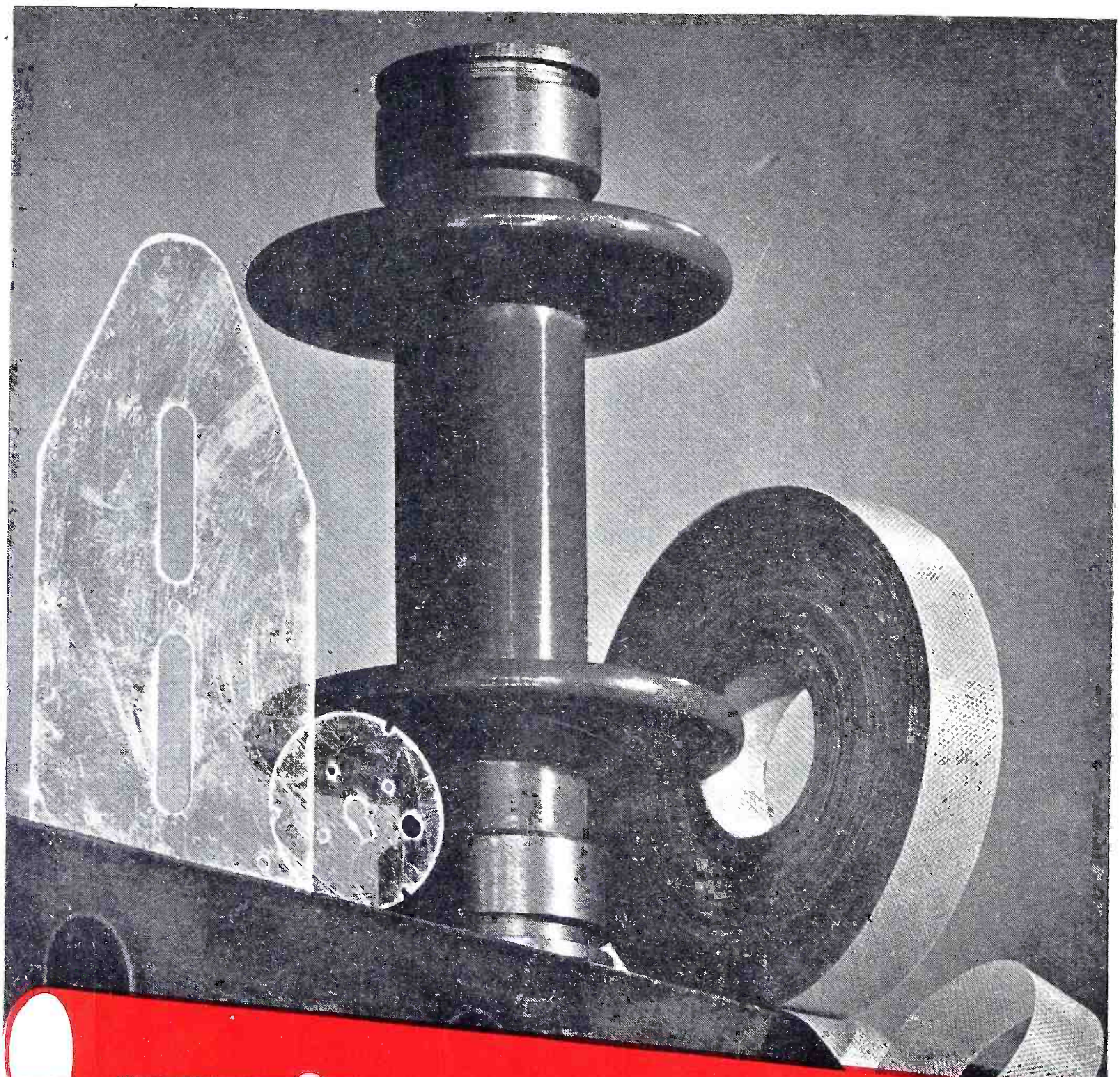
Electronic Engineering

Incorporating . . . ELECTRONICS, TELEVISION & SHORT WAVE WORLD

VOL. 20 No. 244 JUNE 1948 PRICE 2/-



CLASSIFIED ANNOUNCEMENTS

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

OFFICIAL APPOINTMENTS

acancies advertised are restricted to persons or employ-ents excepted from the provisions of the Control ngagement Order, 1947.

.B.C. invites applications for two posts in the elevision Section of the Research Department, Kings-ood, Surrey, as follows : (a) A post in a grade rising y annual increments of £50 to a maximum of £1,100 r annum. Candidates must have an honours degree Physics, or equivalent qualification, and experience photographic reproduction in colour or allied pro-sses. A knowledge of the physiology of colour devision and of modern methods of colour matching is sirable. Some knowledge and experience of sion practice would be an advantage. Preference ll be given to candidates who have carried out iginal research and have made contributions in these lds. The work will entail investigation of colour tics as applied to television. (b) A post in a grade ing by annual increments of £30 to a maximum of 80 per annum. Candidates should preferably hold degree or an equivalent qualification in Physics or ectrical Engineering and must have experience in lour photometry. Some knowledge and experience television practice would be an advantage. Applica-ons, stating age, qualifications and experience, should ach the Engineering Establishment Officer, Broad-sting House, London, W.1, within seven days of the pearance of this advertisement.

.B.C. invites applications for the post of Engineer in Transmitter and Aerials Section of Research partment. The successful candidate will be based itially at Oxford and later at Kingswood, Surrey. plicants must possess a University degree or uivalent qualification, and have a sound knowledge radio fundamentals with a good mathematical back-ound. An aptitude for original investigations is sential. Research experience in the radiation and opagation of waves or in allied subjects is desirable. he work involves theoretical and practical investiga-ons on aerials, transmitters and systems of odulation. The salary is on a grade rising by annual rements of £30 to a maximum of £680 per annum. plications, stating age, qualifications and experience ould reach the Engineering Establishment Officer, oadcasting House, London, W.1, within seven days the appearance of this advertisement.

HE UNIVERSITY OF MANCHESTER Depart nt of Electrical Engineering. Applications are vited for appointment to the staff of the Royal ciety's Computing Machine Laboratory, with the atus of Lecturer in the University. Knowledge of ctronic circuit techniques is essential. Salary scale, oo to £800 per annum. Initial salary according to alifications and experience. Membership of F.S.S.U. d Children's Allowance Scheme. Further particulars om the Registrar, The University, Manchester, 13, whom all applications should be sent not later than une 4, 1948.

NIVERSITY COLLEGE OF SWANSEA. The ouncil of the College invites applications for **either** Assistant Lectureship in Engineering (commencing ary, £450 per annum) **or** a Lectureship in Engineer-g (salary on the scale £500 to £750 per annum, ording to qualifications and experience). Qualifica-ns in Electrical Engineering are essential and some perience in Electronics is desirable. Further par-ulars may be obtained from the Registrar, University llege, Singleton Park, Swansea, by whom applica-ons must be received **without delay.**

SITUATIONS VACANT

ENIOR RADIO ENGINEERS and Designers quired by large manufacturer in the East London ea. Suitable applicants must have adequate hnical knowledge and experience in the design of dio and television equipment. State age, qualifica-ons, experience and salary required to Box 279, E.E.

NGINEER required for laboratory investigation d measurements in conjunction with radio and ctronic devices. Experience in electron optics sirable, with ability for original design. Applicants ould have reached accepted standards of education d carry adequate production-design experience. est London area. Apply, giving age and full details education and experience, to Box 271, E.E.

A LARGE VALVE MANUFACTURER (S.W. London) requires Graduates in Physics or Electrical Engineering as assistants in cathode ray tube development. Must have had some experience of design or manufacture of cathode ray tubes or similar articles. Should be capable of working in this field under direction. Salary, £500 plus, according to age, experience and qualifications. Reply to Box E.E. 584, L.P.E., 110, St. Martin's Lane, W.C.2, quoting reference C/246.

RADIO ENGINEER required to control test and repair section of Service Department in large radio factory, S.E. London area. Applicants should have first-class knowledge of servicing, repair of radio, and television receivers. Good organiser essential. Write, stating age, experience and salary required, to Box 269, E.E.

TECHNICAL ASSISTANT required for the Electroencephalographic Department of a Hampshire hospital. Applicants should have sound knowledge of radio and preferably some knowledge of physiology. Salary according to experience and qualifications, but not less than the scale recommended by the E.E.G. Society. Box 272, E.E.

TECHNICAL SALES REPRESENTATIVE with extensive knowledge of electronic equipment required by manufacturer in London area. Applicants must have technical qualifications to degree standard and must be conversant with current developments. State qualifications, experience, age and salary required to Box 267, E.E.

ELECTRONIC ENGINEER required. Applicant should have degree or equivalent standard. Experience in the following fields would be of advantage : Servo Control Mechanisms, Electronic Valve Theory, in particular the pulse operation of valves ; Magnetic Amplifiers, Electronic Equipment for use in aircraft. Write, stating age, experience, qualifications and salary required, to Box 266, E.E.

TEST AND MAINTENANCE ENGINEER required by The Morgan Crucible Company Limited, Battersea, S.W.11. Aged 25-30, with Matriculation, City and Guilds Certificates or Higher National Certificate or equivalent standard. Must have practical experience in electrical, radio and electronic test equipment. Apply, in writing, giving details of age, experience, qualifications and salary required, to the Staff Manager.

MANCHESTER Firm manufacturing electronic instruments for industrial use, requires an Engineer to take complete charge of final assembly and test. Applicants must have had previous experience of this class of work and must have a thorough knowledge of modern electronic circuit technique. Salary according to age, qualifications and experience. Box 268, E.E.

GENERAL ELECTRIC CO. LTD., Research Laboratories, N. Wembley, Middlesex, require men with Higher National Certificate or equivalent qualifications, and with some factory or laboratory experience, for work in connexion with the development and manufacture of electronic devices. Knowledge of vacuum or high voltage techniques an advantage. Apply by letter to the Director, stating age, experience and academic qualifications.

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 electro-mechanical 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.

ZIFF DAVIS LIMITED, publishers of "Radio News," require a first-class man, preferably an active transmitting "Ham," to edit and prepare for publication MSS. on practical and constructional radio. A sound and up-to-date knowledge of all branches of radio is essential, together with experience in radio journalism or publishing. The position is permanent and offers considerable scope and advancement. Write, giving particulars of age, experience and salary required, to Ziff Davis Limited, Grampian Building, Western Gate, London, W.6.

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, age and salary required and be addressed to Box 270, E.E.

ENGINEER required to take charge of development of high frequency brazing technique by large manufacturing company in Midlands. Good opening for young man 23-30 with sound electrical apprenticeship. Higher National Electrical standard desired. Age, qualifications, experience, salary required, quoting Ref. No. 105, to Box 273, E.E.

ELECTRONICS ENGINEER, H.N.C. or Degree standard, age 30/40, five years experience required by Research Section of large engineering firm in the Midlands for the construction of the vibration indicating and recording gear, strain gauge recording apparatus and the maintenance of laboratory equipment. 5-day week. Reply stating age, experience and salary required to Box No. 440, 8 Serle Street, London, W.C.2.

DEPUTY DIVISION HEAD required for laboratory responsible for development of carrier current telephone and multi-channel telegraph equipment. Replies from those with suitable experience should give qualifications and salary expected. Permanent and pensionable position with good prospects. Box 233, E.E.

SIEMENS BROTHERS & CO., LTD., Ref. 235, Woolwich, S.E.18, invite applications for posts as Senior Engineers in the line telephone transmission laboratory. Suitably qualified applicants only should write, stating details of experience and salary required.

LOW POWER radio transmitter design engineer required. Qualifications Engineering or Physics degree or equivalent and industrial experience of transmitter design. Salary according to qualifications and experience. Pensionable position on permanent staff. Box 249, E.E.

ASSISTANT ENGINEER for design and development of subscribers telephone instruments required. Applicants should have University degree or equivalent and have had previous experience of acoustic measurements. Salary will be paid in accordance with experience and qualifications. Box 250, E.E.

RESEARCH DEPARTMENT of Instrument-making firm in N.E. London, requires graduate in Physics or Engineering with good communications experience, particularly in acoustics and electronics, including the design of amplifiers for outputs up to 2 KW. Write, stating age, experience and salary required, to Box 224, E.E.

LARGE RADIO VALVE MANUFACTURERS in the London area have vacancies for Physical Chemists : (a) Senior Chemists (not over 35) to be responsible for the technical control from a chemical and possibly metallurgical aspect of development and production of radio valves. Little, if any, research work will be covered by this position, so that the man concerned must be keenly interested in the speedy clearance of production problems on the shop floor. Applicants must possess adequate technical qualifications, preferably an Honours degree, and experience within the vacuum tube industry is highly desirable though not absolutely essential. Salary would obviously vary with experience and age. (b) Junior Chemists with degree or similar qualifications in Physical Chemistry and/or Metallurgy. Man required need have no industrial experience, but the position entails very little research work and therefore only men with a live interest in production problems would be considered. Salary according to age and experience. Write, fullest details to Box 280, E.E.

YOUNG MAN, 20-25 years, wanted for work on electrical, electronic, etc., instruments, for research on high-speed diesels by prominent engine manufacturer. Practical experience in lathework, wiring and testing essential. Progressive post. Box 281, E.E.

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CLASSIFIED ANNOUNCEMENTS (Cont'd.)

E.M.I. INSTITUTES (associated with H.M.V. Marconiphone, etc.) require Lecturer in Radio Communications, whose duties will include some technical writing. Science or Engineering degree (or equivalent) and good practical outlook essential. Commencing salary not less than Burnham Scale according to age, qualifications and experience. (Minimum commencing rate, £375, including cost-of-living bonus.) Superannuation benefits in addition. Apply, giving fullest possible particulars, to Principal, E.M.I. Institutes, 43, Grove Park Road, London, W.4.

MURPHY RADIO LTD. have vacancies in the Electrical Design Department for: (1) Senior Radio Engineer with Hons. degrees or equivalent in Physics or Electrical Engineering and several years' industrial experience of radio receiver or television design work. (2) Radio Engineers with good academic qualifications in Physics or Electrical Engineering, preferably with some industrial experience. Applications, giving particulars of training and experience, should be forwarded to the Personnel Manager, Murphy Radio Ltd., Welwyn Garden City, Herts.

SITUATIONS WANTED

EXPERIENCED GENERAL MANAGER (40), capable of accepting full responsibility for Sales, Development, Buying, Production, etc., with manufacturers in Electro-mechanical, Industrial, Electronic or Radio industries. Chartered Electrical Engineer. Available for interview at short notice. 'Phone LABurnum 3580, or write Box 276, E.E.

EX-R.A.F. Wireless Mechanic desires junior post, radio or electrical engineering, with good prospects. Age 24, studying I.E.E. examination. Radio development preferred but not essential. Box 277, E.E.

MR. E. JONES, 5, Park Crescent, West Bromwich, Staffordshire, desires employment with any employer requiring increased output of radio, electrical or radar apparatus. Considerable experience and excellent record in London, Manchester, Birmingham and Nottingham, familiar with taking full control telephone apparatus, relays, meters and with large quantity production assembly belt and conveyor work. Will visit any town in Britain for interview and tender further details.

BUSINESS OPPORTUNITIES

PHYSICIST (M.A.Oxon, A.M.I.E.E., F.Inst.P.), eighteen years' experience of superintending design, manufacture and installation of navigational instruments, acoustical apparatus and light mechanisms, desires arrangement with established company on interesting new projects in above fields. Principals only. Box 275, E.E.

DIRECTORSHIP offered in well-established and highly successful West Country Electrical Manufacturing Company. Applicant must have a thorough knowledge of the Electronic Industry in addition to experience of Purchasing, Factory Management, Costing and Design, and should be capable of taking complete charge. Present owners would be willing to sell a £5,000 to £10,000 interest in the business after complete investigation. Write, stating age, experience and initial remuneration required, to Box 278, 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

REWINDS. Send your burnt-out mains transformers, fields, chokes and solenoids for rewind. Loudspeaker repairs. Southern Trade Services, Ltd., 297/299, High Street, Croydon. Telephone: 4870.

GLASSWORK wanted. Electronic, vacuum and laboratory apparatus manufactured to specification. Kearney & Collins, 8, Ditton Street, Ilminster, Somerset.

E.A.R.L. SERVICES. Further commissions can now be accepted by the Advisory and Design Services, while the Supply and Technical Publicity Services have been extended. The Information Service will still bring answers to electronic problems (commercial and technical) by return of post. Inquiries: Electronic Applications Research Laboratory, Matford Avenue, Exeter.

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.

MISCELLANEOUS

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.

CHARTER for Technical Staffs in the Engineering and Metallurgical Industries. The proposals in the Charter have aroused great interest in the profession. They are being widely discussed. Any Engineer or Metallurgist may have a copy free on request. Write to the Publishers, The Association of Scientific Workers, 15, Half Moon Street, London, W.1.

L. & G. SHERWOOD specialise in light precision electro-mechanical engineering prototypes, assemblies and repetition work. 306, Archway Road, London, N.6. Office: BIShopsgate 2631.

FOR SALE

METERS, new, boxed, all moving coil flush mounting, 2½ in. round (rectifier type), 0–100 v. A.C., 10s. 6d. 2 in. square face, 0–10 v. D.C., 5s. Triplets, 2½ in. square face, 0–200 mA and 0–500 v. D.C., 12s. 6d. 1N22 crystal diodes, 3s. 6d. S.A.E. for complete stock lists. Harry White, 155, Humberstone Road, Leicester.

VACUUM CONDENSERS, Eimac VC12, new, boxed, three only, 40s. each. Box 274, E.E.

ALTERNATORS, 110/220 D.C. input, 1¼ KW 125 volt 500 cycle output. Ex-Naval, £25 each. Universal motors converted from Air Ministry generators, ¼ h.p., 4,500 revs., 25s., incl. carriage. Autosyn motors for remote indication, 1½ in. by 1½ in. Make, Pioneer, 30s. each. Oscilloscope units in case, less 2¾ in. C.R. tube, 10s. (postage 1s. 6d.). S.A.E. comprehensive lists. Amateur Radio Service G6HP, Canning Street, Burnley.

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.

RADIO, ELECTRICAL and OPTICAL Government Surplus Gear for sale. Receivers, components, charging transformers and metal rectifiers. Heavy duty slider rheostats, switches, charging boards, meters, eddy-current heaters Electroflo recording pyrometers, binoculars, gunsighting telescopes, prismatic monoculars, sub-standard meters and test gear, rack and panel assemblies, transmitting gear, valves, cathode ray tubes. Chore Horse lighting sets, 12 v., 300 w., £10 each. H.R.O. receivers, £12 10s. each. 18 valve sets with valves for salvage, £2 each. Prismatic monoculars, 50s. each. Prisms and lens from binoculars, 24s. doz., assorted. Periscope prisms, 10s. pair. 4 in. lens, blanks, Crown and Flint, 10s. pair. Charging board with 0 M/c s. meter, 6 H.D. rheostats, fuses and switches at 50s. each, etc., etc. S.A.E. for list, or better still, call and see for yourself. H. English, The Maltings, Rayleigh Road, Hutton, Brentwood, Essex. 'Phone: Brentwood 1685.

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 volt 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 carriage paid. S.A.E. list other interesting items. Cross, 19, Riversdale Road, West Kirby, Cheshire.

THE ENOCK PICK-UP is now available in limited quantities. Moving coil (licenced under Voigt Patents) with precision-made polished diamond stylus. Weight at needle point, ⅜ oz. No resonances within the recorded range. Price, £36 15s., incl. tax. Full particulars from Joseph Enock Ltd., 273a, High Street, 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. Please send for particulars, or better still, let us demonstrate. Joseph Enock Ltd., 273a, High Street, Brentford, Middlesex. EALing 8103.

U.H.F. and S.W. COMPONENTS. Split-stator condensers, silver-plated coils, stand-off insulators, ceramic flexible couplers, low-loss valveholders, special U.H.F. and S.W. valves, slow-motion dials and drives, co-axial connectors, circuits, manuals. Everything for the enthusiast. Valves, most British and American types in stock. 6A7, 6A8G, 6AG6, 6B7, 6C8G, 6F7, 6F8G, 6K6G, 6N7GT, 6SA7, 6SJ7, 6T7G, 6U7G, 12K7GT, 12K8GT, 12Q7GT, 12SA7, 12SR7 25A6G, 35L6GT, etc., etc. Send 2½d. stamp for components and valves lists. Inquire for whatever you want. Eddystone Stockists. City and Rural Radio, 101, High Street, Swansea, Glam. 'Phone: 4677

MAGSLIPS 3 in., precision made, perfect condition, 50 cycle operation, ideal remote control, angular position indicator, phase shifter etc., 25/- each. Potentiometers, wirewound: 300 ohms, 6 watts, with knob, 1,200 ohms, 20 watts, ceramic, all 3/6 each; carbon two gang, 1 Meg.-1 Meg., 3/3, 30 K. ohms-30 K. ohms, ¼ in. spindle, 3/9 each. All post free. Hopton Radio, 1, Hopton Parade, Streatham High Road, London, S.W.16.

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.

WANTED

I WILL BUY a metal detector to detect at 10 feet below ground. Write to Felix Rovira S., P.O. Box 1305, Caracas, Venezuela.

E.H.T. TRANSFORMERS, only known commercial types—new. Details and price to Southern Trade Services Ltd., 297/299, High Street, Croydon. Telephone: 4870.

For high speed relay operation

the MULLARD helium-filled Triode EN31

Mullard

In the Mullard Gas-filled Triode EN31 the use of helium as a filling medium results in an extremely short de-ionisation time. This factor offers considerable advantages for relay operation in high-speed counter circuits, whilst at the same time serving a vast field of applications in process timers and position control apparatus. Used in time base generation circuits, the EN31 is outstanding, since the short de-ionisation time makes it possible to obtain unusually high-frequency saw-tooth oscillations.

SPECIAL FEATURES OF EN31

MAXIMUM OPERATING FREQUENCY. The short de-ionisation time enables it to be used effectively at frequencies up to 150 kc/s. **PRE-HEATING TIME.** The pre-heating time required is sufficiently low to enable the heater to be fed from an indirectly-heated rectifier without the necessity of a time delay switch in the anode circuit. **LOW GRID CURRENT.** The low grid current taken by the valve enables it to be operated directly by a photocell. **CONSTRUCTION.** The electrode system is of robust construction, and it embodies design features which also contribute to the short de-ionisation time. The valve is capped in an octal base.

VALVE DATA

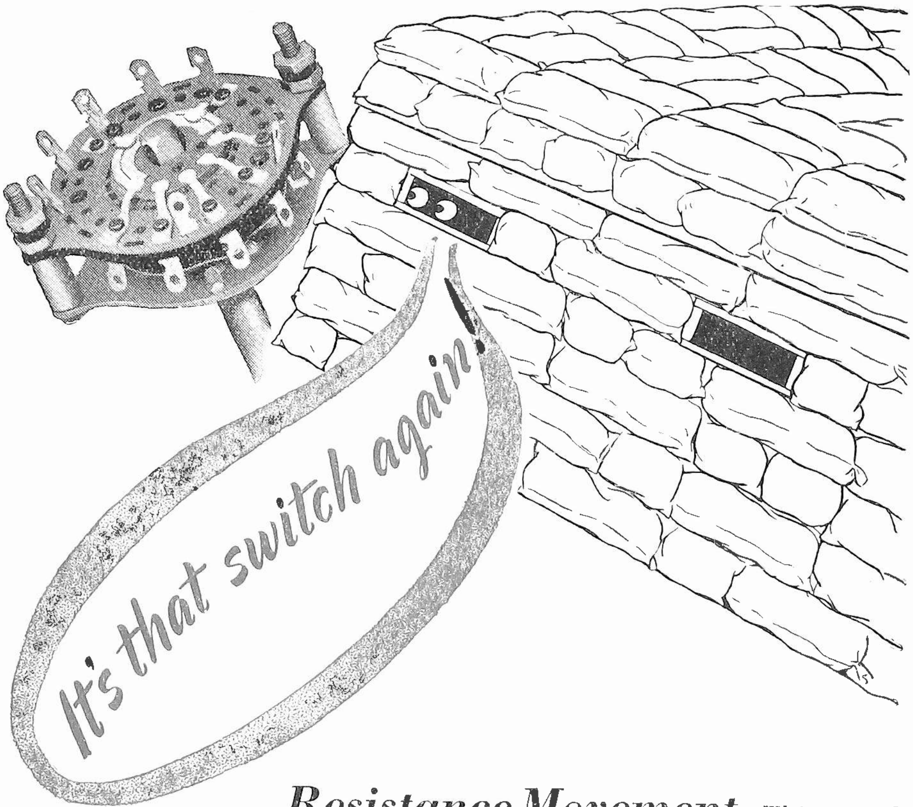
Max. Operating Frequency	150 kc/s.
Control Ratio	35
Minimum Pre-heating Time	15 secs.
Max. Peak Anode Voltage	1,000 V.
Max. Peak Anode to Grid Voltage	1,500 V.
Valve Voltage Drop	33 V.
Max. Peak Anode Current	750 mA
Max. Mean Anode Current	10 mA
Heater Volts	6.3 V.
Heater Current	1.3 A.

