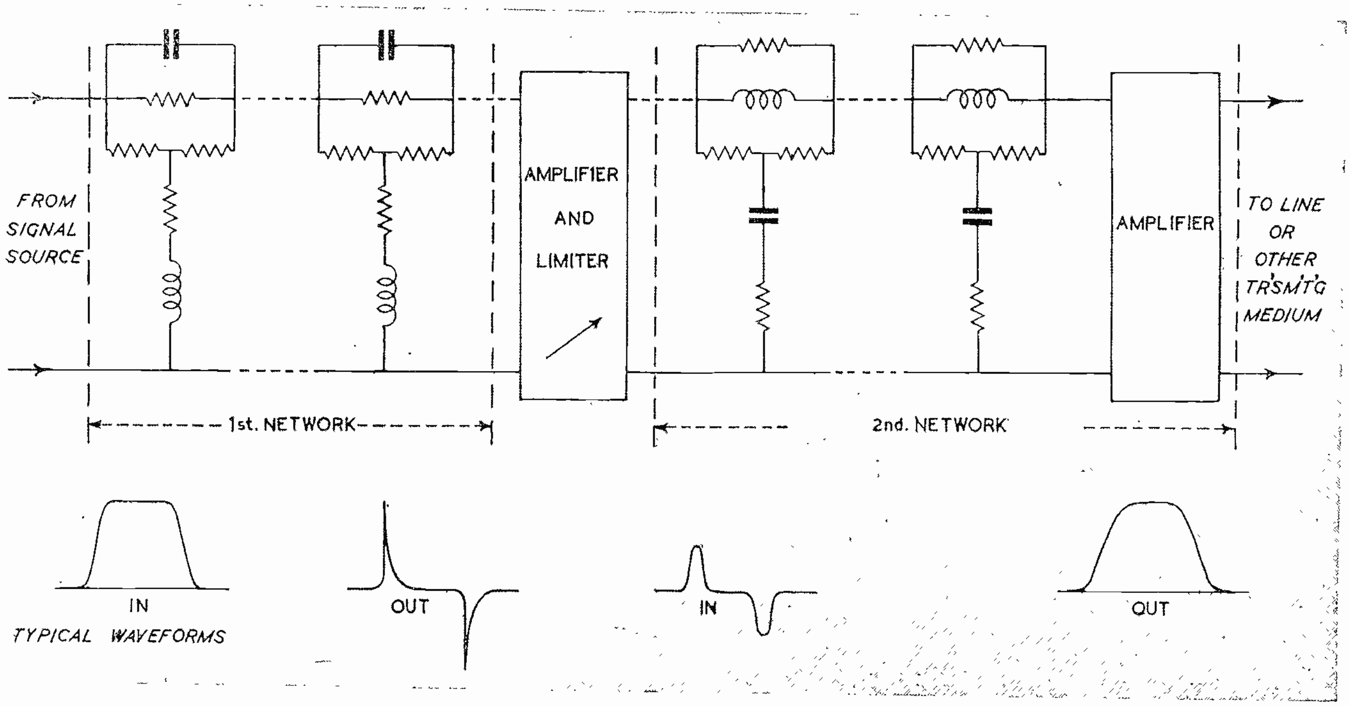
A familiar remedy is to include in the sending circuit a network which reduces the amplitude of the upper frequencies which might otherwise be transmitted with phase distortion sufficient to introduce marked deterioration of the transmitted signal as a whole. This is tantamount to introducing distortion of type (1) above to avoid more serious consequences from distortion of type (2) above.

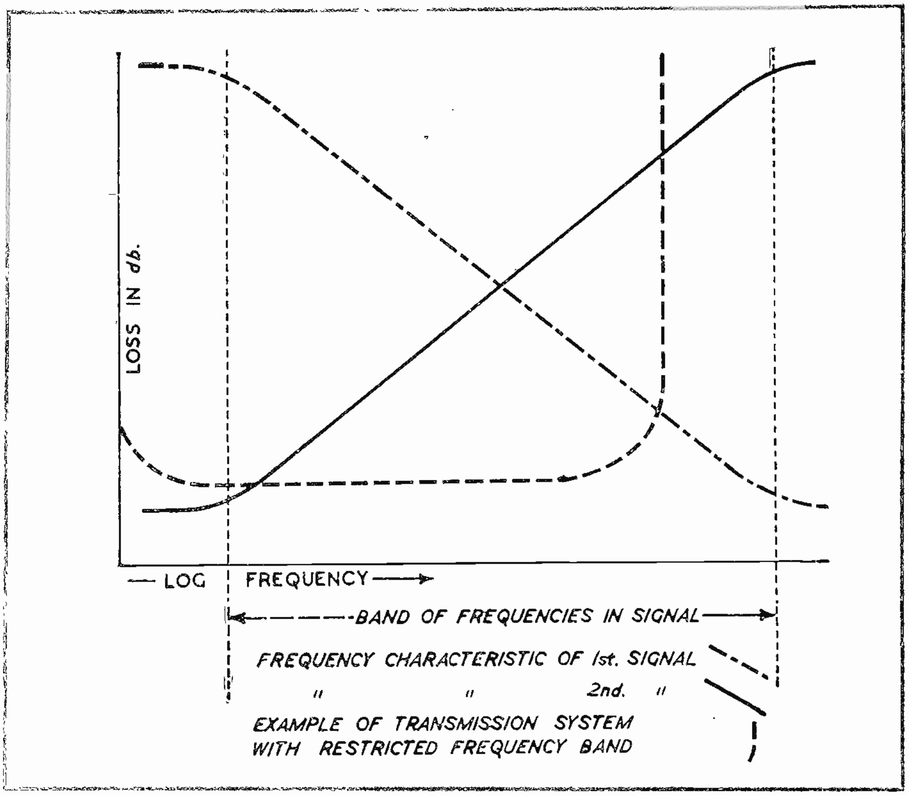
The effect on the received waveform of a pulse transmitted over a line or other circuit which will not very satisfactorily transmit the very high frequency components in the pulse, is often to produce a "die away" ripple just before and after the sharp edge of a pulse, the apparent frequency of this ripple being roughly that of the cut-off frequency of the line. The "up" and "down" slopes of pulses may also be reduced.

The effect of a network which reduces the amplitude of the higher frequencies is to reduce the amplitude of many of the components which contribute markedly to the slope of the nearly vertical sides of pulses, and to reduce the amplitude of the distortion ripples which precede and follow these sharp wave fronts. In the case of television signals such a device reduces the amount of detail all over the picture, regardless of whether the high frequency components do or do not form part of wave fronts, the presence of which is likely to cause this type of distortion (ringing).

In an arrangement devised by the writer, the television signals are passed through a distorting network of a well-known type such that the amplitude of all the upper frequencies is progressively increased over the complete band of frequencies generated in the original signals by an amount which is very approximately 6 db. per octave. Distortion of this type is mathematically equivalent to differentiating, and the instantaneous magnitude of the wave thus produced is directly proportional to the slope of the original signal. This distorting network is followed by a limiter which can be adjusted to cut off any desired amount of the extreme peaks of the "differential" wave: the limiter may be balanced so as to cut off both the extreme positive peaks and extreme negative peaks. If the signal is then passed through a second network which has attenuation and phase characteristics inverse to those of the first distorting (differentiating) network, the original signal will be restored for most of the time, i.e., when the limiter is not in operation: while the limiter is in operation the slope of the signal is limited to a maximum figure set by the limiter. This treatment has the effect of modifying the signal in such a way as to reduce ringing distortion, but affects the high frequency content of the signal only at the moments when serious "ringing" distortion would otherwise have been present. The time during which the limiter operates can be controlled by circuits of adjustable time constant, in any well-known manner.

* Head of Designs Department, The British Broadcasting Corporation.





Essentially the arrangement consists of modifying picture, or other signals, by a first network which emphasises the higher frequency components, approximately according to a particular law (6 db. per octave), then limiting, and then restoring by a second network having a characteristic approximately the inverse of the first network. The first and second networks may be of the usual type connected directly in circuit, or either may be of the type more commonly used to obtain the characteristic of the other, but connected in the negative feed-back path of an amplifier.

Part or all of the second network may be connected after the line or transmission medium which cannot transmit the full unmodified original signals without distortion when part, or all, of the second network characteristics can be obtained from the line or transmission medium itself so that the provision of a complete second network at the receiving end becomes unnecessary.

The two schematics illustrate this arrangement.

Ignition Interference Suppression on the "Televisor"

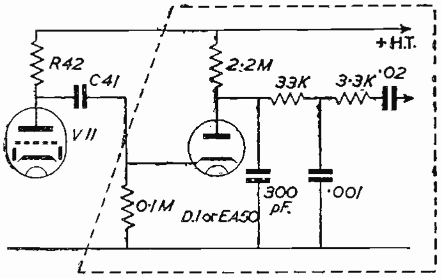
In many areas where the Televisor has been installed, the interference level, particularly of ignition interference from cars, has been sufficiently high to make it necessary to fit suppressors or limiters.

Numerous queries requesting information as to how this could best be done have been received and though details have already been given in a previous article (Electronic Engineering, October, 1947) the following notes may be of interest since they refer more particularly to the Televisor.

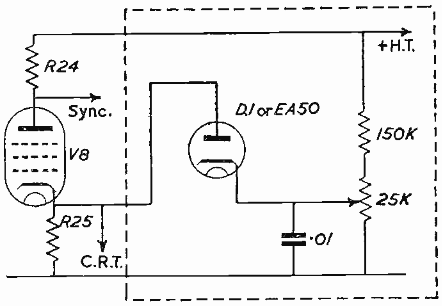
Dealing with the sound receiver first, it may be seen that the output from V_{11}, which would normally go to the output pentode V_{20}, is instead taken to the cathode of a diode.

The anode of this diode is biased positively and therefore conducts. Signal potentials appearing on the cathode cause the anode to follow in sympathy and in fact an undistorted audio signal appears at this point, due however, to the 300 pF capacitor which is connected between anode and earth there is a time delay, with the result that if a short pulse is fed to the cathode, the anode is unable to follow it and the signal is practically biased off, what little does remain being integrated.

It should be mentioned that when using a circuit of this type, there is some cutting of the higher audio frequencies, it is usually not very serious and is certainly preferable to the interference.



Above : Sound receiver Below : Vision receiver



Fitting of the diode and its associated components on the sound receiver chassis can be very easily done as there is ample space and no special precautions are necessary.

The diode heater is fed from the normal heater supply to the sound receiver. The vision interference limiter is somewhat simpler in operation since it is a plain amplitude limiter. The diode in this case has its cathode biased positively so that it is non-conducting until the anode exceeds this potential.

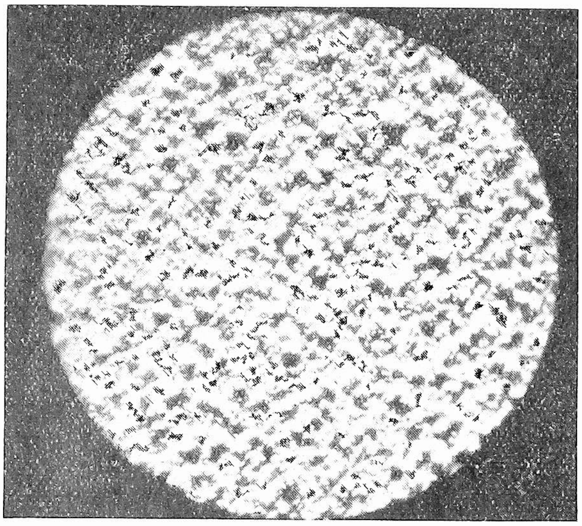
If, therefore, the bias is adjusted so that the diode does not conduct on an input voltage equivalent to peak white, but does conduct above this value, then all interference pulses above this value will in effect be short circuited and instead of large white blobs appearing on the C.R.T. screen they will be reduced to a relatively small size with an equivalent reduction in nuisance value.

The best position on the vision chassis where the diode limiter can be fitted is on top of the chassis directly against V_8 the heater leads may then be taken through a hole in the chassis as can also the positive bias supply for the cathode.

POWER DIODES

Part 2. The Manufacture of High Vacuum Oxide-coated Rectifiers

E. G. ROWE, M.Sc., M.I.E.E., D.I.C.,* R. E. B. WYKE, A.M.I.E.E.,* W. MACRAE, M.Sc., A.M.I.E.E. *



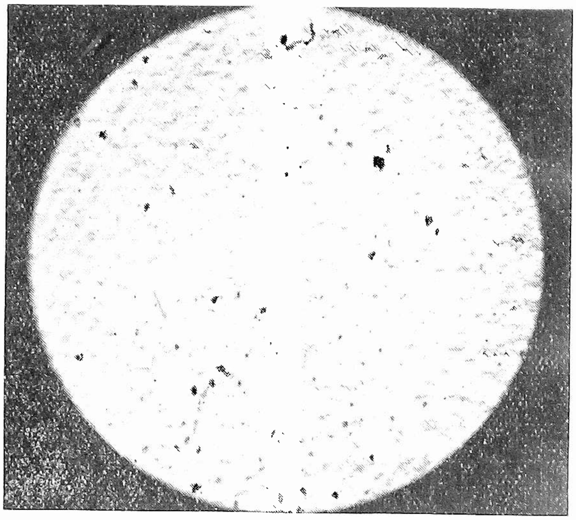


Fig. 1a (*left*). Photo-micrograph of coating showing fluffy adherent appearance

Fig. 1b (*right*). Unsatisfactory coating with hard, close surface

It is assumed in this article that the reader is generally familiar with the usual methods of valve manufacture and these are dealt with briefly, attention being paid to the special differences existing in the making of rectifying valves. Conventional valve manufacturing principles are that the manufacturing sections receive components ready made by servicing departments. These components are assembled, sealed-in, pumped, aged and tested. It is customary for all valves to be retested prior to despatch and the whole organisation is supplemented by Quality Control and Life Testing units.

Component Manufacture

Conventional type presses are employed to make the metal components which are suitably designed for high speed production, outputs of the order of 4,000 an hour being obtained for anodes and similar components.

Indirectly heated rectifying valves use cathodes of conventional pattern which are first de-greased and then sprayed with an emissive coating of barium and calcium carbonates in a nitro-cellulose binder together with a solvent. Since the amount and texture of the coating applied is quite critical, the spraying rooms are fully air conditioned and 8 per cent. of the cathodes sprayed are checked for coating weight. A desirable coating should be very adherent yet fluffy in character, photographs of such coatings together with a hard undesirable surface are shown in Fig. 1.

* M.O. Valve Co., Ltd.

Directly heated valves use wires and strips, the latter being made by rolling wire down to the required sizes. The quality of the material is controlled by chemically checking each ingot of the raw nickel before the drawing operations commence.

Wires and strips are coated on the plant shown in Fig. 2, the coating material being picked up continuously by a combination of cataphoretic deposition and surface tension. The strip is passed over pulleys, the lower one of which is immersed in a bath of the coating material. Between the pulleys, and surrounding the strip, is a cage electrode to which a voltage is applied, the strip forming one electrode with the cage electrode negative. The electrolyte is a mixture of strontium and barium carbonates, alcohol, water, nitro-cellulose and solvents and its container is rotated around fixed agitating paddles connected to the electrode system support.

Drying is carried out either by an electric oven or by eddy current heating after which the strip is spooled with paper spacing between layers to avoid damage to the coating. Subsequently the reels of coated strip have to be cut into the correct lengths and the ends scraped for welding on to the pinches.

Assembly

It is recognised as good practice for all component preparations to be carried out apart from the assembly operators, these being concerned solely with assembling the finished parts supplied. Two methods of assembly organisation are employed, one being the "group" system and the other the "unit" system.

In the "group" method of assembly the operators are arranged in teams in which each operator carries out one or two operations only and then passes the job on to the next operator and so on. This method is the more efficient theoretically, but is more liable to be disturbed by variations in speed from operator to operator and by absenteeism. An improved development of this scheme is to divide the entire assembly process into sub-assemblies which can be produced at the rate of about thirty per hour.

In modern practice an ordinary "broadcast" rectifier is usually assembled by a team of three assembly operators with an examiner to every four teams. Such operators take from two to three months to become really efficient at their jobs.

In the "unit" system each operator assembles the complete valve from start to finish. This scheme has the advantage of being more flexible than the "group" system and is employed mainly for small quantity or difficult types, but has the disadvantage of being slower because of the time taken to change the welding electrode and welder current settings during the course of the assembly operation, and, of course, it takes appreciably longer for an operator to learn a complete assembly sequence than it does to learn one operation only.

In both methods, jigs are employed in order to obtain accurate location of components with respect to the pinch and to each other, and also to ensure consistency of spring tension on directly heated valves. These jigs, samples of which are shown in Fig. 3, must be of simple construction and designed for easy cleaning. After assembly, each valve is examined for faults and is subsequently stored in a warm dry atmosphere at about 35° C. until required for pumping. The getter cup, complete with getter pellet, is then welded on to the support wire just prior to sealing-in, in order to avoid deterioration on standing. Fig. 4 shows a photograph of an operator at work.

A serious difficulty, particularly on the higher voltage types, is to maintain the seals free from foreign matter such as dust and dirt, because such particles adhere to the electrodes very readily and carbonise during pumping, thereby forming arcing points when the valve is load tested. To remedy this fault the seals are washed in hot distilled water immediately prior to pumping.

Pumping

The pumping schedules for rectifiers require considerable attention to ensure that a high ultimate emission level is maintained. Particularly with directly-heated cathodes, it is found that unless the cathode is well activated on the pump, the final emission will not be satisfactory. Care has to be taken to control the contamination of the anode surface by barium during pumping as excessive deposits cause severe initial back-emission and in valves having high peak voltages on load test, this can wreck their performance.

Machine pumping is normally carried out on either a 24-head automatic unit or, alternatively, for larger types, on an 8- or 16-head rotating machine.

The 24-head pump shown in Fig. 5 basically consists of 24 exhausting heads indexing around a rotary valve which can be connected in various combinations to sections of a bank of 15 double-stage oil pumps. Five positions are used for the operations of loading, sealing-off and pump stem extraction; eleven positions for "baking," the oven being of the gas-fired type with a temperature gradient adjusted to raise the glass envelope to about 450° C. near the oven exit, and eight positions are then left for treatment purposes. The processes involved consist of "degassing" the anodes with the cathode at full "flashing" temperature and finally gettering and sealing-off. As stated earlier, the possible schedule variations are almost unlimited, the controlling factor being the pressure which is built up at each stage, particularly after the cathode has achieved its maximum temperature. Such schedules are generally determined initially by experimental bench pumping and then by using a travelling Pirani gauge on the machine pump.

Index speeds in general use vary from 9-14 seconds so that the effective treatment time is of the order of 90-100 seconds only.

Electrode heating is accomplished in the usual way with RF heating sets and adequate anode degassing requires careful design of the anode heating coils to achieve a uniform anode temperature of 1120°-1170° K. The maximum cathode temperature attained should be 1320°-1370° K. corresponding to a current density of approximately 8-8½ watts/cm.^{2} of cathode surface. The deleterious deposits on the anode surface which must be avoided at all costs (see Part I) are generally caused by incorrect timing of anode degassing and filament lighting. If the gas pressure is too high when the cathode begins to degas, barium and partially decomposed binder migrate on to the anode. Further protection is often sought by raising the anode to 1100° K. subsequent to cathode degassing.

