Wireless World

RADIO · ELECTRONICS · ELECTRO-ACOUSTICS

SEPT. 1944

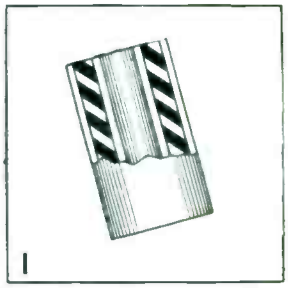
1/6

Vol. L. No. 9

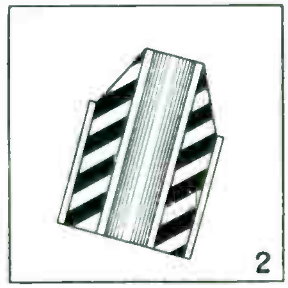
IN THIS ISSUE: WAVE GUIDES : A SIMPLIFIED EXPOSITION

PRIMER ON RUBBER BONDING

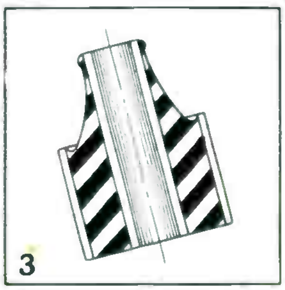
NUMBER **7** IN SERIES



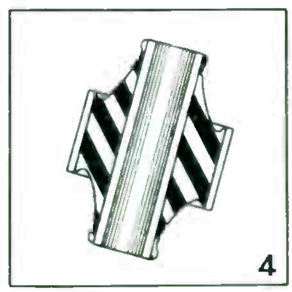
1. Simplest form of bush.
Fits existing shaft and boss.
Uneconomical in rubber use.
Distributes stresses unequally.



2. This gives flat rubber contour with high stress concentration at edges of rubber-metal bond. It gives equal stress at bonded surfaces but unequal stress in rubber volume and also unbalanced application of radial load.



3. This hyperbolic rubber contour gives partially even stress distribution with stress reducing pips at metal edges, the stress concentration is at the flat edges and there is unbalanced application of radial load.



4. The double hyperbolic rubber contour gives even distribution and allows for central application of radial load. Stress-reducing pips prevent stress concentration.

You may wonder whether a bonded product would solve your problem. We should know—if you asked us.

R B. 24

FLEXILANT TRADE MARK

RUBBER BONDERS LTD.

ENGINEERS IN RUBBER BONDED TO METAL

FLEXILANT WORKS · DUNSTABLE · BEDS.

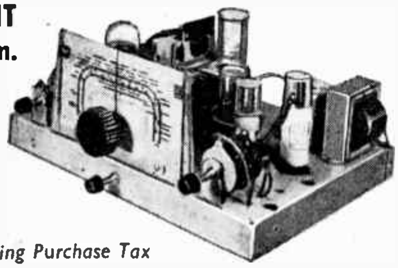
◆ LINAGLOW LIMITED ◆

"LIBERTY SIX"

SIX-VALVE SUPERHET CONSTRUCTORS KIT

ALL-WAVE 16-50m., 200-560m., 1,000-2,000m.

Brief Specification : Frequency changer with two valves, separate oscillator, **Six Tuned Circuit.** 465 KC. Iron cored I.F.s. Separate tone and volume, 5-watt output. 8" P.M. speaker with baffle and output transformer, supplied with all valves, chassis, Practical and Theoretical wiring diagram and Parts Lists, Nuts, Bolts and Wire, ready to assemble, 200/250 volts A/C.



Carriage paid **£16 . 16 . 0** *Including Purchase Tax*

SERVICE KITS

SKJ. 1 8-mfd. 400/500 v. Aluminium Can Electrolytic; 6 each Silver Mica Condensers, Resistors and Trimmers, **12/9.**

SKK. 1 32-mfd. 325 v. Aluminium Can Electrolytic; 6 each Silver Mica Condensers, Resistors, Trimmers and Tubular Paper Condensers, **15/9.**

SKL. 1 32-mfd. 325 v. Aluminium Can Electrolytic; 1 2-mfd. T.C.C. Tubular 250 v. Electrolytic; 6 each Silver Mica Condensers, Resistors; 1 radio screwdriver; 1 each 2, 4 and 6 B.A. Box Spanners, **21/6.**

SKM. 1 8-mfd. 400/500 v. Aluminium Can Electrolytic; 1 2-mfd. T.C.C. Tubular 250 v. Electrolytic; 6 each Silver Mica Condensers, Resistors, Tubular Paper Condensers; 1 tone control, **29/6.**

SKN. 1 8-mfd. 400/500 v. Aluminium Can Electrolytic; 1 40-mfd. T.C.C. Block 250 v. Electrolytic; 6 each Silver Mica Condensers, Resistors and Tubular Paper Condensers; 2 tone controls, **35/-.**

SKO. 1 8-mfd. 400/500 v. Aluminium Can Electrolytic; 1 16 × 8-mfd. 350/450 v. Aluminium Can; 1 24-mfd. T.C.C. Block 250 v.; 12 each Silver Mica Condensers, Resistors, and Tubular Paper Condensers; 3 assorted Volume Controls; 2 pushpull 4-point switches, **59/6.**

SKP. 2 8-mfd. 400 v.; 2 32-mfd. 325 v.; 1 16 × 8-mfd. 400 v.; 1 24-mfd. 250 v. Electrolytics; 12 each Silver Mica Condensers, Resistors, Trimmers and Tubular Paper Condensers; 2 4-point pushpull switches; 2 tone controls, **£3.19.6.**

SKQ. 1 8-mfd. 400/500 v. Aluminium Can; 1 16 × 8-mfd. 350/450 v. Aluminium Can; 1 32-mfd. 325 v. Aluminium Can; 1 40-mfd. T.C.C. Block 250 v.; 1 24-mfd. T.C.C. Block 250 v.; 1 2-mfd. T.C.C. Tubular 250 v. Electrolytics; 25 each Silver Mica Condensers and Resistors, 12 each Trimmers and Tubular Paper Condensers; 3 assorted radio screwdrivers; 1 each 2, 4 and 6 B.A. Box Spanners; 2 I.F. Transformers Aluminium Can iron cored 465 KCs.; 1 set Long, Medium and Short Aerial and Oscillator Coils, **£5.5.0.**

MICROPHONES. De Luxe Piezo Crystal Microphones in chromium case. Specification: 60 D.B. below 1 volt. Frequency response 30-8,000 C.P.S., **6 Gns.**

As above—Standard model in bakelite case, **3 Gns.**

HIGH FIDELITY MOVING COIL MICROPHONE, 25 ohm impedance, frequency response level 50-8,000 cycles. 78 D.B. below 1 volt, **£5.15.0.**

AERIAL AND OSCILLATOR COILS. Best double silk covered Wire Wound, colour coded on bakelite formers, Short, Medium and Long Wave, 16/50, 200/550, 1,000/2,000 metres, **15/-** the set.

SCREENED INTERLACED FLEXIBLE MICROPHONE CABLE. Single. Special offer, **9d.** per yd. Twin, **1/3** per yd.

TUBULAR PAPER CONDENSERS, 350-500 v., D.C. working. .0001, .0003 mfd., **4/-** doz.; .001, .004 mfd., **6/-** doz.; .01 mfd., **7/-** doz.; .05 mfd., **9/-** doz.; .1 mfd., **12/-** doz.; .23, .5 mfd., **15/-** doz.; or assorted parcel of 50 for **27/6.** Minimum orders, 1 doz., any type.

UNIVERSAL RAZOR RESISTANCE. Suitable for practically every type of electric razor, drops voltage from 200/250 to 100/110 v. Supplied in safety metal cage with asbestos lining. Specification: 1,500 ohms with adjustable slider, **10/6.**

12in. AUDITORIUM P.M. LOUDSPEAKER CHASSIS. Ticonal magnet, 10 ohms, 12/15 watts. Exceptionally sturdy construction, **£7.15.6** each.

FLAT FLEX. 9-way, 14/36, 18/20ft. lengths, suitable for amplifiers, extension speakers, remote control and many other purposes. Finest quality pre-war manufacture. **7/6** per coil.

LOUDSPEAKER FRETS. Coppered brass, 8½ × 7in., **3/6**; 14½ × 9½in., **8/9.**

SILK COVERED BAFFLE BOARDS. 12 × 9in., ¾in. ply, 6½in. hole, **4/6.**

ALUMINIUM VALVE CAPS. Special price, **6d.**

PORTABLE REXINE COVERED AMPLIFIER CARRYING CASES, fitted with baffle for 8in. or 10in. speaker and microphone holder, metal corner protecting plates, rubber buffers, suitable for Auditorium extension loudspeaker or amplifier construction. Size 15in. × 16in. × 10in., **£2.19.6.**

50 only
CATHODE RAY OSCILLOSCOPES
Constructors' Kits

by prominent well-known radio engineer.

The instrument with unlimited uses. Designed to meet a Universal Demand.

All parts supplied—theoretical and practical wiring diagrams and full instructions for assembly and operation. No extras to purchase, all parts are new, ex manufacturer's pre-war stock. Invaluable to Radio Dealers and Service Engineers. Demonstration model can be seen working in our Showrooms.

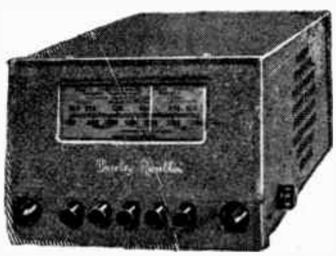
Specification: Magnetic deflection and focussing. C.R.T. 7in. Screen. Multi-stage amplifier and Linear Time Base incorporated. Mains input 200/250 v. 50 cycles. Anode potential 5,000 v. **£22.17.6.**

Oscilloscope when completed is in chassis form mounted on tubular metal frame.

SPECIAL OFFER. Manufacturer's clearance stock of 1-watt CARBON RESISTORS Wire and Clip ends. Values unmarked, ranging approx. from 20,000 ohms to 2 meg. Unique opportunity. Per 100, **12/6.**

CAR RADIOS

NEW AMERICAN 5-VALVE SUPERHET CAR RADIOS



2 Wavebands (200-2,000 metres). Push-button and Manual Controls. 6-volt. Built-in Speaker. Complete with roof-top bar Aerial. Small and compact. 7 × 5 × 12in. Crackle finished enamel.

18½ gns. *including P.T.*

VALVES.

American Types at B.O.T. Controlled Retail Prices. For replacement purposes only. 1H5, 6J5, 12F5, 12J5, 12SF5, **9/2**; 1C5, 1N5, 5Y3, 25Z6, **11/-**; 6Q7, 12Q7, 45, 75, **11/7**; 6F6, 6K7, 12J7, 25L6, **12/10**; 6A8, 6B8, 6K8, 6SA7, 12SA7, **14/-.**

Also British Valves at Manufacturers' List Prices. AC/ME, **10/6**; UU4, UU6, UU7, **11/-**; HL41DD, TDD4, **11/7**; AC/VP2, CL4, EF39, KTW61, Pen 45, SP41, SP42, T41, VP41, **12/10**; D1 diode 1in. Peanut Valve with valve-holder, **12/10**; ECH3, FC13, X63, **14/-**; AC6Pen*, EL35, Pen 46*, U21, **18/3.**

* Post Office Permit necessary.

All prices include Purchase Tax. Add 3d. per valve postage.

TUBULAR STEEL FRAMES. Cadmium plated for radio chassis mounting and many other purposes, drilled ready for use. 18in. high × 14in. wide, very useful for swivel frame in Radio Laboratory, **7/6** the pair.

UNIVERSAL RESISTOR. Suitable for practically every type of American and British AC/DC Receiver. Supplied in safety cage with asbestos lining. Specification: 750 ohms, .3 amp., with four sliders for adjustable tappings, **12/6.**

I.F. TRANSFORMERS. Iron cored Litz Wound, Aluminium Can. Limited quantity. **17/6** matched pair. **9/6** each.

LINE CORDS. 3-way heavy duty .3 amp., 360 ohms, **10/6**; 480 ohms, **13/9**; 600 ohms, **17/6.**

VALVE HOLDERS—AMPHENOL TYPE. International or Mazda Octal, chassis mounting, **1/-.**

ADJUSTABLE CAR AERIALS. Chrome bar roof fixing, complete with suction rubbers, etc., **15/-.**

SCREENED LEADS. 8ft. long, fitted 2 Wander plugs, suitable for Gram., Mike, Pick-up, etc., **4/6.**

MAINS TRANSFORMERS. 200/250, 350-0-350, 6.3 v. 3 amp., 5 v. 2 amp., 120 m.a. shrouded, **42/6**; 300-0-300, 4 v. 6 amp., 4 v. 2 amp., 150 m.a., **42/-**; 325-0-325, 4 v. 6 amp., 4 v. 2 amp., 2 v. 1.5 amp., 150 ma., **45/-**; 350-0-350, 6.3 v. 3 amp., 5 v. 2 amp., 100 m.a., **37/6**; 325-0-325, 6.3 v. 3 amp., 4 v. 2 amp., 100 m.a., **42/-.**

AUTO TRANSFORMERS. Step up or down; 100/220/240 v., 100-watt, **35/-.**

LOUDSPEAKER TRANSFORMERS. Multi-ratio and Push-pull transformer, ratios 30 : 1, 45 : 1, 60 : 1, 90 : 1, and P.P. Class B, 75 m.a., **12/6.** Heavy duty multi-ratio transformer, ratios 24 : 1, 41 : 1, 48 : 1, 58 : 1, 82 : 1, 116 : 1, 80 m.a., **15/6.** Class B and Q.P.P., 75 m.a., **12/6.** Triode/Pentode 40 m.a., **8/9.**

LOUDSPEAKERS. P.M. 3-ohm voice coil without transformer, 8in., **25/6**; 6½in. Celestion, **22/6**; 10in. Mains Energised, 250, 500, 1,200 ohms field, **35/-** each; 10in. B.T.H. Model R.K. Mains Energised, 1,000 ohms field, 15 ohms speech, weight 28-lbs., reconditioned as new, **£6.6.0.** Ideal for P.A. work. Directional Baffle for R.K., 3ft. × 2ft. 6in. × 1ft. 6in., felt-lined with suspension hooks, made from 1in. ply, as new, **£3.15.0** each. 8in. Celestion with Transformer, **37/6.**

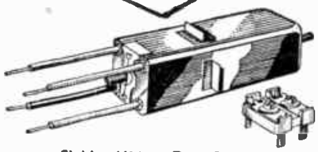
3½in. GOODMAN P.M. LOUDSPEAKER. Extra heavy magnet for Midgets and communication sets, **30/-.**

VOLUME CONTROLS. 1,000, 5,000, 10,000, 20,000, 25,000, 50,000, 100,000 ohms, ¼, ½, 1 and 2 megohms, without switch, **4/9** each. As above, with switch, **6/9.** 100,000 ohms Double Pole Switch, best American, **7/6.** WIRE WOUND, best American, New, ex television, 2,000 and 10,000 ohms, **5/-** each.