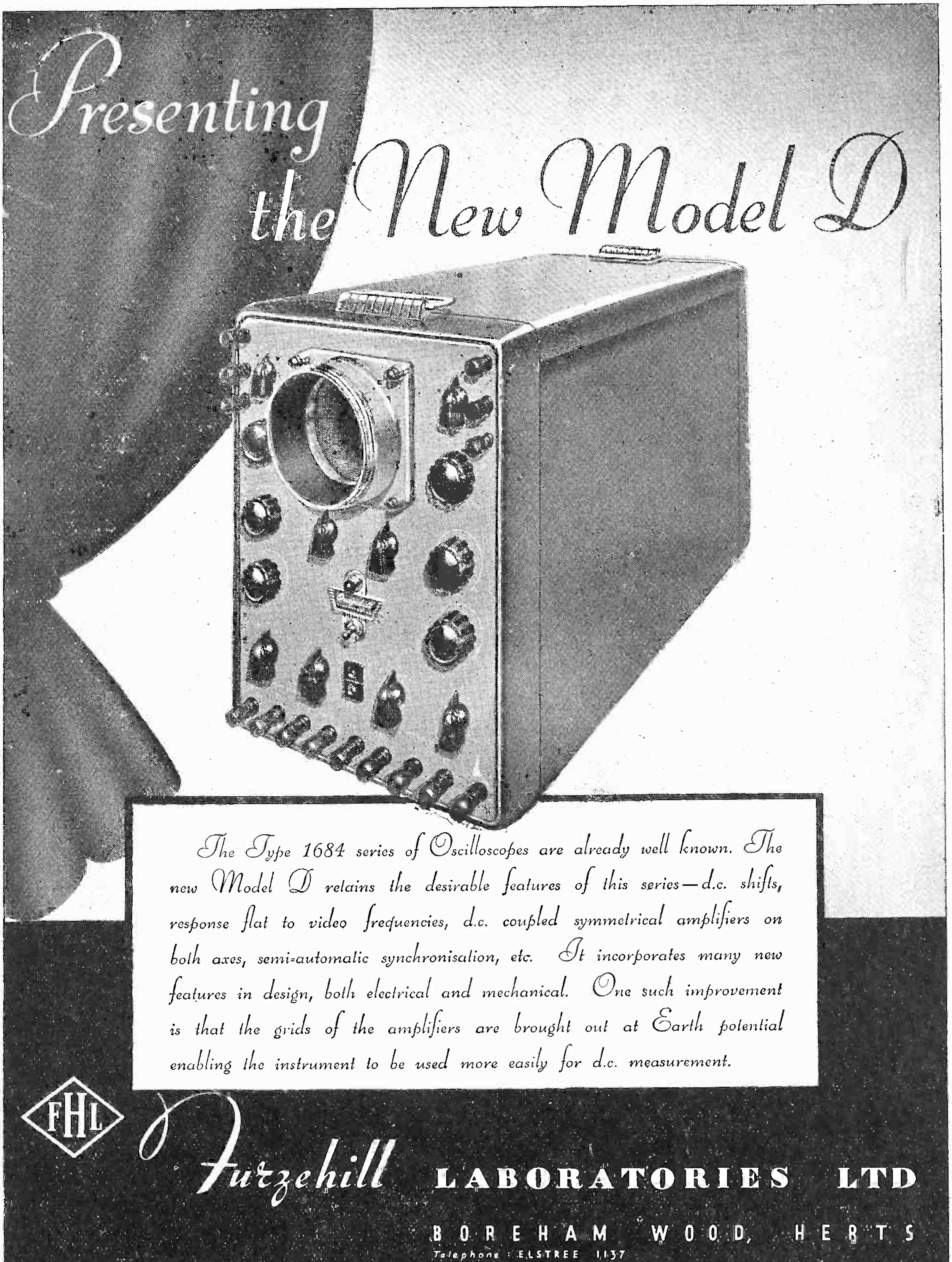
Mullard

THERMIONIC VALVES & ELECTRON TUBES

MULLARD ELECTRONIC PRODUCTS LTD.
(Formerly The Mullard Wireless Service Co. Ltd.)
CENTURY HOUSE, SHAFTESBURY AVENUE, W.C.2.

MVT28


It's that switch again!


Presenting the New Model D
The Type 1684 series of Oscilloscopes are already well known. The new Model D retains the desirable features of this series—d.c. shifts, response flat to video frequencies, d.c. coupled symmetrical amplifiers on both axes, semi-automatic synchronisation, etc. It incorporates many new features in design, both electrical and mechanical. One such improvement is that the grids of the amplifiers are brought out at Earth potential enabling the instrument to be used more easily for d.c. measurement.
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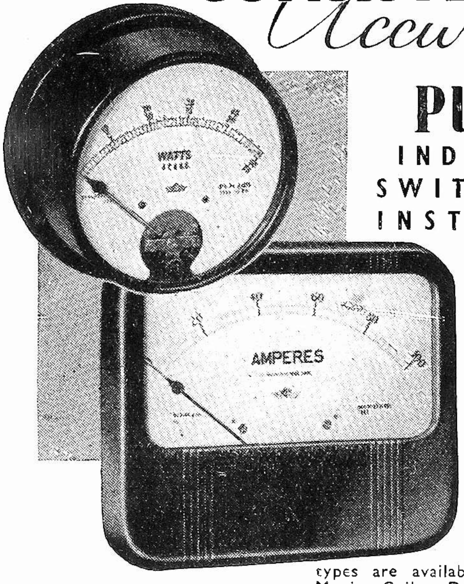
Furzehill LABORATORIES LTD
BOREHAM WOOD, HERTS
Telephone : ELSTREE 1137

CONSISTENTLY *Accurate*



PULLIN

INDUSTRIAL SWITCHBOARD INSTRUMENTS

PULLIN Type S Industrial Switchboard Instruments are completely new in design. The 4″ and 6″ Round Projecting Type case is of pressed steel, has a full open dial, and can be converted easily to flush type by using a separate fitment. The 6″ dial rectangular pattern has a clean open scale. All types are available in Moving Iron, Moving Coil or Dynamometer Pattern.

MIP

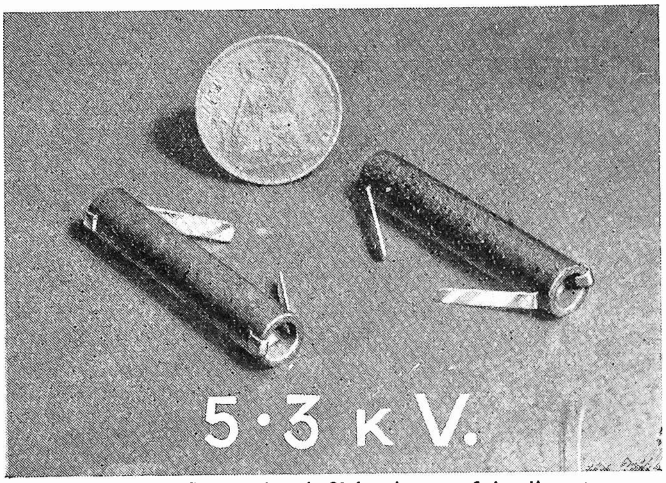
We can give early deliveries—write for details

Address all enquiries to

MEASURING INSTRUMENTS (PULLIN) LTD

Dept. E, Electrin Works, Winchester Street, London, W.3

Telephone: ACOrn 4651/4



from two rectifiers each only 2½ ins. long × 7/16 in. diameter.

An outstanding advance in metal rectifier design has resulted in such a great reduction in size and weight that the 36EHT rectifiers can be soldered directly into the receiver wiring. The two units type 36EHT45 illustrated will deliver 5.3 kV output in a voltage doubler circuit fed with line flyback pulses from a television line output transformer.

WESTINGHOUSE

WESTALITE

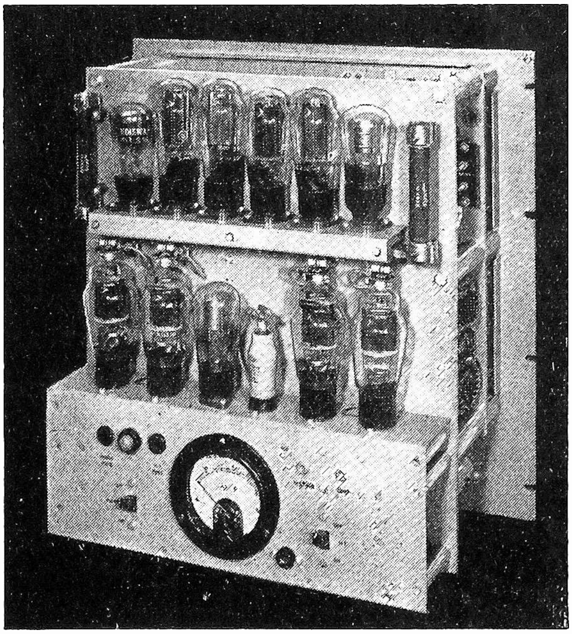
36 EHT. RECTIFIERS

Write for Data Sheet No. 60 to **Dept. E. Engr. 6, Westinghouse Brake & Signal Co. Ltd., 82 York Way, King's Cross, London, N.1.**

Small quantities of these Rectifiers are available to bona-fide manufacturers as samples.

ALL-POWER

CONSTANT VOLTAGE POWER SUPPLIES



SPECIAL LABORATORY UNITS

This forward mounting Rack Unit, illustrated with cover removed, provides a constant output voltage of 300 D.C. at any current up to 600 mA. The output impedance is a fraction of an Ohm, and the residual output ripple is less than 2 mV.

This is only one of the many special Power Supply Units we are making to customers' requirements.

ALL-POWER TRANSFORMERS LTD.

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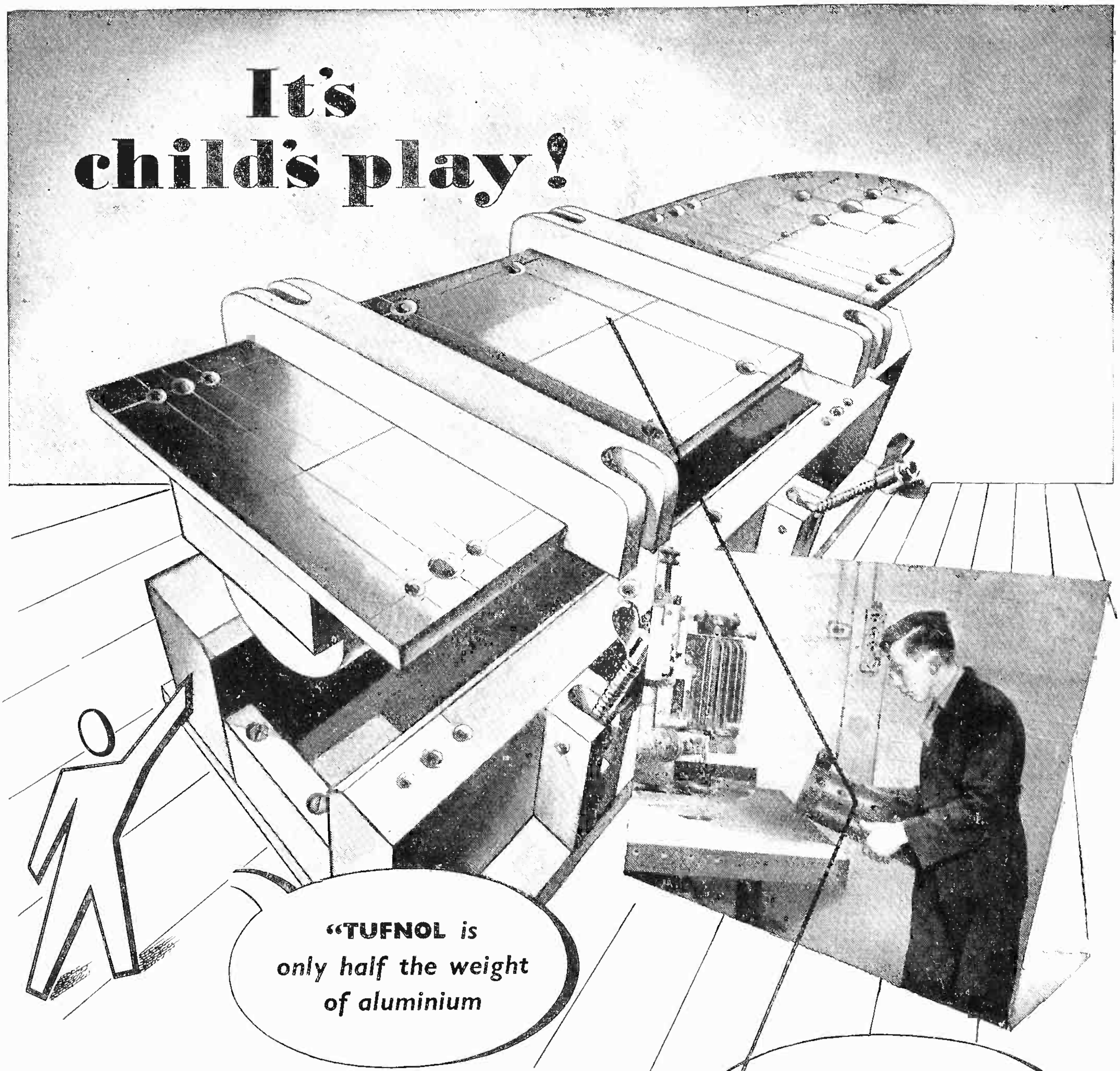
Tel.: LIBerty 3303



Made of Tufnol, even bulky jigs can be lifted and carried by juveniles. Furthermore, any shape of jig can be made easily and accurately in Tufnol.

This is only one example of how engineers in every industry are taking advantage of the outstanding physical properties of TUFNOL.

Can **TUFNOL** *improve your products or plant?*

Tufnol Engineers will gladly help you.

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TUFNOL

205

Electronic Engineering

EDITORIAL, ADVERTISING AND PUBLISHING OFFICES, 28, ESSEX STREET, STRAND, W.C.2.

TELEPHONE: CENTRAL 6565 (10 LINES) *MANAGING EDITOR:* G. PARR, M.I.E.E. *TELEGRAMS:* LECTRONING, ESTRAND, LONDON

Monthly (published last Friday of preceding month) 2/- net. Subscription Rate: Post Paid 12 months 26/-.

Vol. 20. No. 244 June, 1948

CONTENTS

Research

SOME time ago in this column a comment was made on the inevitable duplication which occurred in various research projects. It is gratifying, though hardly surprising, to note that the Department of Scientific and Industrial Research makes a similar comment on the importance of avoiding wasted effort.

In an introduction to their recently issued booklet: "Fundamental Research Problems of Telecommunications"* it is stated: "No doubt universities and industrial research laboratories will initiate investigations aiming at solving some of the problems. The Department would like to hear of any such work at an early stage with a view to the possibility of offering advice and directing attention to any apparently undesirable duplication of effort."

The wording of this sentence in Civil Service English should not be taken as indicating the style of the book, which is actually a most useful guide to the subject of telecommunications research and deserves to be widely read.

It is a collection of reports of sub-committees (called "working parties" in the book—a title reminiscent of sewing meetings) on various problems in the electronic and radio field which still require study. It is not only of value to the established research laboratories, most of which were represented on the sub-committees, but is a fruitful source of suggestions for post-graduate research at universities and technical colleges.

As an example, the report on Circuitry cites nearly twenty mathematical and practical circuit problems which offer a wide scope for selecting that aspect which appeals to the individual research worker.

A list of the remaining reports gives a good indication of the wide field available: Wave and Line Propagation, Valve Fundamentals, Materials, Contact Phenomena, Luminescence, Photo-emission, and Television Appraisal.

The last named gives an opportunity for the less technical but scientifically inclined viewer to take part in the improvement of television technique. There are suggestions for the investigation of subjective impressions connected with tone range, surrounds, ambient lighting, and other factors relating to picture quality. Work of this nature undertaken by organised viewing groups should yield interesting results, and it may be found that the criteria of a satisfactory picture will vary with locality and type of viewer.

Stress should be laid on the word "organised," as there is little use in the collecting of random information under conditions which are not controlled. The organised direction of research in this or any other subject welcomes co-operation, but only with a proper approach, and solitary investigators may be disappointed at having their efforts unappreciated.

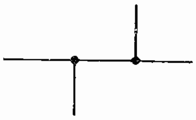
Those who say that there is very little more to be found out in science should read this Report. It may convince them that there are still a number of loose ends to be tidied up.

* H.M. Stationery Office, 1s. 6d. net.

of a dot where none was intended, a connexion wrongly appears.

The recommendation is that:

The connecting points of two wires to a third wire should be staggered, thus:—



Apart from avoiding mistakes, the staggered arrangement is usually clearer. For example, if the horizontal conductor is the earth-line, it is unlikely that the two vertical conductors have any functional relationship: by separating the points of contact, the separation of function is emphasised. This recommendation, which appeared in a British Standard Specification as far back as 1934, has not been given the attention it deserves. The writer, having at last realised its value, does not allow himself to break this rule *under any circumstances*.

The earth or chassis line should be a horizontal straight line drawn thicker than any other conductor,

(but see the reference to detached earths in Section 3 below).

Where a large number of wires are shown as parallel lines, they should never be spaced equally, but always in small groups according to their functions, with wider spacing between groups.

Equally-spaced parallel lines are loved by some draughtsmen—they are *so* easy to draw. If this recommendation is neglected, it is often necessary laboriously to trace out single conductors by using a pencil-point.

Wires need not be always drawn as vertical and horizontal lines; it is sometimes preferable to show a connexion between two points by a single oblique line.

Sparingly used, oblique lines can be used to draw attention to important conductors. They are often suitable for showing circuits converging on or diverging from a point.

3. The Use of "Detached" Contacts, etc.

The recommendations in this section, if observed, will reduce the length of interconnexions by enabling each *part* of a component to be placed in its correct functional position.

In a complicated diagram it is preferable to join some components to individual "earth" symbols instead of to the main "earth" line.

If difficulty is experienced in explaining this system to beginners, it has sometimes been found useful to suggest that the paper, on which the diagram is drawn, is a metal surface and that the "earth" symbols are tags projecting from the surface.

The detached contact system is recommended for use in diagrams depicting a number of relays.

This system, which has been used for many years by telephone engineers, is the only possible system which offers any hope of making such diagrams intelligible.

Valve heaters may be terminated by arrow-heads and reference letters, the heater-supply pairs being terminated with corresponding arrow-heads and letters.

This recommendation is already widely observed.

When the "halves" of a "double" valve are associated with different parts of the circuit diagram, the valve can be split in two.

It is not always necessary to draw the leads connecting two multi-point plugs or sockets; short lengths may be drawn adjacent to each plug or socket and pointing towards each other, each group of ends being bracketed together with a word or code letter. If the sequence of connexions at one end is not the same as at the other end, the connexions should be coded individually.

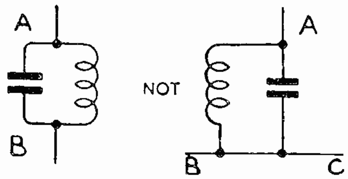
The "detached" system can sometimes be usefully applied to H.T. or grid bias bus-bars: a lead is terminated and an appropriate note (*e.g.*, +500 V, −20 V) written near it.

4. Networks

Components which are unctionally in parallel

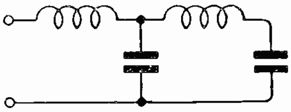
representing, for instance, an oscillatory circuit

should be drawn thus:—

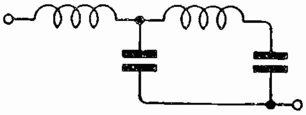


This recommendation is a good example of the increased clarity resulting from a simple re-arrangement. The underlying idea is that the symbol-group represents a two-terminal device AB and not a three-terminal device ABC. In the latter, the lead BC acts both as part of the tuned circuit and also, perhaps, as an "earth" line.

2-terminal networks should be drawn with the terminals at the same end, thus:—



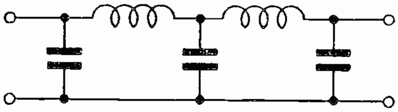
NOT



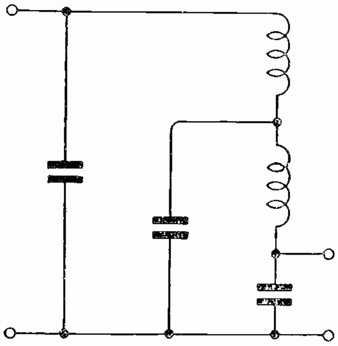
This network, which may form part of the modulator of a radar, can be regarded as an artificial line open-circuited at the far (right-hand) end. A pulse, entering at the left, travels to the right, where it suffers reflexion and returns to the left. If the network is drawn as in the sketch underneath, the operation is less clear.

This recommendation is similar in spirit to the one before it.

4-terminal networks such as filters, smoothing circuits, attenuators and phase-shift networks, should be drawn as ladder networks, thus:—

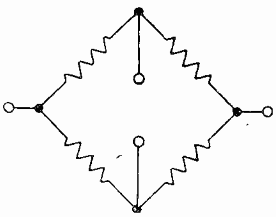


NOT

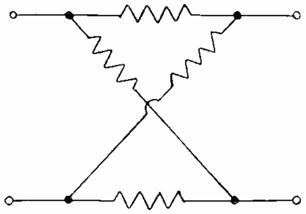


In case it may be objected that the sketch underneath, is unlikely to be encountered, it is pointed out that this layout is often used for the resistance-capacitance I.F.-stop filter feeding the L.F. amplifier in a Broadcast set. The writer was told that in one drawing office this practice was due to a rule that all resistors should be drawn vertical—a striking example of unintelligent standardisation!

Bridge circuits should be drawn in the diamond shape, thus:—



The lattice network thus:

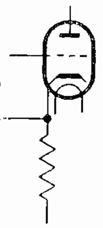


is an equivalent circuit. This configuration should only be used when the network is used as an attenuator or phase-changer and *not* when used as a "null" device.

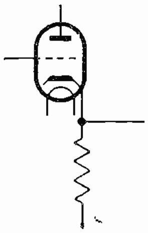
5. Frequently occurring groupings of symbols should be drawn in standard recognised forms.

The single symbol (*e.g.*, a resistor) is usually regarded as the "unit" of diagram construction. With the increasing standardisation of circuit techniques, however, a larger unit consisting, perhaps, of a valve and its associated components, may appear so repeatedly that it is worth while standardising the arrangement.

A number of recommendations are directed to this end.



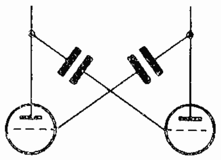
A cathode-input resistor should be connected to the left-hand end of the cathode thus ←——



A cathode-follower output resistor should be connected to the right-hand end of the cathode, thus ——→

These two recommendations comply with the left-right convention.

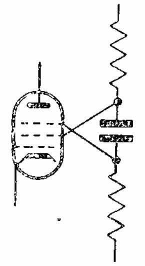
In a multi-vibrator or "flip-flop" circuit, the coupling condensers should be drawn thus:—



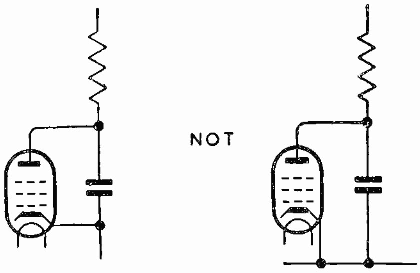
This is already fairly common. The writer reserves this striking arrangement for this type of circuit, avoiding it in the case of sinusoidal oscillators.

The next three items have been associated with radar display circuits.

The "transitron" should be drawn thus:—

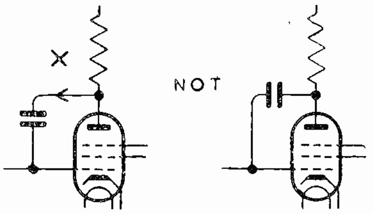


The switching valve in a certain type of time-base circuit should be drawn thus:—



The recommended arrangement suggests that the valve shunts the condenser.

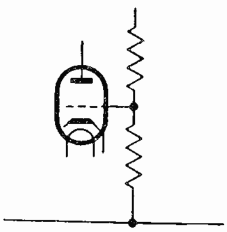
When a condenser is connected between the anode and grid of a valve in order to increase the "Miller" effect, its plates should be drawn parallel to the grid and the anode, thus:—



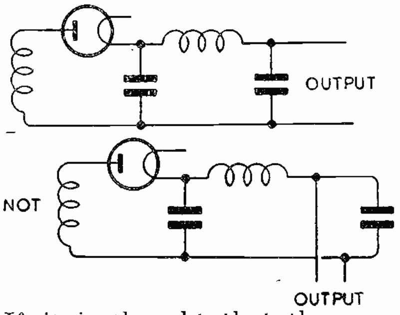
The condenser plates are parallel to the "condenser" formed by the grid and anode.

Since there is a "cause-to-effect" feedback path from the anode, through the condenser, to the grid, the writer likes to draw an arrowhead on this lead as at X.

Potential dividers providing voltage supplies or bias to valves should be drawn straight and vertical, thus:—



Rectifier circuits should preferably be drawn with the rectifying device horizontal and the reservoir condenser vertical. No output should be taken from the part of the lead between the diode and the reservoir (or smoothing) condenser.



If it is thought that the second part of this recommendation seems unnecessary, the writer would state that he has seen more than one diagram in which the whole of an amplifier came between the choke and the smoothing capacitor.

6. Valves

Two push-pull valves should be shown as mirror-images separated by the earth line. A 2-channel amplifier should *not* be so drawn.

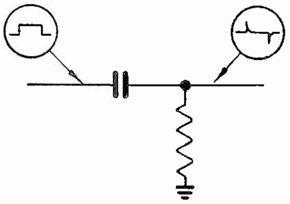
Where two or more electrodes are connected together, they should still be drawn separately but shown connected.

For example, the anode suppressor and screen grids of a pentode strapped together to form a triode. This recommendation is specially necessary if the useful practice of writing the valve-pin numbers round the envelope is observed.

Connexions should never be shown as made to more than one point (or end) of an electrode in a valve, unless in the actual valve both ends are brought out through the envelope as in the case of the heater or filament, or in the case of the anode and grid connections of some V.H.F. valves.

Two or more valves in parallel may be drawn as one, with a note of the number, providing that the parallel connexions are made at the valve electrode connexions.

The operation of a circuit can often be clarified by the inclusion of representations of wave-forms, thus:—



No attempt should be made to draw an *exact* representation of the wave-form.

When the operation of a circuit depends on the presence of a "stray" quantity (e.g., stray capacity) this should be shown by the appropriate symbol drawn "dotted" with an explanatory note.

A.C. Operated Triodes

A graphical method of predicting the operating conditions of a triode deriving anode voltage from the A.C, mains, and the use of this method in designing a sensitive relay.

By A. GRAINGE*

SMALL electronic controls consisting of one or two valve stages have supplied in the last decade or so a steadily increasing need by industry. In many cases because of size, simplicity, and relative cheapness it has been advantageous to operate the valves in such circuits with their anode voltage derived directly from A.C. mains.

While standard text books and articles in the technical Press have described numerous examples of this technique, the author feels that little attempt has been made to place this use of electronic principles on a basis that would make it readily understandable from the non-mathematical point of view. The purpose of this article is to demonstrate a method of determining operating conditions and predicting performance using a method that is an extension of conventional "load-line" practice in investigating circuit conditions which have too often been over-simplified in explanations such as " current passes through the valve in half-wave sinusoidal pulses."