Economics dictate that the pump index shall be as short as possible, the ultimate speed of schedules being limited by the degassing time of the anode, the "flashing" time of the cathode and the pulling speed of the pumps. It is common practice to achieve higher speeds by reducing the degassing time of components by pre-treatment with hydrogen or vacuum furnace cooking.

The 24-head unit has the limitation that for rectifier work it cannot readily handle large valves both on account of the physical clearance between successive pump positions and the volume of gas the unit can handle. In consequence, for large valves, use is made of an 8-head unit consisting of eight pumping heads mounted on a turntable and each connected to its own oil pump. The electrode treatment services are very similar to those used on 24-head pumps but the pump index time can be varied from 45 seconds to 4 minutes, thus permitting a far more thorough outgassing of the electrodes than is possible on the short-index 24-head pumps.

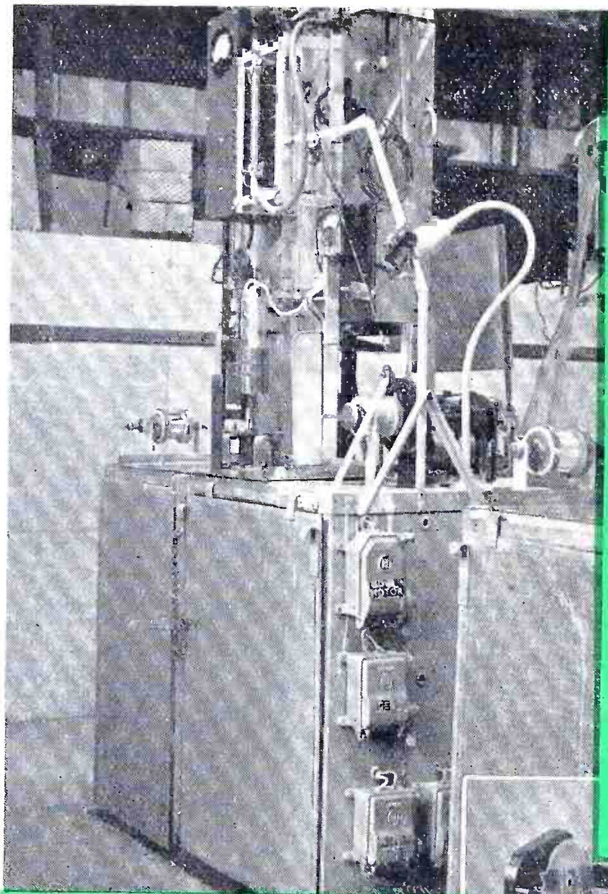
Activation and Ageing

After capping and before testing, valves are treated in various ways to improve and to stabilise the degree of cathode activation and to enhance their voltage performance properties. In general, the treatment, or ageing as it is generally known, is basically the same for both directly and indirectly-heated valves. Valves are mounted in 90-position racks and are run for a period with both the filament voltage and the anode dissipation somewhat in excess of the normal operating conditions. Fig. 6 shows a typical unit, two of which are serviced by one operator who unloads and reloads one during the time the other is running.

Directly-heated valves usually come off the pump with their cathodes almost fully activated, so that little more is required other than to stabilise their emission. A typical ageing schedule for a small directly-heated rectifier would be to operate the cathode at 1120°-1170° K. and to draw from it two or two-and-a-half times the normal operating anode current for a period of about twenty minutes.

When dealing with normal "broadcast" rectifiers (those valves whose peak inverse voltage is below 2 KV) it is not necessary to "voltage age" them in any way because these valves have such large factors of safety against flashover that such treatment is quite unnecessary, and the anode/cathode clearances are so

(Continued on page 258)



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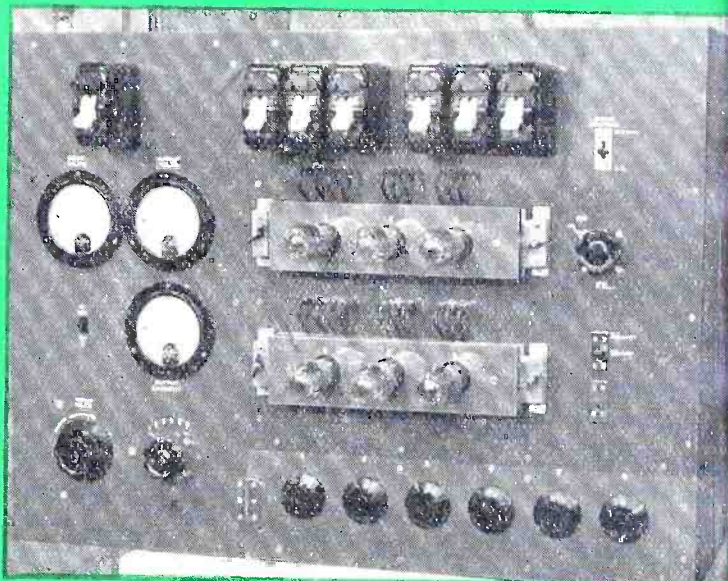
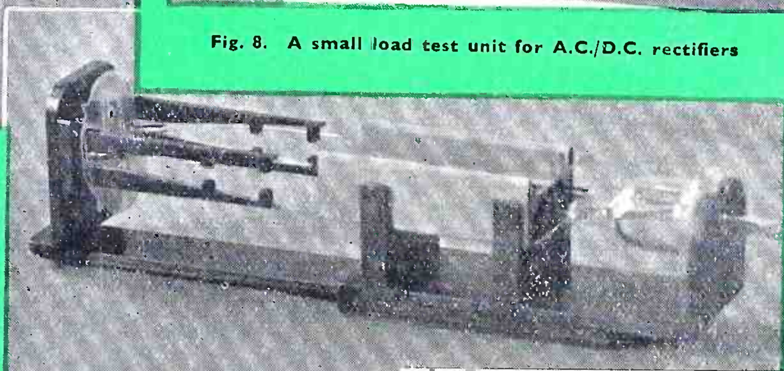


Fig. 8. A small load test unit for A.C./D.C. rectifiers



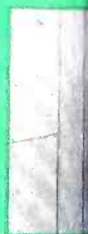


Fig. 10.
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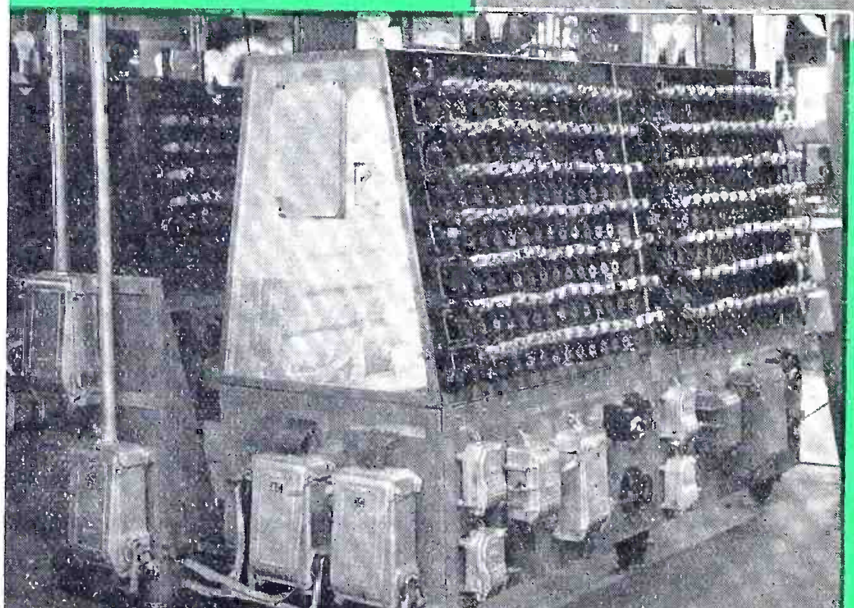
Fig. 2 (*above*). Plant for continuous coating of filament wire

Fig. 6 (*below*). Ageing rack or stabilising cathode emission before testing



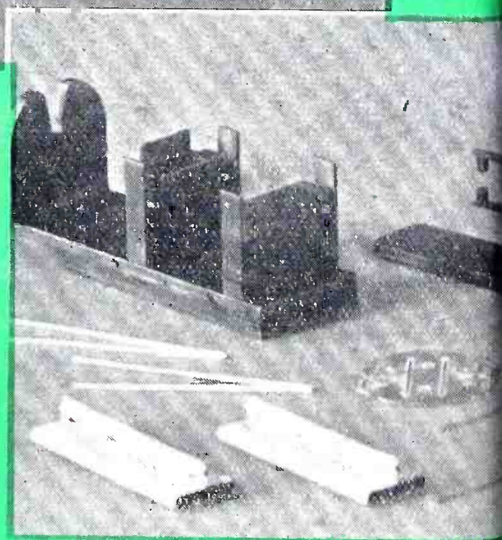


Fig. 3. Jig used for rectifier assembly. The two
ponents are shown disassembled in the view abov
assembled and filament held in jig ready for in

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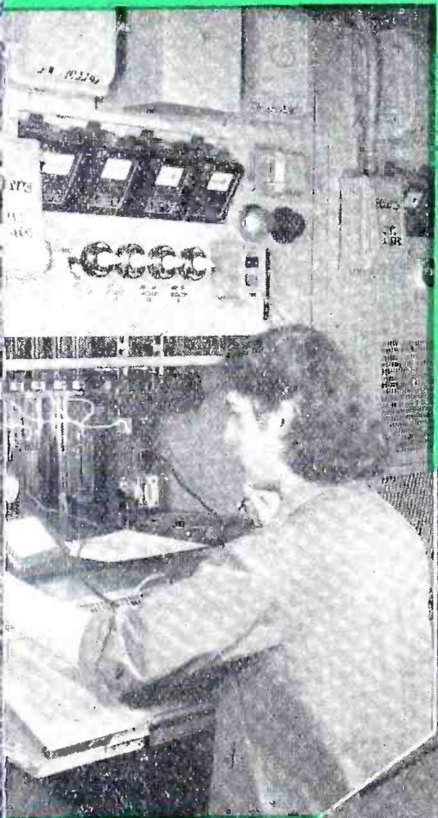


ted rack for life testing larger
inputs up to 3KV. R.M.S.

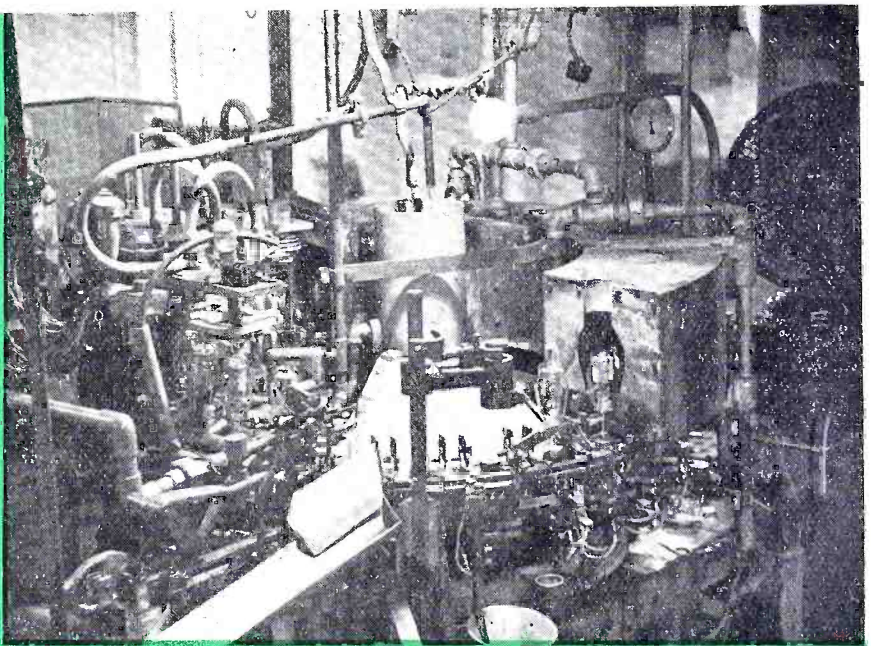


Fig. 5. 24-head automatic rotating pump with heating oven and H.F. heater for degassing electrodes during pumping

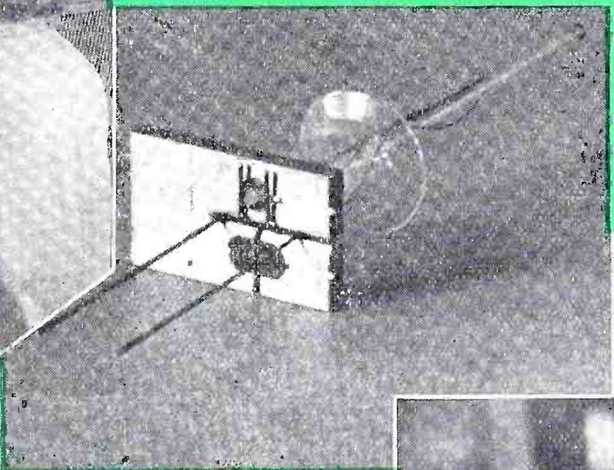


Fig. 3 (*above*). Clamp for bending electrode supports in correct position

(*below*). Jig with components assembled ready for welding

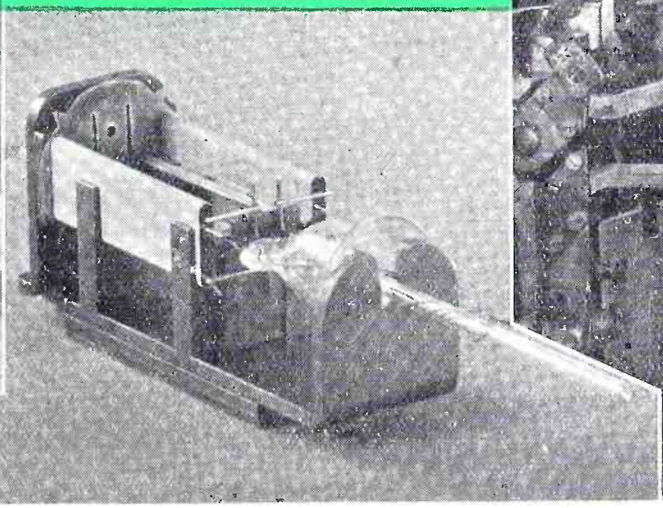
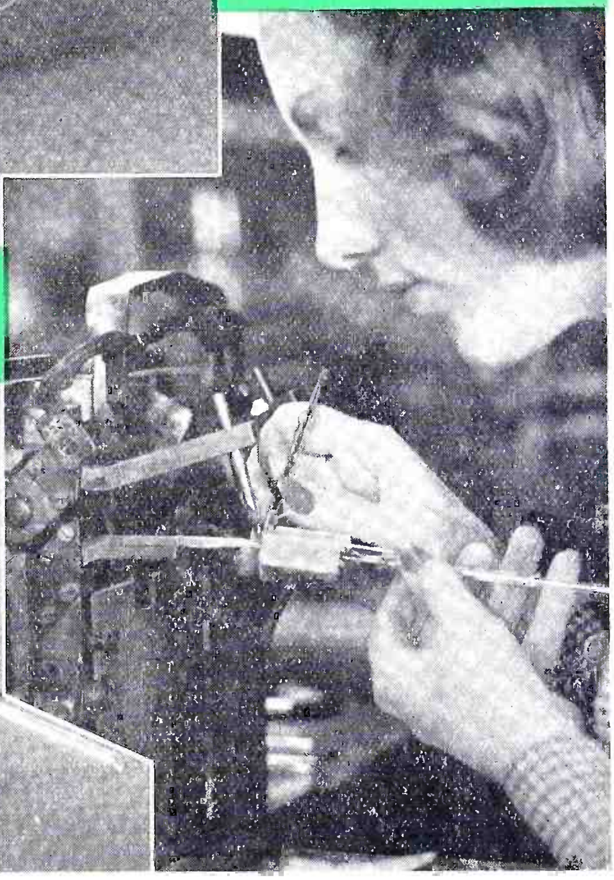


Fig. 4 (*below*). Operator welding filament hooks on a full-wave directly heated rectifier



h the com-
left) Anodes
anodes

(*Continued from page 255*)

small that damage may result to the cathode surface.

For valves used for voltages above this figure the usual practice is to connect an ordinary mechanical type spark coil between the anode and cathode and to spark for about one minute with the valve cold using a voltage of about 2½/3 times the normal maximum peak inverse voltage it will meet in service. Such processes can be very harmful unless carefully watched and are only used when necessary.

Testing of Rectifiers

Valves are tested mainly to ensure that they will give good service at their ratings and therefore every effort is made to test under conditions as near to the maximum ratings as possible. There are many factors disturbing the simplicity of this contention, the chief being that it is often necessary to build up an empirical correlation between specific uses of the valve and existing convenient tests although no obvious technical connexion exists between the two. Such a position can arise from the fact that valve making is such a complicated series of technical operations that it has tended to be an art rather than a science and the significancy of various processes must often be a matter of opinion because of inadequate precise knowledge. To summarise the above, the main objects in the mind of the valve manufacturer are to produce rectifiers having a satisfactory life with reliability throughout that life, and these requirements have to be interpreted into practical tests which can be made speedy and repetitive.

A testing organisation not only consists of factory testing but also includes quality control and life test sections which are maintained at considerable expense to protect the customers' interests.

Factory Testing

All valves are tested in the manufacturing section and those which pass satisfactorily are sent to stock. Before a valve is issued from stock, however, it is held for some days and is then retested by another testing department independent both of the manufacturing sections and the valve stores.

Testing Parameters

It is usual to test for filament or heater current at fixed filament or heater voltage. This not only checks for continuity but by setting limits enables a control to be kept both on the filament or heater material and also on the factory processing operations.

The main test employed is a static one which is primarily intended to check that the cathode emission is adequate, but which imposes a secondary check on valve impedance. A further test sometimes used is "reduced emission test" which consists basically in plotting the anode current filament voltage characteristics of the valve. The valve is set up with the filament operating at its normal temperature and the anode voltage set to give the maximum anode current possible without overdissipating the valve. This value of anode voltage is then maintained constant and the fall in anode current noted as the temperature of the filament is steadily reduced. In this way, the slope of the filament voltage/emission current curve is obtained and by plotting this slope (actually read as a percentage drop from the initial anode current reading taken at the normal working value of filament volts) against output on load test and life performance, it is possible to set limits for the product (Fig.7).

From such a test the peak emission of the valve can be assessed quite accurately, as may be seen from the curve, and it has an advantage over normal static emission tests in that it is independent of valve impedance variations, but unfortunately it is not readily adaptable to mass production.

On the lower voltage types the basic insulation is very much in excess of that required and practical experience has shown that an operational test is usually unnecessary. The exceptions to this rule on low voltage types are the series-running half-wave and voltage doubler valves which have to withstand high voltage peaks between heater and cathode (*e.g.*, the U31 rated at 250V R.M.S. has a peak of 700 V between heater and cathode).

On higher voltage types it is customary to employ some form of equipment test such as load testing, dissipation testing or flashover testing. The valves are tested singly or in pairs, while in certain cases a reading of D.C. output voltage is called for. During this type of testing valves are rejected for softness and gassiness, discharge between electrodes, excessive sparking, electrode distortion and filament vibration.