WIRE END CARBON RESISTORS. New, ex television chassis, ¼, ½, 1 and 2-watt. Assorted parcel of 100, **35/-.** 3-gang. .0003 VARIABLE CONDENSER, with geared slow-motion ball drive, pointer and dial frame. Ceramic insulation, **14/6.**

◆ CALLERS to Show Rooms,	LINAGLOW LIMITED	◆ POST ORDERS to Dept. M.O.24
61 HIGHGATE HIGH ST., N.6.	HOURS OF BUSINESS 9 a.m. to 5.30 p.m.	3 HAMPSTEAD LANE, N.6.
Phone : MOUntview 9432.	Monday to Friday.	*CASH WITH ORDER ONLY.*

F·W·S·CO.



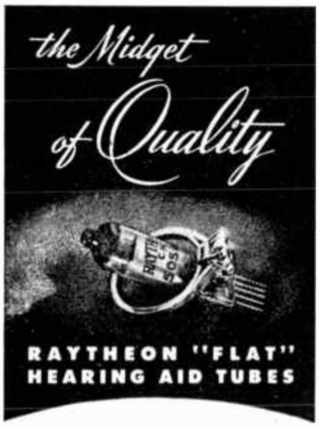
Sickles Midget Transformer and Trimmer.

WORLD'S LARGEST RADIO COIL MANUFACTURERS

RADIO FREQUENCY INDUCTORS
INTERMEDIATE FREQUENCY TRANSFORMERS
RADIO FREQUENCY COIL CHOKES
MICA COMPRESSION CONDENSERS
AIR DIELECTRIC CONDENSERS
MICA MOULDED CONDENSERS
SICKLES SILVER CAP CONDENSERS
GANGED PERMEABILITY TUNING
COMMUNICATIONS EQUIPMENT
F.M. EQUIPMENT PARTS
U.H.F. RADIO EQUIPMENT
SPECIAL ELECTRONIC EQUIPMENT

★

The F. W. SICKLES Co.
CHICOPEE, MASS., U.S.A.



They fit inside a delicate ring, they are so small; but they are mighty in dependable performance for hearing aid apparatus. Long lived with low battery drain, RAYTHEON Flat hearing aid tubes give quality performance for electronic hearing aids.

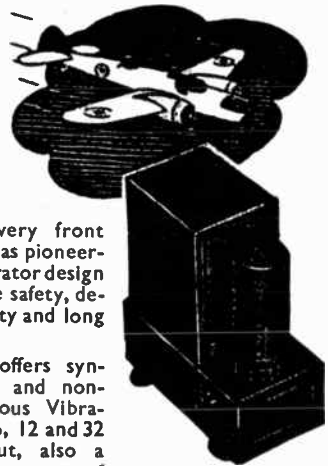
RAYTHEON
PRODUCTION CORPORATION
HEARING AID TUBE DIVISION
Newton, Massachusetts.

ARMY-NAVY 'E' WITH STARS Awarded all four Divisions of Raytheon for Continued Excellence in Production.

P. R. MALLORY & CO. Inc.

MALLORY VIBRATORS

ARE ALWAYS DEPENDABLE



Along every front Mallory has pioneered in Vibrator design to ensure safety, dependability and long service.

Mallory offers synchronous and non-synchronous Vibrators for 6, 12 and 32 volt input, also a complete range of 'STRATOSPHERE' Vibrators plus the world famous Mallory 'VIBRAPACK' (Regd. Trade Mark).

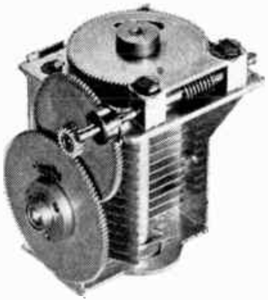
Mallory engineers are at your disposal.

★ Vibrapack is a registered trade mark, the property of the P. R. Mallory & Co., Inc., Indianapolis, U.S.A. Units which do not bear this trade mark are not of genuine Mallory manufacture.

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA, U.S.A.
Radio and Electronics Division

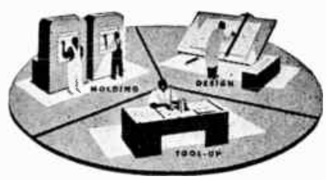
G.I.

VICTORY PRODUCTION



WHEN the mission of complete victory is accomplished, General Instrument will help "Win the Peace" by making the best use of still greater knowledge and experience in the manufacture of variable condensers and drives.

THE GENERAL INSTRUMENT CORPORATION
ELIZABETH, N.J., U.S.A.



WHEN you think of plastic mouldings for post-war products we suggest you consult the Kurz-Kasch "Plastic Round Table"—a group of specialists in design, materials, tool-up and moulding. Kurz-Kasch can give you complete service under one roof, one responsibility.

KURZ-KASCH INC.
Moulders of Plastics,
DAYTON . OHIO
U.S.A.

ALSO
"MYKROY" CERAMIC INSULATING MATERIALS
GENERAL ELECTRONIC VACUUM CONDENSERS

FOR THE FUTURE

These Manufacturers will help solve your post-war problems.

Register your name now for full details which will be sent you when supply conditions again permit.

FRANK HEAVER LIMITED

Kingsley Road, BIDEFORD, N. Devon

Clear as a Crystal

AND HERE IS THE REASON . .

. . . the answer has been found in Bullers Low Loss Ceramics to the problem of Dielectric Loss in High Frequency circuits.

Years of Laboratory research and development have brought these materials to a high degree of efficiency. To-day they are in constant use for transmission and reception, and play a vital part in maintaining communications under all conditions.

Made in Three Principal Materials

FREQUELEX

An Insulating material of Low Dielectric Loss, for Coil Formers, Aerial Insulators, Valve Holders, etc.

PERMALEX

A High Permittivity Material. For the construction of Condensers of the smallest possible dimensions.

TEMPLEX

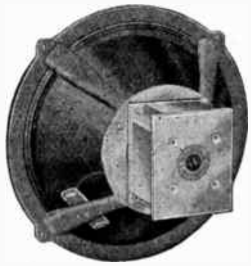
A Condenser material of medium permittivity. For the construction of Condensers having a constant capacity at all temperatures.

BULLERS, LTD.
THE HALL,
OATLANDS DRIVE,
WEYBRIDGE, SURREY
Telephone: Walton-on-Thames 2451
Manchester Office: 196 Deansgate, Manchester.

Bullers

LOW LOSS CERAMICS

Wharfedale



PUBLIC ADDRESS LOUD SPEAKER

W.12

ALCOMAX MAGNET

ONE of the first large Speakers to be fitted with the new ALCOMAX Magnet, giving enormous magnetic flux with moderate size (12" × 6¼") and weight (9-lbs.).

The entire unit is of robust construction to stand up to heavy input.

Flux Density 11,500 lines/CM2

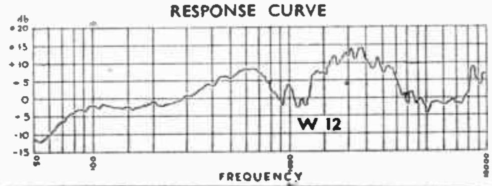
Total Flux 130,000 lines

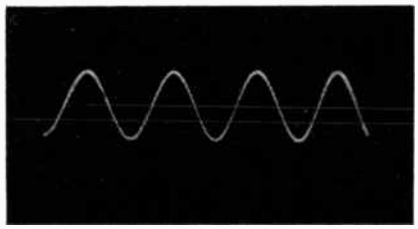
Speech coil impedance 12/15 ohms

LIST PRICE 135/-
(Priority Orders Only)

WHARFEDALE WIRELESS WORKS
Hutchinson Lane, Brighouse, Yorks.
Phone:-Brighouse 50 'Grams:-WHARFDEL

RESPONSE CURVE





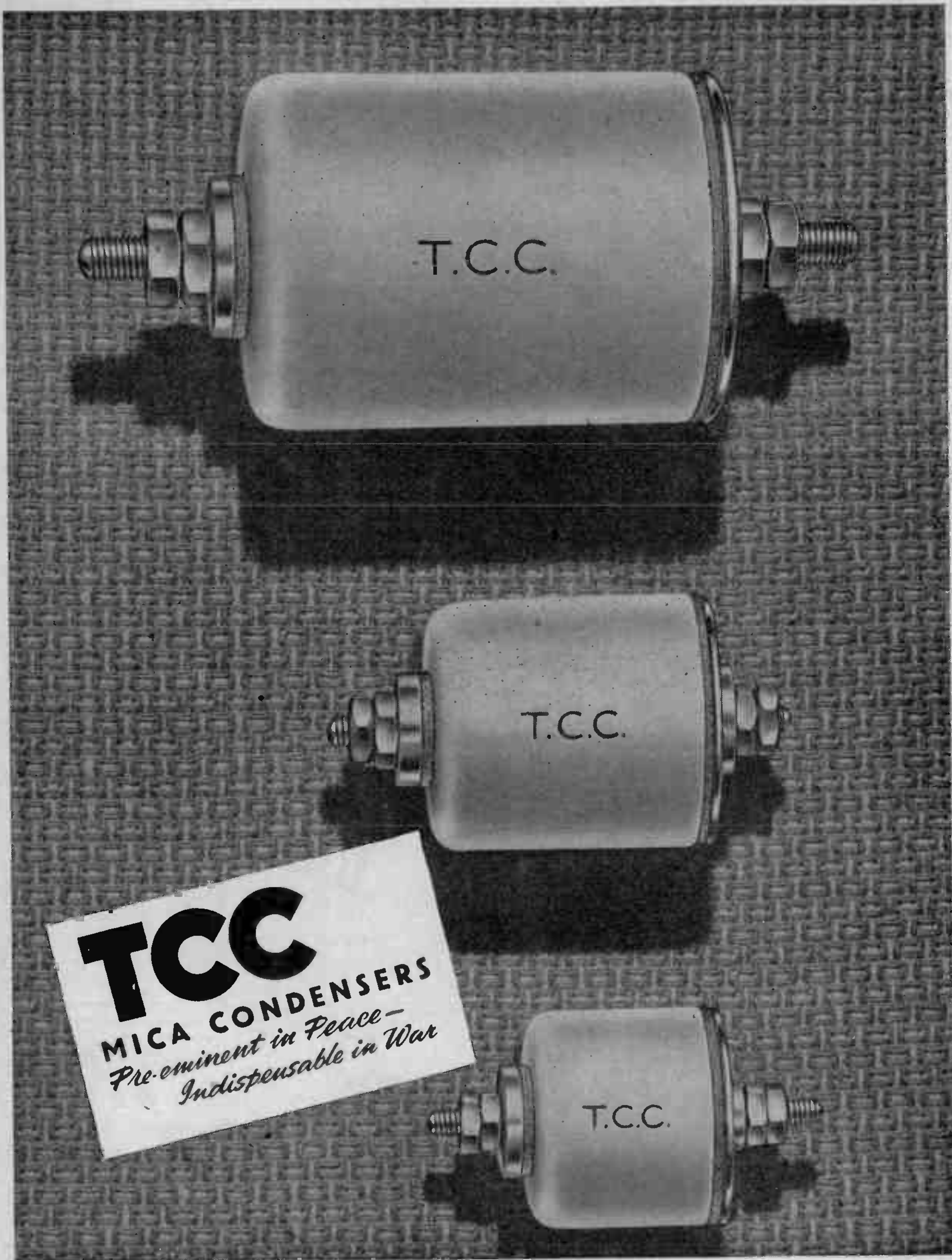
B.S.R. STANDARD SINE WAVE SOURCES

TYPE LO.800A. OSCILLATOR

—an actual oscillogram of output voltage is illustrated—gives good waveform even below 10 c.p.s. This necessitates a minimum "pull-in" between the two H.F. oscillators. Superlative design results in an almost perfect waveform from the lowest to highest frequencies. The output voltage is constant to within a few per cent. over the frequency range. This Model is chosen as a Standard by most Departments. Stable, reliable. Indispensable to all serious workers.