Later in this articles the method to be described will be used to illustrate the design of a simple electronic control. Bearing this in mind, a few assumptions may be made before investigating the general case. These are:—

(1) The valve will be used as a relay and will have maximum and minimum D.C. equivalent values of anode current (and no intermediate values) controlled by some switching arrangement in the grid circuit.

(2) The anode voltage will be derived from a supply of 230 V 50 c/s., a common value.

(3) The valve under investigation is a PEN 383; an A.C/D.C. mains output pentode, in this application connected as a triode (Fig. 1).

(4) The anode load R_L will be purely resistive requiring, at the two maximum and minimum values of anode current noted above, certain known power dissipations.

* The Hutchinson Instrument Co.

In this case R_L – 2,000 ohms.

Two explanations must be made:

(1) The anode current of the valve passes in half-wave pulses, not necessarily of sine-wave form. This distortion of the current pulse occurs because the impedance of the valve is not constant. At the beginning of each "positive-going" half-cycle of anode voltage the impedance is very high and it is not until the anode voltage has reached an appreciable value (in the valve under consideration, 50 volts for V_g = – 5 V) that the rise in anode current becomes a more linear function of the rise in anode voltage.

Moreover, in this type of circuit, where a known power has to be dissipated under certain conditions in the anode circuit, the limiting factors of this power are the supply voltage and the maximum safe anode dissipation of the valve. As power can be developed only in alternate half-cycles, it is often a practice to allow anode currents to pass momentarily that are considerably greater than the maximum continuous safe current. While this is legitimate as long as the safe anode dissipation wattage is not exceeded, it does often cause great distortion of the current pulse due to the limitation of cathode emission. It should be added that under such conditions the valve can be a generator of quite reasonable " square " pulses.

(2) If the anode current pulse is sinusoidal, and the method to be described does allow a check to be made on this fact, then the power dissipated in the anode circuit is equivalent to that of an unvarying anode current whose value would be 45 per cent. of the R.M.S. value of the sinusoidal pulse (see standard text books). Because of this, the R.M.S. value of a sinusoidal anode current pulse can be measured in the anode circuit using a D.C. milliammeter if the reading is multiplied by the factor 100/45. In the following text this equivalent value (R.M.S. × 45/100) will be referred to as the "equivalent continuous anode current" or E.C.A.C.

Method

On a set of anode characteristics drawn for the triode connexion of the valve, a " load-line " can be drawn from a point on the X-ordinate at the potential of the H.T. source and of "slope" equal to the anode load. Moreover, knowing that the valve, during the half-cycles of mains voltage that are positive with respect to the cathode, will have every instantaneous value of anode voltage from zero to $\sqrt{2} \times$ 230 V, a family of " load-lines " could be drawn that would give at any instant the value of anode current for a given grid voltage.

This, however, is not very helpful as no control over the grid voltage has been considered. Fig. 1 shows a circuit of quite conventional electrode connections; the grid and cathode being returned to "earth" by R_g and R_0 respectively. Let us suppose that in the anode circuit we have to establish an E.C.A.C. of 22.5 mA to maintain closed a device that requires 1.0 watt of input power. While calculations would determine the exact value of R_0 to provide 22.5 mA of E.C.A.C., the anode characteristics do not supply the answer in a readily obtainable manner.

To this end the " operating characteristics " of Fig. 2 have been drawn. On the X-axis a scale of grid voltage is laid down and on the Y-axis a scale of anode current in milliamps. Alongside this latter scale an alternative scale of E.C.A.C.s has been provided so that any anode current value which is the R.M.S. value of a sinusoidal pulse can readily be converted to an E.C.A.C. value.

The curves are constructed by transcribing from Fig. 3 the relationship that occurs between anode current and grid voltage at the interception of a "load-line"

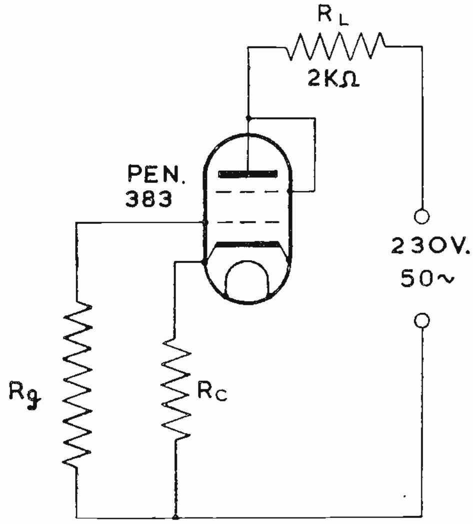


Fig. 1. Fundamental circuit for triode valve operating on A.C.

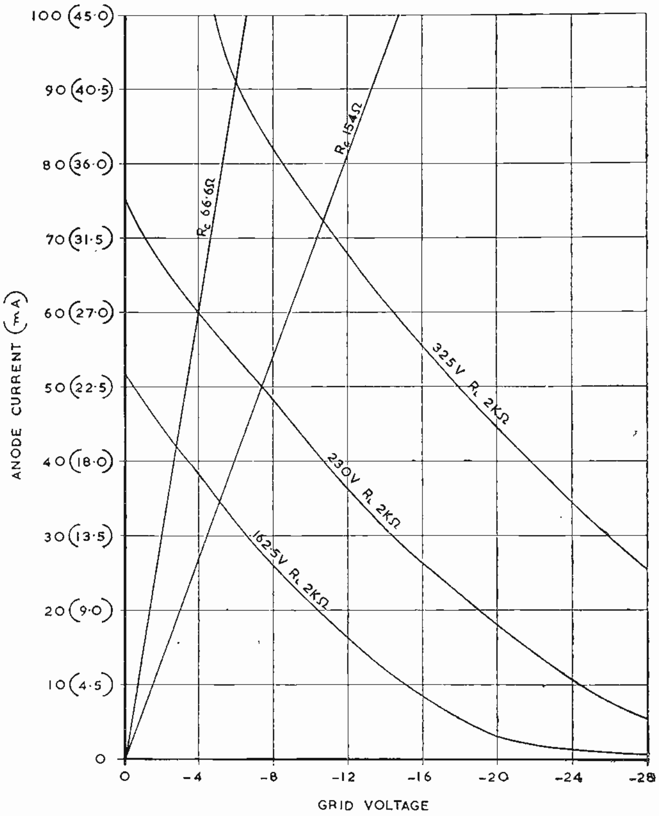


Fig. 2. Operating characteristics of Pen 383 with R_L 2 KΩ.

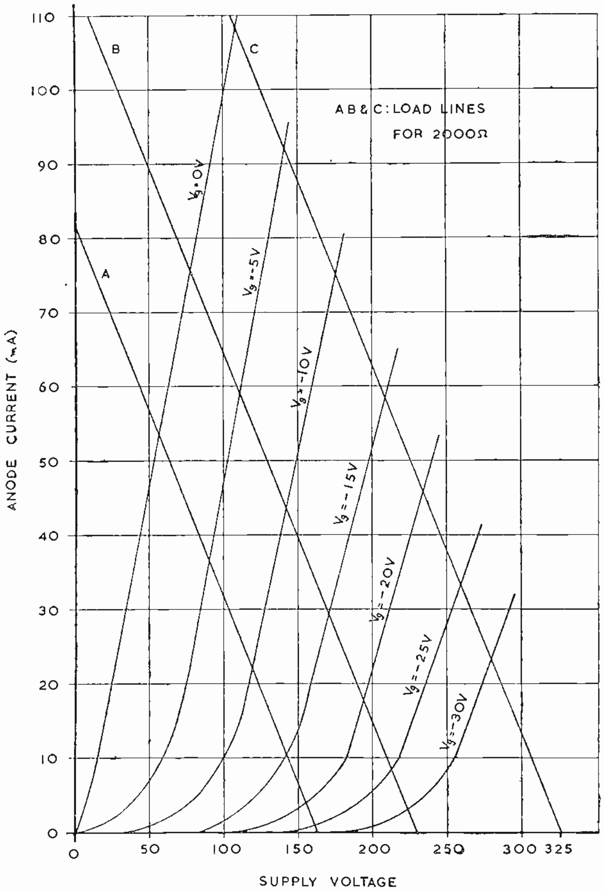


Fig 3. Anode characteristics of Pen 383 (triode connected)

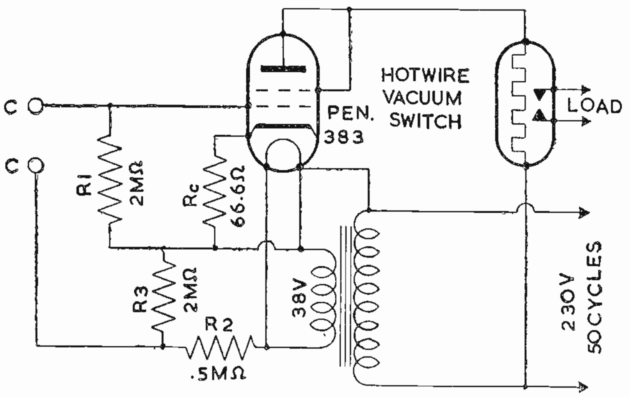


Fig. 4. Simple thermionic valve relay.

with a curve of constant grid voltage. In Fig. 3 "load-lines" have been drawn for the peak, R.M.S. and half-peak values of the supply, *i.e.*, at 325, 230 and 162.5 volts: Transcribed to Fig. 2, they give at any instant the grid voltage/anode current relationship for the valve, taking into account the volts drop across R_L. Their greatest use, however, is for the simple determination of R_C.

By illustration: on the "load-line" marked 230 volts, a point is selected opposite the E.C.A.C. value of 22.5 mA; a straight line is then drawn from this point to the origin of the graph. The "slope" of this line is the value of R_C (154 ohms), required to maintain an anode current in R_L that will dissipate 1.0

watt, if the current pulse is sinusoidal. To check this latter fact, values of instantaneous anode current are then noted for the interception of the " cathode bias line " with the three "load-lines." If these three instantaneous anode currents are in the relation $\frac{1}{2}$, $\sqrt{2}$ and 1, the pulse may be assumed to be sinusoidal with a considerable degree of accuracy. In the example worked out above, the three anode currents were 71.5, 50 and 34.5 milliamps at 325, 230 and 162.5 volts: a very close approximation to sinusoidal values and a confirmation of assumption made in the use of the E.C.A.C. value.

If the valve is to be used as a relay a switching device in the grid can be made to apply during the " positive-going " cycles of anode voltage a more negative bias to the valve. Let us assume that the power in R_L must be dropped to .25 watt: an E.C.A.C. of 11 mA through 2,000 ohms. This E.C.A.C. would be provided by a sinusoidal pulse of 24.5 mA R.M.S. Interpolating on the 230 V " load-line " shows a negative bias of −17 volts. This, in a method to be described, would be provided by the superimposing on the grid of the valve an A.C. voltage, 180° out of phase with the anode voltage and of R.M.S. value of 15 volts. At these much lower values of anode current the self-bias due to R_C will be small—at 24.5 mA approximately 2 volts of " self-bias " from R_C are generated, making a total of −17 volts R.M.S. superimposed on the grid. It is unlikely that in the " off " position of the valve, as a relay, that consideration of the wave-form of the anode current pulse will be necessary, but judicious use of the curves would give a good indication of the nature of the pulse.

Electronic Control

Many industrial electronic circuits are used as a means whereby sensitive switching devices, themselves only capable of passing currents of the order of 10^{-5} or 10^{-6} amps. control indirectly the switching of loads of several kilowatts. The relay here described (Fig. 4) is controlled in the grid circuit by the contacting of a mercury-in-glass thermometer in which for certainty of operation, and other factors, it is advantageous to maintain low switching currents. The relay will control a load of 2 KW.

The intermediate stage between the valve and the load is a hot-wire vacuum switch—which will close a 2 KW circuit for an input power of 1.5 watts (and open the circuit to reduction of the input power to .05 watt).

The following figures approximate to the working constants of the circuit:

R_L (hot-wire vacuum switch control coil)—2,000 ohms.

E.C.A.C. (vacuum switch contacts closed)—27 mA.

E.C.A.C. (vacuum switch contacts open)—5 mA.

From Fig. 2 it will be seen that an E.C.A.C. of 27 mA requires an anode current pulse of 60 mA R.M.S. and R_C will have the value 66.6 ohms. An E.C.A.C. of 5 mA requires an R.M.S. grid voltage of —24 volts; the R.M.S. value of anode current pulse then being 11.1 mA.

When the contacts "C.C." in the grid (Fig. 4) are open, the hot-wire vacuum switch contacts will be closed and the load in operation. On closing "C.C." an out-of-phase voltage of—24 volts is superimposed on the grid through the network R_1, R_2 and R_3 and the E.C.A.C. of the valve is dropped to 5 mA—thus switching off the load.

The current flowing through the contacts " C.C." is only 12×10^{-6} amps. and represents a power dissipation in the contacting circuit of only 250 microwatts.

While this relay represents a simplification of the general scheme it is possible to extend the field of application so that inductive anode loads such as contactors can be operated when "by-passed" by the right value of capacity.

Designs can be evolved to enable 5-10 watts to be handled in the anode circuit while yet maintaining very small grid input powers—which is the main justification for this type of relay. Adaptation of the circuit for A.C./D.C. use is achieved by replacing the valve filament transformer with a dropping resistor and suitably amending values of R_C, R_2 and R_3.

Electrets

IN the May, 1948, issue of *Radio Craft* an article by V. H. Laughter describes in detail the materials, method and equipment for making electrets, the electrical counterparts of permanent magnets.

If a mixture of carnauba wax, resin, and beeswax is melted and subjected to a strong electric field while cooling, a positive charge appears on one side and a negative charge on the other. These charges can be retained for several years without decrease in strength.

A suitable mixture is carnauba wax 45 per cent., white resin 45 per cent. and white beeswax 10 per cent. An aluminium cup about 2 in. diameter and $\frac{1}{2}$ in. high is lined with .001 aluminium foil to receive the wax and above it is mounted a disk of aluminium $1\frac{1}{4}$ in. in diameter, also foil wrapped. The wax is shredded into the cup and melted to a depth of about 3/16 in., the top plate being then lowered to make contact with the surface of the molten wax.

A D.C. voltage of about 10,000 is then applied between the plate and cup, a series resistance being inserted to limit the current if sparking takes place. The wax should jump perceptibly when the potential is applied, and is then allowed to cool gradually to room temperature with the voltage on. When the wax is solid the cake is carefully removed from the plates, the foil is stripped from the surface and replaced with fresh foil. The electret should be preserved in a foil wrapping in a tin with silica gel until required for test. The presence of the charge can be tested by means of an electrometer or 1,000-megohm valve voltmeter.

The author points out that there is a wide field for experiment, both in the best method of manufacture and materials used and in the applications of electrets to capacity microphones, pickups, and interior elements of certain vacuum tubes.

Some do not show a positive polarisation, although the negative charge is less on one side than the other: if raw A.C. is used, both sides are usually negative.

It should be understood that the electret represents a static charge and is not a source of power. The presence of carnauba wax is important, as electrets made without this show only a temporary charge.

The Measurement of Telegraph Distortion

The B.B.C. "Start-Stop" Distortion Measurement Set

By A. B. SHONE, B.Eng., A.M.I.E.E.* and R. T. FATEHCHAND, B.Sc.(Eng.)*

1. General

INFORMATION can be conveyed from point to point by telegraph signals which may operate on various systems: the two main systems are the Morse system and the "Start-Stop" system. The B.B.C. is only concerned with the latter type of system, utilising a five element code.

On this system each character is represented by five positive or negative signal elements preceded by a "Start" signal of 20 mS duration, which is always of the same polarity and starts a printing mechanism at the receiving end. A "Stop" signal of opposite polarity to the "Start" signal and having a minimum duration of 30 mS, follows the five-element code and stops the receiving end printing mechanism. The "Stop" signal continues until the "Start" signal of the following character is transmitted.

In mechanical "Start-Stop" systems it is important that the polarity of the signal should be correct throughout the time intervals that the receiving device interrogates the signal. The positions of these time intervals (shown hatched in Fig. 3) are fixed relative to the commencement of the "Start" signal, and the distortion with which we are concerned is therefore $\frac{a}{x}$ or $\frac{b}{x}$ (whichever is the greater). This ratio is termed the Effective Distortion. (The necessity of measuring Effective Distortion, rather than the Distortion as defined by the C.C.I.T. Reference (1), is given in Reference (2)).

2. Design Considerations of New Distortion Measuring Set

In the past, all telegraph distortion measuring sets (T.D.M.S.) (either mechanical or electrical) have been of the recurrent variety. In general such time bases are only suitable for use with test signals of a particular repetitive type.

Typical T.D.M.S. of this type

* Designs Department, British Broadcasting Corporation.

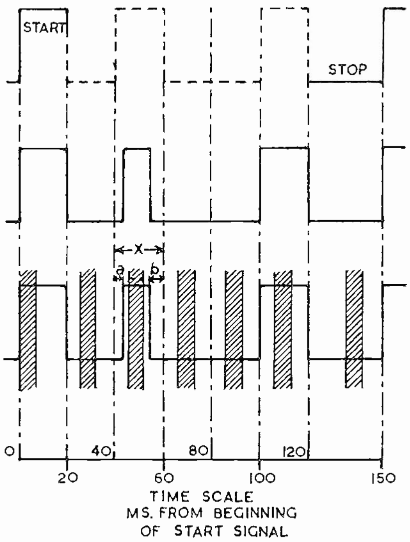


Fig. 1. (above). Undistorted teleprinter signal
Fig. 2. (centre). Distorted teleprinter signal
Fig. 3. As Fig. 2 but with operating times of printer mechanism shown hatched

which are in use are described in References (3), (4), and (5).

The operation of such measuring sets gives rise to considerable difficulty in the synchronisation of sending and receiving equipment when measuring over a line or radio link. Furthermore, such sets are incapable of measuring distortion on a circuit while it is in traffic.

For some time the need has been felt for a "Start-Stop" time base capable of operation on actual teleprinter signals.

The tremendous advances made in radar techniques during the last war have paved the way to the solution of this problem, and these techniques have been utilised in the design of an electronic "Start-Stop" T.D.M.S.

(In passing it is interesting to note that the Bell Laboratories have recently developed a "Cathode-ray Telegraph Distortion Measuring Set" (Reference 6) which though using different circuits achieves an almost similar result: experience will show which is the better solution).

3. General Description

3.1. Circuit Layout

The circuits used are quite conventional excepting for the Phantastron Time Base and the Multiar. A simplified circuit diagram is shown in Fig. 4.

Incoming teleprinter signals are of the type shown in Fig. 5a. and, on setting the "Operate/Calibrate" switch to "operate" are passed into a resistance-capacitance pulse deriving (or "differentiating") circuit which produces a pulse on each change of signal polarity Fig. 5b. Only the positive pulse which occurs at the commencement of the "start" signal is required. This pulse is amplified and inverted, Fig. 5c, and is then used to trigger the Phantastron Time Base whose output voltage is shown in Fig. 5d. After an initial drop in voltage of a constant amount determined by the valve and circuit parameters the time-base voltage falls linearly; at the end of the sweep the voltage quickly returns to its pre-triggered value until such time as the cycle of operations is restarted by another positive pulse.

The Phantastron type of time base (which is discussed in detail in Appendix 1) was chosen because, after the sweep has been initiated, the circuit is uninfluenced by any subsequent pulses until the time base has returned to its rest condition. The sweep duration is adjusted to approximately 125 mS so that the whole teleprinter character up to the commencement of the "Stop" signal is displayed on the oscilloscope screen, Fig. 5k, while allowing the Phantastron adequate time to return to its rest condition before the next "Start" pulse is received. It will be noticed that it is only possible for the time base to be initiated by a positive pulse other than the "Start" pulse if the sweep duration is reduced below 100 mS or increased above 150 mS. There is, therefore, considerable tolerance available in setting up the sweep duration.

The output of the Phantastron time base is fed to the horizontal plates of the cathode-ray tube through a cathode follower in order to avoid interaction between circuits. The teleprinter signals are fed to the vertical plates of the cathode-ray tube.

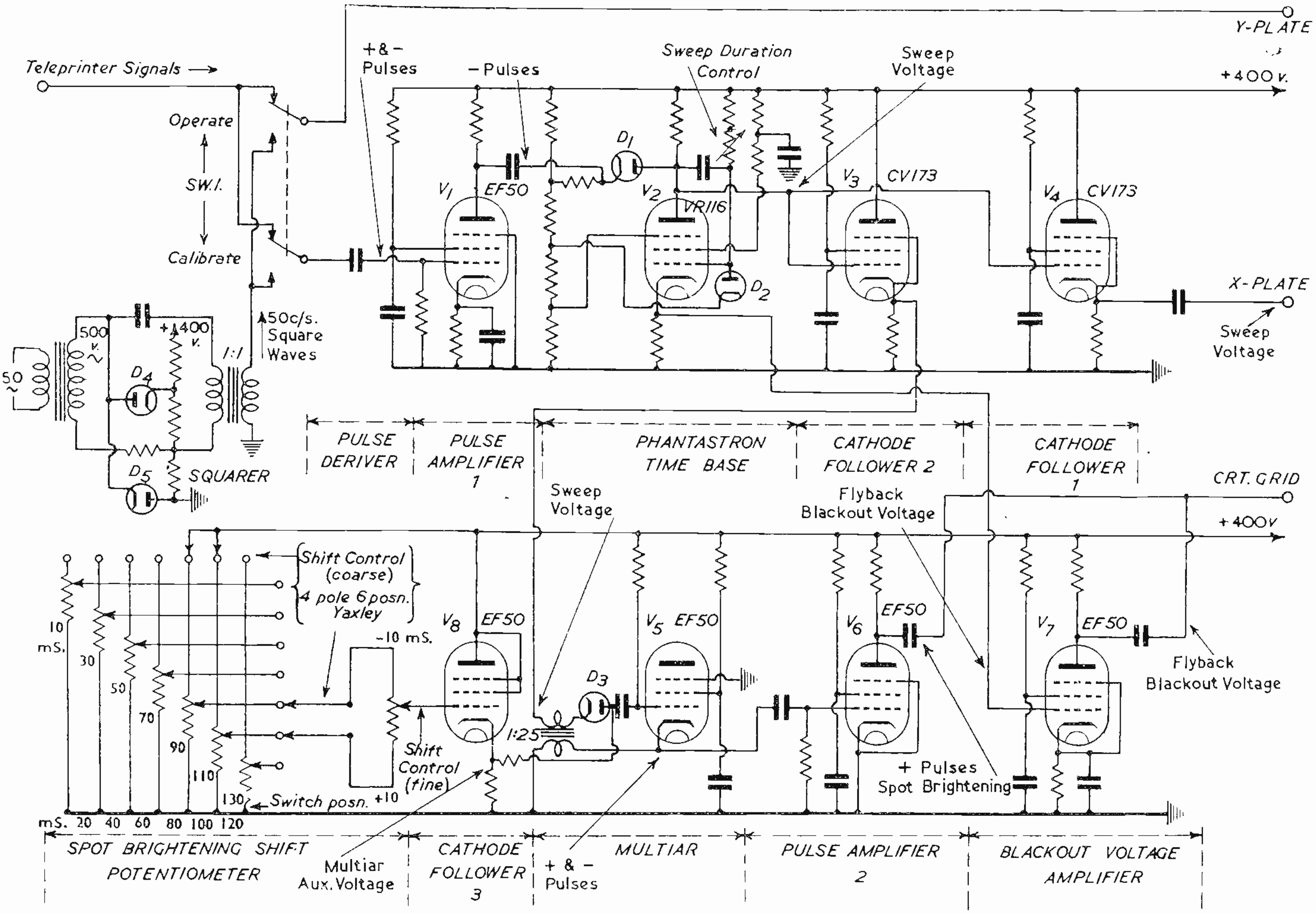


Fig. 4. Basic circuit of B.B.C. electronic TDMS

The wave-form at the cathode of the Phantastron is shown in Fig. 5e. This voltage, after amplification and inversion, is fed to the grid of the cathode-ray tube and conveniently blacks out the trace during the time-base flyback.

The output of the Phantastron is also fed to the Multiar. As before, a cathode follower is used to avoid current surges in the Multiar circuit feeding back into the Phantastron circuit. In addition, the Multiar is fed with an auxiliary voltage and is arranged to " fire " at the instant when the time-base voltage from the Phantastron equals the auxiliary voltage.

The auxiliary voltage is provided by a potentiometer. The range of this potentiometer is such that the Multiar can be adjusted to " fire " at any point of the time base. The details and calibration of this potentiometer are dealt with later, but in passing it should be noticed that the potential on the wiper of the potentiometer will be upset should any current be allowed to flow in the wiper. The potentiometer voltage is therefore fed to the Multiar *via* a cathode follower, whose cathode impedance is kept as low as possible. In this way, the potentiometer settings are not influenced by current surges when the Multiar " fires."

The wave-forms of the grid voltage, anode current and cathode voltage of the Multiar (whose circuit is discussed more fully in Appendix 2) are shown respectively in Figs. 5f, 5g and 5h. It will be seen that two voltage pulses are produced on the Multiar cathode during each time-base cycle, a negative one when the falling time-base voltage equals the auxiliary voltage and a positive one when the time-base voltage passes through the same value on its fly-back These pulses are passed to an amplifier which suppresses the positive pulse but inverts and amplifies the negative pulse, Fig. 5j. The latter pulse is then fed to the grid of the cathode-ray tube and momentarily increases the intensity of the electron beam, which results in a bright spot on the screen of the cathode ray tube. This bright spot can be moved to any point of the trace by suitable variation of the potentiometer supplying the auxiliary voltage.

The potentiometer is calibrated in milliseconds by means of the 50 c/s. A.C. mains. (Should the frequency of the mains deviate by more than one or two per cent. from 50 c/s. an alternative standard frequency must be used.) This 50 c/s. voltage is squared by two diodes, and fed into the equipment as an artificial teleprinter signal when the " Operate/Calibrate " switch is set to " Calibrate." The waveforms then occurring are similar to those present when the teleprinter signal was injected and are shown in Fig. 5. As reversals occur in this artificial signal at 10 mS intervals the potentiometer can be accurately calibrated every 10 mS by shifting the bright spot along the trace to each of the change-over points in the squared calibrating signal. The time of change-over is dependent upon the degree to which the sinusoidal 50 c/s. supply is squared. As we are not interested in obtaining an accuracy better than 2.5 per cent., there is no advantage in reducing this time below .25 mS.