Some form of insulation test is often used and this is done by means of a 250 or 500 volt megger set and is normally carried out with the filament not alight. Conditions of vibration may be simulated by tapping the valve bulb, generally by mechanical means.

Test Equipment

Testing apparatus usually consists either of low voltage static equipment or of high voltage dynamic units. The former type is used to check such parameters as heater current, emission and anode impedance while the latter type tests the valve under operating conditions. The low voltage units are constructed in wood and have a desk or "console" shape with no special electrical protection required for the operator because the voltages used seldom exceed 100. The higher voltage equipments are fully protected and are usually made of metal with the electrical circuits conforming to conventional rectification circuit practice. A photograph of such an equipment used for testing a number of A.C/D.C. rectifiers simultaneously, is shown in Fig. 8.

Quality Control

An independent check on valve quality is made by a section under technical control and which keeps a running commentary on the characteristics of all valves in manufacture. Valves selected at random by trained collectors are subjected to extensive tests on units specially constructed to give maximum accuracy. In addition to the normal production tests a number of special tests are done and the information obtained is plotted in chart form. By this means, adequate warning is given when the production is straying from its theoretical mean ratings, information is supplied to enable the technical staff to correct the matter, and by statistical methods an estimation is obtained of the total percentage of rejections likely in the bulk product.

Life Testing

The tests carried out on production give an assurance that the valves manufactured are satisfactory initially, but it is essential that the valve manufacturer shall be assured that the product he is selling to his customer will also give a satisfactory life. In order to do this he has to set up an elaborate life testing equipment capable of continuously testing a percentage of manufacture and as no successful method of forced life test has been found it therefore takes a year to obtain 6,000 hours of life. Such runs are not often practicable and it is fortunate that experience enables the technician to assess the probable performance by a careful examination of life curves taken to 500 hours. Samples of such curves are illustrated in Fig. 9.

Generally speaking, it is desirable to life test valves under the most onerous conditions that they are likely to meet in service. In certain cases, static life tests with D.C. voltages are all that are necessary, but with rectifying valves, dynamic set-ups simulating operating conditions are essential. The circuits must have components with accurately known characteristics and must be supplied with input voltages which are stable and unaffected by mains and load fluctuations.

A photograph of a typical life testing rack is shown in Fig. 10. This gear is capable of testing eight valves under biphase half-wave conditions at input voltages up to 3 KV R.M.S.

After life tests are completed all valves are returned to the Works where a detailed examination of the actual valves and their performance is made so that improvements may be made both in current production and in future designs.

Future Indications

Investigations are in hand to produce multiple pump units which will exhaust larger types of rectifiers on an indexing principle. This involves the provision of greater schedule flexibility together with facilities for "bombardment" of electrodes during exhaust to obtain adequate degassing.

It may be worth a thought that rectifiers offer the greatest hope of the achievement of the valve makers' dream of automatic assembly. Rectifiers are mechanically the simplest of valve structures and are not very subject to redesign while the quantities required can justify the expense involved in setting up such mechanised units.

(*To be continued.*)

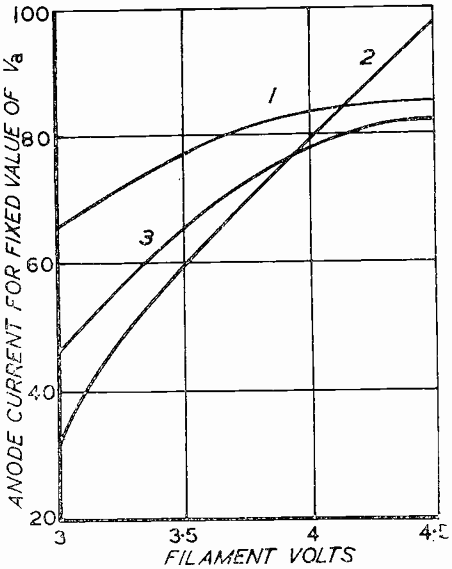


Fig. 7a. Variation of anode current with change of filament voltage for valves of varying emission quality

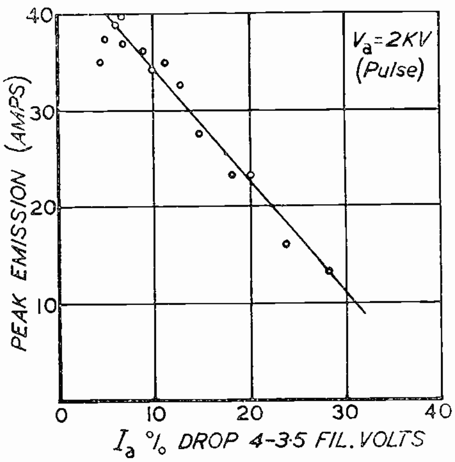


Fig. 7b. Correlation between emission measurements at reduced filament volts and peak emission

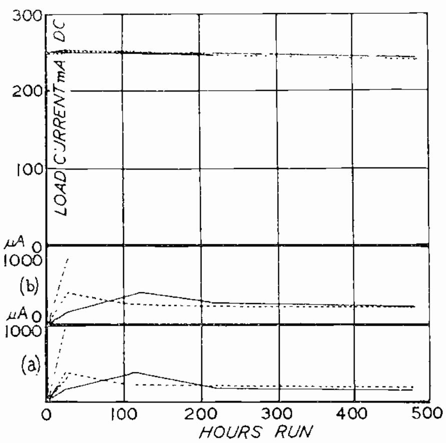


Fig. 9. Life performance curves of typical rectifiers. The tendency for variations in early life is typical of all oxide-coated rectifiers

Printing Scales and Labels

AN economical means of producing durable, accurate, and attractive scales and labels has long been a problem for manufacturers of scientific apparatus. Such articles have usually been made by a process of machine engraving in high-class work, or by printing or hand lettering in lower quality instruments.

In the *Marconi Review* for April-June, R. A. Boeckstens* describes some of the newer processes for producing labels and scales on any type of material and in a variety of different styles.

Chemical engraving can now be applied to most metals and to many forms of plastic. The method of etching is similar to that employed in block making, but the depth of the etching is only .005-.01 in. where the lettering has to be filled in, against .03 in. of the average line block. For metals, a "resist" of bichromated fish glue or albumin is used, which becomes insoluble under the action of light and can be washed away from the parts of the metal not acted on through the photographic negative. For zinc or steel a suitable mordant is nitric acid, and for aluminium, copper, or copper alloys, ferric chloride.

The etching process is greatly accelerated by using an electrolytic etching bath, which is described in detail in the article.

For plastics and glass, the label is first coated with a solution of bitumen in benzene and over this a coating of bichromated colloid is applied. After exposure under the negative development is carried out in water to remove the unexposed parts of the colloid. The bitumen is then removed by development in benzene and the plate etched by H.F. (for glass) or plastic solvent.

The double coating is not required where the colloidal coating will withstand the action of the solvent.

The use of a "resist" gives attractive finish to anodised aluminium labels, especially if certain areas are left bright and others dyed in the usual way.

* P. 51, Vol. XI No. 2.

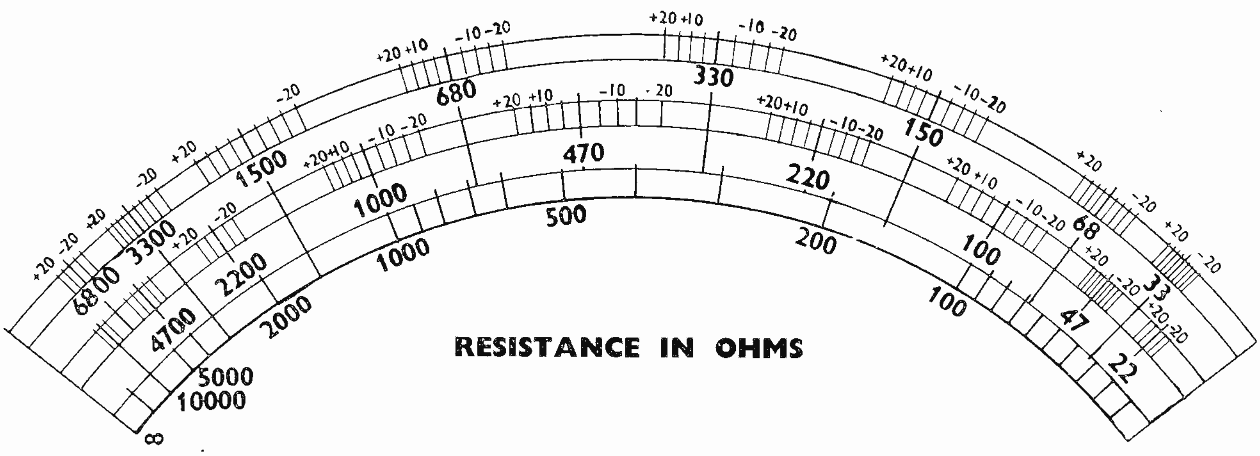


Fig. 1. Limit scale derived from ohms range of multi-range meter, calibrated to ± 20% on preferred values

Tolerance Testing Techniques

By D. W. THOMASSON*

IT is common practice in radio and electrical work to express certain values in tolerance form. A resistance, for example, may be quoted as being "470 ohms ± 10 per cent." meaning that it may be any value between 423 ohms and 517 ohms. The advantages of this are undeniable, and it is unlikely that anyone would be tempted to refer to the resistance as "between 423 and 517 ohms" in practice. The tolerance form expresses the value with adequate precision, and permits the use of a "preferred" series of standard values, which is a great convenience to both manufacturers and designers.

When a check measurement is made, on the other hand, it is almost invariably made in terms of absolute values, the limits implied by the tolerance being worked out first. The resistance quoted above might, for example, be measured as 444 ohms. It would often be more convenient to know that it was 5.5 per cent. below the nominal value.

This may not be important in the laboratory, where the calculation of limits from percentages is regarde as an elementary exercise. In the test-room, on the other hand, it is a serious matter, especially if the calculation has to be performed for a hundred different values each day. Whether they are employed on quality control or goods-in inspection, the test-room staff have little time or inclination for exercises of this kind.

The main reason why checks are made in terms of absolute values is that most forms of measuring apparatus give readings of this form. There seems to be a widespread impression that measuring instruments capable of giving readings in the tolerance form are either excessively expensive or incapable of giving sufficiently accurate results. This is by no means true if the problem is approached in a sensible manner. The methods which will be described herein are little more costly than the equivalent orthodox methods, while the results are quite as accurate. The saving in time they make possible justifies their use in any test work where speed and convenience are important.

Limit Scales

A simple, though not fully satisfactory, method of providing tolerance readings is to equip existing instruments with special scales. Fig. 1 shows a scale of this sort drawn for the resistance range of a well-known test instrument, the original scale being shown for comparison. It can be seen that the limit scale is by no means easy to read, in spite of the fact that relatively few limits are marked. The nominal values are in the 10, 15, 22, 33, 47, 68 series of preferred values.

A more satisfactory form of limit scale uses a single set of limit calibrations, provision being made for adjusting the indication for the nominal value to the "zero," or "nominal" point of the scale. The control used for this purpose can be calibrated in terms of the nominal value, or the setting made against a standard component.

In an unusual capacitance meter using this form of scale, the capacitor under test was charged through a variable resistance to a predetermined peak voltage, the charging circuit being disconnected when this voltage was reached[1] and the capacitor discharged for a fixed period. The charging time was proportional to the capacitance for a given value of charging resistance, and the meter deflection was made proportional to the charging time. The meter scale could therefore be calibrated in terms of percentages of the nominal value of the capacitor, while the resistance was calibrated in terms of nominal values. If the actual capacitance was 20 per cent. above the value to which the resistance was set, the meter reading was 20 per cent. above the central "zero" mark on the tolerance scale.

Designed for test-room use, this meter was simple and reliable, but was not capable of a particularly high standard of accuracy. Furthermore, its working range was somewhat restricted. An investigation was therefore made into the possibilities of tolerance reading bridges.

* Electronic Applications Research Laboratory, Exeter.

Bridge Methods

The normal bridge apparatus used for measurement purposes gives highly accurate readings in terms of absolute values, but does not lend itself to the direct reading of tolerance. It is also unsuitable for high speed testing, since the bridge has to be set up to a precise balance for each reading, and this operation takes an appreciable time, even with the simplest types of bridge.

A bridge of the ratio-arm type, in which the balance is obtained by simultaneous adjustment of two of the arms, may be arranged for tolerance reading by an adaptation of the ratio scale, as suggested in the case of the multi-range meter. A further improvement may be made by using a form of servo-mechanism to obtain the balance automatically. The null indicator is replaced by a suitable amplifier, which must be able to discriminate between opposite phases of the bridge output if an A.C. supply is being used, and the output of the amplifier is passed to a motor geared to the ratio arm control. The servo circuit is arranged so that the motor turns the ratio control to the position giving balance, the operator's work being reduced to connecting the component under test and observing the reading.

This scheme is of particular interest when automatic sorting is required, the servo-mechanisms being made to operate the sorting apparatus. For ordinary check work, however, it has certain disadvantages. The most important of these is that the operation is still too slow for high speed testing, due partly to the inertia of the mechanical system, and partly to the fact that the ratio control will always turn to the extreme limit position when the test terminals are disconnected. An improvement can be made by arranging that the servo system is only operative when the terminals are connected, but the operation time is still too great to permit really high testing rates to be achieved.

For resistances, a higher testing rate may be obtained by use of the following method. The "standard" arm of the bridge is adjustable, and a wide range of values may be set up with the aid of a second "multiplier" arm. The third arm is always set so that the balance condition corresponds to a value of the unknown which is a selected percentage above or below the nominal value set up on the first two arms. A key-switch is used to select the "high" or "low" balance position, and the test is carried out by connecting the unknown and then throwing the key-switch, observing the meter meanwhile. The meter shows the bridge output, and is only calibrated with a centre mark indicating balance. If the deflections are both on the same side of the centre mark, the resistance is outside the selected limits, while if they are on opposite sides, the resistance is within the limits. An example of this type of bridge is shown in Fig. 2.

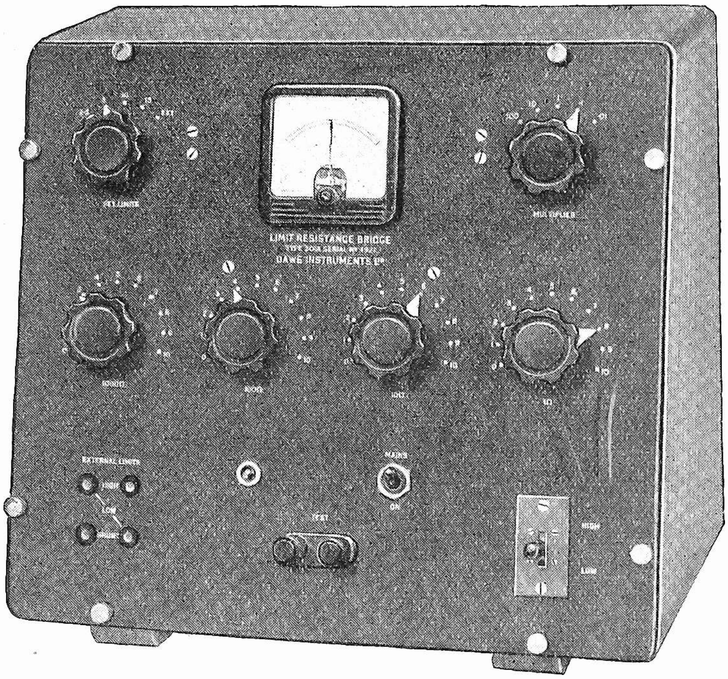


Fig. 2. Limit resistance bridge suitable for quantity testing (*Dawe Instruments Ltd.*)

This method meets the requirements in respect of operation time and accuracy where resistances are concerned, but the method is not conveniently extended to the measurement of capacity and inductance. For these, it is better to use a method based on the relation of bridge output to the deviation of the unknown from the value giving balance.

Off-balance Indicators

It can be shown (see Appendix) that under certain conditions, the output of a bridge is proportional to the product of the percentage deviation of the unknown from the value for balance and the bridge ratio. The conditions are: The deviation must not be greater than about 20-25 per cent.; the bridge ratio must be small, *i.e.*, the impedance of the unknown must be large compared with the impedance of the standard; the output current drawn from the bridge must be negligible.

These requirements can generally be met without difficulty, but where there is likely to be any considerable variation in the power factor, there are particular advantages in the use of a cathode-ray tube indicator. The input to the vertical plates is taken from the input to the bridge, while the horizontal plates are fed by an amplifier connected to the bridge output.

The display is viewed through a calibrated graticule, and takes the general form of a loop trace (*see* Fig. 3). If the phase angle between the bridge input and the amplifier output is zero, the loop closes to a straight line. Line or loop, however the percentage deviation is read by the point of contact of the curve and the top line of the graticule. The amplitude of the bridge input is adjusted so that the curve just touches this line, and the deviation is read against the vertical lines. To increase the accuracy of reading, the trace may be marked at the point of maximum vertical excursion.

So much for reading deviation. It is also useful to be able to read phase angle. Referring to the vector diagram of Fig. 3, it will be seen that the shape of the loop will depend on the angle ϕ, while the phase angle of the unknown is θ. The relationship between these angles is complex, but an approximate expression may be used when the deviation and θ are small. In this case, the angle θ is roughly:

$$\frac{\phi_m \times \text{percentage deviation}}{100}$$

Thus, an actual phase angle of m combined with a 10 per cent deviation will show as 10° on the display. With larger values of θ the relation changes to $\phi = (90 - \theta/2)$ but the expression above will hold for most acceptable values of θ in practice.

The value of ϕ may be read by the intersection of the trace with the vertical axis of the graticule, which may be suitably calibrated.

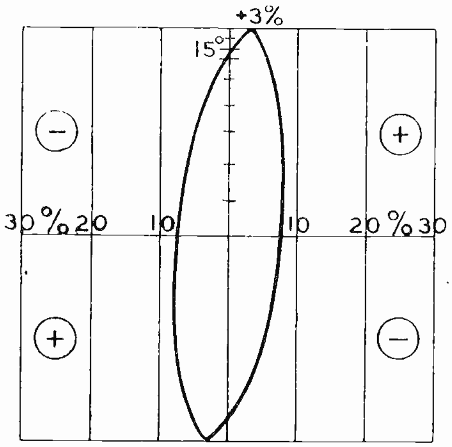


Fig. 3. Display on indicator of percentage reading capacity bridge with corresponding vector diagram (col. 3)

With careful attention to detail design, this method can be used to form the basis of an extremely useful test instrument. The accuracy, even with inexperienced operators, is quite high enough for most purposes, while the display permits continual monitoring of the bridge input, so that the reading is not affected by supply voltage variations. The range of values which can be tested is only limited by the available standards included. A typical example of the coverage is a capacitor test set which uses six decade ranges, covering all capacitances between 10 $\mu\mu$F and 10 μF.

Conclusion

Several different approaches to the problem of tolerance testing have been suggested, all of which are characterised by their own particular virtues and vices. In a case like this, the final choice of method must be based on many factors, and it would be unwise to say that any one method is universally better than the others. For many purposes, the provision of limit scales for existing instruments would be adequate, but the more complex methods are well worth their greater cost, which is rapidly repaid by the improved test efficiency.