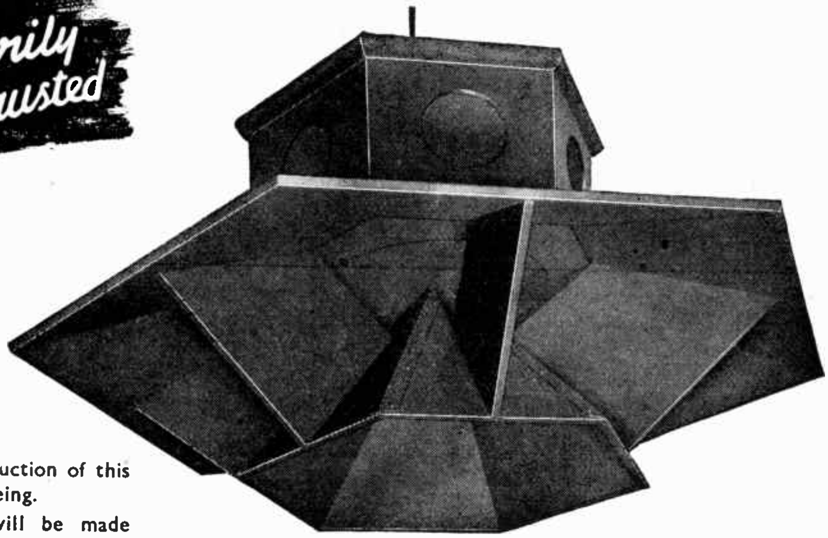
Output up to 5 watts. Three range output voltmeter incorporated—0-250, 0-50, 0-10. Four output impedances, 5000, 1000, 600 and 15 ohms. Frequency ranges (3 models), 0-15000, 0-25000 and 0-50000 c.p.s.

BIRMINGHAM SOUND REPRODUCERS LTD.,
Claremont Works, Old Hill, Staffs.
Cradley Heath 6212/3. Grams: Electronic, Old Hill


T.C.C.
T.C.C.
T.C.C.
TCC
MICA CONDENSERS
Pre-eminent in Peace—
Indispensable in War

Concentric Diffuser Loudspeakers for P.A.

Supplies temporarily exhausted



We regret to announce that the very limited supplies of the Concentric Diffuser Loudspeakers have now all been disposed of. Due to the heavy demands made on us by the Services for special Loudspeakers and Telephone Apparatus, we have been obliged to discontinue production of this popular model for the time being.

A further announcement will be made immediately we are able to recommence production.

GOODMANS INDUSTRIES LIMITED

Quality & Performance as before

LANCELOT ROAD. WEMBLEY. MIDDX.

TAYLOR VALVE TESTER

MODEL 45A

This new and improved Taylor Valve tester measures the Mutual Conductance of all types of amplifying valves and also checks the emission of Diodes and Rectifying valves

Two ranges of Mutual Conductance measurement are available being 3 mA/V full scale and 15 mA/V respectively. Anode and Screen Volts can be adjusted to suit the valve under test and a variable supply of Grid Volts is also available A switch gives a choice of 17 different filament Volts covering from 1.1 Volts to 117 Volts

Sixteen valve holders are provided to cover all the popular British, American and Continental types Separate tests are available for checking Continuity, Element Shorts and Heater to Cathode Leakage The three selector switches ensure that the correct voltage is applied to every pin of the valve under test.

A comprehensive book of instructions is issued with each instrument, complete with a valve chart giving settings for over 2,000 valves of all makes

The instrument is operated from A.C Mains and a mains adjustment is provided covering from 200-250 Volts at 40-100 cycles.

Model 45A/S

Price £17 . 0 0

Please write for technical brochure.

Taylor electrical instruments Ltd

Send your enquiries to

TAYLOR ELECTRICAL INSTRUMENTS LTD.,
419-424 Montrose Avenue, Slough, Bucks.

Telephone: Slough 21381 (4 lines) 'Grams. "Taylins, Slough"

RELIABILITY

It is always there when you want it—it is of tested, unvarying quality.

In the same way you can depend on

TRIX

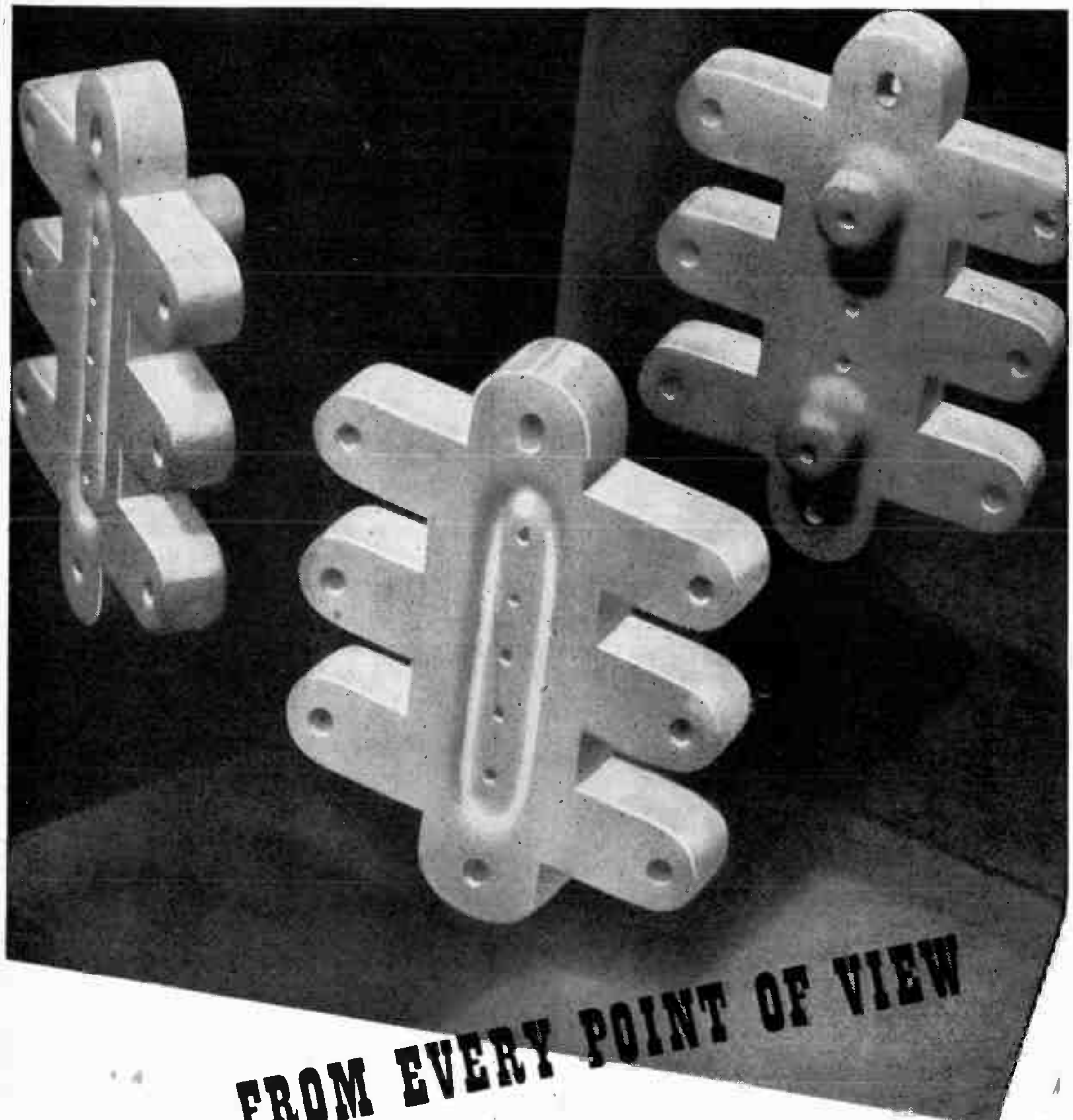
Quality Sound Equipment

Reliability is the most important factor with Sound Equipment too—you can take Trix for granted in this respect. For the present, supplies are restricted to priority orders.

TRIX ELECTRICAL CO. LTD.

1-5 MAPLE PLACE · TOTTENHAM COURT ROAD · LONDON, W.1

Telephone Museum 5817. Telegrams: TRIXADIO, WESDO, LONDON



FROM EVERY POINT OF VIEW

Frequentite is the most suitable insulating material for all high frequency applications. Ten years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

STEATITE & PORCELAIN PRODUCTS LTD.

Head Office: Stourport-on-Severn, Worcester. Telephone: Stourport 111. Telegrams: Steatain, Stourport.

SP30

★ IN THE DEVELOPMENT AND MANUFACTURE OF

Radio Frequency CABLES

B.I. HAVE PLAYED A LEADING PART

★ . . . . and though supplies are directed to the Services, the experience gained over a considerable manufacturing period is available for the benefit of approved users.

Note.—From fundamental principles, B.I. have made outstanding contributions to design and construction of cables for radio frequency transmission and have perfected production technique.

BRITISH INSULATED CABLES LTD. PRESCOT, LANCS.

M.R. SUPPLIES

have the following superior and brand new **ELECTRICAL and INDUSTRIAL EQUIPMENT** in stock and available for immediate delivery or collection. All prices nett cash.

GRAMPIAN OUTPUT TRANSFORMERS to suit all speakers. Tapped primary and secondary providing 8 ratios with C.T. for push-pull. The best replacement type, **9/6.**

ALL-STEEL TOOL or AMPLIFIER RACKS. 30ins. high with three trays each approx. 15in. by 17in. Very strongly made and suitable for workshop, lab., and for mounting amplifier, etc., **30/-** (carr. 2/-).

TRANSFORMER BOBBINS solving the re-wind problem. Standard for most commercial receivers. Prim. tapped 200/240 v. Secs. 350-0-350 v. 75 m.a., 4 v. 4 a. 4 v. 3 a., core opening 1¼in. square and 1¾in. through, **18/6.** Also with 6.3 v. 4 a., and 5 v. 3 a., same price.

ROTHERMEL-BRUSH MINIATURE PIEZO-CRYSTAL MICROPHONES. Only 1¼in. diam., made for deaf-aid but quite suitable for all microphone uses. In aluminium housing with no front grille, **29/6.**

G.E.C. POWER PACKS (BCS.2332) for 60-watt amplifiers. A.C. mains 190/250 volts. Supplied with two U18 Osram Rectifiers. Smoothed H.T. delivery 450 v. 345 m.a. and 6.3 v. for 8 heaters. Heavy duty output transformer is incorporated with primary to match four KT66 in parallel P.P. and secondary providing taps for 2.5, 5, 7.5, 15 and 600 ohm loading. Very robustly built in closed chassis form, weight 48 lbs. **£21** (carr. 5/-). We have only 25 left.

STEP-DOWN MAINS TRANSFORMERS. Prim. 200/240 v. (tapped) and sec. 5, 12 and 17 v. at full 6 amps, **49/6.** **POWER TRANSFORMERS.** Prim. 230 v., secs. 1700-0-1700 v. 400 m.a. and 6.3 v. 5 a., high insulation, finished with brackets and terminal panels, weight 55 lbs. **£13 10s.** (carr. 5/-).

"FUZIT" ELECTRODE WIRE JOINTERS. Both models again in stock! Place twisted ends of wire in jaws of tool—press and release trigger—instantaneous and perfect wire-jointing. Complete with well-housed portable transformer (200/250 v.) and all leads, ready for use. Model 30 (for 50 to 30 SWG), **£25.** Model 20 (for 30 to 20 SWG), **£23.** (Pt. pkg./carr., either, 3/6.) Govt. number must be quoted for this item.

LONDOX RELAYS. In 6in. by 4in. by 2½in. metal housing. 230 v. A.C. coil with 10 amp. Mercury "make" switching, **49/6.** Also same size with 6 v. D.C. coil and 15 amp. Mercury "make" switching, **57/6.** Also unhoused type with 230 v. A.C. coil and 3-pole change-over 6 amp. silver contact switching, **42/6.** Also 6 v. D.C. coil with 3 amp. 2-pole "break" switching, **7/6.**

SLIDING RESISTANCES, 100 watts. Fully enclosed, 6½in. long. Following range now in stock: 400 ohms 0.5 amp., 200 ohms 0.7 amp., 100 ohms 1 amp., 50 ohms 1.4 amp., 10 ohms 3 amps., and 4 ohms 5 amps. Any one **25/-.** Also a few, same size, 172 ohms, suitably graded for a current taper of 1 to 0.07 amps at 12 volts, **29/6.**

STAGE DIMMERS. Constantly rated and with carbon break flicker switch and "off" position. For controlling stated load from full bright to blackout at 220/240 v. With screw-motion drive and handwheel. 1,000 watts, **£6 17s. 6d.** 1,500 watts, **£8 8s.** (Pkg./carr., either, 6/6.)

TOGGLE PRESSES (Stanelco), double acting, precise tool for all small pressing operations in many trades. Senior model, pressure 1½ tons, weight 150 lbs., **£30** nett. Minor, pressure .8 ton, weight 80 lbs., **£23** nett, both ex this address.

MICROPHONE STANDS all very best quality. Floor Type, collapsible, extending to 5ft. 6in., all chromium, **45/6.** Table Stands, telescopic, chrom. with black base, **25/-.** All chrom., **29/6.** All stands have standard ¼in. (26) thread.

Please include sufficient for packing/postage.

M.R. SUPPLIES, 68, New Oxford Street, London, W.C.1

(Telephone: MUSeum 2958)

CASE *by* IMHOF'S

ESTABLISHED 1845

THE HALLMARK OF A GOOD INSTRUMENT

If you are inclined to the view that your instruments deserve a case that is better built and of more attractive and functional design, or you build equipment that needs precision sheet metal work, you will be interested to have this catalogue. A penny stamp and the request on your business letterhead will bring it you.