The practical form taken by the potentiometer is seven separate potentiometers whose tapping points are set to the Phantastron sweep voltages corresponding to the time intervals (measured from the sweep commencement) of 10 mS, 30 mS, 50 mS, 70 mS, 90 mS, 110 mS and 130 mS respectively. The tapping points of two adjacent potentiometers are connected to a further potentiometer (whose impedance is very much higher so that it does not upset the setting of the two side potentiometers) which is calibrated ± 10 mS. The connexion of the tapping points to this latter increment potentiometer is by means of a rotary switch whose settings are marked 20 mS, 40 mS, 60 mS, 80 mS, 100 mS, and 120 mS. The setting of the increment potentiometer is set to either extreme (*i.e.*, + 10 mS or − 10 mS) while the seven potentiometers are adjusted in turn, using the calibrating signal. As stated, the impedance of the increment potentiometer must be kept high, about 4 megohms being used. As we aim at an accuracy of ± .5 mS, this potentiometer was constructed of forty 100,000 ohm resistors of 1 per cent. accuracy. It is, of course, assumed that the Phantastron time base is linear over the range of voltage covered by the increment potentiometer, but this assumption is well justified in practice.

The above arrangement of potentiometers is convenient as it follows from the definition of Effective Distortion, given in Paragraph 1 above, that the ± 10 mS Potentiometer can also be calibrated ± 50 per cent., and thus directly reads the percentage Effective Distortion.

As has been mentioned above, the time reading accuracy is fixed by the width of the various pulses, the time of change-over of the calibrating signal, the accuracy of the increment potentiometer and the linearity of the time-base voltage over the range covered by the increment potentiometer. In the present equipment all these factors have been controlled so that the time measuring accuracy obtained is + ½ mS (that is, the Effective Distortion can be measured to ± 2.5 per cent.). No difficulty would be involved in improving upon these figures by reducing the width of our pulses, etc. As, however, this means increased amplification to maintain the amplitude of the narrower pulses there is no point in aiming at an accuracy greater than is required in practice.

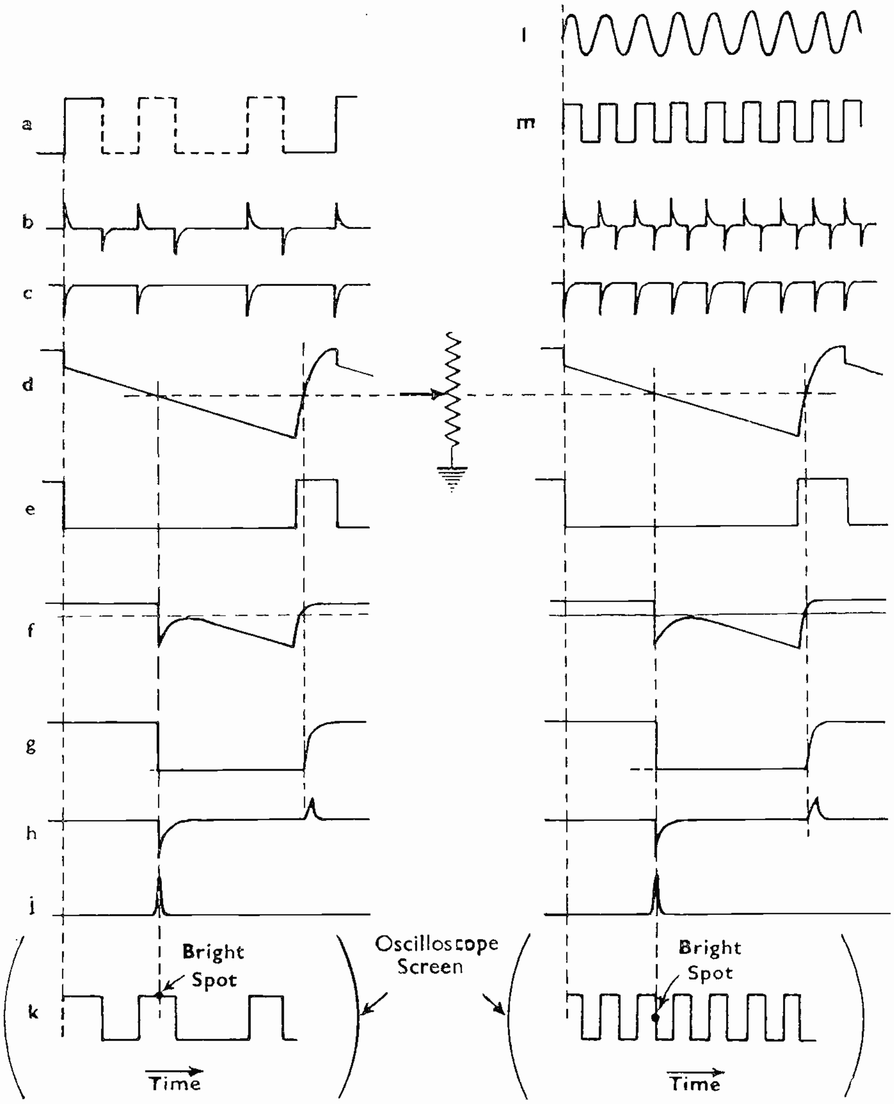


Fig. 5. B.B.C. electronic TDMS waveforms

3.2. Advantages

In addition to the all-important advantage of being able to measure distortion on actual teleprinter signals, there are other very desirable features:

(a) As the brightening spot and time base are derived from the same voltage supplies, any "jittering" due to voltage fluctuation is common to both and the position of the brightening spot relative to the trace remains unchanged.

(b) As the spot is travelling very much faster at the change-over points of signal polarity than during the rest of its sweep, all the advantages of an expanded trace are gained, without the use of dangerously high voltages.

(c) There is a complete absence of moving parts which would inevitably introduce distortion.

(d) There is on the C.R.T. an exact display of the teleprinter signal under test which gives confidence in the results and complete certainty as to the sense of the distortion.

4. Acknowledgments

We would like to tender our thanks to the Chief Engineer of the British Broadcasting Corporation for permission to publish this paper, and to the Head of Designs Department and to the Superintendent Engineer (Lines) for their help and encouragement in the development and materialisation of our ideas.

Finally, but by no means least, we would like to tender our thanks to Professor F. C. Williams, O.B.E., of Manchester University and his war-time colleagues at T.R.E. Malvern. The work they did in developing such circuits as the Phantastron and Multiar has directly contributed to the simple solution of the problem.

References

[1] C.C.I.T. Avis No. A.1 (a), of the Second Reunion, 1929.

[2] *P.O.E.E.J.* Vol. 26, Part 1, page 2.

[3] "The Siemens and Halske Stroboscopic Distortion Measuring Set." Documents of the Third Reunion of the C.C.I.T., Vol. 1, page 30.

[4] The Jolley Stroboscopic Distortion Measuring Set. *P.O.E.E.J.* Vol. 26, Part 1, page, 3, et Sec.

[5] The S.T. & C. Cathode Ray Oscillograph Distortion Measuring Set. *Electrical Communication*, Vol. 11, No. 4, page 197, and Vol. 12 No. 1, page 15.

[6] *Bell Laboratory Record*, April, 1947.

[7] "Ranging Circuits, Linear Time-Base Generators and Associated Circuits" (Abstract), *J.I.E.E.*, Vol. 93, Part IIIA, No. 1, page 320 and 321.

[8] "Ranging Circuits, Linear Time-Base Generators and Associated Circuits." *J.I.E.E.*, Vol. 93, Part IIIA, No. 7, pages 1193 to 1197.

APPENDIX I

The Phantastron

The following is a condensation of information given in References (7) and (8).

The form of the Phantastron circuit used in the B.B.C. T.D.M.S. is shown in Fig. 6. With the values of components indicated, sweep durations of 100 mS to 150 mS are obtainable.

All voltages subsequently quoted are positive with respect to earth unless otherwise specifically stated.

The input required is a pulse, negative with respect to earth, of about 40 volts amplitude. Initially the circuit conditions are as follows:

Voltage on suppressor grid, 26 V.
Voltage on V_3 cathode, 42 V.
Voltage on V_2 cathode, 47 V.

These voltages are given by a bleeder chain R_1, R_2, R_3, R_4.

The diode V_3 is conducting and therefore the grid of V_2 is caught by the diode in the neighbourhood of 42 volts. V_2 is a VR.116 which has a short suppressor base. Thus the suppressor voltage prevents any anode current, the screen initially taking all the space current. V_a tries to rise to $V_{H\cdot T\cdot}$, but it is caught by means of the diode V_1 to 370 V determined by the bleeder chain R_1, R_2, R_3, R_4. The initial anode potential is therefore 370 V.

The cycle of events which occur when the Phantastron is triggered can be divided into six stages. The wave-forms obtained are shown in Fig. 7.

Stage 1. Initial Drop

When a negative pip is applied to the anode of V_2 *via* C_3 and V_1 the resultant drop in voltage of the

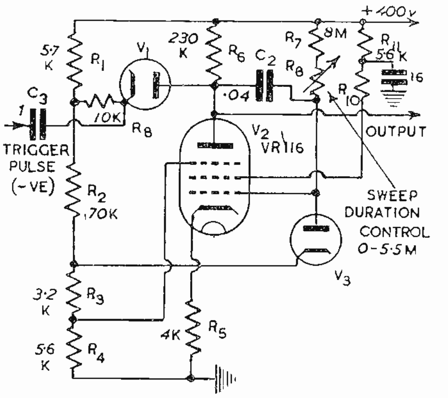


Fig. 6. Phantastron Time-base

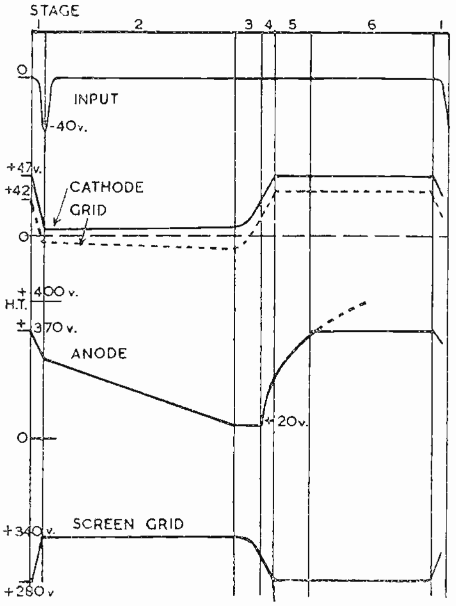


Fig. 7. Phantastron waveforms

anode of V_2 is transmitted to the grid via C_2. The drop in voltage on the grid is followed by the cathode since the cathode load is not decoupled. As the voltage on the cathode falls, the suppressor grid voltage rises relative to the cathode, and the anode then begins to take current. Thus, owing to a very large anode load (230 KΩ), the anode voltage falls and V_1 is cut off. This drop in anode voltage is transmitted back to the grid via C_2, and V_a and V_g then fall together until an equilibrium position is reached, in which the control grid is almost cut off.

Stage 2. Linear Sweep

V_2 is now cut off, and there is no grid current flowing, the grid tends to rise towards $V_{H\cdot T\cdot}$ through R_7 and R_8. This rise in V_g causes a fall in V_a, which in turn feeds back through C_2, and tends to oppose the original rise of V_g. The anode voltage then falls in a near linear manner at a rate:

$$\frac{E_{H\cdot T\cdot}}{(R_7 + R_8)\, C_2} \text{ volts per sec., for}$$

$E_{H\cdot T\cdot}$ in volts, R_7 and R_8 in ohms, and C_2 in farads.

Stage 3. End of Sweep

During Stage 2, V_a falls linearly, and V_g and V_c rise. This continues until V_a approaches the cathode voltage. At this point the rising V_g tends to increase the space current, but the falling V_a reduces the anode current. The result is that V_a remains fairly constant. Therefore there is little feed-back from the anode *via* C_2 and so V_g rises rapidly towards $V_{H\cdot T\cdot}$ with an initial time constant approximately $C_2\,(R_7 + R_8)$.

Stage 4. Initial Fly-back

As V_g and V_c rise, the voltage on the suppressor grid relative to the cathode falls, and so the anode current is cut off. Therefore V_a starts to rise too, and the result is that V_a and V_g increase rapidly, both ends of C_2 moving together. The anode current then charges up the strays from anode to earth, and the leak R_7, R_8 charges up the strays from grid to earth.

Stage 5. Remainder of Fly-back

As V_g rises above 42 volts, diode V_3 starts to conduct, and so V_g is caught at its original steady value. The grid end of C_2 cannot rise any further, and hence V_a rises exponentially towards $V_{H\cdot T\cdot}$ with a time constant C_2R_6. But when V_a reaches the voltage on the cathode of V_1 the latter diode conducts, and so V_a is caught at its original voltage.

Stage 6. Quiescent Period

The circuit is now quiescent until the next pip is applied, when the cycle will be repeated.

Sweep Duration

The sweep period is approximately:

$$T = \frac{(V_a)_0 - (V_g)_0}{\frac{dV_a}{dt}}$$

where $(V_a)_0$, $(V_g)_0$, are the values of V_a, V_g, before triggering.

Since $-\frac{dV_a}{dt} = \frac{E_{H \cdot T \cdot}}{(R_7 + R_8)\,C_2}$

$$T = \frac{[(V_a)_0 - (V_g)_0]\,(R_7 + R_8)C_2}{E_{H \cdot T \cdot}} \text{ secs.}$$

for $(V_a)_0$, $(V_g)_0$ and $E_{H \cdot T \cdot}$ in volts, R_7, R_8 in MΩ, and C_2 in μF.

The sweep duration is controlled by varying R_8, and in the present circuit can be adjusted from 100 to 150 mS.

APPENDIX 2.

The Multiar

This is a " pick-off " circuit which generates a pulse the instant a linear sweep, which is applied to it, passes through a given adjustable value.

The basic circuit is shown in Fig. 8 and the relevant waveforms in Fig. 9.

Let e be a descending linear sweep of voltage which starts and ends above earth potential, Fig. 9, which is applied to point " A " on the Multiar, Fig. 8, and let a positive voltage E_1 be applied to the free end of R_1. Then when e is greater than E, the diode D_1 is non-conducting, and V_1 is drawing grid current, set by R_2, and an anode current I_a set by R_3. This state of affairs holds until e approaches E_1, when D_1 conducts and connects the secondary of the transformer T to the grid of V_1. Assuming the rate of descent of the sweep is great enough to make $C_1 \frac{de}{dt}$ much greater than the current in R_2, V_1 will then start to cut off, the sawtooth appearing on its grid via C_1. Since the primary of the transformer is connected in the valve cathode circuit, the falling anode current produces a voltage across the transformer secondary and consequently on the grid via D_1 and C_1.

An oscillation will therefore build up in the circuit provided the transformer is non phase-reversing. The turns ratio of the transformer and the circuit gain are made such that the first half-cycle of this oscillator will cut V_1 right off, thereby injecting a step function of current of amplitude I_a into the transformer, *see* Fig. 9c, which in turn produces a pulse voltage across R_4 and L_p in parallel of amplitude $R_4 I_a$ which decays back to zero with time constant, L_p/R_4. The induced voltage in the secondary of the transformer T is added to the descending sawtooth applied at A, and appears at the grid of V_1 *via* D_1 as shown in Fig. 9, and provided the decay time L_p/R is suitably chosen, V_1 will not conduct again until the return stroke of e, during which small pulses of reversed sign are produced: here the action is unlikely to be regenerative as the pulse is such as to tend to make D_1 non-conducting and the grid of V_1 cannot rise faster than it would under the influence of I_R flowing into the grid-ground stray capacitance.

Thus, if E_1 is derived from a potentiometer, a pulse initiated at any point of the sweep is available.

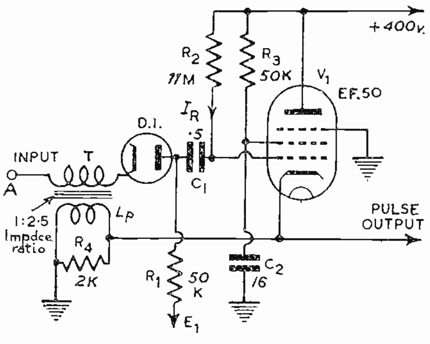


Fig. 8. Multiar

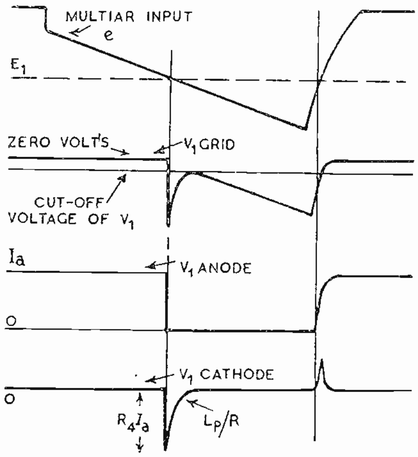


Fig. 9. Multiar waveforms

JUNE MEETINGS

Institute of Physics

Electronics Group

Summer Meeting

Date: June 12. Time: 2.30 p.m.

Held at: Lecture Theatre, London School of Tropical Medicine, Keppel Street, London, W.C.1.

Discussion: " Substances of High Permittivity."

Opening papers—" A Survey of Ferro-Electricity " by Vera Daniel, Ph.D. " Theory of Dielectrics and Ferro-Electricity " by A. F. Devonshire. " High Permittivity Titanates " by D. F. Rushman, Ph.D., A.R.C.S.

Those wishing to attend please notify the Hon. Secretary before June 3.

Hon. Secretary: G. W. Warren, Research Laboratories, General Electric Co., Ltd., North Wembley, Middlesex.

The National Physical Laboratory

Open Day

The National Physical Laboratory at Teddington is holding from 2.30-6 p.m. on Monday, June 21, an Open Day to which representatives of industrial organisations are being invited. Accredited representatives of industrial organisations interested in the work of the Laboratory are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than Saturday, June 5.

Institution of Electronics

N.W. England Section

Date: June 4. Time: 6.30 p.m.

Held at: The Reynolds Hall, College of Technology, Manchester.

Lecture: " Television."

By: L. C. Jesty, B.Sc., M.I.E.E.

Hon. Secretary: L. F. Berry, 105 Birch Avenue, Chadderton, Lancs.

The Television Society

Formation of Midland Centre

As television broadcasting will be extended to the Midlands in the near future, it is essential for all interested in this new science to have a common platform for study, discussion and practical construction. The Television Society, which was founded in 1927, has therefore formed a Midland Centre with Headquarters in Birmingham. The inaugural meeting was held in April at the University, Birmingham. The next meeting will take place on June 2, at the University.

Hon. Lecture Secretary: Dr. W. Summer, 169 Mary Vale Road, Bournville, Birmingham, 30.

Making Small Apertures in Metal Plates

IN certain optical and electrical devices it is necessary to provide small circular apertures in metal screens or diaphragms. These may be required to be of diameters as small as 0.025 mm. (0.001 in.) or less. It is, of course, quite out of the question to drill these holes, and consequently more elaborate methods have been used. These processes include closing in a larger hole by compressing the metal by suitable punches, or by making the diaphragm in sections, each containing part of the hole. These methods are shown in the accompanying sketch at A and B.

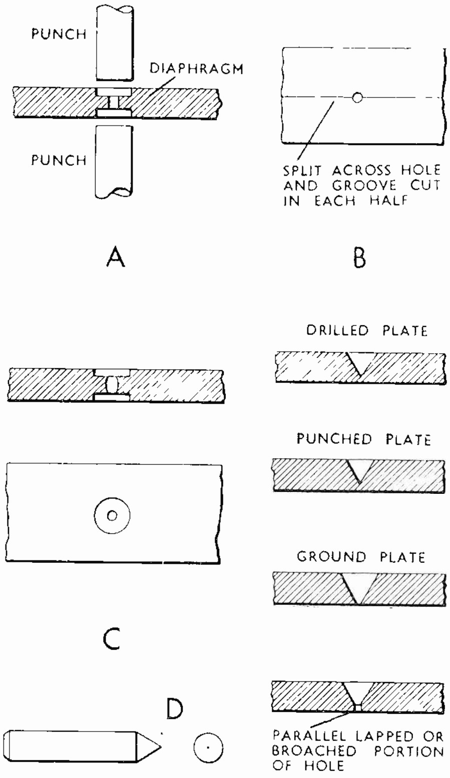
A serious fault of the contraction process is that precise location of a hole or a group of holes is extremely difficult and also the holes are usually distorted from the desired round or other shape in both planes as shown at C in the sketch. The complexity of a sectionalised diaphragm embodying a system of holes usually precludes the adoption of this alternative.

In the process to be described these faults are avoided and almost any layout of small holes can be produced and the diaphragm or plate containing these holes can be of any reasonable thickness.

For simplicity it is assumed that a circular hole 0.025 mm. is to be pierced in the centre of a brass or steel disk 2.5 cm. diameter by 0.3 cm. thick.

The first stage is to accurately mark the position which, if the disk has been turned on the lathe, may be done before removal from chuck or faceplate by the use of a small centre drill. The plate is now drilled with a conical hole, the included angle of which should be 60°, for reasons which will appear later. This conical drilled hole should enter the plate to within approximately 0.1 cm. of the other side.

An accurately ground steel conical punch of the form shown at D in the sketch is now located over the hole previously drilled. This punch is also of 60° angle and consequently will fit the drilled hole. Pressure is now applied either by a press, or less satisfactorily by a hammer until



the punch point is within 0.01 cm. of the undrilled side. This distance can be determined by measurement over the punch and plate or by the use of a height gauge or depth gauge.

The undrilled surface is now ground away until the extreme point of the punch deepened hole is visible, and the grinding may be continued until the hole is the desired diameter. A useful control of this dimension is given by the fact that if a 60° angle punch is used the increase of diameter is equal to the amount taken off the surface of the plate (sin 30° = 0.5).

If the thickness of the diaphragm does not exceed 0.05 cm. the drilling may be dispensed with and the conical punch indentations made direct in the plate, these being first located by very small punch marks. It is then necessary to provide means for holding the punch upright, this being conveniently done in the absence of a suitable press by providing a bush or collar through which the punch can slide.

Instead of the grinding process, the conical punched side of the plate may be covered by an acid-resisting paint or wax and the outer surface etched away until the holes are the desired size. Aluminium diaphragms, of course, may be etched by an NaOH solution.

An objection to the process is that the holes are of conical form. This, of course, is of positive value in certain optical apparatus as a means of reducing reflections within the hole. In other cases when a parallel hole is desired the initial hole may be lapped until a portion of the cone is enlarged to parallel. This is not difficult, as it is the initial piercing that is the usual difficulty and the enlargement by lapping or broaching is comparatively simple.

This process is also applicable to the production of holes in hardened steel. In this case the plate is suitably hardened after drilling and indenting by the conical punch and the unpunched surface ground away as described.

Holes made in this way are not subject to distortion on hardening, and the edge of the hole is not damaged by the high temperature required for hardening the steel.

H. E. HOLMAN.

Communication from Electrical and Musical Industries, Ltd.

Cathode-Follower Precautions

Users of miniature tubes are cautioned against employing the 6AG5 and 6AK5 types in cathode-follower circuits, since the internal shields of these types are connected to the cathodes, and are not therefore capable of being grounded, as such shields should be, according to an application note in *Radiotronics*.

Recommended types for cathode-follower service are the 6AU6 and the 6BA6, both of which have the internal shields connected to the suppressor grid. Optimum connexions for these tubes are with the suppressor grids at the same D.C. potential as the cathode, but with an effective by-pass to ground.

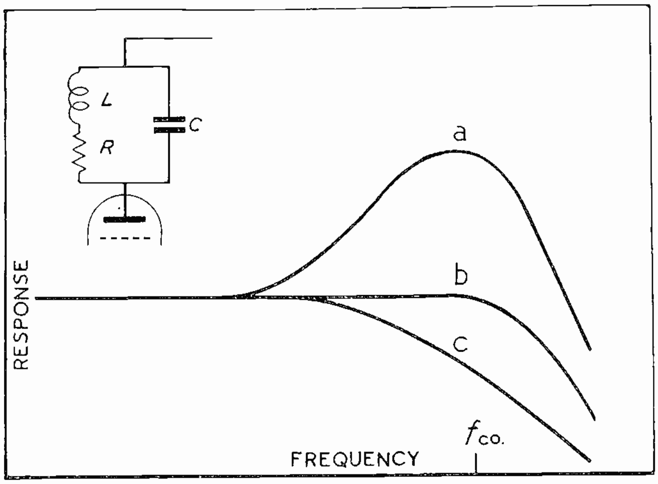


Fig. 1. Effect of varying the inductance of an inductively loaded amplifier working into a capacitive load

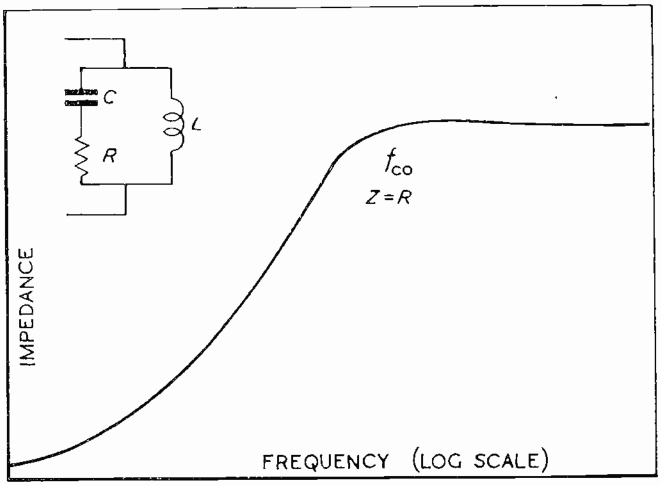


Fig. 2. Impedance-frequency curve of high-pass filter circuit

A Bass Correction Circuit for Moving Coil Pickups

By N. WINDER, A.M.I.E.E.

THE February, 1947, issue of ELECTRONIC ENGINEERING contained an interesting bass lift circuit for moving-coil pickups. There are usually several methods of tackling any problem, however, and the present writer ventures to put forward a circuit which has some attractive points. It is, so to speak, a by-product of work in another field, but fits in almost ideally with the requirements of bass correction for gramophone records.