APPENDIX

Bridge Equations for Unbalance

In the Wien Bridge, (Fig. 4) if the indicator is assumed to have infinite impedance, the voltages across the arms R_a and X will be:

$$E_a = \frac{E_1}{1+m} \qquad \text{.................} \quad (1)$$

$$E_x = \frac{E_1}{1 + \left(\frac{R_s}{R_x} + \frac{C_x}{C_s}\right) + j\left(\omega C_x R_s - \frac{1}{\omega C_s R_x}\right)} \qquad \text{.........................} \quad (2)$$

The bridge output will be the difference between these two voltages:

$$\frac{E_o}{E_1} = \frac{1}{1+m} - \frac{1}{1 + \left(\frac{R_s}{R_x} + \frac{C_x}{C_s}\right) + j\left(\omega C_x R_s - \frac{1}{\omega C_s R_x}\right)} \qquad \text{....................} \quad (3)$$

If the resistances are the only considerable elements:

$$\frac{E_o}{E_1} = \frac{1}{1+m} - \frac{1}{1 + R_s/R_x} \quad \ldots (4)$$

If R_x is now changed to $(1 + d)$ times the value for balance, the following relation may be derived:

$$\frac{E_o}{E_1} = \frac{1}{1+m} - \frac{1}{1 + \frac{m}{1+d}} \quad \ldots (5)$$

$$= \frac{md}{m^2 + m(d+2) + (d+1)} \quad \ldots (6)$$

If m and d are both small compared with unity, this approximates closely to $-md$, so that the bridge output for constant input can be stated to be proportional to the bridge ratio multiplied by the deviation of the unknown from the value for balance.

A similar treatment for the case where the resistance are negligible shows that for a deviation in the capacitance under test to $(1 + c)$ times the value for balance, the output is given by:

$$\frac{E_o}{E_1} = \frac{mc}{m^2(c+1) + m(c+2) + 1} \qquad \text{........................} \quad (7)$$

Which reduces to mc when m and c are small.

A similar treatment may be used for inductance bridges.

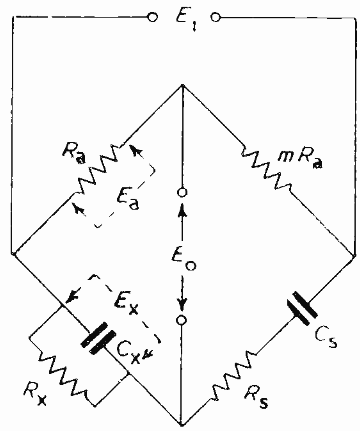
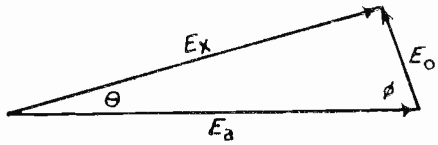


Fig. 4. Wien bridge circuit



A Pressure-Sensitive Electronic Guard

The Protectron, manufactured by the Brinnell Company, of Granby, Connecticut, is an electronic device for use in conjunction with an electric motor-driven machine to "trip" at any preset *mechanical* load increase above normal. It is instantaneous in action, sensitive to minute overloads and adjustable to any degree of overload within practical limits. It is also compensated for fluctuations in terminal voltage.

When the device trips, a red light is switched on and a relay is energised to initiate any control function.

The equipment successfully combats "jamming" in automatic machinery by "sensing" oversized stock, "pile-ups," dull punches and a multitude of other causes before damage occurs.

By tripping at a preset degree of dullness, this apparatus can enforce the sharpening of tools, thus increasing tool-life up to 600 per cent. In certain applications, such as broaching, this setting for dullness eliminates completely the major cause of damage to tools.

Other uses include the stopping of pumps or signalling when shears or drills are dull.

Cabinets for Projection Television Receivers

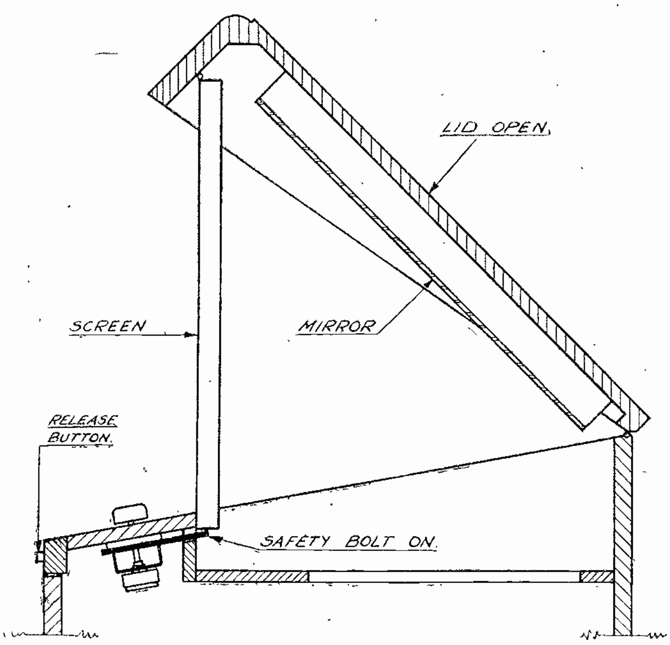


Fig. 1.

THE majority of post-war television receivers are of the type in which the picture is viewed directly from the cathode-ray tube, but if a comparatively large picture of the order of 20 in. by 16 in. is required, the limitations imposed by the physical dimensions of the cathode-ray tube make it necessary to employ an optical magnifying system in conjunction with a suitably positioned image receiving screen. In designing a cabinet for such a receiver, it is desirable that when not in operation, the screen should be housed within the cabinet and should be capable of being moved to its viewing position with a minimum of manual effort. A problem arising from such an arrangement is that it might be possible to close the cabinet with the television receiver left switched " ON," which is obviously undesirable.

A convenient solution of the problem is to provide a safety interlock between the television ON/OFF switch and the screen lifting and lowering mechanism, as illustrated in the drawings in which Fig. 1 shows the upper portion of the cabinet with the lid open and the screen in its viewing position, and Fig. 2 shows the lid closed and the screen housed within the cabinet. Fig. 3 shows details of the interlock mechanism.

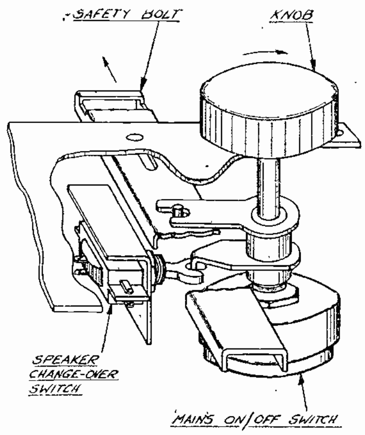


Fig. 3. (above)

The cabinet lid is adapted to be raised by a weight and pulley system (not shown) on the actuation of a release button, so as to bring the screen to a substantially vertical viewing position for receiving an image from the cathode-ray tube housed vertically within the cabinet via the optical system and a mirror mounted on the inner surface of the cabinet lid. When the television switch is moved to the ON position a safety bolt is automatically projected to lie beneath the bottom edge of the screen, so that with the switch in this position, the screen cannot be lowered, and hence it is necessary to switch OFF before it is posible to close the cabinet. The interlock mechanism is clearly shown in Fig. 3, and the movement of the control knob may also be employed to change over the loudspeaker connexions from a broadcast receiver to the television sound receiver.

The scheme offers a further advantage in that, if the weight and pulley system holding the screen and lid in the raised position, should fail, the safety bolt guards against a collapse of the lid which might result in damage to the screen and the mirror. In such circumstances it could be arranged for the lower edge of the streen to engage a suitable slot in the safety bolt so as to prevent movement of the control knob in either direction. The operator would then be warned automatically of a fault in the screen lifting mechanism.

Communicated by E.M.I. Engineering & Development, Ltd.

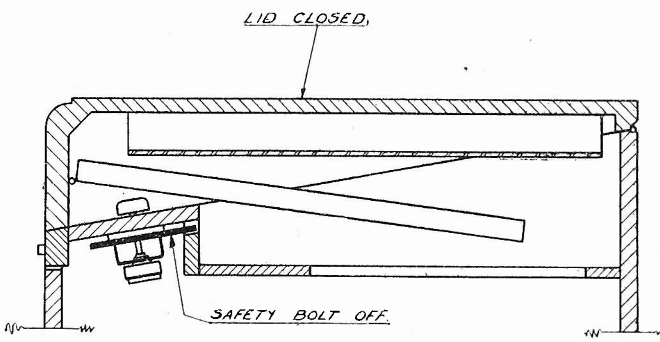
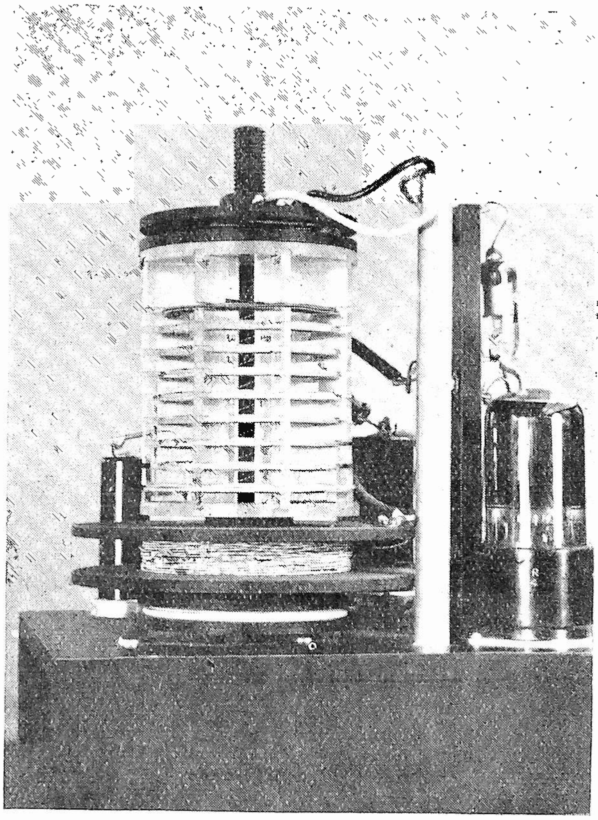


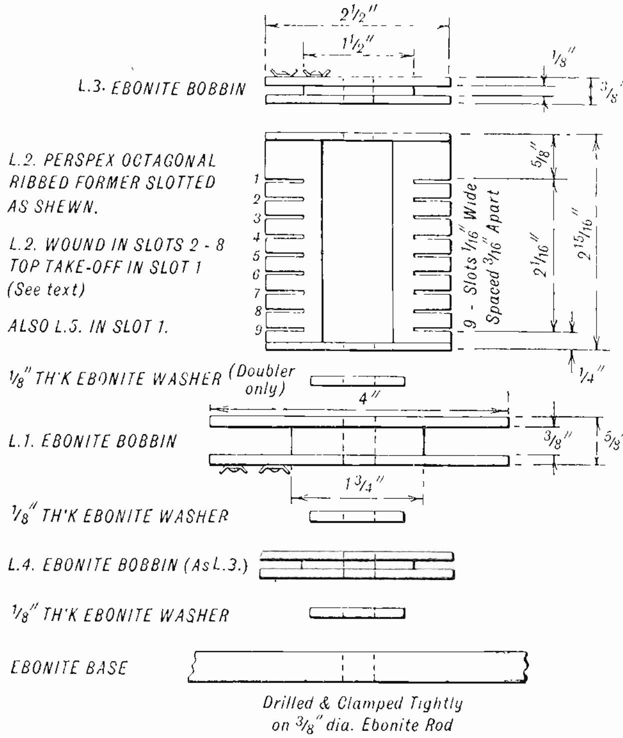
Fig. 2. (right)

Radio Frequency E.H.T. Supplies

By K. C. MACLEOD*

Extracted from a paper read before the Constructors' Group of the Television Society, April 14th, 1948, (to be published in full in the Society's Journal).





View of finished unit (*left*) **and detailed dimensions of former** (*above*)

The attached diagrams give details of the circuit and transformer construction for a 12 KV R.F. E.H.T. unit. The unit may, by adjustment of the oscillator anode tuning capacity C_1 and of the rectifier heater windings L_4 and L_5, be made to deliver between 8 and 15 KV. Alternatively, by omission of rectifier V_3, its heater winding L_5, and reservoir capacity C_3, it may be operated as a half-wave unit delivering 6 KV, or by suitable re-adjustment of C_1 and L_2 any voltage in the range 4 to 7.5 KV.

The dimensions and windings of the individual coils in the transfomer assembly, also the spacings between the windings, as shown in the diagram, are critical, and must be strictly observed if the correct rectifier heater voltages at 12 or 6 KV E.H.T. output are to be obtained. It is assumed that all coils are wound in the same direction, in which case the phasing will be correct if the arrangement in the circuit diagram is followed.

The placing of the washers between the individual coil formers lengthens the surface leakage path between windings and the wide cheeks upon the primary former serve as a flash guard.

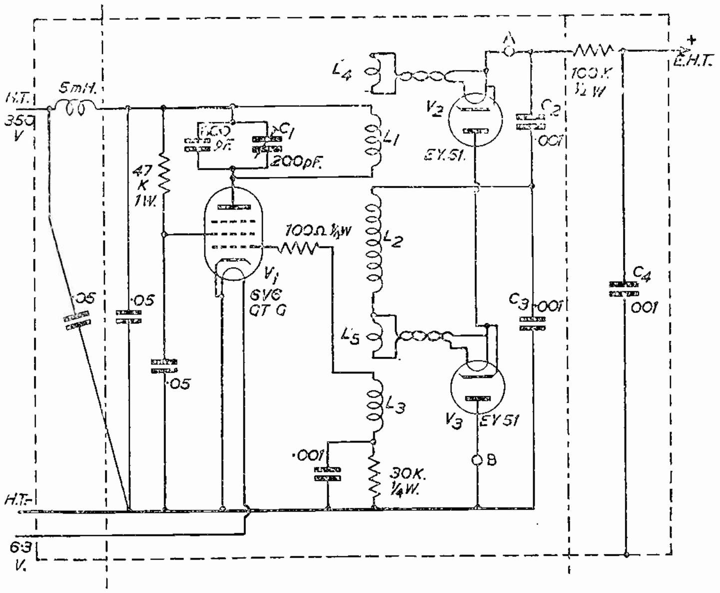
In order to avoid corona, the leads from L_2 are brought out in 14/40 P.V.C. covered flex. The winding of this coil is commenced at the high potential end at the bottom of slot 2, and the lead-out is subsequently attached and wound for three turns into the vacant top slot before being brought out, thus providing a protection for this end of the coil. At the lower end, the lead is attached and wound for at least one complete turn upon the top of the winding before being brought out. Both leads must be kept well clear of other wiring and firmly anchored, also leads from L_3 must be kept well clear of L_2. Where required, the heater winding L_5 is wound into the first slot of the L_2 former upon the top of the three turns of the take-off lead, the leads to V_3 being twisted up with the latter. No metallic parts, screws, etc., may form part of the H.V. coil former assembly, the parts of the octagonal ribbed former being preferably cemented together.

If outputs other than 12 KV or 6 KV are required, or if, for any reason, any alteration is made in the high-frequency transformer design, the heater windings L_4 and L_5 will require modification. The voltage output from L_5 is proportional to that delivered by L_2 and therefore to the E.H.T. output, and adjustment of the number of turns should be made accordingly. The voltage output from L_4, however, is proportional to that across L_1. When the E.H.T. output is adjusted by the tuning of L_1 by C_1, the voltage across L_1 does not change appreciably; slight changes in L_4 output may be corrected by variation of the L_1 to L_4 spacing washer, should an alteration of one turn upon L_4 prove too coarse an adjustment.

* Cinema Television, Ltd.

COIL WINDING DATA

	L.1	L.2	L.3	L.4	L.5
No. of sections ...	1	8	1	1	1
Inside dia. of winding ...	1¾"	1½"	1½"	1½"	1¾"*
Width of winding	⅜"	%"	⅛"	⅛"	%"
Turns per section	125	300	150	8	6
Wire	27/42 Litz	38 S.W.G. silk & enam.	32 S.W.G. silk & enam.	20 S.W.G. silk & enam.	22 S.W.G. silk &. enam.
Inductance ...	1mH	145mH	* Wound over L.2. End lead in slot 1.		
Q at 100 kc/s. ... (no load)	150	165			
Coupling ...	20%				



The circuit of the complete E.H.T. unit is shown on the right. Note arrangement of screening compartments, (broken lines).

To check rectifier heater voltages, which should be 6.3 V ± 5 per cent., a valve voltmeter should be used. To check V_2 heater voltage the unit should temporarily be changed to positive earthed E.H.T. *output* by transposing the connections to the rectifiers at points A and B on the circuit diagram, V_2 heater now being at earth potential. C_1 is set for desired output voltage, and L_1 then adjusted where necessary. V_3 heater may be checked by visual comparison with V_2. Actual measurement of the voltage output from L_5 requires the following procedure:

(a) Remove V_2, and disconnect one side of C_2

(b) leaving V_3 anode connected to C_3 disconnect both from earth,

(c) earth V_3 cathode,

(d) temporarily readjust C_1 for one-half the final required E.H.T. across C_3,

(e) check and adjust V_3 heater voltage

(f) restore original connections and re-set C_1.

The unit must be fully screened to prevent radiation and suitable filters inserted in the oscillator H.T. supply lead and E.H.T. positive output lead. These filters should be accommodated within separate compartments in the copper screening box. All connexions between the unit and the box should be made at one point only.

The oscillator anode and screen input from the 350 V H.T. supply should be 15-30 mA. over an E.H.T. output of 0-500 μA at 12 KV. The regulation of the voltage doubler is approximately 4½ per cent. for 100 μA load, and that of the half-wave version, 3½ per cent. for the same load.

Should the inductance of the high voltage winding L_2 or its distributed capacitance and/or the associated stray capacitances of an individual model show any appreciable deviation from the original, the frequency of operation will be affected, and the fixed capacity in parallel with C_1 will require slight modification if the correct range of output voltages is to be obtained. Correct phasing of L_1, L_2 and L_3 may be checked by noting that an increase of C_1 capacity produces a fall in E.H.T. output voltage.

A Magnetic Fluid Clutch

A NEW type of electromagnetic clutch, having extensive applications and many unique features, has been developed at the National Bureau of Standards by Jacob Rabinow, Chief of the ordnance mechanics laboratory. The development of this clutch, which is based on his discovery that frictional forces between solid surfaces and certain types of fluid media can be controlled by application of magnetic fields, was part of the work on the mechanical aspects of the high-speed electronic digital computers. The new magnetic fluid clutch is particularly suitable to applications in servo mechanisms, automatic machinery, and other fields where ease of control and constancy of characteristics are important. Mr. Rabinow has assigned all patent rights for the clutch to the U.S. Government.

The magnetic field clutch operates on the following basic principle: When the space between two parallel magnetic surfaces is filled with finely divided magnetic particles and a magnetic field is established between the two plates, the magnetic particles bind the plates together against movement parallel to their surfaces. The magnetic particles may be finely divided iron which for most applications, is mixed with a liquid, such as oil, to prevent packing and to afford smoother operation of the clutch. When a portion of this mixture is acted on by a magnetic field, the iron particles are mutually attracted, bind together in the field, and the mixture "solidifies." As the magnetic field can be produced by an electric current, a very simple means is thus obtained for the control of the binding force over a very wide range.