ALFRED IMHOF LTD. 112-116 NEW OXFORD STREET, LONDON, W.C.1. MUSEUM 5944

HIVAC

THE SCIENTIFIC VALVE

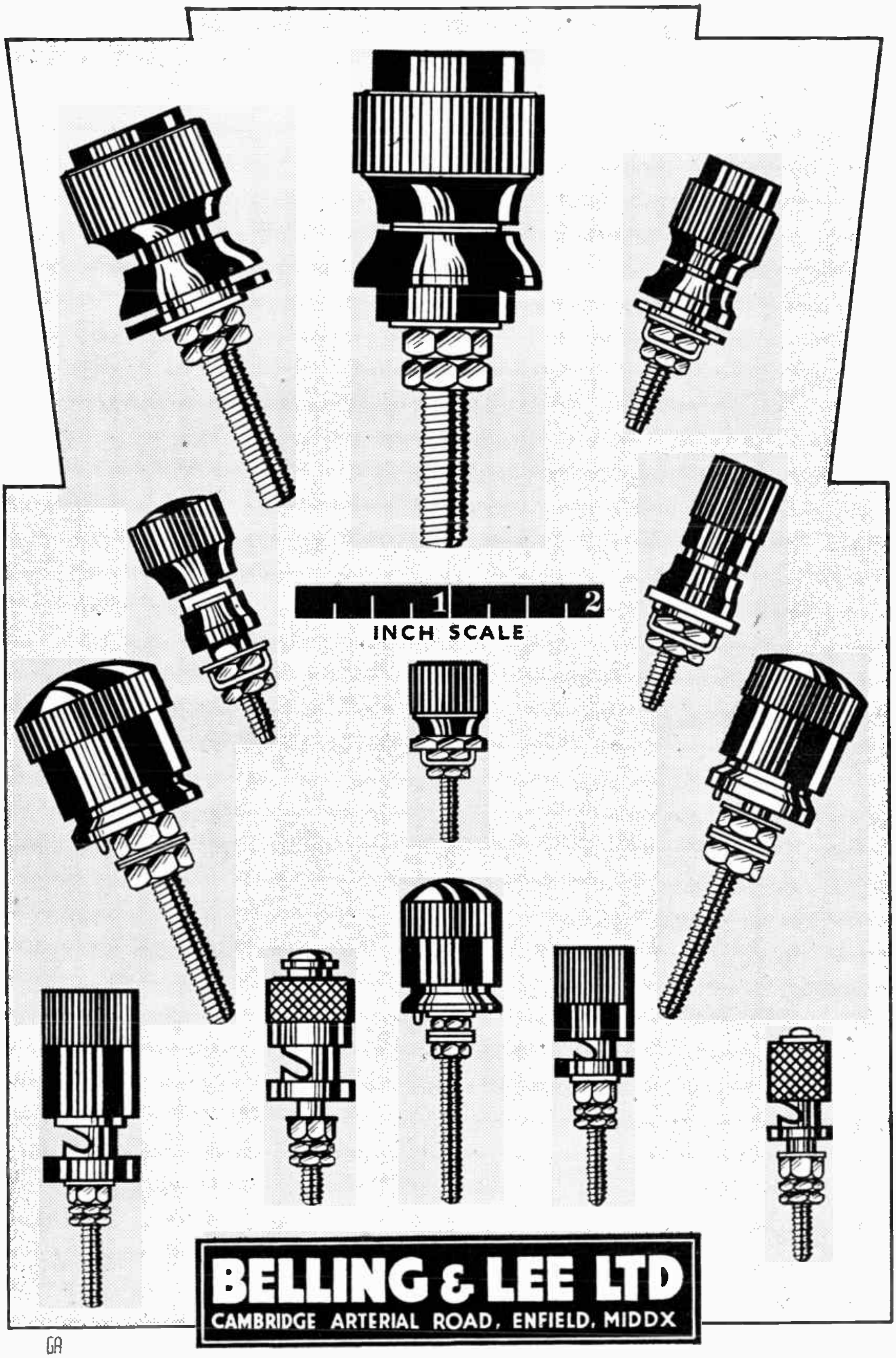
BRITISH MADE

Specialists in

MIDGET VALVES

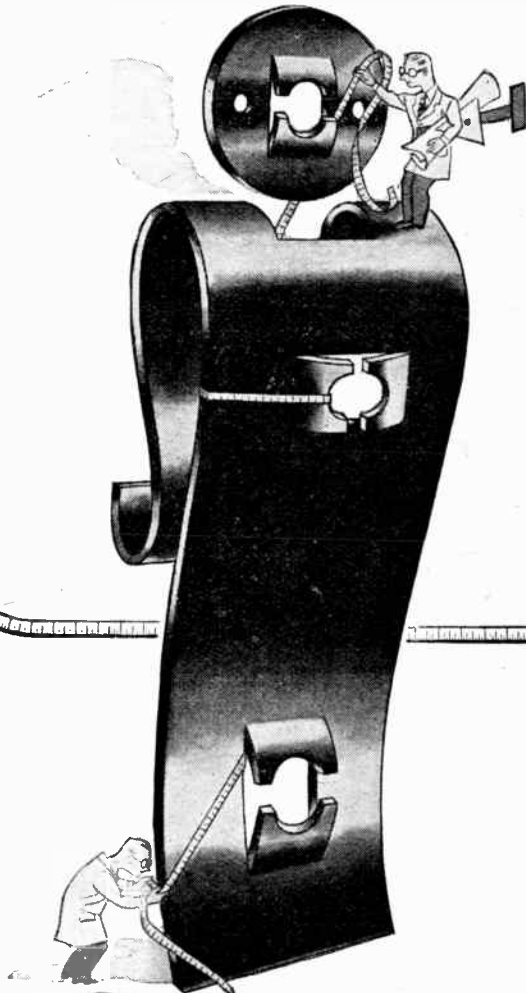
HIVAC LIMITED
Greenhill Crescent,
Harrow on the Hill, Middx.

Telephone: Harrow 0895.


1
2
INCH SCALE
BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

Made to measure

The standard Spire nut is only one form, and the most elementary form at that, of fixing by the Spire method. There are already over 300 special Spire designs, each of which has been "made to measure," for some particular job. In most of them no separate nut or washer is needed. The Spire fixing is part of the component itself. It is pretty safe to say that Spire can simplify *most* assembly jobs. Send us along any ordinary assembly-parts or drawings. We'll see if we can't cut out some of the bits and pieces and reduce the operational time by designing a Spire assembly. No charge for this. If it works we'll get your order If it doesn't we'll tell you so and there's no harm done.



THAT'S Fixed THAT! ***NP 1506.***
Aircraft manufacturers and coachwork builders employing stressed skin construction are saving time and money and material by the use of this simple Spire fixing. It serves to hold the tack bolts in position until riveting of skin sections has been completed. It is quicker to use than the usual square pressed nut and is easily removed for further use when its "holding job" is done

Spire ✱ **A BETTER way of fixing**

Simmonds Aerocessories Limited · Great West Road · London · A Company of the Simmonds Group

Wireless World

Radio • Electronics • Electro-Acoustics

34th YEAR OF PUBLICATION

Proprietors :
ILIFFE & SONS LTD.

Managing Editor :
HUGH S. POCOCK,
M.I.E.E.

Editor :
H. F. SMITH.

Editorial, Advertising and Publishing Offices:
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

Telephone :
Waterloo 3333 (35 lines).
Telegrams :
" Ethaworld,Sedist,London."

PUBLISHED MONTHLY

Price : 1/6

(Publication date 25th of preceding month)

Subscription Rate : Home and Abroad 20/- per annum.

Branch Offices :

COVENTRY :
8-10, Corporation Street.
Telephone : Coventry 2310.
Telegrams :
" Autocar, Coventry."

BIRMINGHAM :
Guildhall Buildings,
Navigation Street, 2.
Telephone :
Midland 2971 (5 lines).
Telegrams :
" Autopress, Birmingham."

MANCHESTER :
260, Deansgate, 3.
Telephone :
Blackfriars 4412 (4 lines).
Telegrams :
" Iliffe, Manchester."

GLASGOW :
26B, Renfield Street, C.2.
Telephone : Central 4857.
Telegrams : "Iliffe, Glasgow."

As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

SEPTEMBER 1944

DOMESTIC · COMMERCIAL · INDUSTRIAL · SCIENTIFIC · MEDICAL · EXPERIMENTAL

THE MULLARD WIRELESS SERVICE CO. LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2. (77 rev.)

Wireless World

Radio • Electronics • Electro-Acoustics

Vol. L. No. 9 SEPTEMBER 1944 Price 1s. 6d.

Monthly Commentary

Plea to Set Designers

IT can reasonably be assumed that manufacturers of broadcast receivers are at present considering, more actively than at any time during the past five years, the designs of their post-war products. Apart from the more obvious and fundamental aspects of design, of which the problems are self-evident, there are many secondary matters to which thought should be given. One of these is raised by *The Wireless Trader,* which has recently stressed the desirability of planning sets for easier maintenance and repair. That journal, and those of its readers who have contributed to the subsequent discussion, seem to be agreed that many sets are sadly deficient in this respect, and that nearly all of them are susceptible to improvement.

Lack of accessibility, especially of components likely to need replacement, is the main complaint. It is pointed out that the removal of the chassis from the cabinet usually entails much unnecessary work, partly because components are often mounted inside the cabinet in such a way that they must be disconnected before removal can be effected. It is suggested that the chassis should be easily removable as a complete receiver unit, except perhaps for the loud speaker, in which case there should be sufficient length of speaker lead to avoid the need for disconnection. Unnecessary complications, such as fanciful tuning scales of extremely doubtful "sales appeal" that necessitate complicated cord drives, are condemned, as is the practice of fitting multiple high-tension leads in battery sets. Correspondents of *The Wireless Trader* also deplore the fitting of multiple "wafer" switches in such a position that the set must be more or less stripped before a faulty contact can be put right. They also plead that trimmers should be mounted accessibly, and that design should be made uniform so that all trimmers may be actuated by a standardised tool. A particularly strong case is made for fitting "consumable" components (such as electrolytic condensers) in a way that allows easy access and replacement.

All these pleas seem to be eminently reasonable, and we think it will be to the ultimate benefit of all—not forgetting the consumer, who ultimately bears any unnecessarily high service costs—that the question of easy maintenance should be borne in mind by designers. Of course, arguing on the principle that prevention is better than cure, it may be urged that designers would be better occupied in devising broadcast receivers that do not break down, and that the prospective buyer of a set will be anything but favourably impressed on being told that a particular type of set is designed for easy repair. That is true enough, particularly of the cheaper kind of set, but it must not be forgotten that after the war the industry will be catering for a much more critical market. At least half a million persons have been introduced to more or less technical aspects of wireless during the war. They will know that all wireless apparatus stands in need of occasional overhaul, and will be favourably impressed to find that reasonable precautions have been taken to ensure easy—and consequently cheap—maintenance. The influence of this large section of the public is likely to be widespread.

Railway Radio.—Although the idea of using wireless communication for increasing the safety and efficiency of railway operation is by no means new, comparatively little progress has been made in applying it in practice. To the layman in railroad matters this is rather surprising; here, it would seem, is one of those cases where the special attributes of radio communication could be used to great advantage. The subject has lately been discussed at great length in the U.S.A., where a sub-committee of the Senate has heard a mass of evidence on the possibilities. The Federal Communications Commission has declared itself to be sympathetic towards the general principle, and no fewer than nine railroads have been granted authority to instal experimental operational radio systems. Conditions are vastly different in this country, but the matter is one that should, we think, be considered seriously here.

WAVE GUIDES

How to Visualise Their Action and Characteristics

By

Sqdn. Ldr. M. G. SCROGGIE

THERE are at present two ways of explaining wave guides. One, the proper way, is mathematically. That was all right so long as the only people interested in wave guides were a few scientists, who, naturally, could cope with the mathematics.

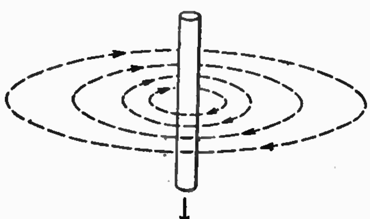


Fig. 1. Magnetic field represented by broken lines circling the direction of flow of an electric current.

But as wave guides come into practical use, many who handle them will find their mathematical ability too elementary to derive much enlightenment from the standard treatises. To them a wave guide has to be described as a pipe which if radio waves are fed into one end will deliver them at the other.

This conception is not likely to satisfy the mentally inquisitive, nor does it help one to apply wave guides intelligently nor even to maintain them in a serviceable condition.

Wave guides are, in fact, only one example of a technique that will no doubt come into common use as applications are found for very short wavelengths. Other devices are cavity resonators, such as rhumbatrons, and radiating horns.

In ordinary "circuit" theory we are accustomed to base our ideas on currents and voltages, with magnetic and electric fields as incidental phenomena. To understand wave guides and other enclosed space devices it is necessary to reverse this order and think in terms of the fields, with currents and voltages as secondary effects. So the first step is to brush up one's knowledge of fields with the aid of a favourite text-book, remembering that fields are *not* in the form of lines (even imaginary ones) but that the lines in diagrams are just to show the directions in which the magnetic and electric forces act, and to some extent to indicate the relative intensity of those forces in different parts of the fields.

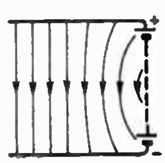


Fig. 2. Electric field represented by continuous lines between places at different electric potentials

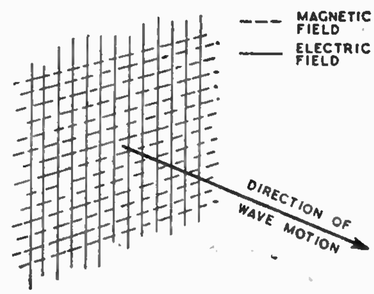


Fig. 3. In an electromagnetic wave the directions of the electric field, the magnetic field and the motion of the wave are all three at right angles to one another.

Here are the leading points briefly:

1. Every current (that is to say, electric charge in motion) either along a wire, or in space as in an electron stream, is associated with a magnetic field, which acts as indicated by loops drawn around the current path (Fig. 1).

2. Every voltage is associated with an electric field, which acts between points which are at different potentials (Fig. 2).

3. Every moving (or growing, or collapsing) magnetic field causes a voltage to be generated, and therefore an electric field; while a moving electric field similarly generates a magnetic field; so it is possible for the two to be mutually supporting in the form of an electromagnetic wave moving at right angles to the forces of the two fields, which are at right angles to one another (Fig. 3).