As anyone who has used wide-band audio- or video-frequency amplifiers knows, the response at high frequencies can be extended by using inductances in series with anode resistances. What perhaps is not so widely known is that there is a critical combination of resistance, inductance, and capacitative load which ensures a sensibly flat response up to any given frequency, without any resonances. In working with such circuits it was noticed that after the cut-off frequency the attenuation began at the rate of 6 db. per octave, which is such a significant figure to anyone interested in moving-coil pickups that further investigation was obviously called for.

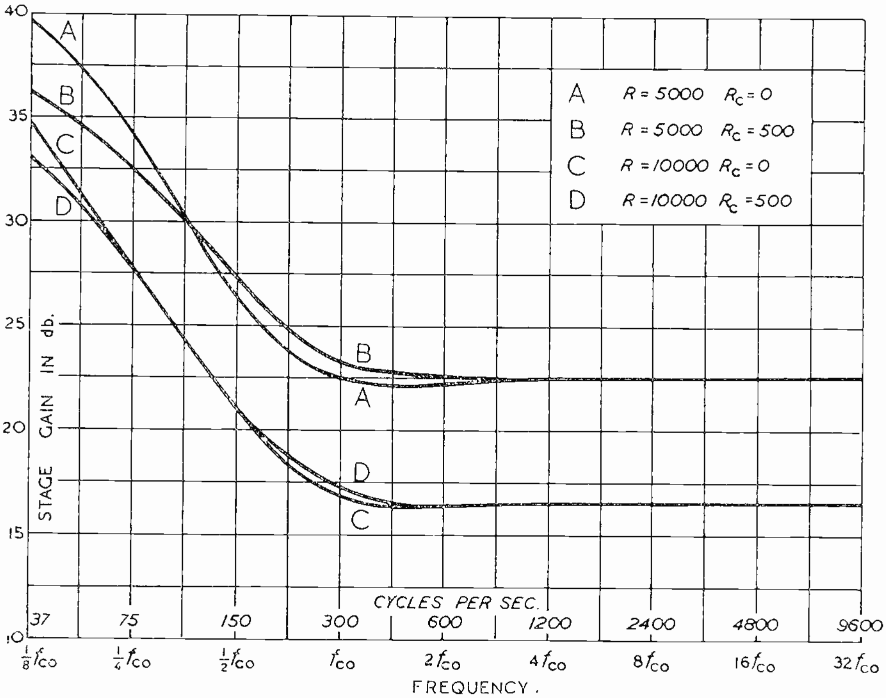
An inductively loaded amplifier working into a capacitative load boils down to the circuit of Fig. 1. Although at first glance this has the appearance of a tuned circuit, it need not necessarily produce any resonant effects. The curves of Fig. 1 are those obtained with differing values of inductance: (a) is the response when too much inductance is used, and (c) when too little. Terman states that the condition for the ideal curve (b), using pentode valves, is that at the required cut-off frequency the resistance should be made equal in magnitude to the reactance of the condenser, and that at the same frequency the reactance of the coil should be half of that figure. That is at f_{co} $|X_L| = \frac{1}{2}R$ and $|X_c| = R$. This should be a useful tip to designers of C.R. oscilloscope amplifiers.

In applying this for bass boost the first step is to turn the circuit from a low pass to a high pass combination, and this can be done simply by interchanging the positions and magnitudes of the two reactances, as in Fig. 2. Now at cut-off frequency $|X_c| = \frac{1}{2}R$ and $|X_L| = R$. Under these conditions the impedance of the circuit at differing frequencies follows the curve of Fig. 2.

If such an impedance is used for negative feed-back in the cathode of a pentode valve, the output from the anode will have a reversed characteristic, and will accordingly be of the form desired. It will have a constant output down to any given frequency, followed by a sensibly linear increase for two, three, or more octaves according to the values chosen. Fig. 3 gives the complete circuit for such a pre-amplifier, and except for one warning and one piece of advice, readers interested more in results than in derivations may skip the rest of this article. The warning is that any inductance so early in an amplifier is prone to pick up hum, and care should be taken in positioning. In some cases it may even be necessary to screen the choke in a mu-metal box. Those who have a choke somewhere near the required value, but not exactly the 5 henries specified, can use their choke, but must alter the resistance and condenser to suit, making the resistance equal to the reactance of the choke at 300 c/s., and making up a bank of condensers such that their reactance at 300 c/s. is half that of the choke. 300 c/s. is chosen as the cut-off frequency to accommodate the slight bend in the response curve, and so allow the bass compensation to be in full swing from 250 c/s. down. Standing bias for the valve is obtained by making up the D.C. resistance of the choke to 200 ohms (not more if it can be avoided).

Several questions must still remain in the minds of most readers, and it is proposed to be a little more exact about the frequency correction obtained, and also to examine the influence of such factors as mutual conductance of valve, and the resistance element of the choke.

With a pentode valve with feed-back in the common grid and cathode circuit, the stage gain is $\frac{g_m R_L}{1 + g_m Z}$ where g_m = mutual conductance, R_L = effective anode load and Z impedance in the cathode. When



the impedance of Fig. 2 is substituted for Z, and due consideration paid to phase shift in the network, the formula becomes considerably lengthened but is still workable.

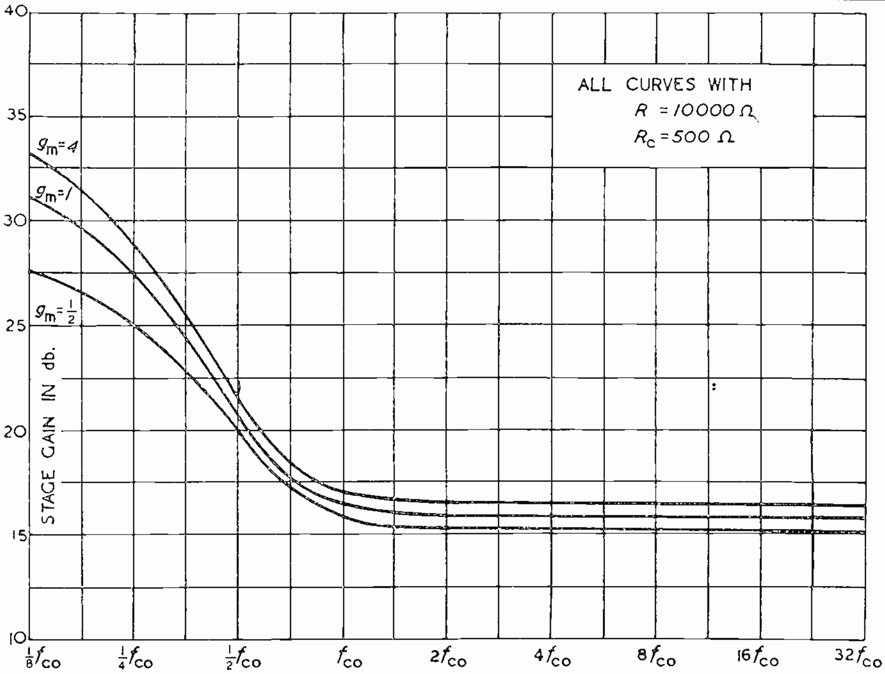
It is: Stage gain =

$$g_m R_L \sqrt{\frac{(R + R_c)^2 + (X_L - X_c)^2}{[R + R_c + g_m(R R_c + X_L X_c)]^2 + [X_L(1 + g_m R) - X_c(1 + g_m R_c)]^2}}$$

where R_c is the resistance of the choke. Since $g_m R_L$ is the gain without feedback the portion of the formula under the square root sign becomes the frequency correction factor. Fig. 4 shows the application of this formula to a high-slope pentode in the circuit in Fig. 3. The curves show a frequency response nearer to the ideal than any the writer has yet seen. The output from the highest frequencies down to the cut-off frequency is flat to less than 1 db., and the change at cut-off frequency to a linear rise is sharp and without peaks.

Fig. 4 (above). **Stage gain curves derived from the formula of col. i, showing effect of resistance in choke**

Fig. 5 (*below*). **Curves showing effect of variation in g_m on stage gain**



Effect of Resistance in the Inductive Arm

The effect of appreciable resistance in the choke is to modify the response, and the manner of so doing is brought out by curve B of Fig. 4. The sharpness of the bend at cut-off frequency is slightly reduced, and after an initial rise below cut-off frequency it begins to flatten out well before the curve of the resistanceless choke (curve A). Nevertheless, curves C and D show that with an A.C. resistance of 500 ohms the rise in bass response can be maintained for a sufficient number of octaves, provided that the feedback at high frequencies is

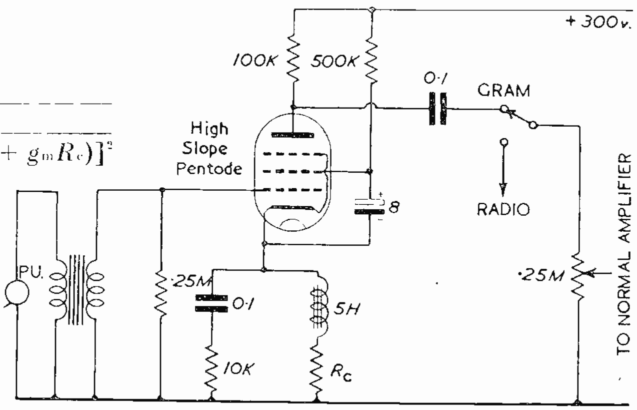


Fig. 3. Pre-amplifier and bass boosting circuit for pick-up

increased. Curves A and B are with a feedback resistance of 5,000 ohms, and Curves C and D with 10,000 ohms.

In considering any particular choke the reader should remember that the D.C. resistance only measures the copper losses of the windings, whereas with audio-frequency currents the iron losses also come into the picture. The A.C. resistance is accordingly greater, but by how much depends on each individual choke.

How much resistance can be tolerated depends on how much stage gain can be sacrificed. With the main feedback resistance R equal to 5,000 ohms, and L and C to suit, the D.C. resistance of the choke

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A Method of Measuring Cloud Heights

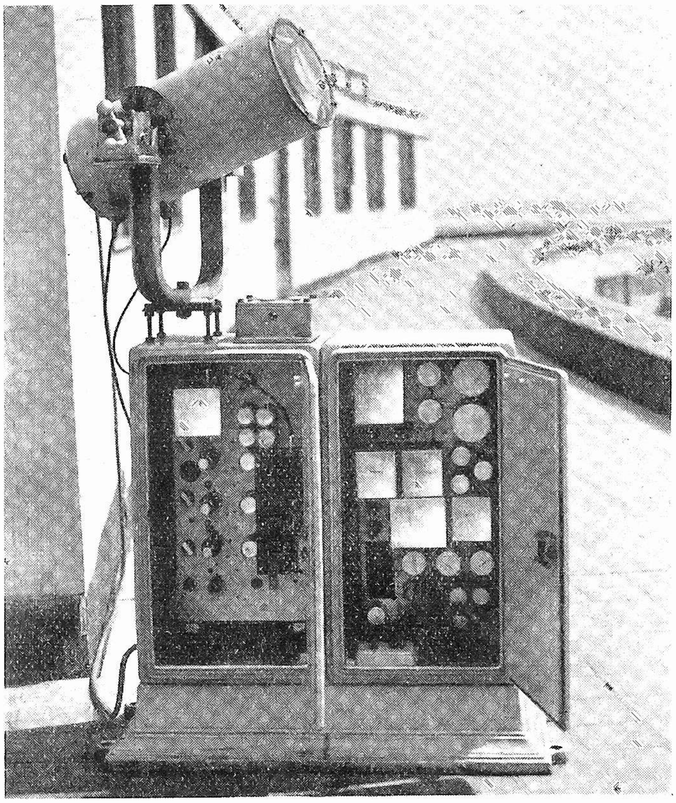

Fig. 2. Photo-electric 'Ceilometer' with amplifier at left, discriminator and power supply at right

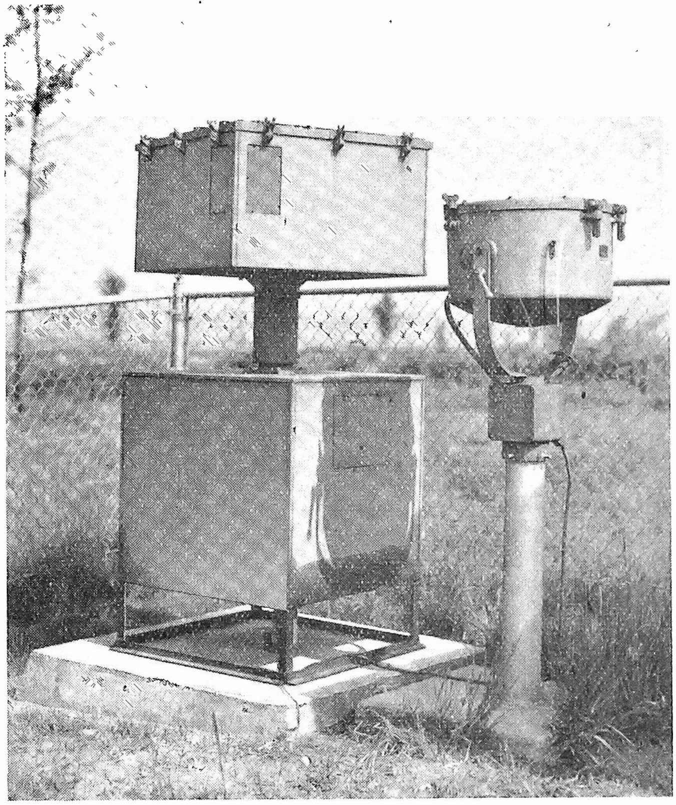

Fig. 1. Vertical beam projectors used by the U.S. Weather Bureau for measuring cloud heights

THE U.S. Weather Bureau has introduced a method of measuring the height of clouds and rain and snow ceilings up to 20,000 ft. A mercury arc projector is used in conjunction with a photo-cell pick-up unit, and an intense beam of modulated light is directed vertically against the cloud.

The scattered spot formed on the base of the cloud is detected by the pick-up unit and the height determined automatically by triangulation. The work has been carried out at the National Bureau of Standards, and equipment built to the Bureau's design has proved satisfactory even in severe weather.

would have to be kept down to 30 or 40 ohms, but the stage gain would then be at a maximum, and the output would, in fact, be of the order of one volt R.M.S. with an average moving coil pickup and transformer. With R equal to 10,000 ohms, and the reactances adjusted to suit, the stage gain would be approximately halved, but half a volt is sufficient to load most normal amplifiers, and with this combination of values a choke with its D.C. resistance made up to 200 ohms would be quite satisfactory. This not only enables a conveniently small component to be used, but also takes care of the standing bias for the valve.

Effect of Mutual Conductance

R.F. pentodes vary widely in their mutual conductance. It is, however one of the characteristics of negative feedback amplifiers that gain is only slightly dependent on mutual conductance, and this is well brought out by the curves of Fig. 5. In assessing the figure for any valve it is unsafe to take that published by the manufacturer—not because of any turpitude on the part of the maker, but because the published figures are taken under different operating conditions. In the circuit now under discussion a fair approximation would be to take 30 per cent. of the maker's figure. From Fig. 5 it is evident that any high slope R.F. pentode is suitable, but that a valve with low mutual conductance would fail at the lower frequencies unless a larger value of feedback were used, with consequent reduction in stage gain.

In conclusion readers are reminded that pentodes do not act as pentodes unless the screen is adequately decoupled, and it would obviously be foolish to go to the trouble of compensating for bass deficiencies on records, and then throw away the results by inadequate decoupling. The decoupling condenser in the screen circuit is essential. Moreover it should be returned to cathode, and not to earth, in view of the undecoupled nature of the cathode load.

The Chromoscope

A New Colour Television Viewing Tube

By ARTHUR B. BRONWELL*

IDEALLY, a colour television receiver should contain a single viewing tube, comparable in simplicity and cost to the viewing tubes used in the present black-and-white television receivers. The associated circuits required for the addition of colour must be relatively simple and inexpensive, and the overall cost of the colour receiver should compare favourably with that of black-and-white receivers. Such an ideal could easily be achieved if it were possible to obtain different colour phosphors which fluoresce at critical electron beam velocities. A change in colour could then be produced merely by changing the beam velocity. Unfortunately, however, all known phosphors fluoresce with increasing brilliance as the beam velocity increases and there are no known phosphors which fluoresce only at critical beam velocities.

The chromoscope† is a relatively simple, all-electronic colour television viewing tube. It contains a single electron gun, a single composite colour screen and relatively simple and inexpensive associated circuits. The incremental cost of adding colour, using the chromoscope over the cost of black-and-white television would amount to only a few per cent. of the cost of the receiver. The chromoscope is basically a sequential colour television system. Since it is an all-electronic sytem, the colour interval can correspond to the line frequency, the frame frequency, the picture frequency or any other desired interval.

Description

As shown in Fig. 1, the chromoscope consists of a cathode-ray tube which contains a single electron gun and a specially designed colour image screen. The image screen is composed of four parallel, semi-transparent screens, three of which are coated with phosphors corresponding to the three primary colours, red, blue, and yellow (or green). The fourth screen serves as a constant-potential screen, and will be described later.

The individual screens are separated a short distance apart (of the order of one to three millimetres) and are electrically insulated from each other so as to permit independent control of the screen potentials. Any one colour screen can be caused to fluoresce and the others to be extinguished by placing a high positive potential on the screen which is to fluoresce and a low potential on the other two colour screens. In order to obtain a three-colour television picture, it is therefore merely necessary to commutate the screen potentials so as to place a high positive potential sequentially on the three colour screens.

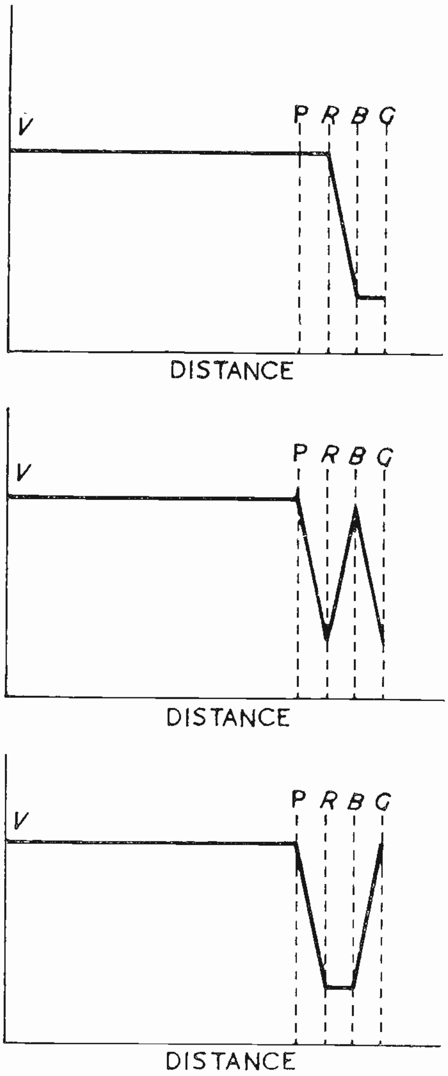

Fig. 2. Plot of potential or electron velocity in the vicinity of the colour screens. Only the high potential screen will fluoresce

The colour pictures formed on the three separate colour screens are optically superimposed and the colour image has the appearance of originating from a single three-colour screen. The resulting television picture can be viewed either directly or by means of a conventional television projection system, although, for reasons explained later, a projection system is preferred.

The basic principle of operation of the chromoscope is that a freely-moving electron has a velocity which is proportional to the square root of the potential, or, specifically,

$$v = \sqrt{\frac{2Ve}{m}}$$

where v is the electron velocity, V is the potential at the instantaneous position of the electron, and e/m is the charge-to-mass ratio of the electron. By virtue of this relationship, the velocity of an electron increases as it approaches a low-potential screen. The screen construction is such that approximately one-third of the electrons strike each screen. However, only those electrons which strike the high potential screen have sufficient velocity to cause fluorescence.

The fourth screen in the image-screen assembly, that nearest the electron gun, is a constant-potential screen. This screen is relatively transparent to light and electrons, and is given a high positive potential. It serves to shield the region between the electron gun and the image screen from potential fluctuations resulting from variations of the colour screen potentials and therefore prevents defocusing errors. The only potential variation in the chromoscope (excluding the deflecting potentials), therefore, occurs in

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† Patents applied for. Experimental tubes are being developed by the DuMont Laboratories.

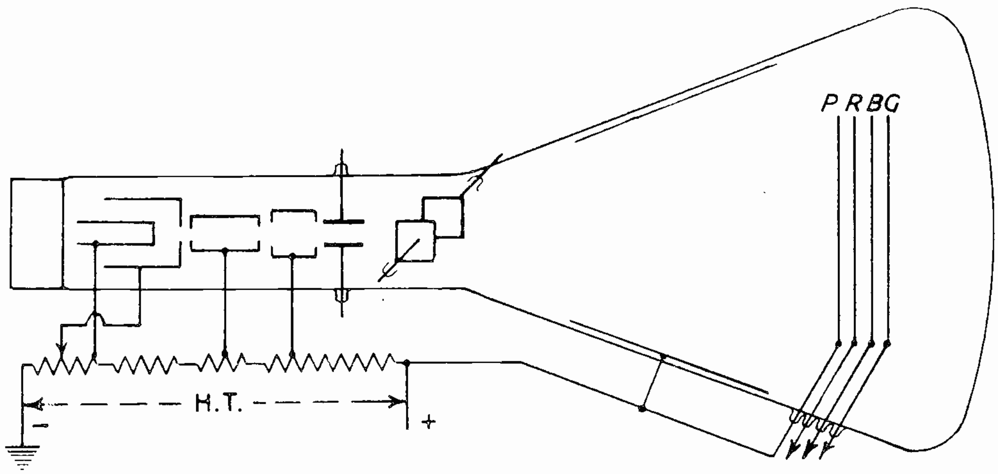


Fig. 1. Diagram of Chromoscope tube arranged for direct viewing

the immediate vicinity of the three colour screens. Since the spacing between screens is of the order of a few millimetres, these potential variations do not adversely affect the focus of the electron beam.

Fig. 2 shows a plot of screen potentials for a red, blue, green colour sequence. Since the electron velocity is proportional to the square root of the potential, the plot in Fig. 2 may also be interpreted as a plot of electron velocity in the region of the colour screens.

Screens

One type of screen construction consists of a close-mesh, parallel-wire screen, containing small-diameter wires or metallic strips placed close together and welded or brazed to a metallic frame. The phosphor is then deposited upon the wire screen. For a 525-line picture definition, each colour screen would contain at least 525 parallel wires. The screens are relatively transparent to light and electrons, while presenting sufficient phosphor surface for the formation of the picture. In a 525-line screen, the wire structure would be no more visible than the line structure in the ordinary black-and-white television picture.

The three colour screens, together with the constant-potential screen, are clamped together and inserted into the cathode-ray tube as a unit, with leads brought out for the potential connexions.

The constant potential screen consists of a grid of very fine wires, but relatively coarse mesh. In this way the screen is almost completely transparent to light and electrons, while, at the same time, serving to maintain a constant potential in the plane of the screen.

The screens normally have an ambient D.C. potential of from several hundred to several thousand volts. The additional potential required to produce full brilliance is keyed by either multivibrators or keying circuits. Three such multivibrators or keying circuits are interlocked so as to operate sequentially at any given instant and only one such circuit operates to apply a high potential to its corresponding screen. Those circuits can be synchronised by either the horizontal or the vertical synchronising pulse.

Features of the Chromoscope

Colour flicker and colour break-up can be completely eliminated by synchronising the colour interval with the horizontal sweep frequency instead of with the vertical sweep frequency. Successive lines of the picture would then be scanned in the red, blue, green colour sequence and the colour repetition rate would be sufficiently high to prevent colour flicker or colour break-up. Since the chromoscope is an all-electronic colour system, it is just as easy to synchronise the colour with the horizontal sweep frequency as with the vertical sweep frequency.

It is the opinion of the author that a sequential system in which the colour is changed at the end of every line offers the only satisfactory solution to the perennial problem of how to receive high-definition television pictures on either a black-and-white or a colour receiver, with a minimum band-width and approximately the present black-and-white television standards.

The chromoscope is particularly well adapted to changing the colour at the end of each line.

Phosphors which have a fairly long persistence can be used, since it is not necessary to erase the picture at the end of every frame. In this respect, the chromoscope is superior to the revolving colour disk system in which each picture must be erased before the next colour filter comes into position.

The colours can be blended in any desired ratio in the chromoscope by merely adjusting the screen potentials. Thus, when the red colour is being scanned, it may be found desirable to have the blue and green colour screens fluorescing at 20 per cent. or 30 per cent. of full brilliance. This may be accomplished either by the use of long-persistence screens or by applying sufficient potential to the various colour screens during the extinction phase to cause partial fluorescence.

Although the chromoscope is still in the developmental stage, it appears to offer a relatively simple and economical solution to the television problem. The tube construction is only slightly more costly than that used in the black-and-white receiver and the associated circuits are relatively simple. The incremental cost of colour television, using the chromoscope, over black-and-white would be relatively small in comparison with other proposed systems.

A Two-Phase Telecommunication System

Part 2. Multi-channel and Multi-group Systems

By D. G. TUCKER, Ph.D., A.M.I.E.E.*

4. Multi-Channel Systems

IF the system is to be of multi-channel type, it should preferably be arranged that the whole group of channels lies within an octave (or some other range depending on the carrier harmonics present or produced in the circuit), so that the unwanted carrier-harmonic products lie outside the range of the receiving band-pass filters; in this case, filters are not required at the sending end, and the channels can be combined by resistance or hybrid coil arrangements.

The use of filters in a multi-channel system requires a consideration of the phase variations likely to be produced by:

(1) Variations in value (due mainly to temperature) of the components of the filters; and

(2) variations in the basic frequency.