—*Technical Bulletin, U.S. Bureau of Standards*, May, 1948.

CORRESPONDENCE

Voltage Stabilisers

DEAR SIR,—The note by Dr. E. J. Harris on a modified version of Miller's compensated voltage stabiliser is particularly interesting; for relatively little attention has been given to this aspect of voltage stabilisers. Attempts to increase the stabilising action of the simple voltage stabiliser, by increasing the gain of the amplifier, can never be completely successful, since the signal actuating the control circuits is obtained from the output voltage only: this voltage must therefore remain at a value differing slightly from the designed figure, so long as the input voltage or load current differs from the respective designed value. Miller's circuit, together with Dr. Harris's modification, compensates for variations in input voltage; variations in load current will still cause the output voltage to change slightly, to provide a correcting signal.

W. R. Hill[1] has given a very valuable review of valve voltage stabilisers, in which he describes a simple method of compensating for variations in both input voltage and load current; the circuit is shown in the figure. The voltage divider R_4, R_5 applies a fraction of the input voltage change to the grid of the control amplifier V_2, in series with the usual control signal derived from the output voltage change, via R_1, R_2. The potential drop developed across resistor R_6, which is proportional to the load current, is also applied to the grid of V_2, in series with the two other control signals.

Hill, following Hunt and Hickman,[2] describes the performance of voltage stabilisers in terms of two performance factors; the regulation factor, $R = e_o/e_i$, $i_o = o$, which is a measure of the effectiveness of the stabilising circuit against input voltage variations; and the internal resistance of the stabiliser, $r = -e_o/i_o$, $e_i = o$, which is a measure of the effectiveness against load current variations: where e_i and e_o are the variational components of the input and output voltages, respectively, and i_o is the variational component of the load current. The derivation of these factors is based on the experimentally observed fact that, within its useful range, the output voltage of a valve stabiliser is an approximately linear function of the input voltage and of the load current. Then the variational component of the output voltage is:

$$e_o = Re_i - ri_o$$

In the case of the fully compensated stabiliser it is, theoretically, possible to make both regulation factor and internal resistance zero (when e_o will also be zero), or even negative. Hill's analysis of the circuit shows that $R = 0$ when:

$$\frac{R_5}{R_4 + R_5} = \frac{(1+1/\mu_1)(1+\mu_2 R_k/(\rho_2+R_L))}{(R_1/(R_1+R_2))\,(\mu_2 R_L/(\rho_2+R_L))} - \frac{R_1+R_2}{\mu_2 R_1}$$

R_5 is normally much smaller than R_4, and is conveniently made adjustable and set experimentally for R = 0, by observing the change in the ripple component of the output.

The internal resistance $r = 0$ when:

$$R_6 = \frac{(1+\mu_2 R_k)/(\rho_2+R_L)}{g_1\left(\dfrac{\mu_2 R_L}{\rho_2+R_L}\right)\left(\dfrac{R_1}{R_1-R_2}\right)}$$

R_6 does not affect the insulation of the rectifier circuits, since it is normally less than 10 ohms. It should be made variable and adjusted in operation; this is especially important since, in practice, r may become negative within the operating range of the stabiliser; oscillations may then occur, which can be eliminated by readjustment of R_6.

The analysis assumes that the circuit behaviour is linear; this is not exact, so that the regulation factor and internal resistance will vary slightly about zero. Hill gives results for a typical circuit in which the output remained within ± 0.1 volt, over short periods, for an input range of 400 volts to 600 volts, at constant load current; and for a load current range from 0 mA to 100 mA, at constant input voltage. Nonlinearity in the amplifier could be reduced by the application of negative feedback.

The long-term stability of this circuit is not so good as that for short periods, owing largely to instability in the voltage regulator tube. The potential performance of the fully compensated stabiliser is such that the imperfect characteristics of this tube contribute largely to the limitation of its practical performance. The voltage regulator should be selected, and operated, for minimum variational internal resistance and low noise; an ordinary neon lamp should on no account be used.—Yours faithfully,

A. H. SIMONS

Johannesburg.

[1] *Proc. I.R.E.*, 1945, 33 p 38
[2] *Rev. Sci. Insts.*, 1939, 10, p 68

The Synchrodyne

DEAR SIR,—I read with interest the letter from Mr. Langberg in the April issue of ELECTRONIC ENGINEERING, as I have also been experimenting with the Synchrodyne in place of the second detector in superhet communication receivers.

This arrangement possesses many advantages over both the synchrodyne and the superhet, especially at very high frequencies. The superhet-synchrodyne not only gives additional preselection, as pointed out by Mr. Langberg, but it also refers the synchronisation to a lower frequency where it is less subject to phasing difficulties. A further very useful property of the super-synchrodyne is its ability to hold signals of poor frequency stability and unintentionally frequency modulated signals. The method is ideal for use in the V.H.F. and microwave parts of the spectrum.

The only real objections to the system are firstly that it is more complicated than a straight synchrodyne and therefore more costly to produce. Secondly, it brings back all the old superhet troubles of tracking in the R.F. stages and more especially of second channel reception in the I.F. strip. To overcome the latter, the intermediate frequency should be the highest at which efficient locking can be obtained; the synchrodyne will then take care of the selectivity.—Yours faithfully,

R. C. JENNISON

The Atomic Energy Research Establishment

Address given by Prof. Sir John Cockcroft on the occasion of the first official Press Visit to the A.E.R.E. at Harwell, July 19-21, 1948.

I HAVE to welcome members of the Press to-day and to show them something of the progress which has been made in two years in building up atomic energy research in our country.

We took over the Harwell airfield of the R.A.F. in April, 1946. Since that time we have been building large machines in its hangars, converting its barrack blocks to use as laboratories and building very elaborate new laboratories for the more exacting requirements of atomic energy work.

Our first duty was to equip ourselves for atomic energy research, and, in particular, for research in the development of nuclear reactors. The simplest class of reactors are those built from graphite and natural uranium. We had to develop the production of pure graphite, in Canada and in this country, and also to produce pure uranium metal—which is not at all easy. From these materials we built in 15 months the simplest possible pile, developing about 100 kW of nuclear energy—the pile known as the GLEEP.

For the last 11 months we have been using this to gain experience in the operational characteristics of piles; to produce radioactive isotopes; to make measurements of nuclear properties of materials used in pile technology and to carry out research.

Future developments will depend very much on how materials stand up to the intense bombardment they receive inside piles. To test this behaviour we have built a more powerful pile, which will develop 6,000 kilowatts of energy and bombard 60 times as strongly as the GLEEP. This pile is a little larger than the GLEEP. Its uranium rods are cooled by high speed streams of air which are snaked through the pile and ejected up a high stack.

On July 3 we loaded the last bars of uranium metal into the pile. Electronic instruments recorded the number of neutrons being produced and the amount of heat being developed by the pile. At 3 o'clock, the instruments recorded 3/10 of a watt; a little more metal was loaded and the pile power began to grow, showing that the "divergent point" had been reached. The power rose more and more rapidly till at 35 watts safety rods driven by compressed air were forced in and shut down the pile as had been arranged. We have now to go through a period of testing at low power before we can start our programme of new work.

Simultaneously with pile building and designing we have been working on the metallurgical problems which are key problems in both existing and future piles. The so-called "hot laboratory," now being built at the far end of the site, provides facilities for chemical work with the intensely radioactive materials which will come from the pile. Very efficient ventilation will sweep away any radioactive dust and prevent its being breathed by the chemists.

We are also building laboratories for chemical engineering and in particular for experimental work on the extraction of uranium from low grade ores.

The immediate objective of the chemists is to provide information for the design of the chemical extraction plant for separating plutonium from irradiated uranium metal. There are also associated problems connected with the separation, concentration and disposal of the highly radioactive fission products and longer term problems.

We are building also at Harwell several particle accelerators; there is a so-called Van de Graaff generator which speeds up atoms by 3 to 5 million volts, and there is a giant cyclotron which will speed particles up to an energy of 200 million volts. These machines are required for the studies of the properties of atomic nuclei.

In view of the possible hazard from radiation and radioactive dusts, very stringent precautions are taken at Harwell. As a result of all these precautions, the actual exposure of staff to radiation is very well below the safe levels which have been recommended by the Medical Research Council, and there has been no single case of harmful effects due to radiation.

A research unit of the Medical Council has been established here which will be the centre of research into the biological effects of radiation in this country.

The Royal Society Scientific Information Conference

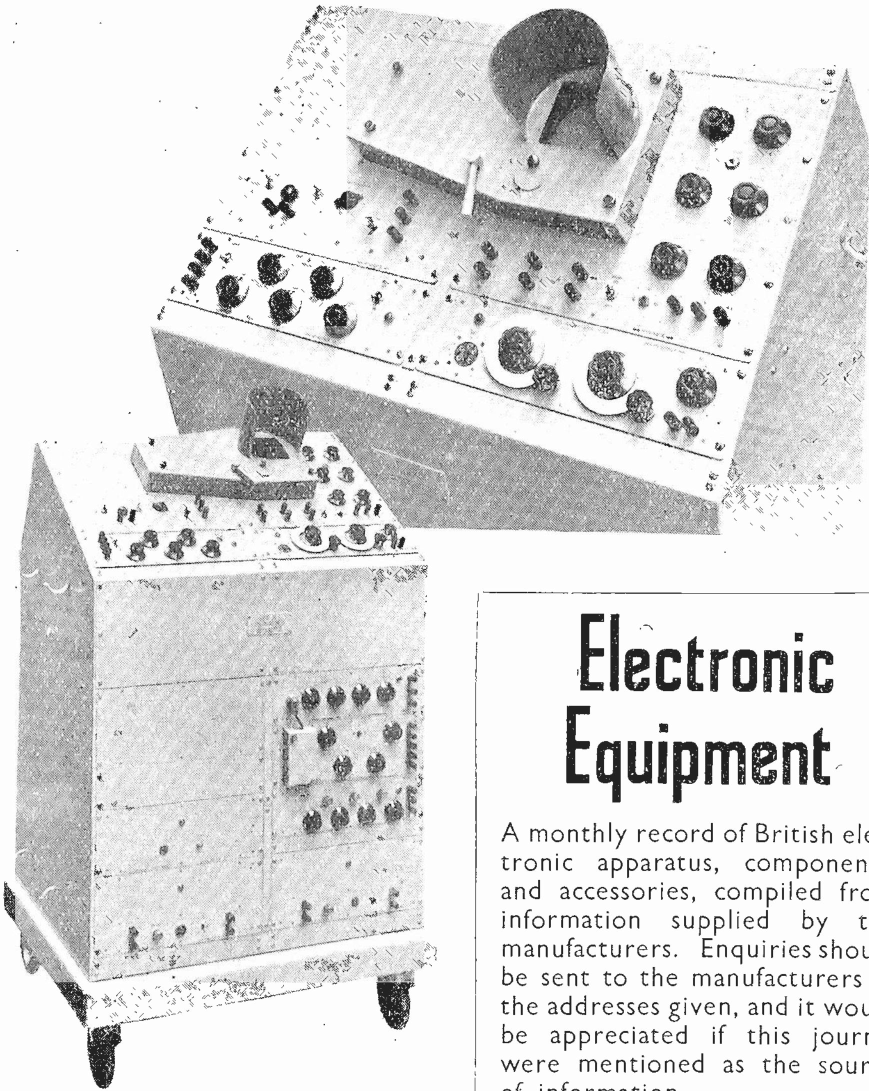
(*Continued from page 248*)

systems of classification will be the primary function of the standing committee to be set up. The section also considered methods of photographic reproduction of various kinds and made recommendations on the suitability of various processes for different purposes. In this connexion the question of copyright was raised and efforts will be made to enable libraries and other agencies to supply photographic copies of articles to scientists without being hampered by copyright restrictions. Machines for the mechanical tabulation and selection of data were also discussed and considerable interest was shown in the American device known as the Bush Selector which is being developed by the U.S. Department of Agriculture. With this instrument it is hoped that it will be possible to select items from microfilm and simultaneously print enlargements at a rate of about 60,000 items per minute. Other topics considered by Section III included the training of special librarians and of scientists in the use of libraries, the compilation of data tables and the co-ordination of translation services.

Section IV was concerned with reviews and progress reports. It felt that the importance of these was not always recognised, and made general recommendations encouraging their publication.

Perhaps the most striking impression gained from the whole proceedings was the extraordinary ignorance of the working scientist of many of the facilities and services which are already available to him in dealing with the literature. Many suggestions which have been under discussion for years by those concerned with documentation were greeted as revolutionary by some of the delegates. If it has no other immediate result, the conference will have served a useful purpose by making some working scientists aware of some of the possibilities of lightening the more tedious parts of his labours.

C. G. A. HILL



Electronic Equipment

A monthly record of British electronic apparatus, components, and accessories, compiled from information supplied by the manufacturers. Enquiries should be sent to the manufacturers at the addresses given, and it would be appreciated if this journal were mentioned as the source of information.

Oscillograph Recorder

THE "Minirack" Oscillograph Recorder, (Type ME15), of which two views are shown, represents a step forward in the design of C.R. oscillographs for general laboratory work. It is built as a desk-type mobile unit which incorporates the camera, so that photographic records can be instantly taken of the waveform or diagram appearing on the tube screen. The 6-in. dia. C.R. tube and the principal amplifiers and time-base are on an inclined panel, and the auxiliary panels and power supplies are mounted on lower vertical surfaces. The camera panel is mounted at the side of the tube panel, the lens and mirror system being protected by a cover which excludes light when recording. Loading, which can be carried out in daylight, is effected from the back, using black sleeves. The camera takes still, continuous-feed and drum records, the total speed range being from 1 to 1,000 inches per second, and it uses 70-mm. wide photographic film or paper. Time-marking is obtained by an auxiliary 1.5-in. dia. C.R. tube and a valve-maintained fork with frequency-reducing multi-vibrators producing standard frequencies of 10,50, 200 and 1,000 cps. This oscillograph can be supplied with several types of amplifier.

A radio frequency (2 Mc s) pre-amplifier employing frequency modulation enables it to be used with capacitance and inductance gauges and pickups for pressure, vibration, or acceleration measurements. Alternatively, an R.C. coupled pre-amplifier can be supplied for dynamic strain gauge measurements, or, if preferred, a direct coupled pre-amplifier for temperature-compensated strain gauge bridges.

Southern Instruments Ltd.,
Fernhill, Hawley, Surrey.

Switches

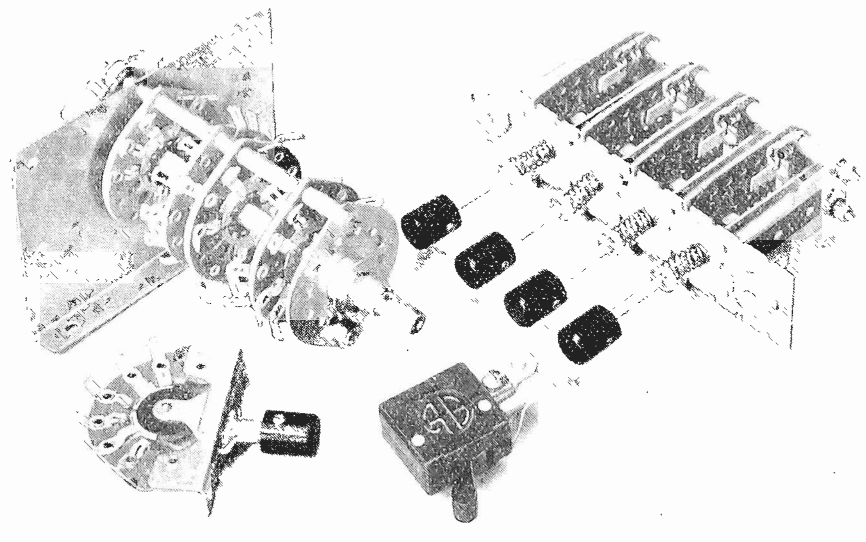
SHOWN on the right-hand side of the adjoining photograph is the A.B. push-button switch, which can be manufactured with any number of buttons and to any electrical specification required, and has been specially designed for radio receivers.

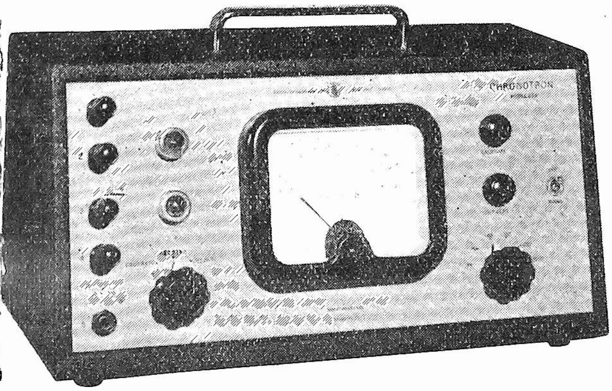
Below it is the A.H. type 5 amp. all bakelite toggle switch.

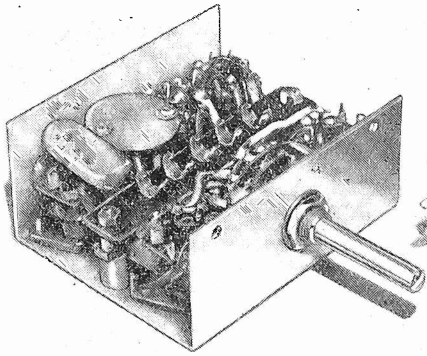
Bottom left illustration is the A.B. LA type lever switch which is used extensively on inter-communication telephone equipment, etc. It is made in two versions, the LA type which is spring loaded to return automatically from either direction to the centre position, or alternatively can be supplied as a lever switch giving the three positions.

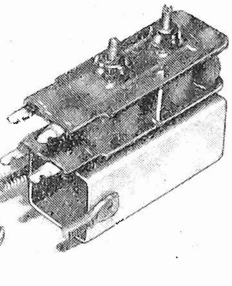
Top left is shown a typical example of the A.B. Oak H type multi-wafer rotary switch, a most useful switch for the radio and electronic instrument designer.

A.B. Metal Products Ltd.,
Feltham, Middx.









The Chronotron

A self-contained direct reading mains-driven instrument for reading short time intervals. The model 25A has six ranges, controlled by the switch on the right, the lowest being 0-4 milliseconds with an accuracy of ± 2%, and the highest 0-1000 milliseconds with an accuracy of ± 1%. Model 25B is similar but covers a higher range of values : 0-40 mS to 0-10 S. Timing is effected by opening, closing, or pulsing the input circuit according to requirements, and the instrument will operate directly from a photo-cell.

Electronic Instruments Ltd.
17 Paradise Rd., Richmond.

Windsor Model 55A Wobbulator

CHECKS receiver alignment by visual tracing of the frequency response curve; used with a signal generator and oscillograph such as the Taylor 65B and 30A.

The triode section of a triode-hexode mixer is used as a 4 Mc/s. oscillator, controlled in frequency by an H.F. pentode as an inductive reactor. Frequency modulation in synchronism with the time base sweep of the oscillograph is obtained by feeding the time base output voltage to the reactor valve, with the amount of frequency sweep controlled by an input potentiometer. Incremental tuning of the 4 Mc/s. oscillator is provided, directly calibrated for 25 Kc/s. on either side of a centre zero for bandwidth measurement. In operation, the signal fed to the receiver under test is frequency difference between the external signal generator and the internal 4 Mc/s. oscillator, and the audio signal produced across the signal diode load is fed to the vertical deflection amplifier of the oscilloscope.