A sort of intermediate stage between ordinary circuits, where we are concerned chiefly with currents and voltages, and wave guides, where the fields demand primary attention, is the transmission line, where both are important. As it is just possible to push circuit theory far enough to provide a useful picture of the action of transmission lines, they may serve as a bridge, for those who have got so far, to proceed to form some workable ideas about wave guides. The following does not claim to be a rigorous treatment of wave guides, but an approach to them from a modest knowledge of transmission lines and elementary geometry.

We start off with a short length of parallel transmission line closed at both ends, and consisting therefore of a rectangular piece of metal (Fig. 4); *a* is the length and *b* the width of the two parallel conductors, and *c* is their spacing. Suppose electrical waves are set moving along this line, by coupling it to some high-frequency generator. The waves are totally reflected at a short-circuited end. They then travel to the other short-circuited end, are reflected there, and presently they reach the starting point, which may be assumed to be anywhere along the line.

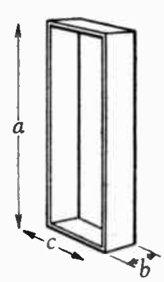


Fig. 4. A short length, *a*, of parallel transmission line, short-circuited at each end, forms the starting point for considering the action of wave guides.

Whether the twice-reflected wave will tend to cancel or to reinforce the wave now starting from that point will depend on their relative phases. If the double journey is exactly half a wavelength, they will differ in phase by that amount, which is 180 degrees, and therefore exactly opposite in phase. If it is one complete wavelength the wave just starting at any point is exactly in phase with a wave that has done one lap of the course, and with another that has done two, another that has done three, and so on. If there were no loss in the line or radiation from it, the amplitude built up in this way by a generator of sustained oscillations would increase without limit. If the line is of copper or other highly conducting metal, spaced by air or other low-loss dielectric, the build-up is very considerable, and the line is sharply *resonant.* As the frequency, and therefore the length of the wave, is varied the reflected waves fall out of step and the build-up is less.

For the double journey to be one wavelength the length a must be half a wavelength, $\lambda/2$. Obviously resonance occurs when a is any whole multiple of $\lambda/2$; but $\lambda/2$ is the shortest possible resonant length, and for the present we shall assume it.

While waves travelling in the *same* direction will always be in phase, the relative phases of waves travelling in *opposite* directions at any point depend on the distance of that point from the reflecting end. At the end itself the short-circuit ensures zero voltage, which involves a voltage phase reversal on reflection. At the centre of our short line, which is $\lambda/4$ from both ends, a further phase reversal, due to the time taken by a wave to make the double journey over this distance, brings the voltages into phase again, so at this point there is permanently an alternating voltage maximum, and therefore maximum intensity of alternating electric field between the conductors. Current—and consequently magnetic field—is distributed in an opposite manner as shown in Fig. 5 (where, however, it must be remembered that the magnetic field occurs 90° out of phase with the electric field, so they do not both reach their peak values simultaneously). We have, in fact, the standing wave system that is characteristic of a resonant line.

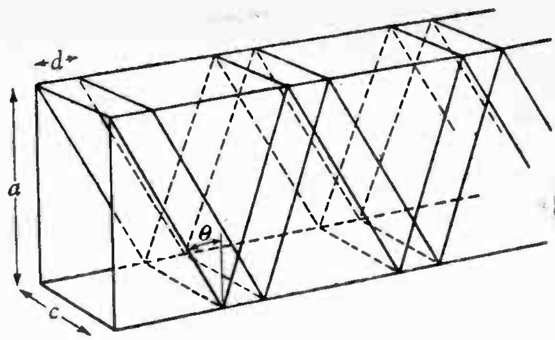


Fig. 6. Perspective view of the "line" (Fig. 4) greatly extended in the dimension *b*, and marked off into zig-zag strips of width *d*.

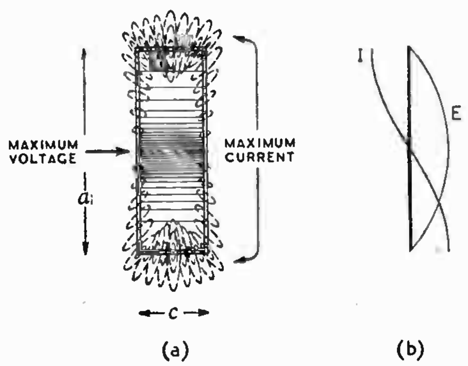


Fig. 5. When the "line" shown in Fig. 4 is half a wavelength long it resonates, and the maximum current (and magnetic field) is at the ends, with maximum voltage (and electric field) at the centre. At (a) the distribution of fields is shown diagrammatically; (b) shows the current (I) and voltage (E) distribution.

Now imagine the dimension b to be greatly increased until it is much greater than either a or c. The rectangular-section tube thus formed is still resonant to the wavelength $\lambda = 2a$, along the direction a.

Next, suppose such a rectangular tube to be marked off into strips of width d forming a zig-zag transmission line, as shown in perspective in Fig. 6. Any wave moving along such a "line" strikes the wall c of the tube at an angle θ, and in accordance with the usual law of reflection is reflected at the same angle. Fig. 7 is a side view of a tube in which the dimension d is equal to $2a \tan\theta$ and therefore the zig-zag "line" employs the whole of the tube.

The dotted line CGON etc., marks its centre, and the portion of tube wall the edge of which is seen as AB forms the first short-circuited end or reflector; DE is the second, BF the third, and so on. From D draw DH perpendicular to CG. Let us, acting for the moment in blind faith, assume that the wavelength is twice HG, i.e., $\lambda = 2a \cos \theta$.

Suppose that at a given moment a wave moving along the strip CG has reached a positive voltage maximum at H. This positive crest is indicated by a row of plus signs ++++. Then as HG is $\lambda/2$, the preceding negative

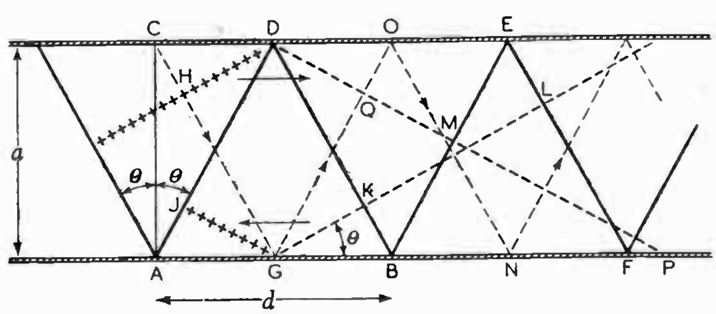


Fig. 7. The Fig. 6 system is further developed by enlarging the width *d* of the strips until they occupy the entire material. The instantaneous positive and negative crests of a wave travelling along the zig-zag ath CGOH are shown as +++++ and - - - - - respectively.

Wave Guides—

crest must be at G, shown by a row of minus signs — — — — (GK). Along one half of the strip this crest has already been reflected; and, as voltage reflection at a short circuit is accompanied by reversal of sign, the reflected half is shown as positive (GJ). From the geometry of the system it is obvious that JD is equal to KD, which is $\lambda/2$, and therefore a negative crest coming from G has reached the line DM. At the end D it has reached the reflecting wall and so a positive crest is just starting from here towards B, and as DK is $\lambda/2$ there is a negative crest at K, extending across the strip to L. This obviously lines up with the crest are equal and opposite and so reduce to zero. A little thought leads to the conclusion that the same is true all along a straight line DG.

At the intersection of DM and GL two negative maxima coincide to give a doubly negative potential at this point, which obviously lies along the axis of the tube. DH and GJ similarly intersect to give a positive peak. The point along the axis, half way between these opposite peaks, lies on DG, which we have already seen to be a zero. By taking intermediate values, the potential can be mapped out over the whole area, and will be found to have a sinusoidal or wavelike distribution along the axis, and also across the arrows near D and G. These join up to form continuous loops, as shown in Fig. 8. Another set of loops, of opposite polarity, exists in the next low-potential region, where current is flowing in the opposite direction.

Phase Velocity

Now imagine the whole system in motion. Assuming the tube to be air-filled, waves travel along the "line" at nearly their speed in free space, 3×10^{10} cm/sec. usually devoted by C. As they do so, it can be seen that the entire field pattern suggested by Fig. 8 must move axially along the tube. During half a cycle, the positive crest at GJ in Fig. 7 has moved along GQ to DMP, from which it

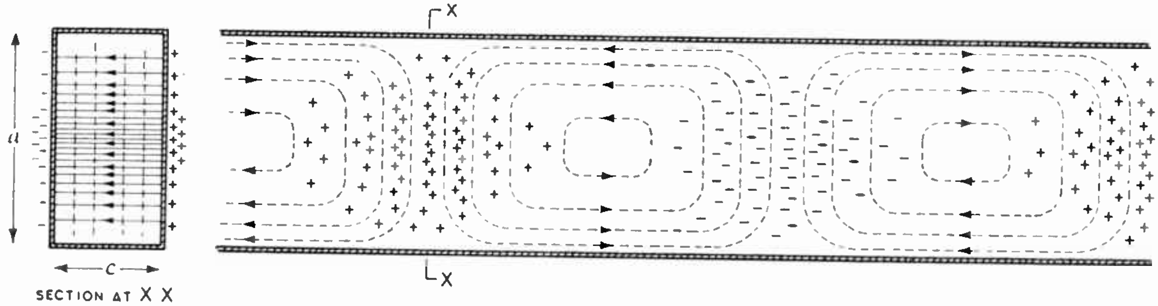


Fig. 8. Instantaneous distribution of fields in the Fig. 7 system shown in end and side elevation. Electric charge is indicated by + and — signs in varying concentration, with electric field lines between them. The magnetic field forms loops, the ends of which appear as lines in the section view.

GK. It can similarly be shown that the next negative crest lines up with DM, and so on. So the dividing up into strips of any particular width is just an artificial aid to consideration of the problem: whether the strips are broad or narrow, the positive and negative crests (and all intermediate phases) line up with one another to form a continuous broad front at right angles to the direction in which the wave is moving.

At the instant selected for consideration, then, and on the assumption that $\lambda = 2a\cos\theta$, the positive and negative crests are distributed along diagonal lines inclined at an angle θ to the axis of the tube.

It is clear that before we can derive the whole potential pattern on this visible wall of the tube we must do some cancelling out. Take D, or G, or in fact any point along the edges, where the reflecting metal forms a short-circuit to the opposite wall: the potentials the tube. This is suggested by the + and — signs in Fig. 8. The opposite wall of the tube, behind that shown, presents the same pattern in reverse sign; and the lines of electric force join positive and negative points on opposite walls, at right angles to the paper in the diagram.

Associated Magnetic Field

So much for the electric field pattern, frozen at this particular moment in time. What about the magnetic field? The region between G and D in Fig. 7 is at this moment at zero potential, but is about to become positive as the fronts HD and GJ advance on it. For this to happen, there must be a redistribution of electric charges which necessitates current flowing (in the conventional direction) from the back wall to the front, especially in the regions around D and G. From Fig. 1 it can be seen that a magnetic field must exist inside the tube along the directions indicated by can be seen that the field pattern has moved along the axis a distance equal to GP. The axial velocity of the fields, called the *phase velocity*, V_P, is therefore $C \times \frac{GP}{GQ}$; and, as GPQ = θ, $V_P = C/\sin\theta$. As we started off with the assumption $\lambda = 2a\cos\theta$, θ and hence V_P depend on the ratio λ/a. The smaller this is, the less is $\cos\theta$ and the more nearly $\sin\theta$ approaches 1 and V_P approaches C. When $\lambda = 2a$, $\cos\theta = 1$, $\sin\theta = 0$; and $V_P = \infty$.

The conclusion that V_P is never less than the speed of light and may be infinitely great may seem rather startling, and contrary to the doctrine that nothing can travel faster than light. But if the meaning of phase velocity is considered, it will be seen that it does not involve any physical movement at that speed. When the crest DM in Fig. 7 travels at velocity C from Q to O, the intersection between it and the reflecting walls travels from D to E, which may be a much greater distance; but an intersection is a mere geometrical relationship and

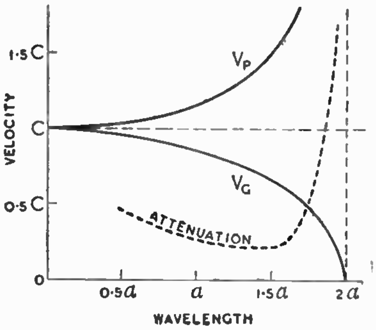


Fig. 9. Phase velocity, V_P, and group velocity, V_G, vary as shown in relation to the velocity of light, C, as wavelength is varied in relation to guide width, *a*. For this type of wave (H_{01}) the critical wavelength equals 2*a*.

does not mean that energy has moved from D to E. The cutting intersection between the blades of a pair of scissors travels from pivot to points at a far greater speed than any part of the scissors.

Group Velocity

Consider now two adjacent but oppositely polarised centres of electric field intensity, such as those shown in Fig. 8. They are half a wavelength apart in phase distribution; but the actual energy in one of these centres has to move to the position of the other along the zig-zag path at the velocity C, and therefore the axial velocity of the energy, which is what counts for signalling purposes, is less than C. It is called the *group velocity*, V_G, because it is the velocity, along the tube, of a group of waves forming, say, a dot in a morse signal. In the time taken for a wave to move along the "transmission line" from G to O in Fig. 7 its axial movement is equal to DO. So V_G is equal to $C \times \frac{DO}{DG} = C\sin\theta$. We have already seen that $V_P = C/\sin\theta$. It follows that $V_P V_G = C^2$, and as $\lambda = 2a\cos\theta$ it is a simple matter to plot V_P V_G in terms of λ for a wave guide—as our tube has become—of width *a*, as has been done in Fig. 9. When $\lambda = 2a$, as we assumed for Figs. 4 and 5, the wave is reflected back and forth across the tube, and its velocity in a direction along the tube is zero.