The magnitude and importance of this is readily seen from an example. If the channel bandwidth is 50 c/s., then a filter designed to this bandwidth will give approximately 6° change of phase shift per section per 1 c/s. change of frequency. If a tuned circuit were used for receiving the "pilot" or frequency-control tone, and this were 750 c/s., with 30 db. discrimination required against signals 50 c/s. away, then the Q-value would be approximately 200, and the phase-shift near resonance would change by about 40° per 1 c/s. change in frequency. It is thus clear that both variations in component values and in frequency must be restricted to small values if excessive crosstalk is to be avoided. Moreover, it is not desirable to use varied types of selective circuit for different channels. A certain measure of compensation is provided if the carrier supplies at the receiving end are fed through filters identical to those used in the channels themselves, because then the relative phases at the demodulator will not vary if the temperature is uniform throughout the equipment. But this still requires that the filters used to select the carrier frequencies at the sending end, and that used to select the pilot from the line, should not produce much phase variation. This can be achieved to a limited extent by avoiding the need for highly-selective filters by using suitable harmonic generating equipment at the sending end (assuming all channel frequencies are derived from a common basic frequency, in which, say, only odd harmonics are generated in one circuit, and even harmonics in another[5]; and systems in which even further separation is effected without filters may be possible. The changes in the pilot receiving filter may be minimised by providing as great a frequency separation as possible between the pilot and the nearest signal frequencies, so that extreme selectivity is not required. Changes in the selective circuits involved in a frequency divider can be minimised by using minimum amounts of selectivity as discussed in Reference 4.

The use of ordinary components (iron-dust-cored inductors, clamped-mica condensers) is likely to give rise to variations of critical frequencies of about 1 part in 10^4 per 1° C. change of temperature, so that over a normal range of about 10° C., about 0.1 per cent. change of frequency may occur. This obviously indicates that ordinary components will be suitable only if the channel bandwidths are greater than about 1/10th of the midband frequency (on the basis of 25 db. crosstalk ratio). Otherwise special components or temperature-controlled ovens will be necessary.

As regards the stability of the basic frequency, this is likely to be less difficult to maintain than that of the filters, but although the effect of battery variations is easily made negligible by the use of lamp-stabilisation,[6] the effect of temperature can only be eliminated by preventing changes of temperature of the tuning unit by enclosing it in a temperature-controlled oven. As the amount of equipment to be so treated is small in this case, this is quite feasible. The use of resistance-capacitance tuning[7] may lead to greater stability, since the temperature coefficient of an RC unit can easily be made less than that of an ordinary LC unit. In this connection, it is worth noting that RC filters also can be made,[8] by utilising feedback effects in valve circuits.

Another possible source of phase error is lack of symmetry of the band-pass filter characteristics about the carrier frequency. The effect is the same as was discussed in Section 3 in connection with the line in a single-channel system, but as it is in this present case difficult to obtain linearity, it is best to specify symmetry. If the filter characteristic is not symmetrical, the phase of the virtual carrier will vary with varying frequency of sideband signal, and the unwanted signals in a channel can then be eliminated by adjustment of the phase shifters only for one particular frequency of unwanted signal.

Yet another source of phase error may be non-linearity of the filter components. If the value of an inductance, say, varies with signal amplitude, then the critical frequencies of the filter will be shifted, with a corresponding change in phase-shift. This trouble can be avoided by using filters only at low-level points in the system, or, in the case of the carrier-supply filters, only with constant levels.

5. Multi-Group Systems

If a very large number of channels is to be worked, it will be desirable—and generally necessary—to divide them into "groups" of, say, 5 to 10 two-phase channels. All groups will be identical and will consist of the specified number of channels arranged in adjacent frequency bands, and most of the requirements discussed earlier will need to be met for all groups. Each group will then be modulated as a whole, as a single-sideband, sup-

* Post Office Research Station.

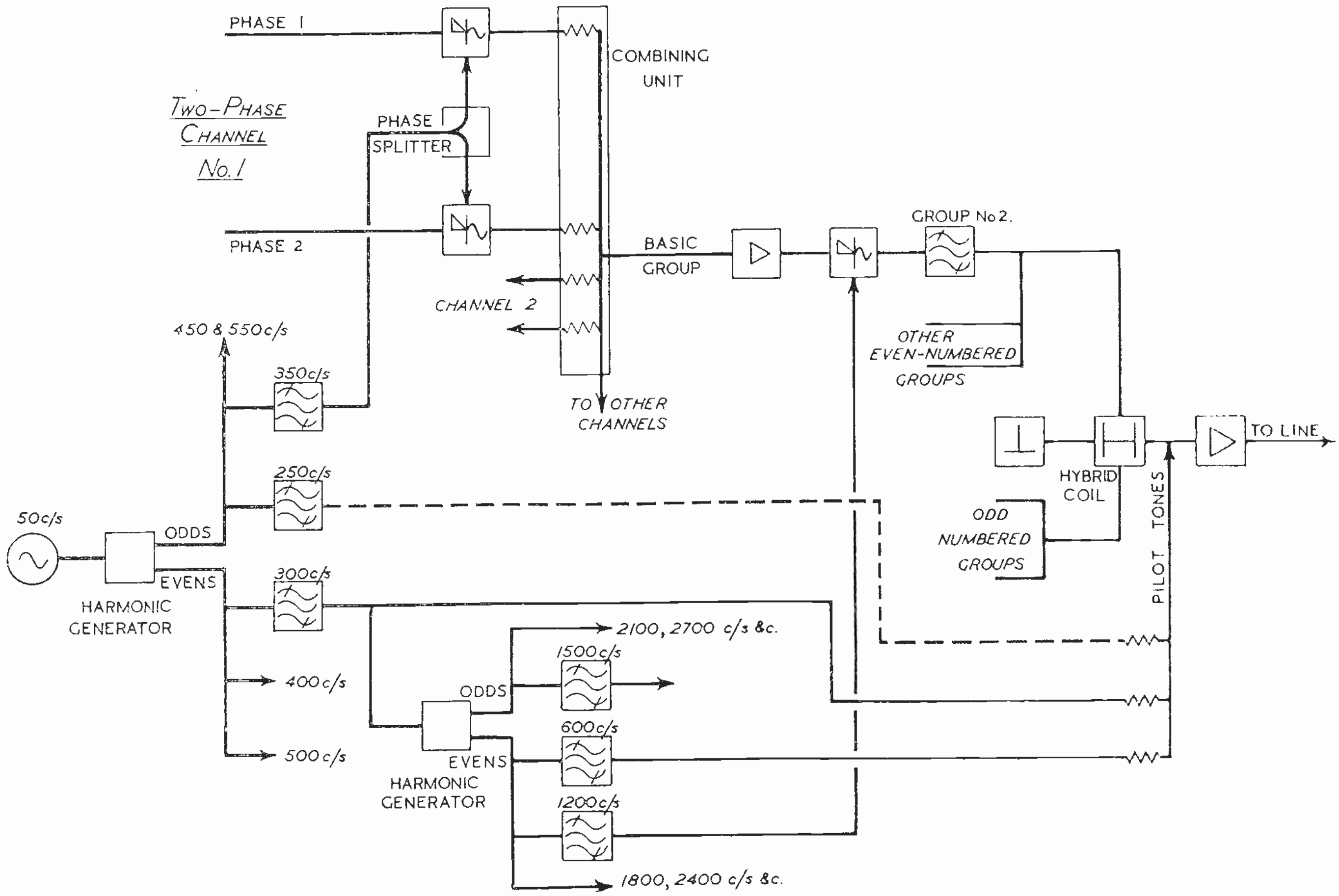


Fig. 2a. Sending end of typical system

pressed carrier, signal, into some particular range in the frequency band to be transmitted to line. Super-group modulation can also be employed, if necessary. There is no greater difficulty in operating such a system than for one basic group, provided certain precautions are taken and certain methods adopted, as follows.

The group modulating frequencies must be carefully synchronised between the two ends, and compensation for variations in phase-shift in the line must be provided. This can be effected thus: Two pilot tones are transmitted (for each super-group if more than one set of groups is used), one of frequency double that of the other, say, f and $2f$. Assume that the line phase characteristic is linear and let the linear phase intercept be ϕ_0. Then one pilot consists of a frequency f with line phase angle $\phi_0 + \phi_1$, designated as $f\,\underline{/\phi_0 + \phi_1}$, and the other consists of a frequency $2f$ with angle $\phi_0 + 2\phi_1$, *i.e.*, $2f\,\underline{/\phi_0 + 2\phi_1}$. Then if any group carrier frequency is nf, it will need to have a phase angle of $\phi_0 + n\phi_1$ if no phase error is to be introduced. The group carrier can be given this phase angle if it is produced by modulating the $(n - 1)$th harmonic of the difference between the pilots with the lower pilot itself, thus:

$$\text{Group carrier} = (n - 1)[2f\,\underline{/\phi_0 + 2\phi_1} - f\,\underline{/\phi_0 + \phi_1}] + f\,\underline{/\phi_0 + \phi_1}$$
$$= nf\,\underline{/\phi_0 + n\phi_1}$$

This pilot system can be fitted in with the requirements of the channels themselves, by using a basic frequency for the channels which is a sub-multiple of the difference between pilots and is therefore obtainable by using a frequency-divider, or by transmitting a third tone differing from one of the pilots by the basic frequency.

With this system complete compensation is obtained for phase shift in the line and associated common equipment, provided the phase characteristic is linear throughout the frequency range of one set of groups. Variations in either the intercept or the slope of the phase characteristic after line-up will produce no error on any channel.

An example in which the channels have a width of 50 c/s., and the basic frequency is 50 c/s., is given below:—

Channels	325- 375 c/s.	carrier	350 c/s.
	375- 425 c/s.	..	400 c/s
	425- 475 c/s	..	450 c/s
	475- 525 c/s.	..	500 c/s
	525- 575 c/s.	..	550 c/s
Basic Group	325- 575 c/s		
Pilot Tones	(250). 300. 600 c/s		
Higher Groups	625 - 875 c/s	group carrier	1,200 c/s
	925-1,175 c/s	..	1,500 c/s
	etc.		

This frequency allocation meets the various requirements specified.

In selecting the single sidebands of the higher groups, care must be taken that the filters used have a sufficiently linear phase characteristic over the frequency range of the group. This is best achieved by connecting in parallel only alternate groups, or even every third group, so that the group filters can have a band width greater than that of the group itself, and thus have a reasonably linear phase response over the working band. The two or three sets of paralleled groups can then be combined by means of hybrids. In the case of the second group shown in the example above, it would not be feasible to eliminate the leak of input to the group modulator from the output signal by means of a filter, owing to the closeness of the unwanted frequency band (325-575 c/s.) to the wanted sideband (625-875); if a balanced (ring) modulator gave insufficient suppression of the input signal, then a larger frequency gap could be left, or a double-modulation process used.

The block schematic of a typical system, using the frequency allocation discussed above, is shown in Fig. 2. A continuously variable phase-shifter (a detailed example circuit arrangement is shown in Fig. 4) is shown in the carrier supply to each channel; this enables an initial adjustment to be made to take up the difference in phase shift between the signal channel and the carrier generating circuits. It could also be used, if necessary, for day-to-day adjustment to take up the effect of varying temperature, which varies the phase-shift in the filters, as discussed earlier. A typical circuit arrangement for the channel equipment at the receiving end is shown in Fig. 3.

The limitation to the number of groups to be included in a supergroup is the narrowness of the band-pass filters used for selecting the groups. While the band is relatively wide (*i.e.*, relative to the mid-band frequency), phase variations in any channel due to temperature variations in the group filters are probably negligible, but when the band is narrow in relation to the mid-band frequency, these variations become important, in the same way as discussed for the channel filters in Section 4.

6. Conclusions

The fundamental principles of a two-phase transmission system have been discussed, and it has been made clear that if two signals are to be transmitted in the same frequency band by this means an extremely high degree of phase stability is required throughout the system. The system depends for its operation on the fact that a twin-sideband signal with suppressed carrier requires a demodulating carrier of correct phase; if the phase of the demodulating carrier is $\pi/2$ radians different from that required for optimum demodulation, no output at all is obtained. Two such signals in the same frequency band can therefore be separated on demodulation if they were originally modulated with carriers of the same frequency but different phase (preferably $\pi/2$ radians difference), and are demodulated in each of two branches by carriers of phase such that one signal is eliminated in each branch.

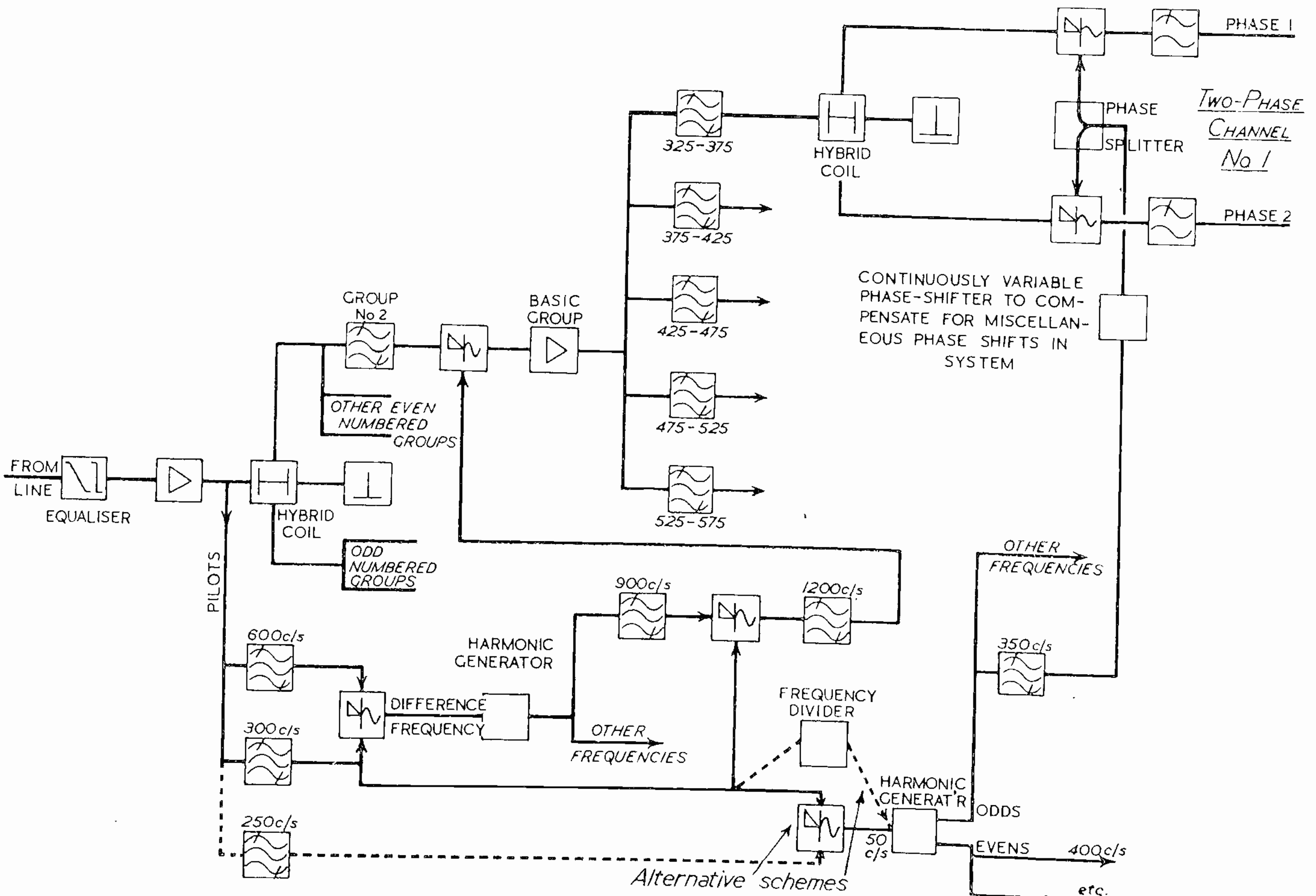


Fig. 2b. Receiving end of typical system

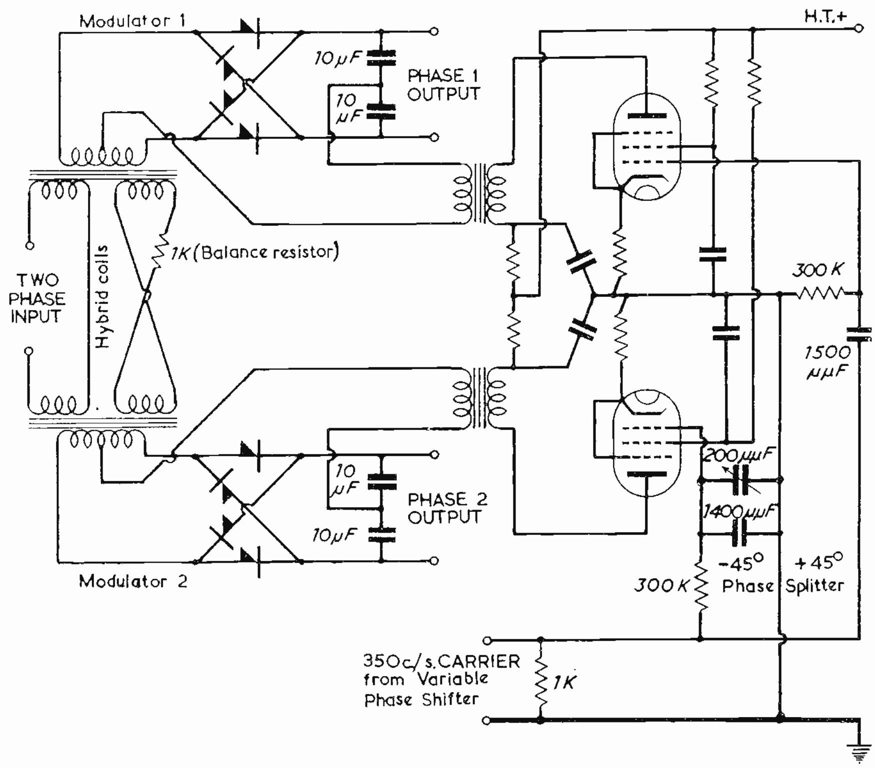
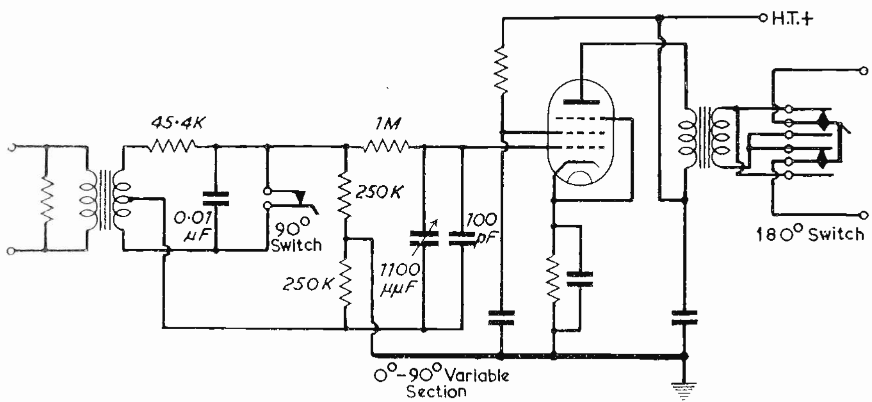


Fig. 3 (*above*). **Two-phase channel equipment (receiving end)—350 c/s. channel**

Fig. 4 (*below*). **Variable phase-shifter (0-360°) for 350 c/s. channel (receiving end)**



Practical difficulties in designing such a system, for single- or multi-channel working, have been discussed, and suggestions made for suitable equipment.

7. Acknowledgments

The author can claim little originality for the ideas put forward here, but hopes that this preliminary discussion will prove useful to others who may find an application for the system. The various considerations and principles set out were freely discussed among his colleagues, and Mr. R. J. Halsey and Mr. R. O. Carter, in particular, made considerable contributions.

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Edison Swan Electric Co., Ltd., 155 *Charing Cross Road, London, W.C.2.*—"Metal-to-Glass Terminal Seals" Radio leaflet R1303 giving detailed information on the full range available of hermetic terminal seals.

Goodmans Industries, Ltd., Lancelot Road, Wembley.—Leaflet giving details on their 15 in. and 18 in. Heavy Duty Loudspeakers, types T10/1501/15 and T11/1801/16 and their Heavy Duty Line Transformer type H5.

Scientific Instrument Manufacturers' Association, London, W.C.1.—1947 edition of the S.I.M.A. handbook. This is nearly double the size of the previous edition and contains full information about the Association, illustrated reviews of the British Scientific Instrument Industry and much other matter. Available from the above address, 10s. 6d. post free.

Telegraph Construction Co., Ltd., 22 *Old Broad Street, London, E.C.2.*—"Thermostatic Bimetals" leaflet dealing with the various available "Telcon" Bimetal strips.

Vitavox, Ltd., Westmoreland Road, London, N.W.9., a fully illustrated catalogue of Vitavox microphones, cone and beam projector loudspeakers, multi-cell and car mounting horns.

A. F. Bulgin and Co., Ltd., Bye Pass Road, Barking, Essex.—The Bulgin catalogue (List No. 176). Price 6d. now available.

Stability Radio Components, Ltd., 14 *Norman's Buildings, Central Street, London, E.C.1.*—SRC Silvered Mica condensers are listed in a new catalogue "Issue 2."

American Standards on Radio Receivers.—Published by the Institute of Radio Engineers, 1 East 79 Street, New York, 21, N.Y. (price 50 cents.) is a report dealing with the testing of Frequency-Modulation receivers in the range between 88 to 198 Mc/s. These Standards cover definitions of terms and methods of testing receivers designed to receive Frequency-Modulated (FM) waves in order to establish standards similar to those already in use of receivers designed to receive Amplitude-Modulated waves. In view of the many uses to which such receivers may be put, the report has been limited to broadcast receivers designed to operate at carrier frequencies between 88 and 108 Mc/s. and having characteristics required to receive transmissions in accordance with the Federal Communications Commission standards for such service. The methods may be used for Frequency-Modulation receivers for other services by applying the proper system requirements.

An Improved Pulse Frequency Divider

By R. T. CLAYDEN*

THE well-known step-divider circuit (*see* Fig. 1) provides a simple, reliable, and accurate method of frequency dividing in pulse circuits. It has, however, a few minor limitations which make it unsuitable or uneconomical for certain applications in its basic form. Two of these limitations are: (1) the leading edge of the output pulse is not coincident with either edge of the input pulse, and (2) the width of the output pulse cannot be easily adjusted, which makes it necessary to provide a separate multivibrator if an output pulse of controllable width is required.

A brief description of the function of the circuit will be useful at this stage.

The valve *V1* is switched on by the incoming pulses, its anode swinging from the full H.T. potential to about the knee of the valve characteristic. Immediately the current in the valve is switched off, the anode potential begins to rise towards the H.T. potential, so turning on the diode *V3*. The capacitance from the anode of *V1* to ground (consisting of stray capacitance and *C3* in series with *C4*) is now charged up to H.T. potential, the anode potential rising on a normal resistance-capacitance charging curve. A step of potential whose rising edge follows this curve is thus generated across *C4*.

When *V1* is again turned on, its anode potential falls rapidly to the knee of the valve characteristic, *V3* is turned off, and *V2* is turned on, thus substantially restoring *C3* to its original state of charge and leaving the increment of charge in *C4*. Each time *V1* is switched off, therefore, a step of potential is generated across *C4*. At a predetermined potential the following circuit is triggered, generating the output pulse and restoring the charge in *C4* to its original condition. The output circuit is therefore triggered by a potential which is rising on a resistance-capacitance charging curve which starts as the valve *V1* is cut off, *i.e.*, at the end of a positive input pulse.

In an interlaced television system it is essential that the leading edge

(*Continued at foot of next page*)

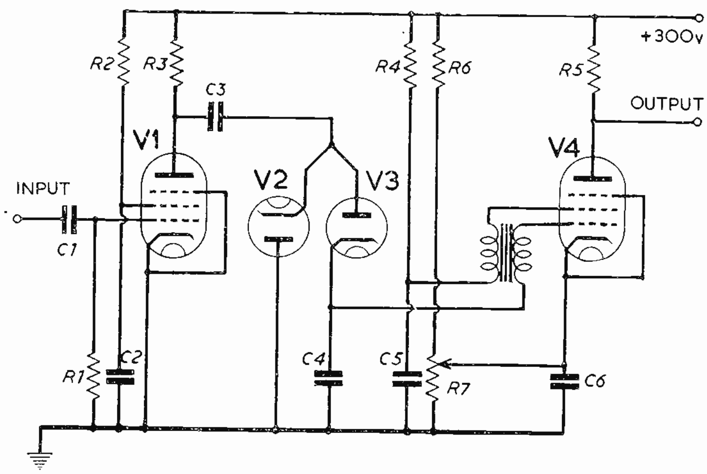
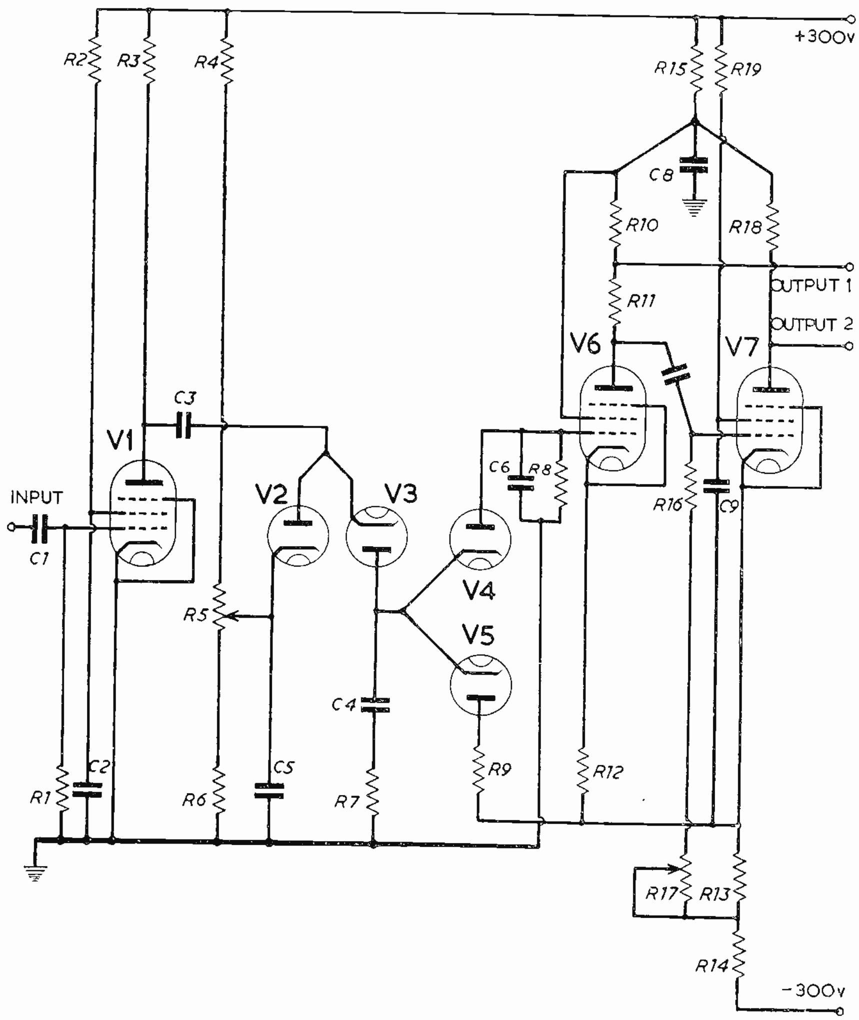


Fig. 1. Form of step-divider circuit

Fig. 2. Improved circuit giving output pulse of adjustable width



* E.M.I. Research Laboratories.