A two pin socket provides input connexion for the external signal generator ; a two pin socket gives the R.F. output, and two terminals provide input connexion for the oscillograph time-base input.

The instrument can be operated on either 100/120 or 200/250 volts A.C. 40-100 c/s.

A comprehensive instruction book is supplied with each instrument.

Dimensions : 12½ ins. by 8½ ins. by 6 ins. Weight approximately 11 lb.

Taylor Electrical Instruments Ltd.
Montrose Avenue, Slough, Bucks.

New Capacitors

THE new T.C.C. "Hikonol" range of capacitors has been designed for flash photography, and has an increased capacitance/volume and weight ratio. The HK28 has a capacitance of 28 uF. and the HK33 a capacitance of 33 uF. Voltage rating 2.5 KV.D.C. Sizes : HK28—4¾ in. by 4$\frac{9}{16}$ in. by 3$\frac{13}{16}$ in. ; HK33—4¾ in. by 5¼ in. by 4¼ in. Prices £6 10s. and £7 10s. respectively.

The "Cathodray" range of high voltage capacitors has been improved by the use of specially developed impregnant. The sizes remain unchanged.

Telegraph Condenser Co. Ltd.
Wales Farm Rd., Acton, W.3.

Screened Coil Pack

A compact screened coil pack measuring 3 in. by 2½ in. by 1½ in. approximately, with one-hole fixing and a spindle 1½ in. long.

The unit covers the bands 16-50, 200-550, and 800-2000 metres when tuned with a 365 pF. capacitor. I.F. is 465 kc/s. Price 35s. boxed.

Alternative types are available with modified waveband coverage for export.

Weymouth Radio Mfg. Co. Ltd.
Crescent Works, Weymouth.

Rotary Mains Switches

OF the A.C. slow make and break type, totally enclosed in moulded case For panel mounting, rated at 10 A. 250 V. Two fixing holes. Type No. R/10, in various combinations.

Alecro (Msx.) Ltd.
73 Hanworth Rd., Hounslow.

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A personal account of the work of the Telecommunications Research Establishment by its war-time Chief Superintendent. 7 plates. 8s. 6d. net

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The latest addition to the MODERN RADIO TECHNIQUE SERIES 15s. net

CAMBRIDGE UNIVERSITY PRESS

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STANDARD VALVES 1947 (Standard Tele Cables Ltd.). 15s. Postage 4d.

RADIO ENGINEERING, by F. E. Terman. 42s. Postage 9d.

FREQUENCY ANALYSIS MODULATION AND NOISE, by S. Goldman. 36s. Postage 9d.

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TELEVISION RECEIVER CONSTRUCTION (10 Articles from W.W.). 2s 6d. Postage 2d.

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THE WIRELESS WORLD VALVE DATA 2s. Postage 2d.

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BOOK

Valve Technique

D. N. Corfield and P. V. Cundy. (Radio Society of Great Britain. Price 3s. 6d.)

THIS is an excellent publication, filling a vacancy which has long existed despite the flood of valve and electronic textbooks in recent years.

Valves are now used in such growing numbers by engineers, physicists, research workers and similar people that a small handbook giving the salient points of application without the theoretical foundation for the formulae used will be welcomed. For example, a mechanical engineer who wishes to use a thermionic valve in a piece of industrial apparatus is concerned to know how the power output varies if certain constants are changed. Precisely how the formula is derived is wasting his time, and amateur-constructors and others who want to be able to apply valves to circuits correctly without wading through masses of electronic theory will find exactly what they want.

A valve manufacturer cannot possibly include in his catalogue all the variants of application that may arise in practice, and the ability to convert what is given to what is wanted will be welcomed by many overworked valvemakers' technical service departments. It is to be hoped that the booklet will be widely read by those who normally prefer to "write to the makers."

While agreeing with the authors' approach via the cathode follower to the negative feed-back problem, the normal amateur might be expected to prefer to be conducted to the one hundred per cent. feed-back state in easier stages.

The handling of the push-pull variants, classes A, AB, B. etc., together with the curves, is admirably done. The explanation of a method of producing dynamic curves from static curves, as found in catalogues, is very lucid and will solve what has been to many amateurs rather a closed book.

The principle of adopting the B.S.I. and B.R.V.M.A. convention of symbols is an excellent idea tending towards uniformity with the valve catalogues.

C. C. McC.

Sound Recording by the Direct Disk Method

D. O'C. Roe. (Birmingham Sound Reproducers, Ltd. 34 pp., six figures and photographs. Price 5s.)

THE reviewer understands that one copy of this booklet is supplied to each purchaser of a B.S.R. sound recording equipment. It is, in fact, an instruction manual for operating the B.S.R. disk recorder, type DR.33 and recording amplifier AR.15, but it contains far more than the usual lists of "how to connect this to that" and "do's or don'ts" relating to the apparatus, or it would not be worth reviewing here.

The reader soon appreciates that the author has practical knowledge and enthusiasm for his subject, which he has managed to convey in the few pages of this booklet. While it may be a platitude to say that "good recordings are not merely the automatic result of good equipment, but depend a great deal upon the skill and experience of the operator," it is nevertheless true, and another wise comment that many private studio recordists should take to heart is the remark that "in all monitoring, the great essential is to learn the characteristics of the microphones and recording equipment, not forgetting, of course, to check that the recordings are satisfactory when played-back on a standard radio-gramophone."

The author does not perpetuate the common misnomer "acetate records" for direct cut lacquer or nitrate records, but a few minor spelling errors should be corrected in future editions. For example, in the Introduction "principal" is written "principle," and either "equaliser" or "equalizer" should be decided on, and not mixed. On p. 34 the common mistake of referring to the Performing Right Society, Ltd., as the Performing *Rights* Society, Ltd. is made, but these slips do not detract from a text that contains useful information on studio acoustics, properties of different types of microphone, typical recording faults, and practical tips for successful sound recording.

The text and diagrams are well printed on fine quality paper, but the price of 5s. is rather high for this kind of publication.

D. W. ALDOUS

The Electricity Supply Acts

By J. W. Chant. 262 pp. + xiii. Stevens and Sons, Ltd. 25/- net.

IN view of the recent transfer of all authorised undertakings to the British Electricity Authority this is an important and well-timed book.

One third of the book is devoted to the Electricity Act 1947 and this is followed by the various Electric Lighting Acts and Electricity (Supply) Acts dating from 1882 to 1945. The Sections of these earlier Acts are only given in full where not repealed by the Electricity Act 1947, but brief notes of the Clauses so repealed are given for reference purposes.

The author is a solicitor with long experience of municipal affairs and of the workings of a large electric power company.

REVIEWS

Micro-Wave Mixers

Robert V. Pound. Edited by C. G. Montgomery and D. D. Montgomery. Vol. 16 of the Radiation Laboratory Series. 381 pp., (McGraw-Hill Book Co. U.S.A.) Price $5.50 (33s. in U.K.).

THIS book is devoted almost entirely to the crystal mixer used as a frequency-changer in radar receivers of the super-heterodyne type. The importance of this type of mixer lies in its high efficiency (low conversion-loss) and relatively low noise-factor—no other type of mixer has so far proved as satisfactory in the micro-wave range. Although simple from a mechanical point of view the crystal mixer is far from simple electrically and this book of some 380 pages by no means covers all possible aspects of the design; nevertheless the treatment is sufficiently thorough to reveal the remarkable advances in knowledge in this field which took place during the war years.

The behaviour of a crystal as a rectifier is first discussed in terms of the barrier-layer theory of semi-conductors, the use of crystals in frequency-changers is then described. Network equivalences for crystal mixers are given and the use of such networks as a basis for design is explained. A section is included on the testing and specification of crystals (further information on this subject is given in Vol. 15 of the Radiation Laboratory series).

Details are given to the design of simple crystal mixers for the 10, 3 and 1.25 cm. bands; other chapters deal with specialised mixers for air-borne combined radar and beacon equipment, two-channel mixers for A.F.C. systems and balanced mixers for local oscillator noise reduction. One chapter (contributed by E. Durand) deals with the design of A.F.C. systems of various types such as the "difference-frequency," "drift-in hunting," "thermal hunting" and "absolute-frequency" types.

A final chapter covers the specialised techniques involved in the measurement of noise-factor and conversion loss, and in the testing of A.F.C. systems.

"Micro-wave Mixers" is primarily a book for the specialist in radar receiver design but should also prove of value to the designer of micro-wave communication systems, particularly when used in conjunction with other volumes in the Radiation Laboratory series.

A minor criticism of the book is the paucity of references to the original sources of information, particularly to British work in this field.

W. J. BRAY

Crystal Rectifiers

Professors Henry C. Torrey and Charles A. Whitmer. Vol. 15 of the Radiation Lab. Series. (McGraw-Hill Book Co. U.S.A.) 443 pp., 216 figs. Price $6.00. 36s. in U.K.)

THE introduction to the book briefly traces the development of crystal rectifiers up to the end of the war. By then they have become a stable and compact device, superior in many applications to the thermionic diode and unequalled as frequency changers or detectors for micro-wave receivers.

"Crystal Rectifiers" is divided into three sections, following the introduction. The first of these is an exhaustive treatise in the theory of semi-conductors and point contact rectifiers. The theory of barrier layer rectification, both for acceptor and donator regions, Hall effect, and the general mechanism of point contact rectification phenomena are discussed in detail. The authors do not claim their treatment to be rigorous and complete. Where observed results are not in agreement with expectations the facts are stated, and due prominence is given to gaps in existing knowledge.

The second and third parts are devoted to the design, processing, manufacture and testing of American rectifiers. Part Two deals with the centimetric wave frequency convertor crystal and Part Three with two other applications. In this connexion it is interesting to note that the authors have entitled Part Three "Special Types" but, since the book was written, some of these "Special Types" approach in importance the micro-wave mixers of Part Two. This remark may be taken as implying that parts of the book are "dated," but so, probably, is any work devoted to a rapidly advancing subject.

Naturally, all the examples and almost all the details of manufacturing technique quoted are American. But the authors give some prominence to British pioneering and subsequent development. It is, however, to be regretted that British types are neither specifically mentioned, nor illustrated nor is any reason given for the American decision to reverse the polarity of their standard crystal from the original British design.

But in general, the authors are to be congratulated on presenting a very comprehensive and authoritative treatise. As they say, data has been obtained from numerous sources, and it is, perhaps, inevitable that the information should tend to be somewhat disjointed and overlapped. Even so, this may be attributed as much to unevenness of war time research and development as to unevenness in the authors' presentation. The book is worthy of its place as to the first and, up to the present, the only work on the subject.

J. H. EVANS

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ABSTRACTS OF ELECTRONIC LITERATURE

C. R. TUBES

Stereoscopic Viewing of R.C. Tube Presentations

(*H. A. Iams, R. L. Burtner and C. H. Chandler*)

This paper describes two methods of presenting three dimensional information on cathode ray tubes. Possible applications are considered and examples given showing both oscillograms and radar presentations in three dimensions. A discussion of the effect of flicker on stereoscopic viewing is included.

—*RCA Review*, March, 1948, p.149.

An Oscilloscope Camera

(*H. E. Hale and H. P. Mansberg*)

Continuous recordings of oscilloscope patterns are made on film or paper at speeds from 1 in. per minute to 5 ft. per second, a range of 3,600 to 1, using electronic motor control. Either film motion or the oscilloscope sweep can be employed as the time base.

—*Electronics*, June, 1948, p.102.

Iron-Cored Deflecting Coils for Cathode Ray Tubes

(*A. Woroncow*)

A concise theory of the magnetic circuits of deflecting coils with iron cores is given, and experimental results with various types of single-field and crossed-field coils are described. The properties of sensitivity, inductance, resistance, defocusing and distortions are considered, particular attention being paid to coils with slotted cores.

—*Jour. I.E.E.*, Part 3a, March-May, 1946, p.1,564.

A Precision Time-Base and Amplifier for Radar Range Measurement

(*J. H. Piddington and L. U. Hibbard*)

A precision time base for use in a coastal defence fire-control radar set is described. The accuracy is about 1 part in 2,000 and the flexibility and neat method of display make it a useful and versatile time base.

Three variations, derived from this original time base are also described. The first of these is a simplified precision version for anti-aircraft fire-control radar. The others are for surface-search radar and aircraft-warning radar sets and have accuracies of about 0.3 per cent. and 1 per cent. respectively.

The four time bases described constitute the display units of nearly all the radar sets developed in Australia. Something like five hundred sets have been built around them.

—*Jour. I.E.E.*, Part 3a, March-May, 1946, p.1,602.

INDUSTRY

New Technique in Glass-to-Metal Sealing

(*J. A. Pask*)

The methods of making metal-to-glass seals described in this article apply to "Kovar"-to-glass seals. Data given are for "Kovar" oxidised at a number of controlled temperatures and for varying times. The optimum obtained with a weight gain of .003 to .007 gr./sq. cm. The powder-glassing method of making seals described consists of grinding the glass, suspending the powdered glass in a suitable liquid, applying it to the prepared metal, and fusing to form a thin glass layer. The glass tube or bulb is subsequently joined to this layer as a glass-to-glass seal. Some examples of applications are given.

—*Proc. I.R.E.*, February, 1948, p.286.*

Soldering Aluminium Alloys

(*F. W. Thomas and E. Simon*)

Difficulties encountered in tinning aluminium have been partly overcome by vibrating solder at an ultrasonic rate while applying it to the work. This disrupts the oxide coating and enables alloying to take place before re-oxidation can occur. The operation is carried out by means of a valve-driven magneto-striction unit. Reasons for the selection of such a unit are analysed, and its characteristics discussed. Features of the polarising coil are investigated and operation of the equipment is described. The method has been applied to other metals which are difficult to solder.

—*Electronics*, June, 1948, p.91.*

Summarised Proceedings of Conference on Electron Microscopy

A brief account is given of the Seventh Conference on Electron Microscopy held at Leeds, September, 1947. A number of short reports, discussions and abstracts of papers by various scientists are included. On the whole, attention during this occasion was directed particularly to the applications rather than to the construction of the electron-microscope. Two types of microscope were especially dealt with: a new French instrument and the latest M-V. E.M.3 model, a prototype of which was demonstrated. A discussion on the choice of photographic materials showed that films, especially the 35 mm. size, are preferable to plates.

—*Jour. Sci. Inst.*, May, 1948, p.167.*

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

MEASUREMENT

The Measurement of Delay Distortion in Microwave Repeaters

(*D. H. Ring*)

Measuring equipment is described which is capable of measuring delay distortion of the order of 10^{-9} seconds in a wide band microwave television relay repeater. Two measuring circuits are discussed. The first is a circuit for measuring the relative phase shift versus frequency from which the delay distortion may be computed. The second circuit gives the delay directly from a single measurement. The measuring equipment is designed to work in the intermediate frequency range from 50 to 80 Mc/s., but by applying suitable conversion equipment measurements can be made at microwave frequencies.

—*Bell. Syst. Tech. Jour.*, April, 1948, p.247.

The Proficorder—An Instrument for Recording Waviness and Other Surface Profiles

(*E. J. Abbot, E. Rupke*)

The instrument described, called a Proficorder, is used for measuring surfaces and provides essential data for the study of surfaces and the processes by which they are obtained. By amplifying electrically the output of a stylus tracer element, it reproduces the actual profile of a considerable length of surface, and permits the study of irregularities of size, shape, and relative position with respect to other irregularities. It can also be used for inspection of surface characteristics in production set-ups. Small angles relative to a given plane can also be measured with this instrument. Components of the instrument are enumerated, and principles of operation and functional details are given. Tests for determining accuracy and sensitivity of the Proficorder are described.

—*Amer. Soc. Mech. Engrs. Trans.*, May, 1948, p.263.*

Thickness Gauge for Moving Sheets

(*J. W. Head*)

The device described has been developed to measure glass and non-magnetic sheets having thicknesses of from ⅛ in. to 1 in. The material is passed between the primary and secondary windings of a measuring transformer; variations in material thickness change the coupling and are indicated by the out-of-balance reading on a bridge. The transformer is fed at audio frequency. The oscillator, amplifier, indicator, bridge and power supply circuits are described, together with the operation of the instrument.