If the wavelength is very slightly decreased, the signal moves along the tube, but over such a zig-zag path that it does so comparatively slowly, and the multiple reflections involved in quite a short axial journey cause a fairly large attenuation. The speed and attenuation at first both rapidly improve as the wavelength is reduced; then as the wavelength becomes very short in relation to the width of tube, the attenuation begins to increase slowly, while the velocity tends towards C.

The wavelength $\lambda_C = 2a$ is called the critical wavelength, and the corresponding frequency the critical frequency; the guide cannot effectively transmit any wavelength not shorter than this. For wavelengths greater than about 10 centimetres, therefore, wave guides are inconveniently bulky in comparison with coaxial feeders; but for shorter waves they are easier to construct and more efficient, because there is no inner conductor requiring solid insulating material to support it.

(*To be continued.*)

R.E.M.E.
MOBILE
RADIO
REPAIRS

The repair and maintenance of the Army's telecommunications equipment—the collective term used for radar, wireless and line gear—is the responsibility of R.E.M.E., and the illustrations show a repair workshop of a mobile wireless detachment which provides repair facilities behind the front line. These mobile workshops, which have proved their value in fast moving warfare, handle all but the simple repairs and adjustments to the wireless and line equipment in the hands of units in the front line, which is undertaken by men of Royal Signals. Equipment beyond repair in the combat zone is returned to the large static telecommunications workshops set up in the various theatres of operation.

Resistance and Capacitance Measurement with the

PENTODE-DIODE VALVE VOLTMETER

Constructional Details of a Suitable Adaptor Unit

By T. A. LEDWARD, A.M.I.E.E.

IN the course of experimental work, one often wishes to know the approximate electrical properties of a component, so that its suitability for some purpose may be determined. The time taken for precision tests in cases where a large tolerance is permissible is not usually justified. In any case, an approximate test is a very useful preliminary to more exact work.

Apparatus may be designed to carry out approximate tests very quickly. In the case of resistance tests, for instance, the direct-reading ohmmeter can save a lot of time as compared with the Wheatstone bridge; but there is, of course, no comparison as regards precision of measurement.

In the case of condensers it is usually desirable, before using them at all, to check approximately not only the capacitance but also the insulation resistance.

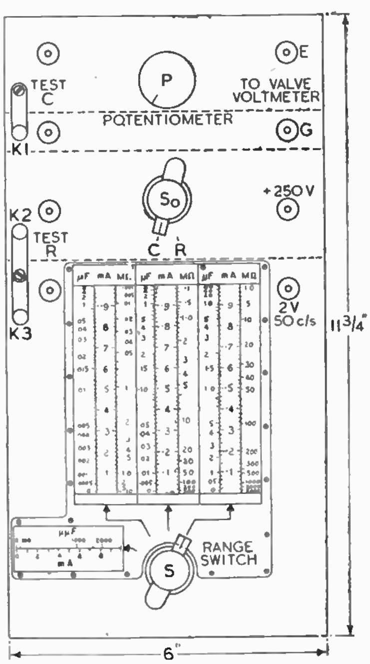


Fig. 1.—Panel layout of adaptor for resistance and capacitance measurement.

This is not meant as a reflection on new apparatus by reputable manufacturers, but an experimenter usually collects an assortment of components of uncertain origin and history. The careful man will, of course, check even new components, "just to be sure." The insulation test of a condenser is often quite as important as the capacitance test. In some cases 100 megohms or less is sufficient, whereas in others, 1,000 megohms may not be good enough.

Ranges Covered

The adaptor to be described was designed principally for checking capacitance and insulation resistance of condensers, and is intended for use with the Pentode-Diode Valve Voltmeter recently described in *Wireless World* (June 1944), but it may, of course, be adapted for use with any valve voltmeter of suitable range and capable of reading either AC or DC.

Additional resistance ranges have been added for convenience, so that the resistance tests are not confined to insulation values. Three ranges of capacitance cover 0.0001μF to 80μF, while three ranges of resistance cover 1,000 ohms to 5,000 megohms. A fourth capacitance range is provided for very low values. The minimum value that can be indicated on this range is 10$\mu\mu$F, and the scale is marked as shown in Fig. 1 at 100, 1,000 and 2,000$\mu\mu$F. This range is not intended to be so accurate as the other ranges, but it does serve the very useful purpose of showing whether an internal open circuit exists between the tag and the foil of a very small condenser. Such open circuits, though perhaps not very common, are by no means unknown. It is an advantage for such a test that the test pressure should be low, and the pressure of two volts used in this adaptor complies with this requirement.

The testing of electrolytic condensers is not covered by this apparatus.

The indicating instrument on the valve voltmeter is a 2½" dial 0–1 milliammeter, and it is obviously undesirable to attempt to mark the scale for the above ranges of capacitance and resistance. One alternative is to plot curves of instrument readings

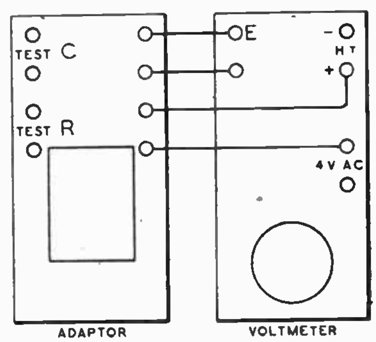


Fig. 2.—Connections between voltmeter and adaptor.

against C and R respectively; but if this is done the shape of the curves is such that they are very little use for even approximate accuracy. The best way is to draw straight scales showing instrument reading on one side and C or R on the other. A pointer knob on the range switch can then be made to indicate the particular scale required for each range. This will be clear on referring to the panel layout shown in Fig. 1.

The test voltages for the adaptor are taken from the valve voltmeter supplies. The resistance test requires 250V DC at 2½mA maximum, while the capacitance test requires 2V 50 c/s at less than 1mA maximum. For the DC supply a connection is taken from the HT+ terminal on the valve voltmeter, while for the AC supply a connection is taken from one terminal of the valve heater 4V supply, which gives 2V to earth. The earth connection forms the other common terminal for both supplies. Fig. 2 shows connections between adaptor and voltmeter.

These practical details of the finished instrument have been given before explaining the principle of operation in order to indicate the convenience of the combination for rapid tests.

The valve voltmeter switch must be set to AC for capacitance tests and to DC for resistance tests. The switch S2 on the valve voltmeter should be set to "INF" and the range switch to 1 volt. Having set the selector switch S on the adaptor to the appropriate range, and switch S_0 to C or R as required, the C or R test terminals are short-circuited by means of the appropriate key K1 or K2, and the adaptor potentiometer P is set to give full-scale reading on the valve voltmeter. This corresponds to zero for resistance tests and infinity for capacitance tests, so the instrument cannot be damaged by using the wrong range. In the case of resistance tests, the zero adjustment described must be made every time the range is changed. In the case of capacitance tests, however, once the adjustment has been made for infinity with K2 depressed this adjustment holds good for all ranges of C.

In explaining the circuit arrangement it will be convenient to start with the resistance test, which is similar in principle—except for minor modifications—to that used in many ohm-meters. In Fig. 3(a), if R_1 is a potentiometer resistance, V a test voltage and R_2 a resistance under test; then if R_2 is short-circuited the voltage across the portion r of the potentiometer will be

$$v = \frac{r}{R_1} \times V$$

Let v be adjusted by means of the potentiometer to give a reading of 1 volt (i.e. full-scale) on the valve voltmeter. If, then,

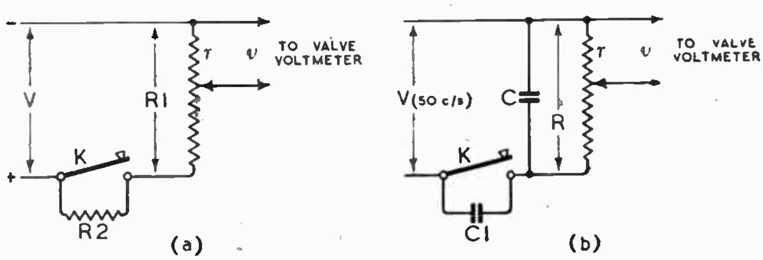


Fig. 3.—Basic circuits (a) for resistance and (b) for capacitance measurement.

R_2 be inserted in the circuit, the voltmeter reading will fall to, say, v_1.

$$\text{Now } v_1 = \frac{r}{R_1 + R_2} \times V$$

$$\text{and } \frac{v_1}{v} = \frac{rV}{R_1 + R_2} \div \frac{rV}{R_1}$$

$$= \frac{R_1}{R_1 + R_2}$$

but $v = 1$

$$\text{therefore } v_1 = \frac{R_1}{R_1 + R_2}$$

This expression, then, gives the instrument reading for any value of R_2 if R_1 is constant. The applied voltage need not be constant so long as it does not alter during the time interval between setting the potentiometer and taking a reading. Clearly, the setting can be quickly checked by pressing the key K2.

The capacitance test is just as simple to perform and not much more trouble to understand. The outline of the circuit is shown in Fig. 3(b). The condenser C might, of course, be omitted, and the scale suitably calibrated for different values of C_1 with R constant. But there are two disadvantages in doing this. First, the scale range for a single value of R would be much more limited; secondly, the reading would be very dependent upon correct frequency. This method has, however, been used for the fourth—very low—range, in order to obtain the necessary sensitivity.

The more satisfactory arrangement, which has been adopted for the three principal ranges, is to make R so large by comparison with the reactance of C that R may be neglected in our calculations; then, if the voltmeter is adjusted to full-scale, i.e. 1 volt, with C_1 short-circuited, the voltage v will be

$$\frac{r}{R} \times V = 1$$

Now with K open and C_1 in circuit, the new voltage applied to the voltmeter will be

$$v_1 = \frac{r}{R} \times \frac{C_1}{C_1 + C} \times V$$

$$\text{and } \frac{v_1}{v} = \frac{rC_1V}{R(C_1 + C)} \div \frac{rV}{R}$$

$$= \frac{C_1}{C_1 + C}$$

but $v = 1$

$$\text{Therefore } v_1 = \frac{C_1}{C_1 + C}$$

This expression gives the reading for any value of C_1 if C is constant.

As already stated, this simple calculation assumes the reactance of C, i.e. $\frac{1}{2\pi fC}$, to be low compared with R, as otherwise the effect of R would considerably modify the conditions, and render a much more tedious calculation necessary. As R must not exceed 2 megohms, the lowest practical value of C is about 0.01 μF, so that this value determines the lowest capacitance range. If the lowest reading is assumed to be 0.01 volt, then

$$0.01 = \frac{C_1}{C_1 + C} = \frac{C_1}{C_1 + 0.01}$$

therefore $C_1 = 0.000101\,\mu F$ and this is the lowest value of capacitance that can be tested in this way. For the three ranges operating on this principle, the values of C are 0.01, 0.1, and 1.0 μF respectively, and the ranges are:—

0.0001 to 0.8 μF
0.001 to 8 μF
and
0.01 to 80 μF

In the fourth range there is no internal capacitor C, and no fixed shunt across the potentiometer, so that when this range is in use the potentiometer resistance is simply in series with the capacitance under test. By similar reasoning to that previously applied, it can be shown that the reading will now be equal to

$$\sqrt{\frac{R^2}{R^2 + \left(\frac{10^{12}}{2\pi f C_1}\right)^2}}$$

Pentode-diode Valve Voltmeter— where C is in micro-microfarads, and the full-scale adjustment is made exactly as before.

For the frequency of 50 c/s, which is used in this case, the expression becomes

$$\sqrt{\frac{R^2}{R^2 + \dfrac{1013 \times 10^{16}}{C1^2}}}$$

The main consideration in the case of the insulation tests is the maximum value of the insulation that can be indicated. This is limited by the maximum value of R, but in this case R is made up of the potentiometer resistance of say 2.25 megohms maximum, and a series resistance. In practice, it is found necessary to shunt the potentiometer in order that the series resistance may have a reasonable value. Suppose we consider it impracticable to make this series resistance more than 50 megohms—and this value can be quite readily made from a few smaller values in series—then, as the voltage across the potentiometer for full-scale must be about 2 volts and the test voltage is 250 volts, the total resistance across the potentiometer terminals will be

$$\frac{2}{250-2} \times 50 = 0.403 \text{ megohms.}$$

Taking the potentiometer resistance to be 2.25 megohms, the shunt required will be

$$\frac{2.25 \times .403}{2.25 - .403} = 0.49 \text{ megohms approx.)}$$

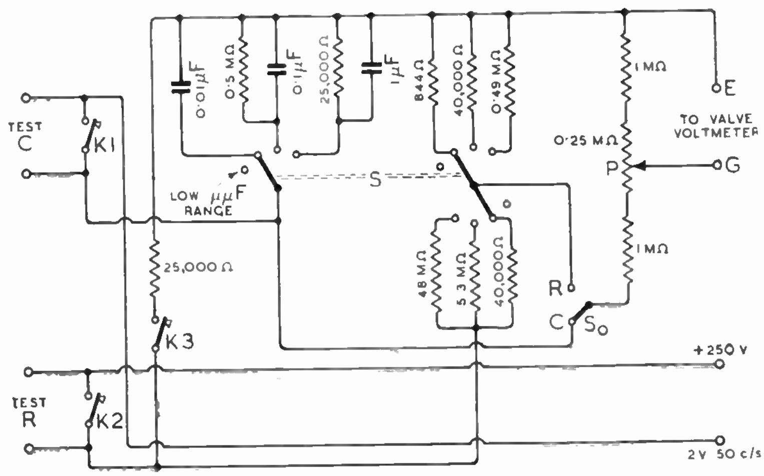


Fig. 4.—Complete circuit diagram. Component values are those used in the author's instrument.

The best procedure is to determine in this way the most suitable values of shunt and series resistance for the ranges required and then to insert the nearest obtainable values. The exact values of the resistors used may then be measured and the scale indications calculated therefrom.