LONDON — BIRMINGHAM TELEVISION RELAY

Fig. 2. Close-up of the paraboloid aerial and the television laboratory

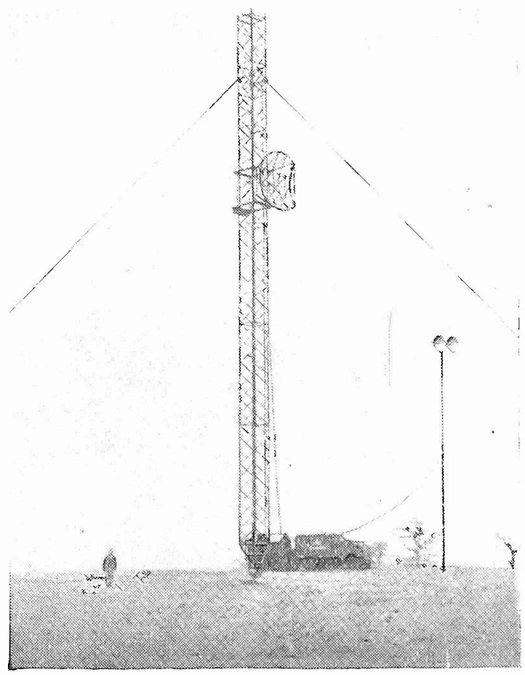


Fig. 1. The temporary masts on which the paraboloid aerial can be raised or lowered

(Photos by courtesy of the General Electric Co. Ltd.)

An extensive series of field trials over the route of the London to Birmingham Television Radio-Relay Link, which the G.E.C. is designing and supplying to the British Post Office, is now being carried out. Temporary masts, such as that illustrated in Fig. 1 have been erected on the sites selected for intermediate stations, and propagation tests aré being conducted between them.

Each mast has been fitted with a suitable cradle to accommodate the special 14-ft. diameter paraboloid aerial system, and the cradles are raised and lowered to investigate variations in receiver signal strength at different heights.

Two mobile laboratories each equipped with C.W. and pulse transmitters for the appropriate frequency range, together with receivers, display systems, and recorders, complete the equipment. Contact between the two mobile laboratories is maintained by decimetre-wave communications transmitters and receivers, the portable mast for which may be seen in Fig. 1.

LINKS IN THE CHAIN

The following sites have been selected for the permanent erection of aerial masts in the London—Birmingham Television Relay:

Grimsdyke House, Harrow Weald
Zouche's Farm, Dunstable
Blackdown Hill, nr. Charwelton
Turners Hill, Rowley Regis

---

of the frame synchronising pulse should bear a constant time relationship to the leading edge of the master frequency pulse from which line and frame synchronising pulses are generated. It is clearly preferablé, therefore, that the frame synchronising pulse generator should be driven from a divider in which each successive stage is driven from the leading edge of the incoming pulse, and with as little delay as possible, as any incidental delay is likely to be variable.

In the circuit of Fig. 2, *V1* is switched on by the incoming pulse. The diodes *V2* and *V3* are connected the opposite way up from those in the circuit of Fig. 1, so that each time *V1* is switched on a negative step of potential is generated across *C4*. Since *V1* turns on to a high current, the capacity from its anode to ground is rapidly discharged and the falling edge of the step across *C4* therefore is sharp. An inductive resistance *R7* in series with *C4* sharpens this edge still further and creates a negative overshoot.

When the potential across *C4* has fallen sufficiently the overshoot on the falling edge of the step causes the diode *V4* to conduct, thus taking the grid of *V6* negative. This allows *V7 to start* conducting, which reduces the current in *V6* and positive feedback occurs until *V6* is cut off and *V7* grid is at its maximum positive potential. The cathode of *V7* is thus raised in potential and causes the diode *V5* to conduct and restore the charge in *C4* to its original condition, *i.e.*, the voltage across *C4* is equal to the voltage at the cathode of the diode *V2*. The grid potential of *V7* now falls until *V6* begins to turn on when positive feedback again takes place and restores the multivibrator *V6 V7* to its original condition with *V6* on and *V7* off.

The width of the pulse on the anodes of *V6* and *V7* is determined by the effective time constant of *C7*, *R16* and *R17*; the end of the leak in this case being returned to a point on the common cathode resistance in order to increase the effective time constant, thus making the discharge more linear. This gives *V7* more time to restore the charge in *C4*.

The division ratio of the circuit is adjustable by the potentiometer *R5*. Within design limits the adjustments of division ratio and output pulse width are independent.

It will be seen that the circuit described is driven from the leading edge of a positive input pulse with a minimum amount of delay, and it provides an output pulse of adjustable width, thus obviating the necessity for a separate pulse generator.

Electronic Equipment

A monthly record of British electronic apparatus, components, and accessories, compiled from information supplied by the manufacturers. Many of the items were shown for the first time at the recent industrial exhibition, and a further selection will appear next month. 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

V.H.F. Bridge Type B.801

THIS is an admittance bridge designed for use in the frequency range of 1-100 Mc/s., with direct reading accuracy of the order of 2 per cent.

A fixed ratio of 9 : 1 between the unknown and the standard is obtained by the combination of a 3 : 1 voltage transformer and a 3 : 1 current transformer.

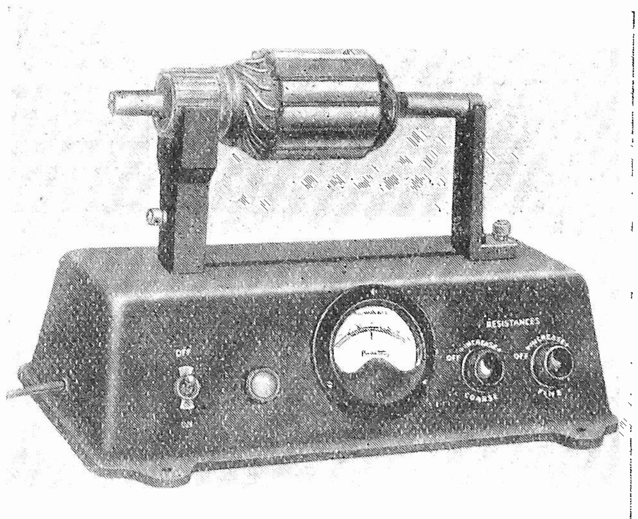
The standard of susceptance is provided by a 60 pF variable capacitor in parallel with a 6 pF vernier, both designed to have minimum series inductance.

With the "Unknown" terminals open, the bridge is adjusted to balance with both the standard capacitors half-engaged. Allowing for the 9 : 1 ratio, this gives a range of susceptance measurement corresponding to 0-±250 pF with one standard capacitor and 0-±25 pF with the other.

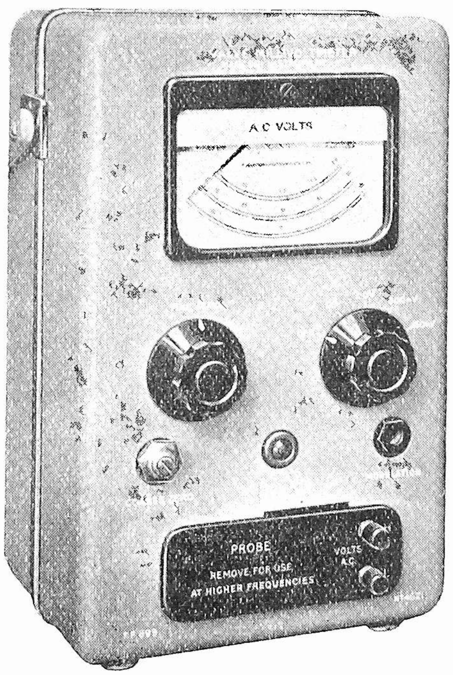
The conductance standards comprise two drums of high stability carbon resistors with a continuously variable resistor to bridge the steps of the drum. The first drum balances conductances of 0-100 mmhos in 10 mmho steps (10-100 ohms and infinity) and the second balances conductances of 0-10 mmhos in 1 mmho steps (100-1,000 ohms and infinity). The continuously variable resistance covers the range 0.1-1.5 mmho (666-10,000 ohms).

An alternative model, B.701, having a 3 : 1 transformer ratio, gives improved discrimination of low conductances at the highest frequencies by restricting the susceptance range.

Wayne Kerr Laboratories, Ltd.,
New Malden, Surrey.



Valve Millivoltmeter



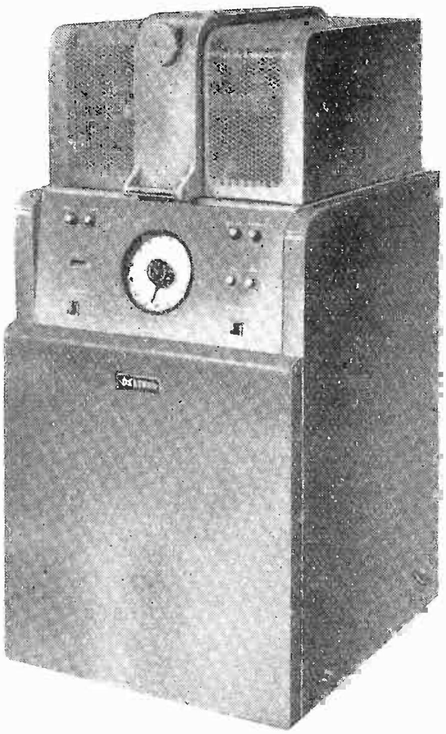
THE type TF.899 is a high-impedance millivoltmeter for use at frequencies between 50 c/s. and 100 Mc/s. and has three ranges covering 0-150, 0-500, and 0-2,000 mV. The instrument is mains operated and uses a triode detector in a bridge circuit with a 3½-in. moving coil meter as an indicator. The triode is housed in a probe unit which is detachable for use at high frequencies, the input capacitance being approximately 7 pF and the resistance greater than 1 meg. at 1 Mc/s.

Marconi Instruments Ltd.
St. Albans, Herts.

Armature "Drop" Tester

THE mains-operated tester shown will locate open- and short-circuits, faults, crossed connexions, and coil resistance variations in all types of armature up to 10 in. long, with commutators up to 3 in. diameter, cores up to 6 in. diameter. Weight approx. 15 lb.

Runbaken Electrical Products,
71 Oxford Road, Manchester 1.



R.F. Heaters

THE "Deltron" Model D.10 plastics preheater shown above has a power output of 2 kW at 18 Mc/s. operating frequency, and will heat 2 lbs. of pre-formed powder through 100 deg. C. per minute approximately. The efficiency is 60 per cent. and the overall dimensions 4 ft. 6 in. high by 2 ft. wide by 2 ft. deep. Weight 400 lb.

Fitted with process timer, automatic lid opening, and variable electrode spacing. A warning light indicates when the clearance gap is too small, and the gap can be adjusted while heating is in progress. An hour meter and filter unit are also incorporated. Suitable for unskilled labour.

Delapena & Son, Ltd.,
Zona Works, Cheltenham, Glos.

A new R.F. heater for pre-heating moulding powders, with an output of 1 kW continuous rating at 27 Mc/s. On a 50 per cent. duty cycle the rating can be increased to 1.25 kW.

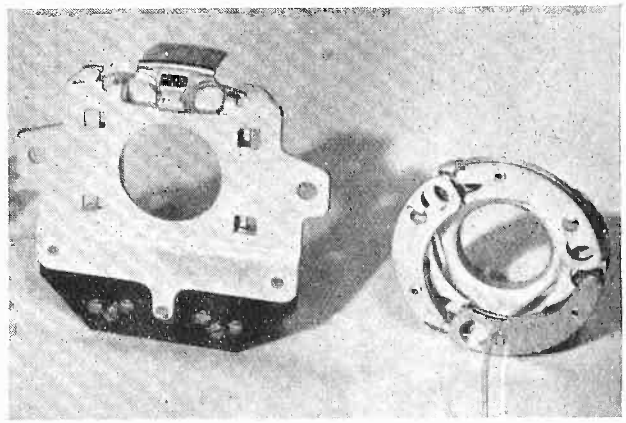
On an average the heater will plasticise 1 lb. of moulding powder in 1 minute, and the large electrode area (10 in. by 8 in.) enables 4 lb. of powder to be plasticised at the same time if required.

Operation is entirely automatic and the timing range is adjustable up to 6 mins.

British Thomson-Houston Co., Ltd.,
Rugby.

Centrifugal Switches

THE wide and growing popularity of the small single-phase motor, particularly in the fractional horse power class, has called for a simple, yet reliable means of self-starting. A range of centrifugal switches has therefore been developed by the Plessey Company suitable for 2, 4 or 6 pole c/s. motors up to $1\frac{1}{4}$ h.p.



The switches are available in two sizes, large and small; the small one shown being suitable for $\frac{1}{2}$ h.p. motors, $\frac{3}{4}$ in. dia. shaft and the large for motors up to $1\frac{1}{4}$ h.p., and $1\frac{1}{16}$ in. dia. shaft.

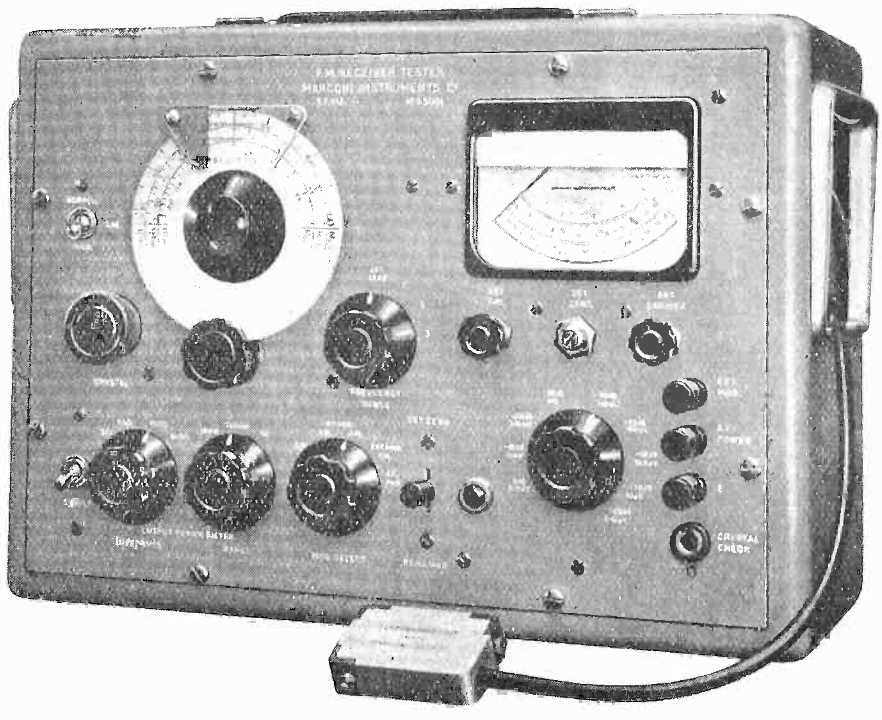
Each switch consists of two parts, one being mounted on the rotor and the other on the stator end shield. When the motor attains some 72-82 per cent. of synchronous speed the rotor portion expands radially and, by engaging with the outer tongue of the stator portion, opens the switch and disconnects the motor starting winding. When the motor is switched off and slows down, the contraction of the rotor re-sets the switch for the next start. These switches are now in production.

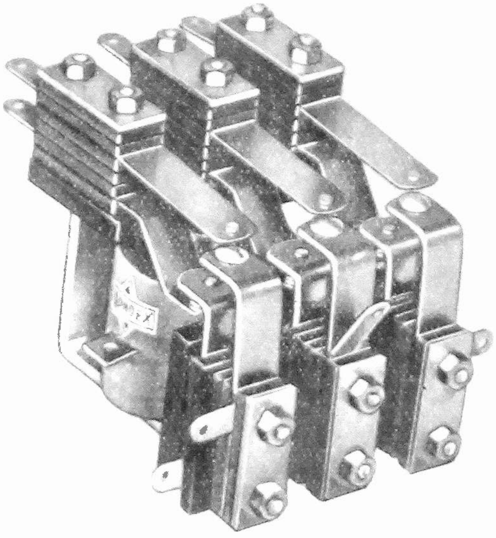
The Plessey Co., Ltd.,
Ilford.

F.M. Receiver-Tester

TYPE TF.913 (below). This a.c. mains operated instrument combines a crystal-standardised c.w., f.m. and a.m. signal generator with an audio frequency power meter in a single assembly of notably small size and weight. The carrier range is 21-168 Mc/s. in three bands of 21-42, 42-84, and 84-168 Mcls., and the output, which has high and low limits of 0.1 V, and 1uV, may be frequency modulated up to a maximum deviation of 75 Kc/s. on the low frequency band, 150 Kc/s. on the medium band or 300 Kc/s. on the high frequency band, or may be amplitude modulated to a depth of 30 per cent. over the complete range. The internal modulation frequency is 1,000 c/s.

Marconi Instruments Ltd.,
St. Albans, Herts.





New Speaker for T V Receivers

A NEW 8-in. loudspeaker unit, type T17 824 3, has been designed to have an exceptionally low leakage field for use in television receivers. The flux density is 7,500, and the gap flux 30,000 maxwells approximately.

The design of a 6-in inverted loudspeaker, prototypes of which were shown at the R.C.M.F. Exhibition, has now been completed and supplies will be forthcoming shortly. The overall depth of the speaker is only 1$\frac{9}{16}$ in.

Goodmans Industries Ltd.,
Lancelot Road, Wembley, Mddx

Portable Miniature Transreceiver

THIS V.H.F crystal-controlled hand transmitter-receiver weighs only 10 lb complete with batteries. The tuning is pre-set to any frequency in the operating channel (65-95 Mc/s) and the range is $\frac{1}{2}$-1 mile in built-up areas and 2-3 miles in line-of-sight range.

The overall dimensions are only 9 in. by 7 in. by 3$\frac{1}{2}$ in., and the power is obtained from a 90 V "Drymax" layer-type battery with a 2 V Exide cell for the low-tension supply. Consumption 20 mA when transmitting, with 700 mA L.T. The instrument is available for export, the valves being interchangeable with American types.

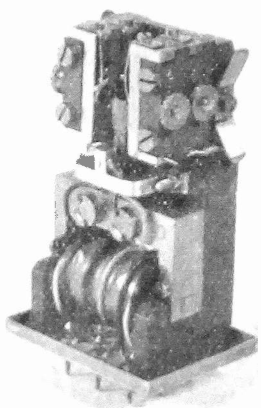
Tele-Radio Ltd.,
177 Edgware Road, W.2.

New Relays

AT the B.I.F., Birmingham, Messrs. Londex showed new additions to their range of relays for A.C. and D.C. operation, in addition to miniature relays and mercury switches.

The photograph above, shows a miniature multiple contact relay, Type ML C, used extensively in telecommunication equipment.

Londex Ltd.,
207 Anerley Road, S.E.20.



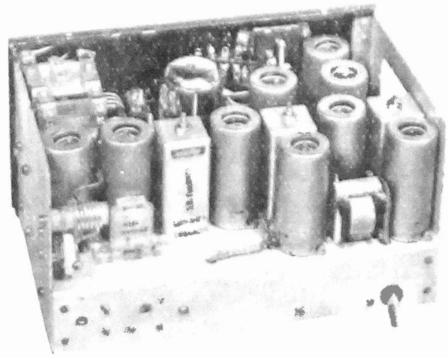
Elargol and Elargothene

IN a brief article in *Electronic Engineering*, June, 1947, a short description was given of Elargol and some of its applications.

Elargol is a silvering agent which allows for conductive lines and areas to be applied to any material, including low-temperature plastics.

By developing the Elargol technique further, Messrs. Ward, Blenkinsop & Co., Ltd., have succeeded in evolving a mass-production method to print any given circuit of any dimensions on to plastic. This service is now available to the industry, whose circuits and components can be printed in Elargol on their own materials, the cost involved being lower than that for any other known method of production.

Under the name of "Elargothene," polythene and polystyrene film of thicknesses between 0.0005 in. and 0.003 in., silvered in the centre, will be available. This silvering, like all silvering with Elargol, is firmly adhering, flexible, and has the conductivity of block silver.



Tufnol Rod and Sheet

AN electrical insulator with high mechanical strength of about half the weight of aluminium, and capable of being machined accurately. It resists corrosion by mild acid solutions and by sea water, and can be stored for long periods without deterioration. In addition to the basic forms of sheet, rod, tube, and angle shown in the photograph, Tufnol can be moulded into special shapes for quantity production.

Tufnol Ltd.,
Perry Bar, Birmingham 22B.

Sensitive Microammeter

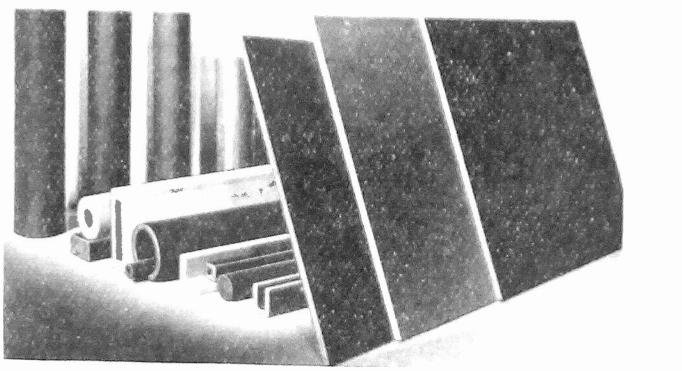
A 4-in. rectangular-cased meter (semi-flush type) with a full-scale deflection of only 5 microamperes. This firm also manufactures a complete range of standard moving-coil and moving iron instruments from 5 uA to 5 KA and 2.5 mV to 5 KV d.c., and 8 mA to 100 A and 2.5 V to 1 KV a.c.

Victoria Instruments Ltd.,
Midland Terrace, Victoria Road, N.W.10.

Miniature Relay

THE Elliott miniature moving coil relay has been designed for use in low voltage circuits for warning control, or other purposes. It measures only 1$\frac{3}{8}$ in. by $\frac{3}{4}$ in. by $\frac{5}{8}$ in. and weighs 1$\frac{1}{4}$ oz. The operating power is 10 uW for one model.

Elliott Bros. Ltd.,
Century Works, Lewisham, S.E.13.



NOTES FROM THE INDUSTRY

Clix Radio Components

The sales of Clix radio and television components manufactured and hitherto marketed by British Mechanical Productions, Ltd., are now being handled by the General Accessories Co., Ltd., of 21 Bruton Street, London, W.1, which is the wholly owned subsidiary of British Mechanical Productions, Ltd., and is their selling organisation through whom all Clix products, in future, will be marketed.

"Metal Powder Report"

Is published privately each month by Powder Metallurgy, Ltd., Commonwealth House, 1/19 New Oxford St., London, W.C.1. It gives considerable technical data on its subject from the points of view of both manufacture and application. A special section is devoted to Electronic applications.

Marine Radar Specifications

A booklet entitled "Marine Radar: Performance Standards" containing the new marine radar performance specification, 1948, which supersedes all previous U.K. specifications for mercantile marine radar equipment, has been published by H.M. Stationery Office, for the Ministry of Transport, price fourpence.

Davy-Faraday Exhibition, Paris

An exhibition to commemorate the work of Davy and Faraday is now being staged at the Palais de la Découverte, (which operates under the aegis of the University of Paris) with the close collaboration and support of the Royal Institution, the I.E.E. and the Science Museum. The managers of the Royal Institution have made available for the purposes of the exhibition some of the original apparatus used by Faraday in his experiments, and pieces of his laboratory and office equipment, while the Council of the I.E.E. have lent a number of Faraday manuscripts, including his Commonplace Book, chemical notes and a number of letters.

Bran's "Radio Valve Vade Mecum"

Universal Services, of 13 Newburgh Street, Regent Street, W.1, and 91 York Street, Baker Street, W.1, have been appointed agents for the distribution of the publication of P. H. Brans entitled "Radio Valve Vade Mecum." The price is 17s. 6d. plus 6d. postage, and copies are only obtainable by post, as they are despatched direct from the publishers offices in Antwerp, and only one copy is available at the moment to each recipient.

Coiled Springs

Prompt delivery can be given of coiled compression springs from 12 S.W.G. to 37 S.W.G. by A. W. Gregory and Co., 4 Great St. Thomas Apostle, London, E.C.4. Finer and heavier gauges according to material in stock.

Canadian International Trades Fair

British Machine Tools (Export) Ltd., 29 Waterloo Street, Birmingham, 2, who are exhibiting Toroidal Potentiometers and other electronic equipment made by Messrs. P. X. Fox, Ltd., of Yorkshire, at the above Fair are also interested in the representation of other firms manufacturing electronic equipment and who are desirous of selling in the Canadian market.

Eddystone Essay Competition

Home Section

The judges of this competition, Mr. John Clarricoats, general secretary of the R.S.G.B., Mr. Austin Forsyth, editor, *Short Wave Magazine* and Mr. G. Parr, editor, ELECTRONIC ENGINEERING, have agreed that in their opinion, the most meritorious essay was contributed by:

Mr. R. C. Jennison, 28 Park Drive, Grimsby,

who selected as his subject "Applications of the New Microwave Amateur Radio Channels."

Other papers considered worthy of special mention were:

Mr. K. Parvin, Thayer Street, London, W.1. ("Band Planning.")

Mr. H. Turner, Laurence Road, Eastlands, Rugby. ("Band Planning.")

Mr. D. H. Johnson, Old Avenue, West Byfleet, Surrey. ("The Relative Merits of British and American Communications Equipment.")

Mr. W. D. Old, Trevenson Road, Carb Brea, Redruth. ("How I Visualise the Application of the New Micro-wave Channels that are Shortly being Allocated to Radio Amateurs.")