—*Electronics*, May, 1948, p.90.*

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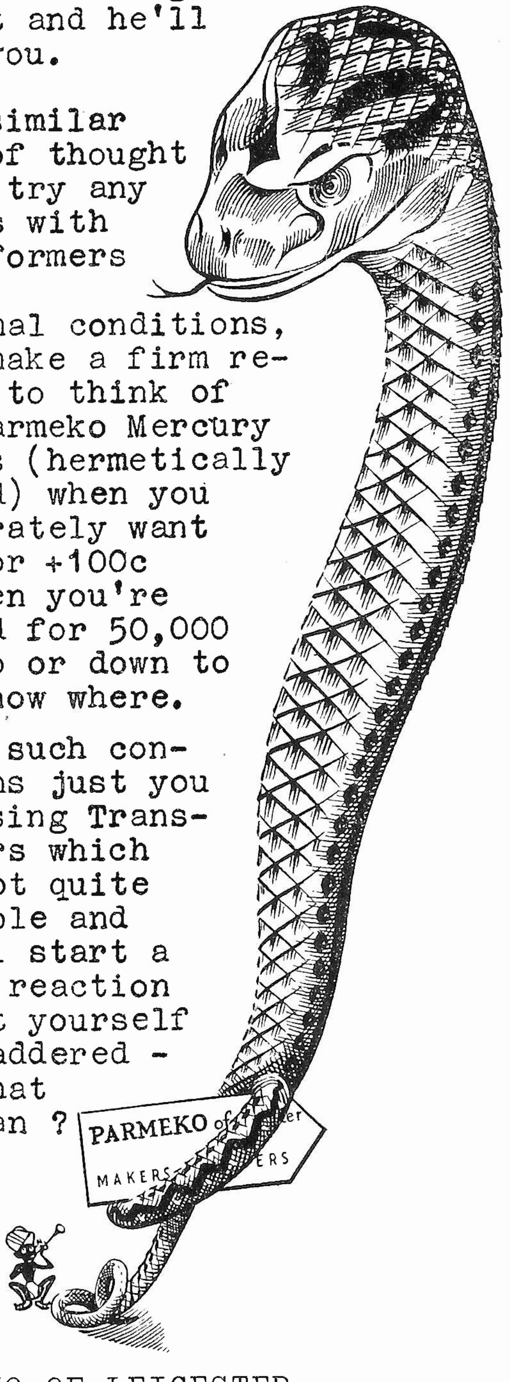

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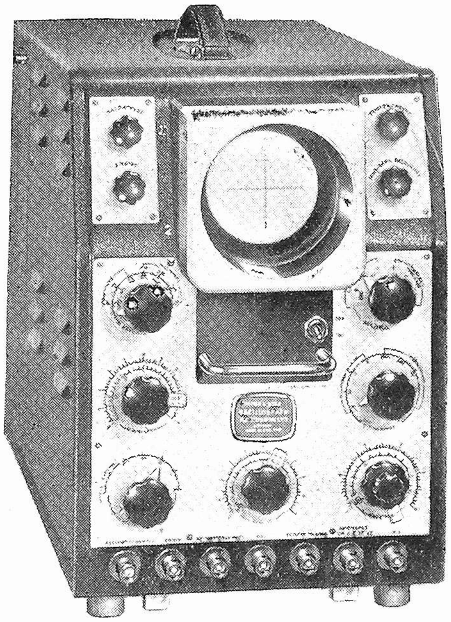

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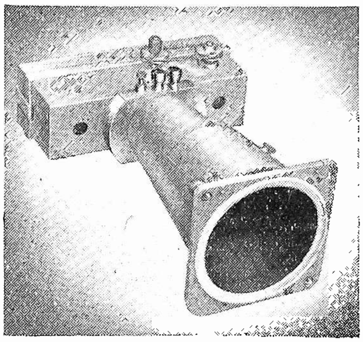

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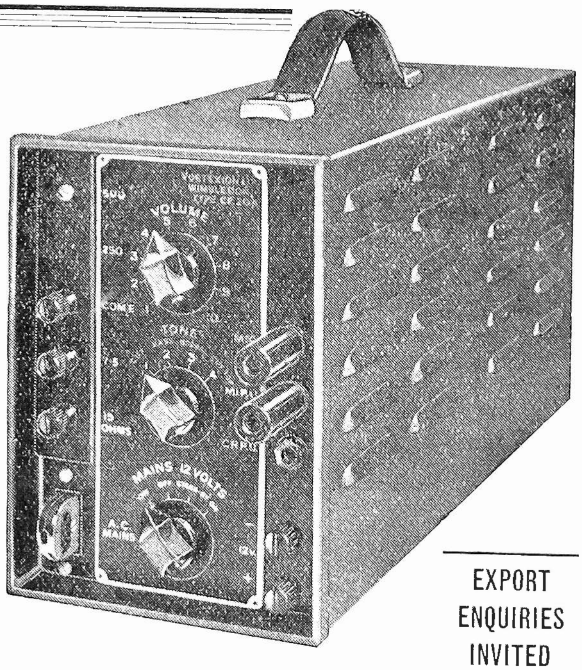

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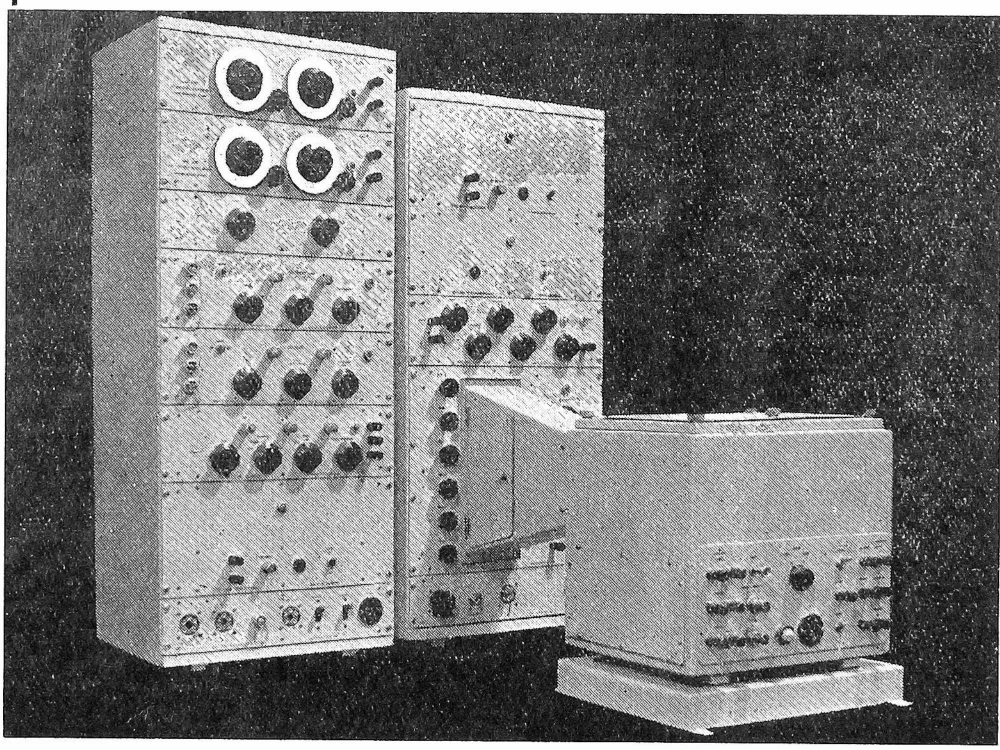

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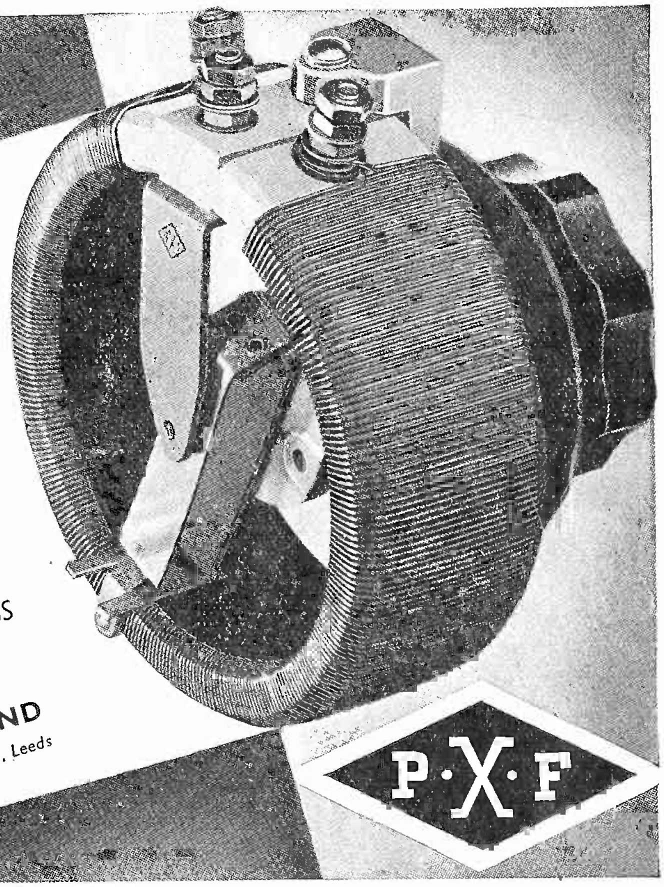

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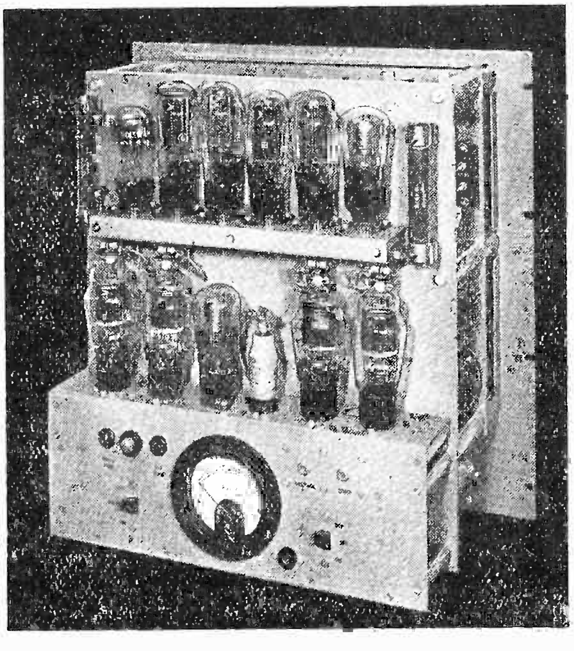

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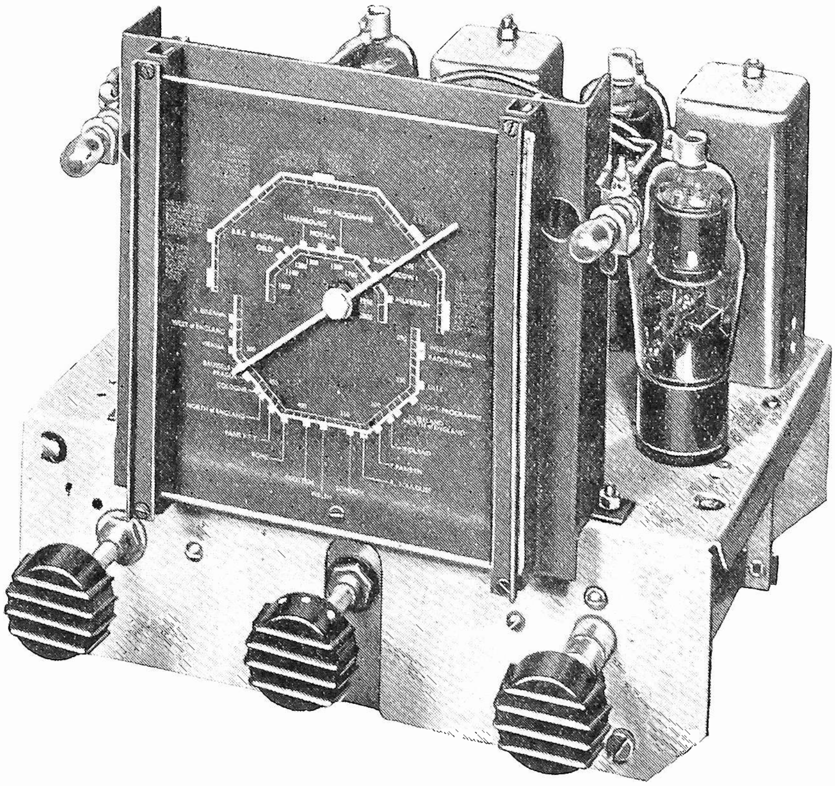

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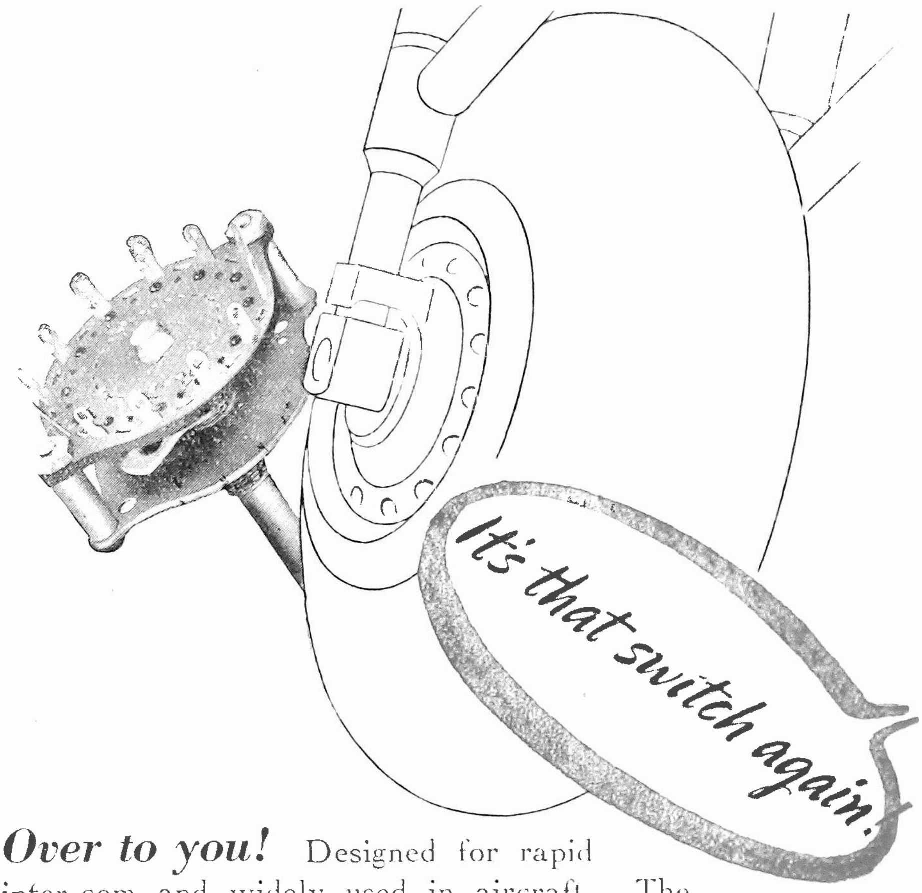

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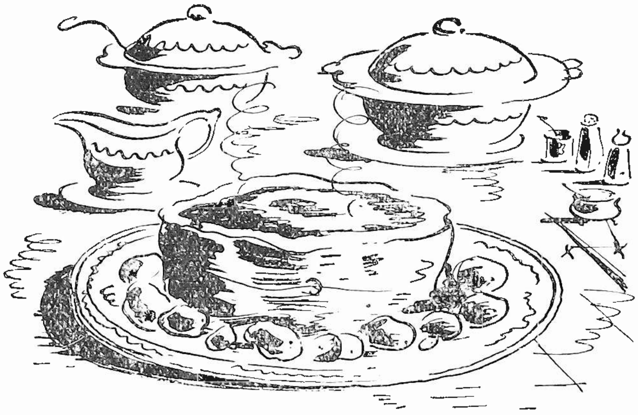

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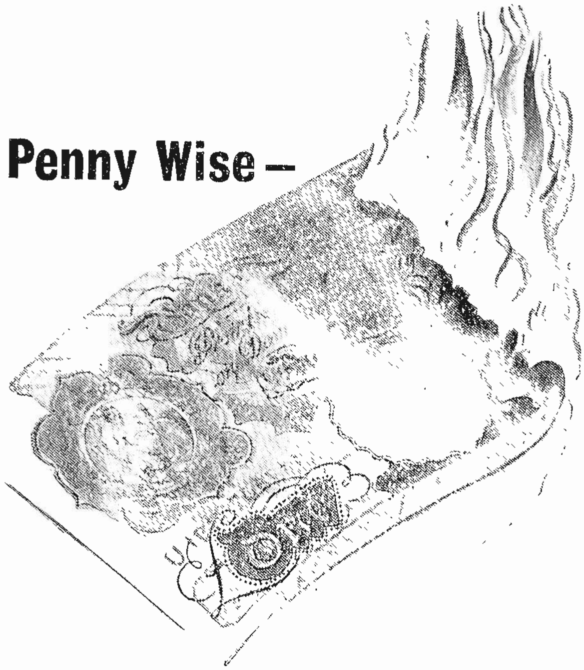

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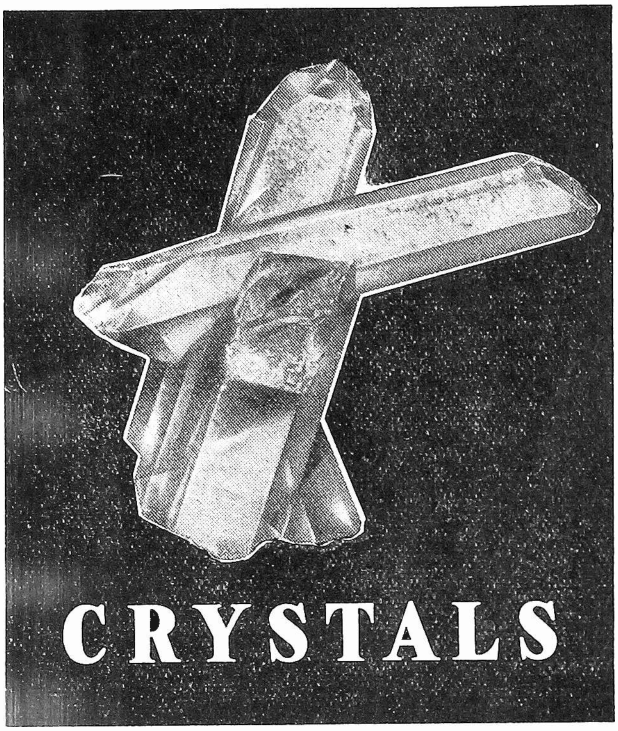

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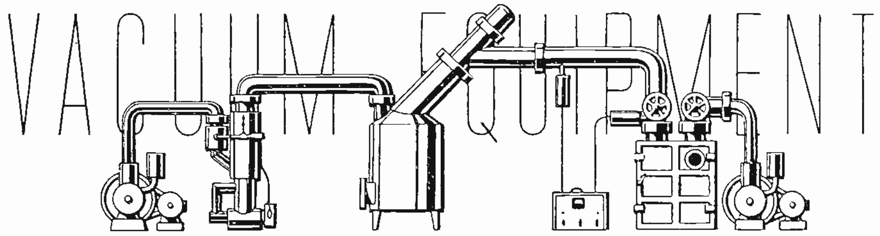

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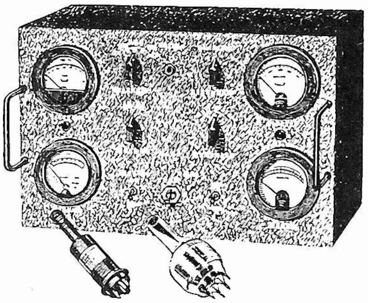

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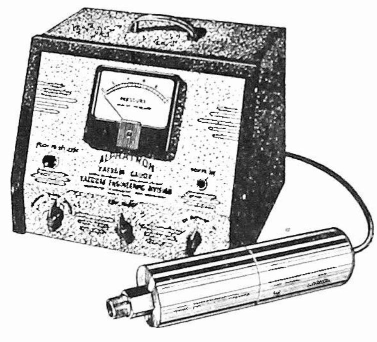

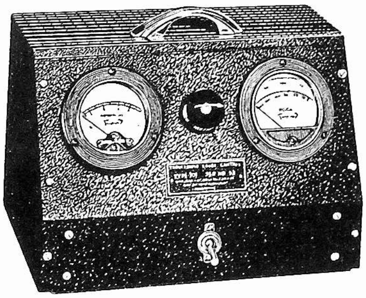

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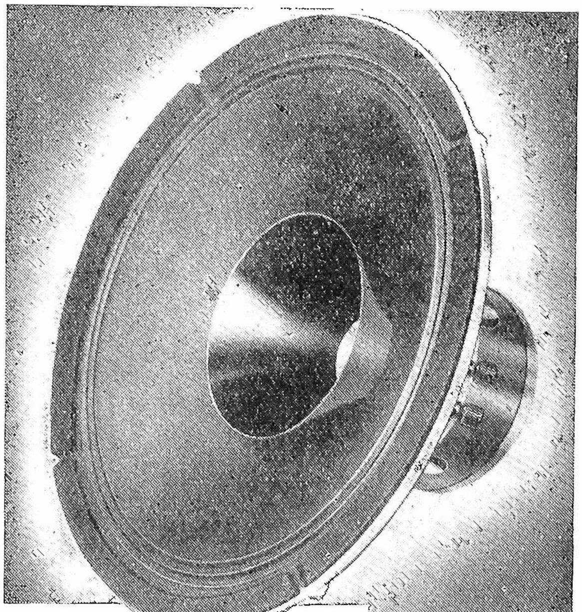
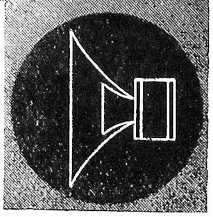


This outstanding instrument marks a further important stage in the development of faithful sound reproduction. The patented twin diaphragm assembly* and high magnetic flux together account for the excellent overall frequency and transient response. Provided that the electrical input is faultless, every inflexion of the human voice is rendered with startling realism, and the natural range and contrast of the orchestra are strikingly re-created. It is absolutely essential to use this Loudspeaker with equipment which has been specifically designed for High Fidelity reproduction, as it will reproduce everything fed to it, including any distortion that may be present. For all normal requirements we recommend our standard 12 in. model T2.