The complete circuit diagram of Fig. 4 shows the actual values used in the writer's instrument. It will be seen from this diagram that the potentiometer resistance which enters into the foregoing calculations is made up of two fixed resistors of 1 megohm each and one 0.25 megohm resistor having an adjustable contact—an ordinary "volume control." The total "potentiometer" resistance is thus 2.25 megohms. This is shunted as shown, according to the range in use.

In the case of the condensers it is better to make up the three values required, of 0.01, 0.1, and 1.0μF respectively, by obtaining the nearest one of each size, but slightly low in value, and then adding small values until the correct capacitance is obtained, the test being made by means of a capacitance bridge. This suggestion is intended for those who do not wish to go to the expense of condensers guaranteed within close limits. If there is no access to a capacitance bridge, comparison may be made with known resistances in the following manner, using a 50 c/s supply:

Connect the capacitance to be measured in series with a resistance of approximately the same ohmic value as the capacitive reactance, i.e. make $R = \frac{10^6}{2\pi f C}$ (approx.) where C is in microfarads and $f = 50$. A 3000 ohm resistance, for instance, will serve in the case of a 1μF condenser. Connect the valve voltmeter across the resistance and apply about 1.5 volts at 50 c/s to the series circuit (see Fig. 5). Note the voltmeter reading. Now replace C with a variable resistance R1 and adjust R1 until the same reading is obtained as before. The total impedance must then be the same as before, i.e.

$$R + R1 = \sqrt{\frac{1}{(2\pi f C)^2} + R^2}$$

where C is in farads and f in cycles per second.

From which

$$C(\mu F) = \sqrt{\frac{1}{(2\pi f)^2 (R_1^2 + 2RR1)}} \times 10^6$$

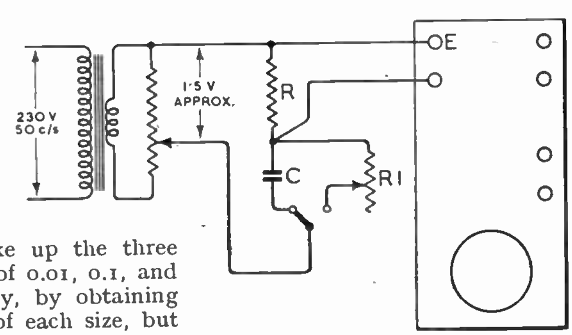
or where $f = 50$ c/s

$$C = \frac{3183}{\sqrt{R1\,(R1 + 2R)}} \text{ microfarads.}$$

The accuracy of the foregoing method depends upon correct frequency and accurate resistance measurement. It is more reliable than one depending upon voltage and current measurement in addition to accurate frequency. The accuracy of the voltmeter does not affect the result, as it is only used to show equality of two readings.

If the 1μF condenser is checked

Fig. 5.—Method of checking values of standard condensers.



in this way, then the $0.1\mu F$ may be checked by means of a simple 10/1 bridge and buzzer, set up specially for the purpose, and using the $1\mu F$ as standard. Similarly, with the same 10/1 bridge, the $0.01\mu F$ condenser may be checked by comparison with the $0.1\mu F$.

When testing the insulation resistance of condensers, particularly the larger ones, the time taken to charge through a series resistance of several megohms, before taking a reading, would be excessive. To obviate this a key K3 is provided, which, when depressed, allows the condenser to charge up to the test voltage through a 25,000 ohm resistance. The insulation reading is then taken with K3 open.

It is important that there should be no leakage over the surface of the panel from HT + to anything else, such as another terminal which would affect the grid voltage. One way of ensuring this would be to use a metal panel and bush all terminals. In the writer's instrument a plywood panel, faced with $\frac{1}{32}$in. ebonite, has been used. Metal foil is interposed between the ebonite and the wood, and the ebonite is cut into sections, as shown by the dotted lines in Fig. 1. The metal foil and switch bodies are earthed. Any surface leakage is thus taken to earth without affecting the reading.

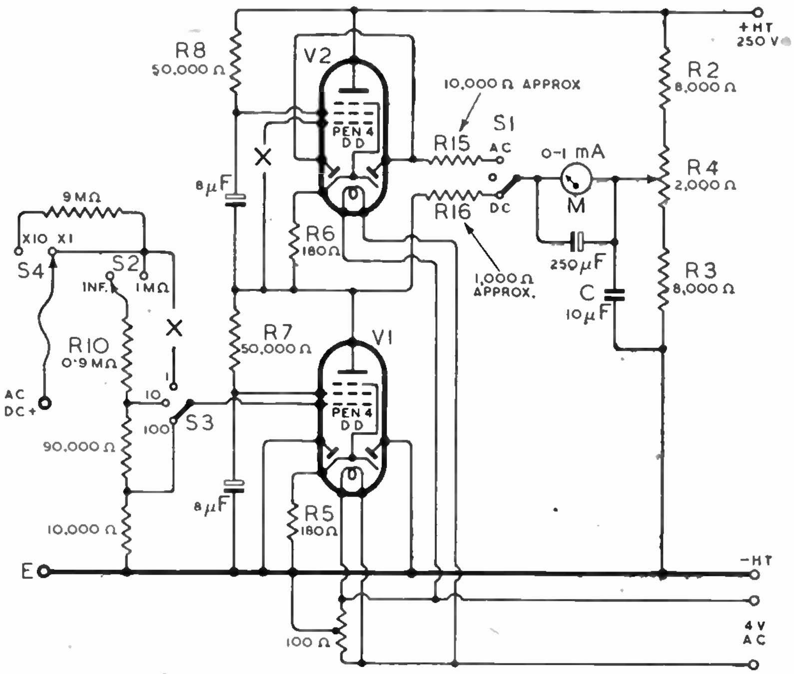


Fig. 6.—Revised circuit of pentode-diode valve voltmeter incorporating improvements described in the text.

It will be noticed in Fig. 4 that the 0.1 and the $1\mu F$ condensers are provided with shunt resistors. These resistors serve the purpose of " leaks " to prevent the accumulation of charges which would be dissipated rather slowly through the potentiometer resistance. The latter is, however, effective for this purpose in the case of the smaller $0.01\mu F$ condenser. These leak resistors are sufficiently high in value to prevent any effect on the instrument reading.

The scales may be conveniently drawn in indian ink on a sheet of bristol board and then glued to an aluminium plate of the shape shown in Fig. 1. The surface may then be treated with a good clear paper varnish and the plate fastened to the panel with very small brass screws. A neat and durable finish is thus obtained.

The accuracy of the readings when using the adaptor, assuming that the capacitance and resistance calibrations have been carried out by calculation as described and not by direct use of variable standards, depends upon the voltage characteristic of the valve voltmeter closely following the scale of the 0-1 milliammeter. The pentode-diode voltmeter was designed to achieve this end so that a special voltage scale would not be required.

Further experience with this instrument has shown that in some cases the values of screen resistor given in the original description (*W.W.* June, 1944, p. 164, Fig. 4) do not quite give a true linear calibration and, although the error would in any case be small, it is usually preferable to increase the value of these resistors, R7 and R8 to about 50,000 ohms. Although the value is not critical it is advisable, after adjusting R15 and R16 to give full-scale reading for 1 volt, to apply 0.5 volt and see that the milliammeter then reads 0.5. If it reads low, increase R7 and R8, readjust R15 and R16, and test again at half-scale. Any readjustment of R7 and R8 will require readjustment of R15 and R16. With the higher values of screen resistor it is advisable to omit the 4000-ohm resistor shown in series with HT +.

Another point is that if the input source under test has a low impedance value, parasitic oscillation may occur. This may be entirely obviated by inserting at X 100-ohm resistors in series with the grid of each of the valves V1 and V2.

OUR COVER

THE air-cooled valves illustrated on the front cover of this issue form part of the equipment of the latest RCA 5-kW transmitter, the 5E. Only one valve is employed in the power amplifier stage, the other being for replacement.

THE WIRELESS INDUSTRY

TECHNICAL details of multi-circuit rotary switches are contained in a new brochure (No. 76) issued by " Diamond H " Switches, Ltd., Gunnersbury Avenue, London, W.4.

A portable gas-fired air heater for the accelerated drying of paint finishes has been developed by Plastic Spray, Ltd., 3, Vere Street, London, W.1.

An illustrated booklet received from Manchester Metal Works, Ltd., 370-374, Bury New Road, Salford, 7, describes the wide range of presswork undertaken.

Improved

CATHODE-RAY CURVE TRACER

Plotting X and Y Axes Simultaneously with Required Curve

By A. H. B. WALKER,
B.Sc. (Hons.), D.I.C., A.C.G.I., A.M.I.E.E.
(Research Department, Westinghouse Brake and Signal Co., Ltd.)

THE very great flexibility of the normal cathode - ray tube is never more fully demonstrated then when it is used to plot the complete dynamic characteristics of some non-linear variable. This application is of very great value in the rapid testing or selection of certain components, where many minutes would be required to take a series of readings and plot a graph by hand. A further valuable feature of the method is that by modification of the applied test waveform the graph may be extended into regions where it would be impossible to make the test in the conventional way, owing to overheating troubles. (For example, the performance of metal rectifiers or valves at very high instantaneous current and voltage loadings.)

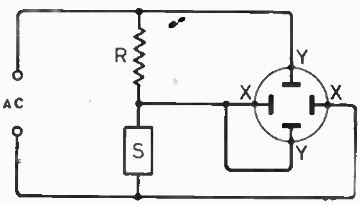


Fig. 1.—Elementary circuit of cathode-ray curve tracer. S represents the specimen under examination.

The most elementary form of curve-tracing circuit is shown in Fig. 1. Here, S represents the unknown variable whose voltage-current characteristic is required to be plotted on the screen, and R is a non-inductive resistance. The voltage drop across R must be at all times proportional to the current in the circuit, and since this voltage drop is applied across the Y plates, it follows that the vertical displacement of the spot must be at all times proportional to the current in S. Since S is directly connected across the X plates, the horizontal deflection must be proportional to the voltage across S. The horizontal and vertical displacements of the spot are therefore always proportional to the voltage and current in S, and this is merely another way of saying that the voltage-current characteristic of S is plotted on the screen. Here it is important to note that this is true for any waveform of voltage applied to the circuit. If S is suspected of having a characteristic which is dependent upon frequency, it is therefore an easy matter to vary the frequency of the applied voltage and observe whether the plotted characteristic changes.

Phase Shift

Normally this simple circuit is very limited in its application, as the voltages which are developed must be suitable for direct connection to the plates, and R must be commensurate with S to obtain a reasonable diagram. It is usual, therefore, to interpose amplifiers between the test circuit and the tube so that R may be made small, and also in order that measurements may be performed at low voltages. The design of such amplifiers is by no means as simple as might be expected, as it is clear that any phase-shift introduced in the amplifiers would appear as distortion in the display.

Unless such phase-shift is completely eliminated at the working frequency, the result will be very nearly meaningless, as parts of the diagram which should appear as lines will open out into loops, and the test sample may be suspected of a hysteresis effect which is not actually present. It is normally convenient to work at a cyclic frequency of 50 c/s when tracing valve or rectifier characteristics, etc., as the test voltage is then easily obtainable from the supply mains, and the repetition frequency is high enough to avoid flicker. A suitable circuit is shown in Fig. 2, and with the values indicated, the time constants are suitable for working at a frequency of 50 c/s. With this arrangement R is chosen according to the characteristics of S, and the applied AC voltage is varied by means of the supply potentiometer, R7 and R8 are then adjusted to give the required size and proportions to the plotted characteristic.

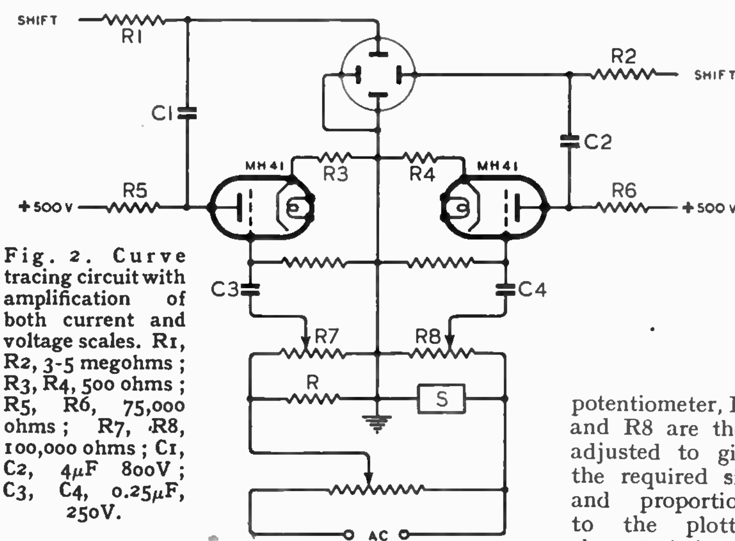


Fig. 2. Curve tracing circuit with amplification of both current and voltage scales. R1, R2, 3-5 megohms; R3, R4, 500 ohms; R5, R6, 75,000 ohms; R7, R8, 100,000 ohms; C1, C2, 4μF 800V; C3, C4, 0.25μF, 250V.

One serious disadvantage, however, remains, and this is that the graph plotted on the screen is not in fact plotted on graph paper, but on plain paper, and a curve of this nature is of very limited use. The normal way in which the "graph paper" is supplied is in the form of a ruled celluloid scale which is mounted directly in front of the screen. The trouble then arises that the "graph" and the "graph paper" are not rigidly connected, so that variations in the shift circuit, or variations of X and Y gain which may be necessary, always move the origin of the graph. The obvious place for the graph paper, or at least the X and Y axes which define the origin of the graph, is on the screen itself. A very simple way of achieving this desirable result is shown in Fig. 3, the only additional components required being a normal vibrator unit of the type generally employed in battery-driven high-tension supply units, and three resistances.