The general standard of the entries was considered high, but, in the judges' opinion, those mentioned above were outstanding as technical contributions on their respective subjects.

The Mazda Valve Manual

The Publicity Department of the Edison Swan Electric Co., Ltd., 155 Charing Cross Road, W.C.2 state that additional Data Sheets are now available to those registered holders who have not already received them. A postcard, quoting the serial number of the manual and full address is all that is necessary.

Philips Amplifiers

Commencing on May 1, 1948, the Amplifier Department of Philips Electrical, Ltd., instituted a comprehensive tie-up with the radio and electrical trade throughout the country for the supply of sound reproducing equipment. Mr. Donald Robinson has been appointed manager of Philips Amplifiers.

The new scheme is to be based on rental maintenance as an additional outlet to the normal outright sale method, and enables the trader to participate in long term rental business without any financial commitment. Arrangements have been made with the Modern Telephone Co., Ltd., of 139 Tottenham Court Road, London, W.1, to undertake the rental maintenance distribution of Philips Sound Reproducing Equipment.

Change of Name of Mullard Wireless Service Co., Ltd.

The Mullard Wireless Service Co., Ltd., has recently changed its name to Mullard Electronic Products, Ltd.

B.S.I. Yearbook

The Yearbook of the B.S.I. which has just been published, gives a subject index and a synopsis of each of the 1,400 British Standards now current. The Yearbook, price 3s. 6d. post free, can be obtained from the Publications Department, British Standards Institution, 24 Victoria Street, London, S.W.1.

E.M.A. Dinner

A successful dinner meeting of the Electronic Manufacturers' Association was held at Kettner's Restaurant on Tuesday, April 20. The President, Major W. H. Berriedale-Johnson (of the Channel Islands Radio Egineering Co., Ltd.), was in the Chair, and the principal guest was Mr. David Gammans, M.P. for Hornsey.

In the course of his address Mr. Gammans referred to the great harm that the purchase tax was doing to the industry. He appealed for the abandonment of what he called "the 1939 mentality" which led to a closed shop in this and other industries. It was nonsense and harmful to the spirit of initiative and private enterprise, on which so much depended, to say that because a man was not engaged in such and such a trade in 1939 he should not be in it today.

The Chairman, Mr. H. A. Knox (of the Magneta Time Co., and the British Vacuum Cleaner and Engineering Co., Ltd.), thanked Mr. Gammans for his speech and proposed the toast of the guests, to which Mr. Willis responded.

BOOK

Radar Aids to Navigation

By John S. Hall. Vol. 2 in the Massachusetts Institute of Technology, Radiation Laboratory Series. 408 pages, price 30s.

THE present volume is the second in an ambitious series of 28 volumes written by the war-time staff of the Radiation Laboratory, Massachusetts Institute of Technology, and dealing with all aspects of radar.

The first of the series has already appeared under the title "Radar System Engineering" and gives a general introduction to the fundamentals of radar and to the principles of design of radar equipment. The present volume deals specifically with the use of radar for the purposes of navigation. It is mainly concerned with description of equipment and of possible future uses of radar, and is not much concerned with its use during the war or with giving a coherent story of its development. The book has been written by a large number of authors, but the editors have performed their task so well that it reads with a fair measure of continuity. It is very well illustrated and it is only a pity that the war-time restrictions on the quality of paper have made it impossible for the printers to do full justice to some of the excellent photographs.

The use of the word radar in this country has not been exactly the same as in the U.S.A. Here one has tended to include within its scope such pulse navigational systems as Gee and Loran which grew up naturally beside search radar and used very much the same techniques. In America, however, such systems are now excluded from the meaning of the word. It is perhaps for this reason that microwave radar is allotted such a large proportion of the book while the Gee and Loran systems, which played a very much larger part, particularly in air navigation, during the war, are quickly dealt with in a short subsection of a chapter.

The book is divided into four parts. Part I deals with the basic principles of radar and with non-radar navigational systems (including Gee and Loran). The first chapter on the principles of radar is doubtless included to make the work complete in itself. Chapter 2 deals with C.W. Navigational aids and the so-called hyperbolic systems and seems to us to be the most inadequate part of the book.

Part II deals with airborne radar and is almost exclusively concerned with the type of microwave airborne radar known in this country as H₂S. It deals primarily with the navigational aspects and not with the use of this type of radar for blind bombing, its main use during the war. A series of excellent pictures showing radar maps is given which illustrate very well what can be done in this respect with the most advanced type of equipment available at the time of writing. A word of warning, however, seems to be necessary in the interpretation of these pictures. Most of the best pictures were obtained with equipment using extremely narrow beams and at flying heights of the order of 7,000-8,000 ft. These narrow beams were normally obtained either through the use of wavelengths of the order of 1.25 centimetres or with extremely large antennas. As used during the war flying heights greater than 20,000 ft. were much more common and the use of such large antennas on operational aircraft was out of the question, so that pictures with very much poorer definition were normally obtained. While such radar maps with high definition are very desirable from a navigational point of view, particularly if microwave radar is used in civil aircraft, the serious limitations imposed by the size of aerial which can readily be carried in civil aircraft should be realised. The use of wavelengths shorter than about 3 centimetres except at fairly low heights is unfortunately ruled out by atmospheric absorption. The wavelength of 1.25 centimetres on which most of the experimental work with narrow beams was carried out is particularly unfortunate in this respect as it lies near the peak of a strong water vapour absorption band. This limitation is indeed stated, but it should be borne in mind throughout when examining the pictures and in particular during the chapter on engineering and economic considerations, in which a case is made for the use of microwave radar on civil airlines. The arguments brought forward are interesting but we cannot altogether agree with the conclusions, as it seems to us that the most difficult problems from a civil aviation point of view are not those of navigating along an airway but of landing in bad weather and of controlling large numbers of aircraft in the vicinity of an airfield. There is an interesting chapter in this part of the book on radar altimeters, a field in which the American work was considerably ahead of developments in this country.

Part III begins with a fairly full description of microwave ground radar systems. Much of the material in this section has already been given in Volume 1. The chapter on traffic control is, however, interesting as it gives the point of view of the scientific staff of the Radiation Laboratory on this important subject. Another interesting section in this part is that on radar aids for landing. In includes a description of the British BABS approach system, and the American GCA system now being used at some of our major airports.

REVIEWS

Part IV deals with shipborne radar and is perhaps the most satisfying part of the whole book. This may be because the use of microwave radar for the purpose of navigation and collision warning at sea is more obvious and straightforward and equipment to meet the requirements more readily available. When considering the use of microwave radar for air navigation in peace-time one is always up against the problem of weight and complexity. See, for example, the figure of 184 lb. all-up weight proposed for a "utility" microwave radar equipment in Chapter 6. For shipborne purposes weight requirements are much less stringent and there can be no doubt whatever that the mapping of coastlines and estuaries by microwave radar is of the utmost use for navigation in coastal waters and will become common practice in merchant ships very soon. Some excellent pictures are given in this section showing the use of high definition radar for this purpose. Fairly large antennas may be used on board ship so that narrow beams are readily available to give this definition. Particularly interesting are some pictures showing the location of storms by shipborne radar.

The reader who is not familiar with radar technique and language will find the book difficult to read in parts, but he will also find much to interest him. On the other hand, the technical worker in this field will not wish to be without this very full account of the American work on this important subject.

R. A. Smith

Radio Data Charts

by R. T. Beatty, D.Sc., revised by J. McG. Sowerby, B.A. Fourth edition. (Iliffe & Sons Ltd., 7/6). 93 pp.; 44 abacs.

First published in 1930, this collection of nomograms has been a standard work of reference for radio receiver designers for many years. It reduces the labour of calculation in upwards of 40 routine design problems and obviates possibilities of error in the interpretation and application of formulae.

The subjects covered range from the design of R.F. coils and transformers to the calculation of loudspeaker dividing networks and include problems relating to parallel-wire coaxial and quarter-wavelength transmission lines.

Each chart is accompanied by an explanatory introduction and worked examples, and the student will find the charts an invaluable adjunct to the ordinary textbooks on radio engineering.

Directional Antennas

By Carl E. Smith, published by the Cleveland Institute of Radio Electronics, Cleveland, Ohio.

The contents of this book are even more specialised than the title would lead one to believe. Although the first 50 pages deal with the theory of directional patterns in a more or less general way, the remaining 50 pages consist of a collection of horizontal polar diagrams of two and three element tower arrays. This section of the book consists, in fact, of no fewer than 15,160 polar patterns which, for the few whose work lies in this direction, can be of inestimable value. In the present case the chief virtue of the book is the fine collection of polar diagrams, the value of such a collection can be best appreciated by those who have had personal experience of calculating a large number of polar diagrams—the fatigue and boredom involved has to be experienced to be believed!

In the present case the polar diagrams were all obtained on an electromechanical calculator. Three views of this machine are given, but strangely enough there is no mention of the principle on which it works. Those who are interested in the machine itself will, however, find a full description in one of the references quoted (Carl E. Smith and E. L. Gove, *Elec. Engr.* v.62 p.78, February, 1943) while another reference (H. Paul Williams, *Elec. Comm.* v.21 No.2. p.103, 1943) gives a description of a similar machine which was developed at about the same time in this country.

The contents of the theoretical part of the book will be familiar to antenna specialists but its inclusion is obviously essential for reference purposes. Part I also contains a number of useful graphs including a valuable set of mutual impedance curves.

In his preface the author states that he has paid special attention to nomenclature and would welcome any constructive suggestions. This is, of course, a topic on which there are as many viewpoints as there are engineers, and it would seem out of place to enter into a discussion on this subject in this review. Where units are concerned, however, the reviewer feels he must register a protest against the use of "millivolts per metre at one mile." With the increasing use of the M.K.S. system, it is high time that we dropped the use of miles in scientific literature—particularly when they are mixed up with metres in the one and same expression. Apart from other advantages, the fact that the velocity at light happens to be 3×10^9 metres per second introduces easily remembered numbers in radiation formulae (as shown, for example, in equation (3) of the book where the distance is specified in metres instead of miles).

H. Paul Williams

ABSTRACTS OF ELECTRONIC LITERATURE

MEASUREMENT

The Wire Resistance Strain Gauge

(*P. Savic*)

An important property of the resistance strain gauge is that it can be used with equal success in tension and compression. The performance of resistance gauges is analysed, and certain outstanding advantages they possess over the older mechanical type are mentioned. The problem of cementing resistance gauges to the test surface is examined, and it is stated that there is considerable scope for further development. Some basic circuits used with resistance strain gauges are explained, including a circuit diagram of a carrier-type strain recording amplifier with phase discriminator.

—*Research*, December, 1947, p.98.

New Scale-of-Ten Recorder

(*R. D. Lowde*)

The special features of the instrument are its compactness and small cost. Its operation is best described as that of scaling by a 2 (2+1) pentode "flip-flop" scale-of-two pairs being employed throughout. These units are designed so that buffer stages are not required. In the output stage additional provision is made for a recorder resolving 1/20 sec., with which statistical loss on random counting becomes 1 per cent. at an average rate of some 4,000 counts/min. The resolving time of the scaler is less than that of an ordinary Geiger-Muller tube, and although not developed as a high-frequency instrument, the model will scale a regular pulse input up to frequencies of the order of 100 Kc/s.

—*Jour. Sci. Inst.*, December, 1947, p.322.

Visual Measurement of Short Pulses of Direct Current

(*P. F. Ordung*)

Within recent years engineering applications using pulses of direct current as short in duration as a microsecond and repeated several thousand times per second have become important. Such pulses may have amplitudes that are greater than 100 A. This paper discusses the techniques and precautions which are essential for oscillographic observations of such pulses. Particular consideration is given to the problem of determination of the band widths required for measurement of such pulses, and of the resistors for metering such currents, and of properly terminating the coaxial transmission line used for connecting the metering element to the oscillograph.

—*J. Franklin Inst.*, January, 1948, p.37.*

INDUSTRY

Electronic Computor for Printing Control

(*J. W. Ludwig*)

Speed of a multicolour web printing press is tripled by application of an electronic-hydraulic system that holds running register accurate from zero to 0.001 inch. Register marks actuate a phototube whose output is compared with a sample of a sine wave taken at the same instant.

—*Electronics*, November, 1947, p.109.

A Symposium on Recent Developments in Relays

(*W. B. Ellwood, J. T. L. Brown and C. E. Pollard*)

The two types of relay described are claimed to give high speed of performance over long periods as required in telephone plants. The switch of the glass-enclosed reed relay comprises a pair of magnetic reed springs of perminvar, mounted inside and in opposite ends of the tube. The performance of the relay is discussed. The mechanical construction of a mercury-contact relay which has been developed by the Bell Telephone Laboratories is described. Attention is paid to contact behaviour, operating characteristics, stability and acceleration of contacts.

—*Elect. Engng.*, November, 1947, p.1,104.*

C. R. TUBES

Performance Characteristics of Long-Persistence Cathode - Ray Tube Screen's. Their Measurement and Control

(*R. E. Johnson and A. E. Hardy*)

Cathode-ray tube indicators employing long-persistence screens have been developed for use in Radar, Teleran, and other systems where field-repetition rate is in the order of seconds. Tube performance in such applications is dependent upon the phosphorescent intensity of the screen following a given excitation. This parameter in turn is dependent upon the fluorescent intensity rate of build-up and rate of decay of the phosphor components. In this paper, a laboratory system for pulse-exciting long-persistence cascade-type cathode-ray tube screens and quantitatively evaluating these characteristics in finished tubes is described. Correlation of these valves with field performance is illustrated.

A range of efficiencies of screen components was measured under steady-state conditions in the conventional manner and compared with their performance in cathode-ray tube screens under pulsed excitation. It is shown that the efficiency of the blue zinc-sulphide phosphor layer is a good indication of its performance but that the efficiency of the yellow zinc-cadmiumsulphide phosphor layer (phosphorescent) phosphor bears no consistent relation to ultimate screen performance. A method for pulse-exciting the phosphor with blue light which gives values correlating with screen performance is described.

The thickness of each phosphor layer and the exhaust-bake temperature employed in tube processing have been found to affect screen characteristics appreciably. Average curves are presented to show the effect of each variable.

—*RCA Review*, December, 1947, p.660.

CIRCUITS

Design of an Ultrasonic Analyser

This description of an ultrasonic analyser applies to the Brush Hypersonic Analyser for laboratory testing and inspection of materials. The material to be inspected is interposed between the ultrasonic frequency transmitter and the receiver; if a diminution of energy occurs the material probably contains a flaw. Each transmitter is capable of handling three or more sets of transmitting transducers, depending upon the length of cable used to energise the transducers. The receiver comprises a 5 valve, resistance-capacitance coupled wide-band amplifier to which the receiving transducer is connected.

—*Electronics*, December, 1947, p.102.

A Note on a Parallel-Tuned Transformer Design

(*V. C. Rideout*)

An analysis of the parallel-tuned transformer used in radio-frequency amplifiers has been made for a slightly over-coupled case. The resulting design formulae are simple and practical. Two cases are discussed: (a) the so-called matched transformer, with resistance loading on either side; (b) a transformer with loading on one side only, which has the same pass-band and phase characteristics as the matched transformer but gives 3db more gain when used as an interstage. A special arrangement of (a) where the matched transformer design is used with one resistor removed, giving a transformer with a considerably double-humped pass-band characteristic and about 6db more gain, is also discussed.

—*Bell Syst. Tech. J.*, January, 1948, p.96.*

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

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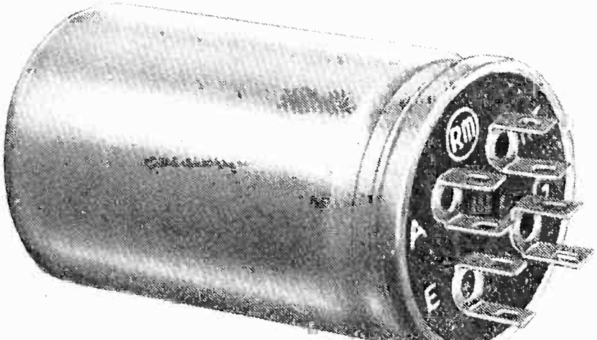

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Marconi No. 14 Lightweight Moving Armature	5	8	4
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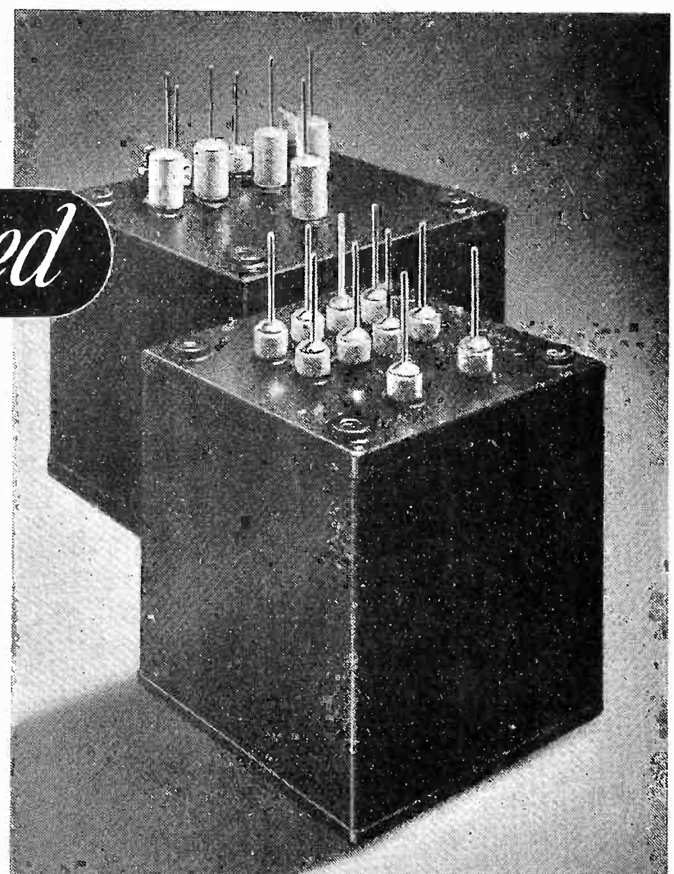

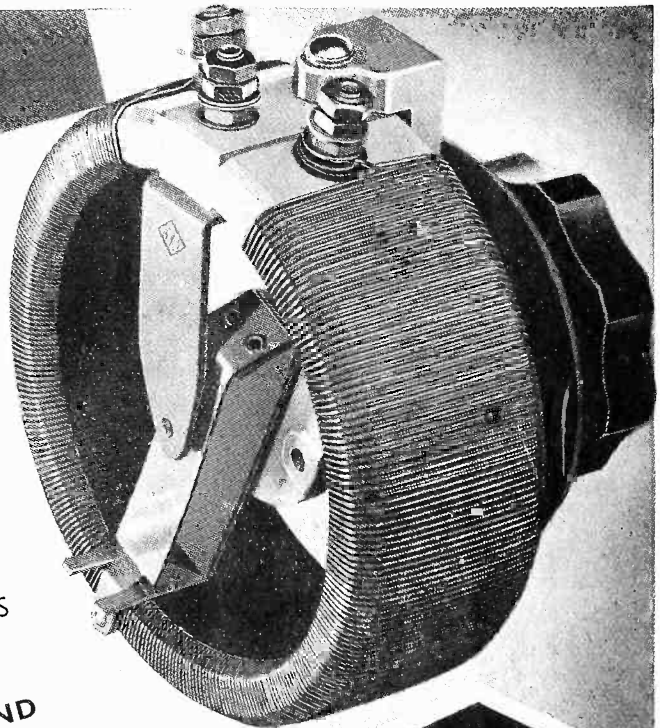

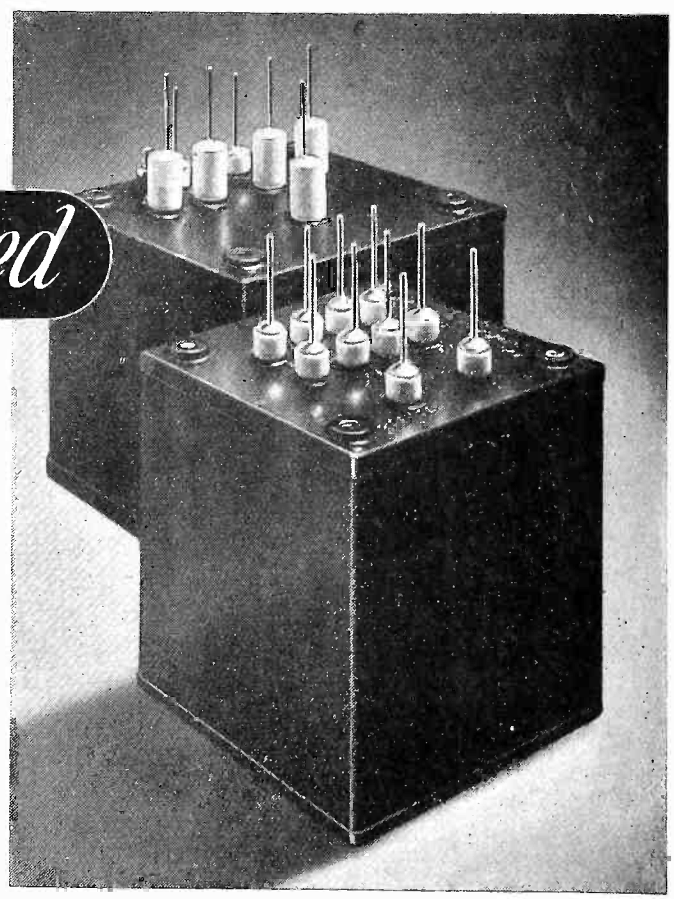

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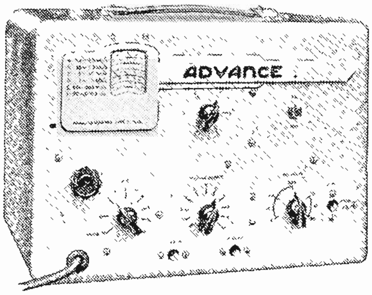

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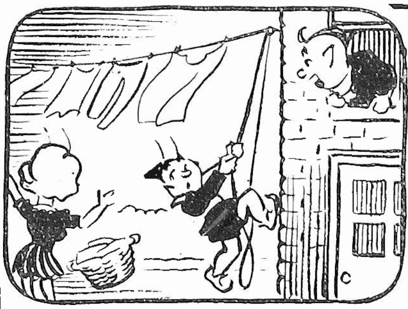

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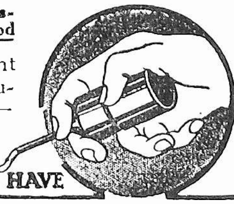

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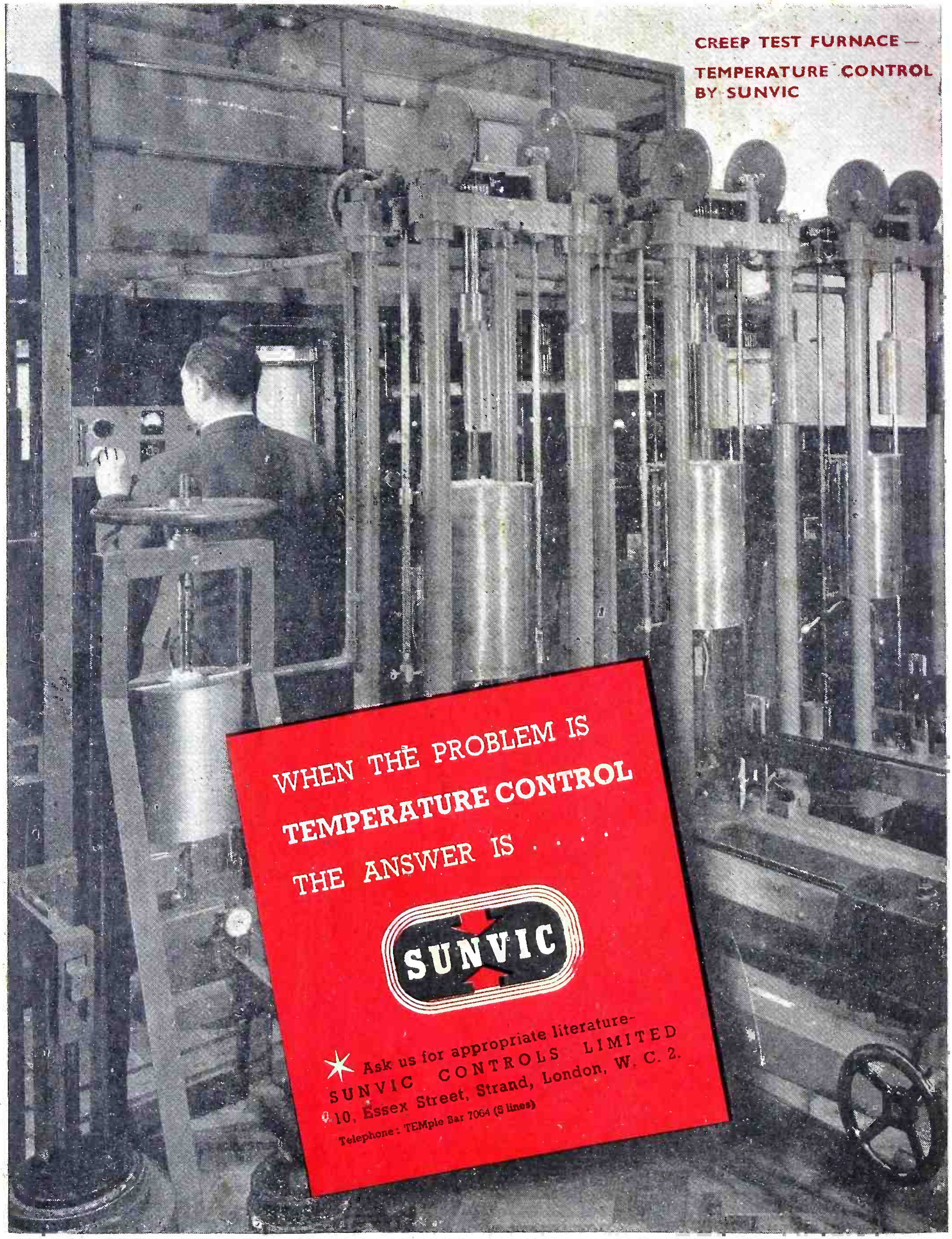

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