Please send for illustrated folder A.88 giving full technical details.

* *British Patent No. 451,754. Other patents pending.*



This sectional diagram of the Axiom Twelve unit illustrates the twin exponential diaphragms with seamless moulded centre cone of extreme lightness and rigidity. A single speech coil drives the two diaphragms, which are coupled through a mechanical compliance. This achieves a perfectly smooth cross-over without any electrical filter network.

FIDELITY G EFFICIENCY

NOTE. To obtain the best results from the Axiom Twelve Loudspeaker it is important to use a first class output transformer, correctly designed to match the equipment. Goodmans type H4 Transformers fulfil these conditions, being wound to individual load requirements. They can be supplied at short notice.

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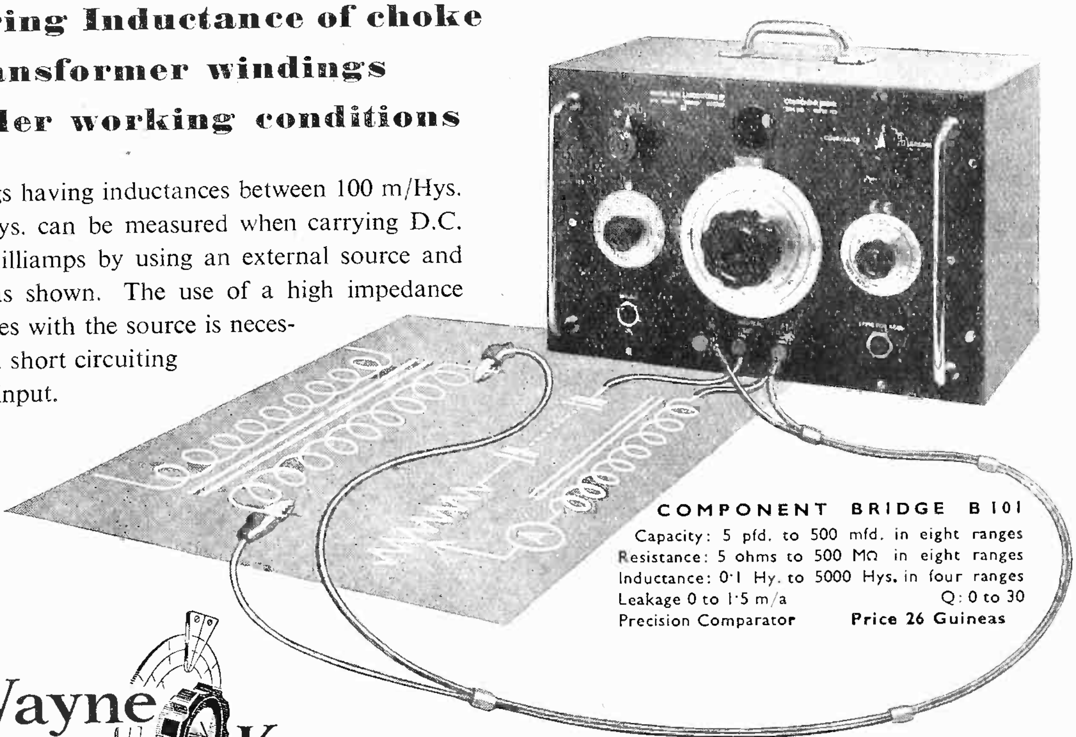
Measuring Inductance of choke and transformer windings under working conditions

Windings having inductances between 100 m/Hys. and 5,000 Hys. can be measured when carrying D.C. up to 100 milliamps by using an external source and connecting as shown. The use of a high impedance choke in series with the source is necessary to avoid short circuiting the detector input.



COMPONENT BRIDGE B 101

Capacity: 5 pfd. to 500 mfd. in eight ranges
Resistance: 5 ohms to 500 MΩ in eight ranges
Inductance: 0·1 Hy. to 5000 Hys. in four ranges
Leakage 0 to 1·5 m/a — Q: 0 to 30
Precision Comparator — **Price 26 Guineas**

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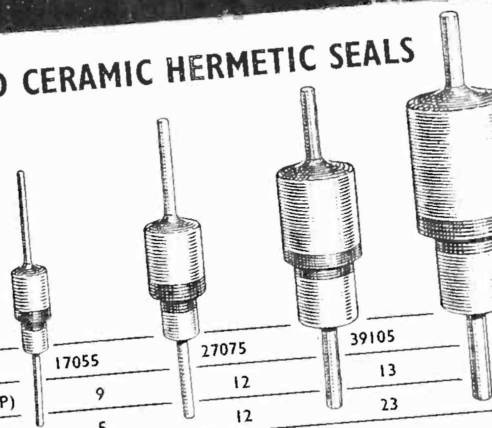
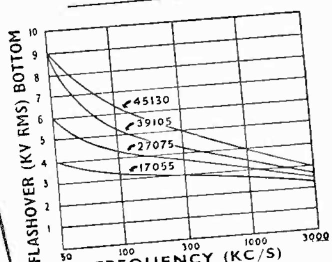


TYPE NUMBER	17055	27075	39105	45130
FLASHOVER KV DC (TOP)	9	12	13	21
MAXIMUM AMPS.	5	12	23	26



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CM20N	500pF	1/6
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M3N	3000pF	2/3
M3N	5000pF	3/-
M3N	10000pF	4/6
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922	8mF 600v.	15/-
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543	0.005mF	0/10
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CP33S	0.01mF 500v.	1/10
CP34S	0.02mF 500v.	1/10
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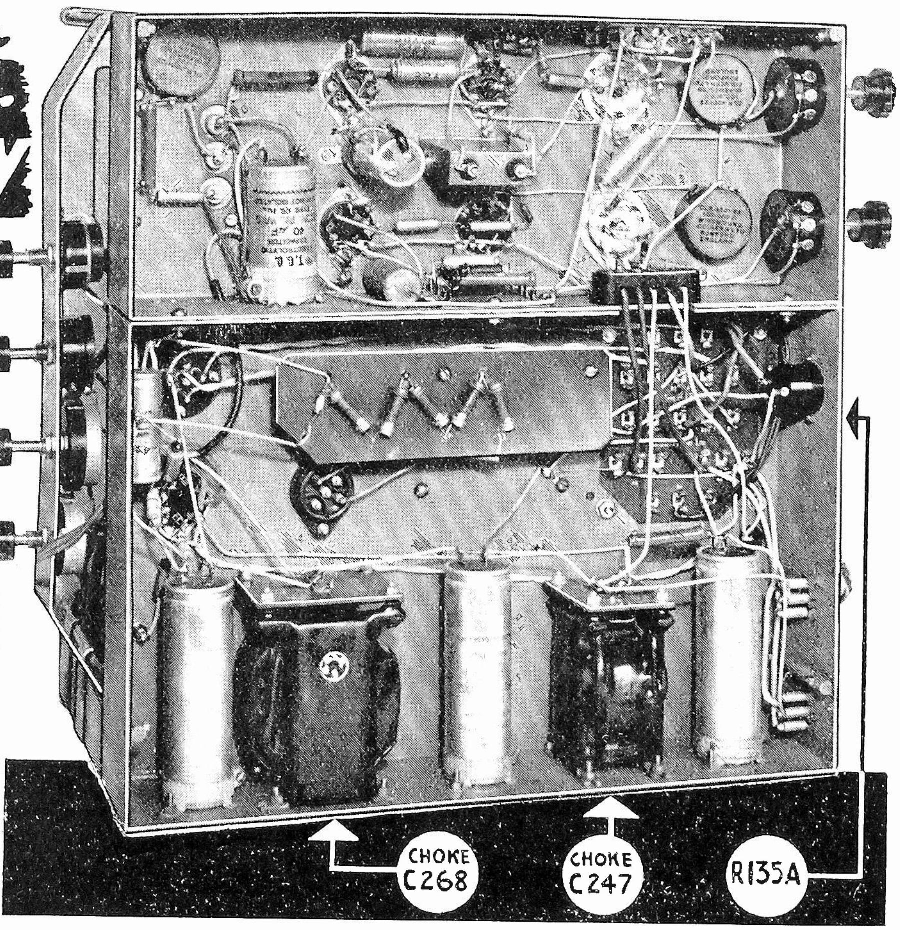

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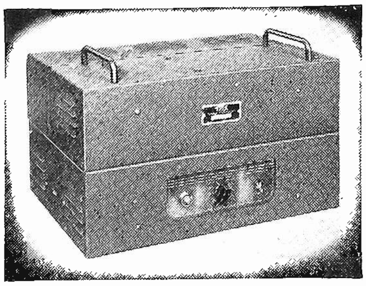

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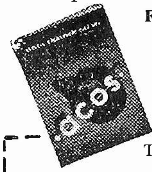

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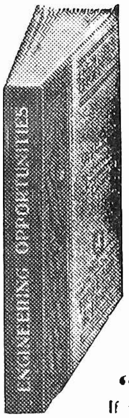

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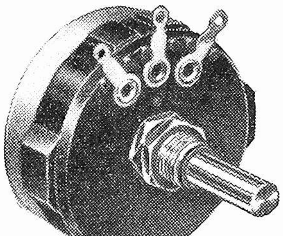

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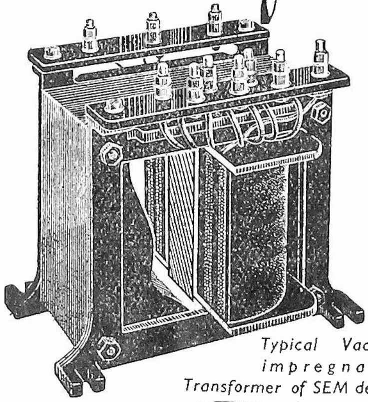

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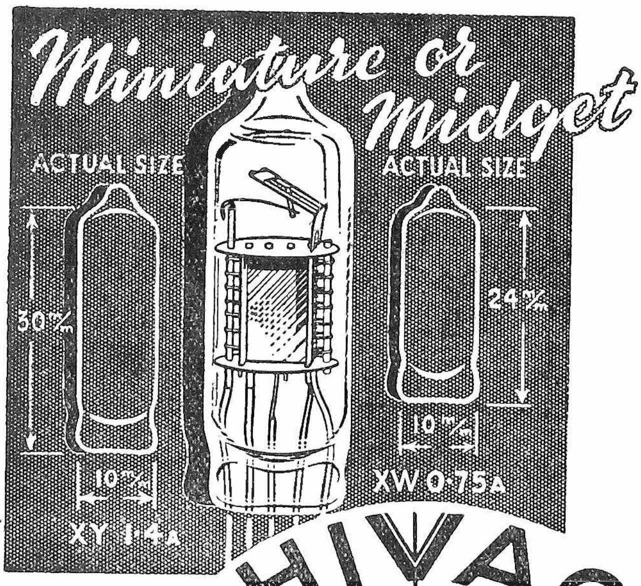

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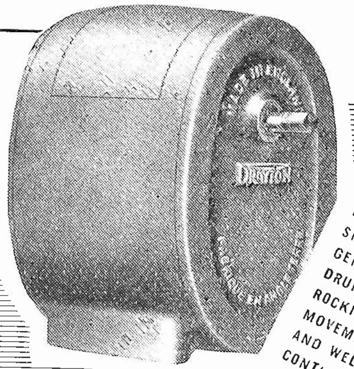

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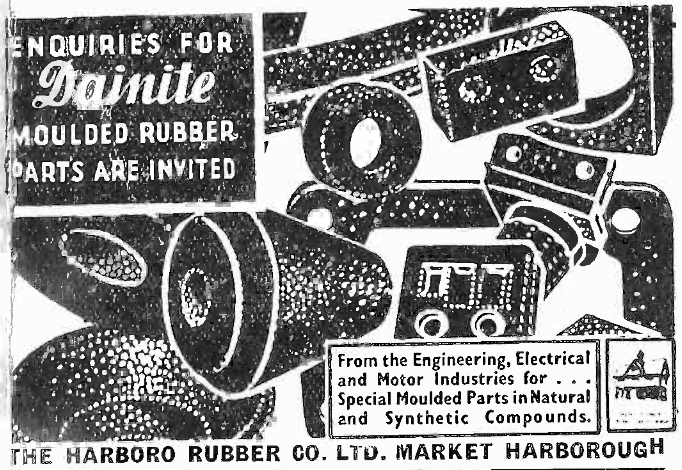
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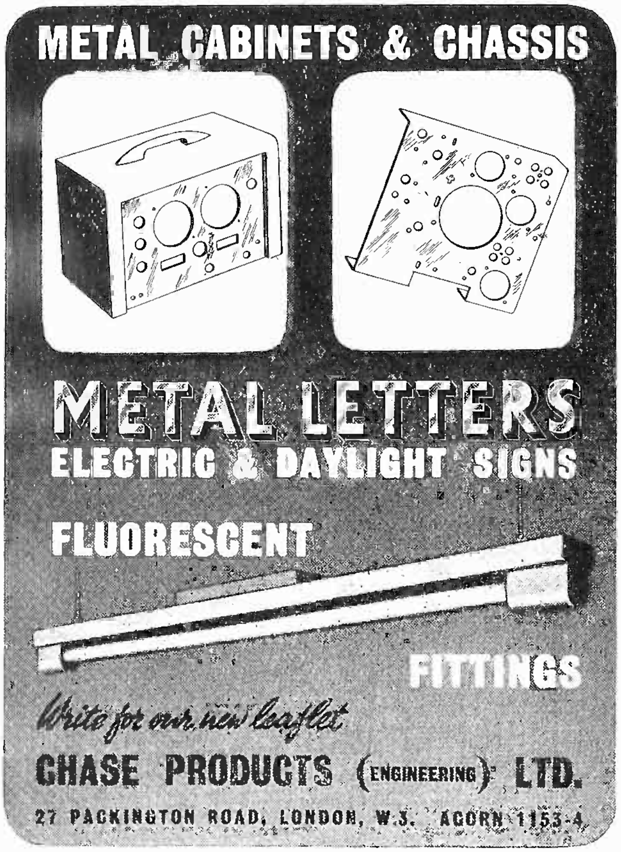
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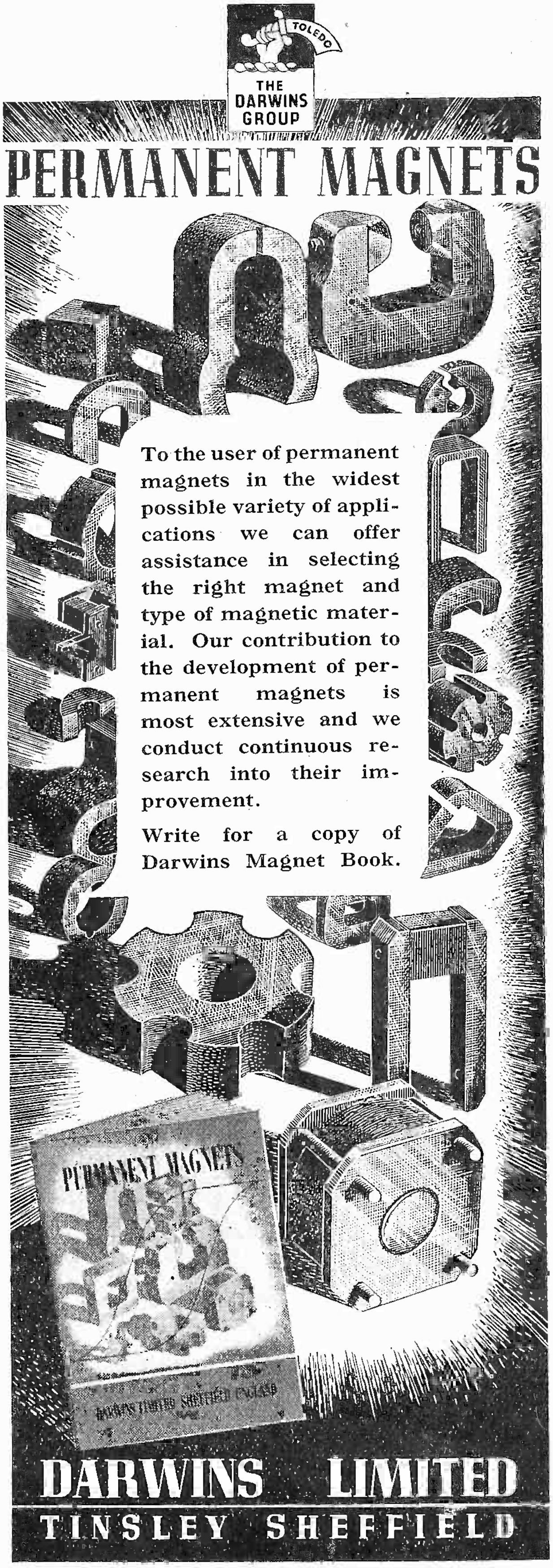
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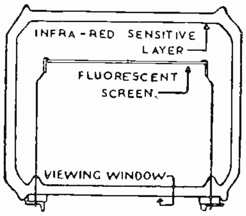

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304B	50 watts Thoriated Tungsten filament R.F.	4304CA
834	50 watts Thoriated Tungsten filament R.F.	4304CA
242A	85 watts Thoriated Tungsten filament A.F.	4242A
211A	85 watts Thoriated Tungsten filament A.F.	4242A★
212E	275 watts Thoriated Tungsten filament A.F.	4212E
270A	350 watts Thoriated Tungsten filament R.F.	4270A
357A	350 watts Thoriated Tungsten filament R.F.	4357A
228A	5 kW Tungsten Filament. Water-cooled	4228A
RK.34	5 watts Double Triode. Indirectly heated	4074A

TETRODES

American Type		Standard Type
282A	70 watts Thoriated Tungsten filament	4282A
260A	100 watts Thoriated Tungsten filament	4260A

BEAM POWER TETRODES

American Type		Standard Type
807	25 watts indirectly heated	5B/250A
813	100 watts Thoriated Tungsten filament R.F.	5C/100A

PENTODES

American Type		Standard Type
RK.20	60 watts Thoriated Tungsten filament R.F.	4052A
RK.28	100 watts Thoriated Tungsten filament R.F.	4069A
803	100 watts Thoriated Tungsten filament R.F.	4069A★

TYPES MARKED ★ ARE NOT EXACT EQUIVALENTS

RECTIFIERS

American Type		Standard Type
274A	High vacuum full wave Oxide-coated filament	4274A
866/866A	HCMV. P.I.V. 10 kV Average current 0.25A	2V/400A
872/8008	HCMV. P.I.V. 20 kV Average current 1.25A	4064B
869B	HCMV. P.I.V. 20 kV Average current 2.5A	4078A
222B	Water-cooled high vacuum P.I.V. 45 kV	4222B

COLD CATHODE TUBES

American Type		Standard Type
313C	Gas-filled relay and stabiliser	4313C
0D3/VR150	Gas-filled stabiliser, stabilised voltage 150V	G180/2M

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