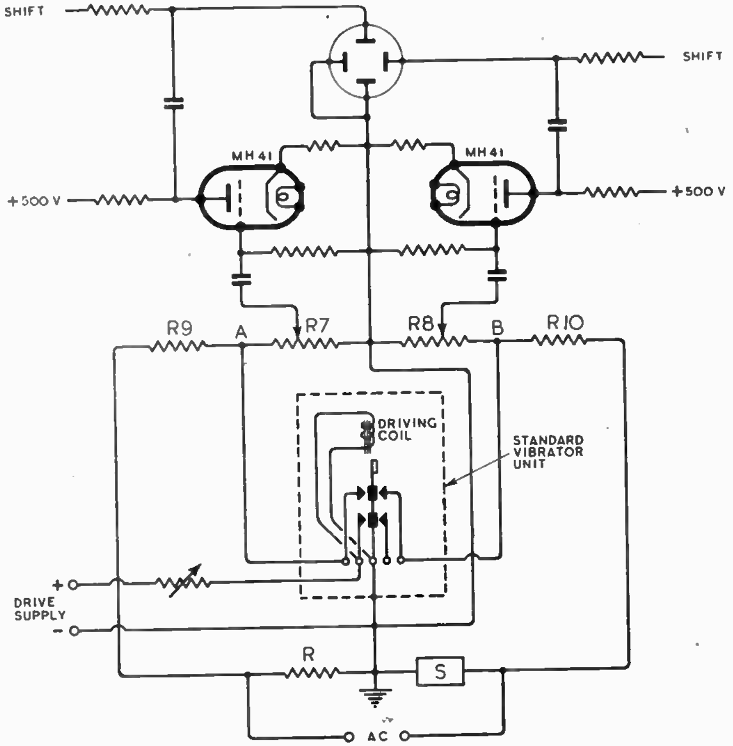


Fig. 3. The addition of a standard vibrator unit to the curve-tracing circuit of Fig. 2 enables both axes to be plotted on the screen simultaneously with the characteristic curve of S. R9, R10, 20,000 ohms, other values as Fig. 2.

The vibrator is driven by energising the coil from a low voltage source of DC in series with a resistance. In Fig. 3, the coil is short-circuited at each swing to the left, thus releasing the reed, the current through the contacts being limited by the resistance. The reed itself is earthed and the two upper contacts only are used to switch the measuring circuit. As the reed swings from side to side, the points A and B will be earthed in turn, and thus the Y and X amplifiers will be alternately paralysed.

Tracing Sequence

The result is shown in Fig. 4, in which the curve represents the path which would be traced out by the spot with the vibrator inoperative. Assuming the spot to start moving from the origin, let point A be earthed by the reed, the Y (or current) amplifier will give zero output, but the amplifier will continue to move the spot to the right, so that the spot will move along the X or voltage axis. The reed now commences its return swing, and as soon as point A is released, the spot resumes its tracing of the required characteristic, and this continues while the reed is swinging over to B. As soon as B is earthed, the X deflection voltage vanishes, and the spot therefore travels along the Y axis until B opens again, when the cycle is resumed.

It might be thought from this that nothing but a muddled pattern would appear on the screen, but in practice, using a 50 cycle "curve tracing" supply, and a vibrator operating at a frequency of 120 cycles, the spot flies across from one duty to the other so rapidly, relatively to the supply frequency, that the fly-over traces are invisible, while the two axes and the curve appear quite continuous. The fly-over is made as rapid as possible by keeping leads short and reducing stray capacitances to a minimum. The relative brilliance of the axes and the curve can easily be varied by changing the drive conditions of the vibrator. For instance, if the vibrator is overdriven, the time of dwell on each side becomes long compared with the fly-over time, so that both axes become brilliant and the curve faint, or even dotted. The opposite result is easily achieved by underdriving and bending out the side contacts slightly so that the time of dwell on either side is short compared to the fly-over time. The curve then appears brilliant, and the two axes faint or dotted. The best adjustment in general is that which gives equal brilliancy on both axes and curve, particularly if photography is contemplated.

One very pleasing feature of the system is that the axes are always drawn just long enough for the

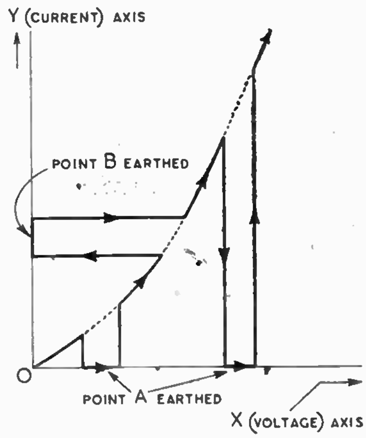


Fig. 4.—Path of spot when tracing out characteristic and axis simultaneously. The missing sections of the axes and the curve are filled in in successive traces. The 'fly-overs' are invisible.

curve being examined. If, for example, R7 and R8 are changed to alter the shape of the curve,

Improved Cathode Ray Curve Tracer—then the axes expand and contract as necessary to accommodate the curve. Calibration remains set if R7 and R8 are not changed, and is easily checked by connecting known values of resistance in place of S. The "characteristic curve" of these resistances is of course a straight line through the origin, and the measurement of the angle between this line and either axis will check the calibration, and also prove that phase shift is absent. The results are clean and satisfactory, as may be seen from Fig. 5, which shows characteristic curves of some typical crystal detectors plotted with the axes by this method.

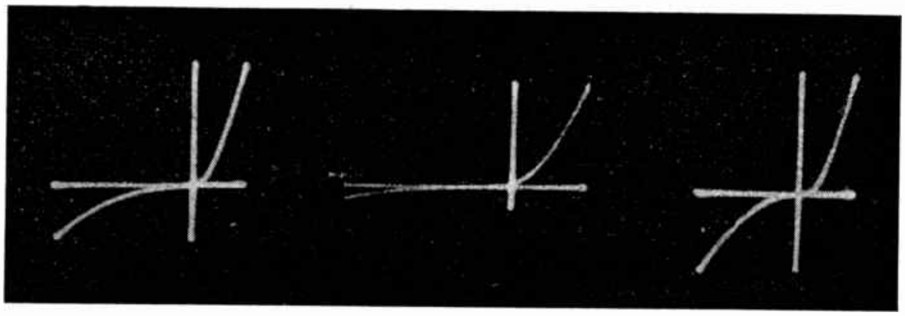


Fig. 5. Photographs of typical curves plotted simultaneously with the X and Y axes on the screen. Note that whatever the proportions of the curve, the two axes are automatically drawn just long enough to accomodate it.

In conclusion it is hoped that this simple addition to known curve-tracing technique (since it can be so readily extended to similar circuits which are used for tracing B-H curves, valve characteristics, etc.), will prove helpful to others, who when confronted with a curve on the screen have difficulty in locating the origin.

Letters to the Editor

QA and Cathode Follower . Resistor Colour Code . "Doctored" Reproduction

Cathode Follower Output

MY letter in your July issue on the modification of the *Wireless World* Quality Amplifier to take advantage of the low impedance presented to the load by a cathode follower type of output stage has resulted in several queries, most of which are concerned with the penultimate stage.

It was first intended to use impedance coupling in the anodes of the original MHL4s, but it is impossible to obtain full drive for the PX4s without over-rating the previous stage. This scheme was then dismissed and the following possibilities were considered:—

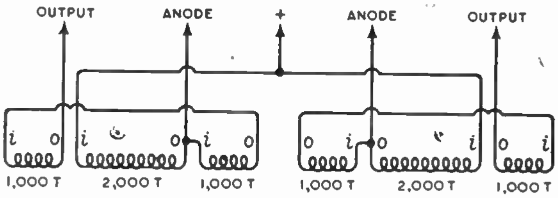
(i) A cathode-coupled high-ratio transformer stage used as suggested by D. Baker in the May issue of *Wireless World*.

(ii) A normal push-pull transformer stage with separated primary and secondary windings.

(iii) An auto transformer stage such as was finally adopted.

The first of these projects was abandoned because it seems to have little that is superior to an anode coupled stage except when damping of the load is important. Here it is not. Moreover, the stage will be less sensitive than the normal type because of the loss of valve gain.

The third scheme was developed in favour of the second for two main reasons. First, the leakage reactance in an auto-wound transformer should be less important than for the equivalent double-wound type, and, secondly, the permissible space factor in the winding space could be less. The second fact is well known and would allow better interleaving of the sections. The observation on leakage reactance can be explained as follows. If the leakage reactance is such that there is, in effect, no coupling between the anode-to-anode winding and the other winding, then in a double-wound unit the attenuation will be infinite, whereas in an auto-wound unit it will correspond with the difference between impedance coupling and auto-transformer coupling; in fact, neglecting any stray or other capacities, and assuming the output impedance very large, the maximum possible loss with a 1 : 2 ratio as has been adopted would be 6 decibels. The neglected quantities are important but apply also to the double winding, so the benefits of auto-winding still survive.



Sectionalising of 200H choke.

The choke was designed for 200H at zero DC, was wound on an old mains transformer core of overall area 1½ sq. in., carried a total of 8,000 turns of No. 36 SWG enamelled wire, had a resistance of 1,000 ohms, and used a butt-jointed core to allow for any out-of-balance plate current. Any assembly of the approximate proportions given above will serve admirably and the inductance can be considerably less than 200H before any marked bass attenuation results. The present interleaving is possibly inadequate and the arrangement as shown in the accompanying diagram would probably be satisfactory.

Transformer drive, incorporating phase splitting, could be used in place of the tapped choke and a transformer of the Ferranti AF5C type could be driven from a medium-impedance triode, preferably by parallel feeding. This involves alteration of the stage prior to the MHL4 one and the transformer would have to handle a 70-volt input without distortion. With ML4s and the auto-transformer nothing need be altered earlier in the circuit than the anode connections to the ML4s, provided the loss of gain is not excessive.

The PX4s still operate into the original load of 8,000 ohms, but this is primarily because it is inconvenient to change it. Power output is ample and there is no perceptible distortion at normal output levels on the loudest peaks. The load might be reduced to about 4,000 ohms, but a high load gives better damping and smaller anode current swing; otherwise the matching is not critical.

The figure of 20 given for the damping factor of the cathode coupled stage is based on a recommendation* that the ratio of the load impedance to the output plate resistance might be termed the "damping factor" of the stage for want of a better definition. It is a very useful quantity for comparing output stages but completely ignores the behaviour of the load. For example, a loudspeaker matched to the cathode-coupled PX4s to give a load of 8,000 ohms would normally present 60 per cent. of that load in the form of DC voice coil resistance; that is, about 5,300 ohms. The additional 200 ohms internal resistance of the output stage is almost negligible. Even with anode-coupled PX4s the plate resistance of 1,600 ohms is a minor part of the whole resistance that decides the degree of damping possible. Two comments seem necessary. First, this so-called "damping factor" is only accurate when the load is entirely dynamic in character, but serves as a comparative term for output stages provided its limits are understood. Secondly, any further reduction in output impedance in an amplifier for driving a loudspeaker is useless until a very marked increase in loudspeaker efficiency becomes possible.

As a last note, the two filament windings of the transformer that supplies the PX4s must be well insulated and should have low capacities between themselves and with respect to earth to avoid loss of high audio frequencies. Marked attenuation in the present amplifier at about 9,000 c/s is attributed either to this or to inadequate interleaving of the driving choke. A. C. ROBB.

Liverpool.

* "Radio Designers' Handbook": Langford Smith: Chap. 2 Sec. (5).

Magnetic Recording

THE lucid article by G. L. Ashman on magnetic recording, in the August issue, is a useful contribution to the scanty literature published in this country on the subject. While recognising it was intended to be only a limited exposition, certain other information could have been included with advantage.

For example, no mention of typical wire or tape velocities is made. These speeds vary from, say, 80ft. per min. with certain perpendicular methods of tape magnetisation, to 360ft. to 600ft. per min. in wire recording, although the 0.004in. wire in the General Electric Model 50 recorder travels at only 174ft. per min., giving 66 min. speech, and approximately 295ft. per min. in the Marconi-Stille tape recorder, as used by the B.B.C.

Secondly, although mention is made of perpendicular and longitudinal magnetisation, cross or transverse magnetisation (in which the magnetisation is in a direction perpendicular to an edge and parallel to the surface of the tape) is not noted. Thirdly, as well as feeding the "erasing" or "wash-out" head with steady DC to magnetise the tape to saturation point, thus removing any previous recording, this eliminating effect is often performed by applying a relatively high-frequency current of, say, 7,000 c/s in some recorders (using a high-stop filter in playback) to 30,000 c/s in the G.E. Model 50, from a valve oscillator.

Fourthly, a few facts on the life of magnetic recordings would have been of interest. It is reported that recordings on "iron wire" made in the early 1900s are still playable, and, with special tungsten-steel alloys to-day, a 2 db. loss in reproduced level occurs after about 5,000 playbacks, and even after 160,000 playbacks the volume level drops only 4 to 6 db.

Lastly, to supplement the excellent list of references appended to Mr. Ashman's article, may I offer the following references, chiefly concerned with interesting practical designs?

1. D. W. Pugsley, "Fundamentals of Magnetic Recording," *Q.S.T.*, May, 1944.
2. T. J. Malloy, "A Magnetic Recorder," *Electronics*, January, 1938.
3. "Wire Recorder," *English Mechanics*, April 5th, 1940.
4. R. L. Mansi, "Construction of Apparatus for Recording Sound on Steel Wire," *Electronics and Television and S.W. World*, January, February, March, 1940.
5. D. W. Aldous, "Recording on Steel Tape," *Wireless World*, June 29th, 1939.

DONALD W. ALDOUS.

Torquay, Devon.

Resistor Colour Code

MAY I support W. Bowen's suggestion in the August *Wireless World* on Standardisation of Resistors? But I fear no argument, however convincing, will have any effect on any standardising body once they have publicly proposed a definite arrangement as a "standard."

If there is even a faint hope of its adoption, I suggest that it is time to alter the existing "body-tip-dot" convention. Whether one is a service-man trying to trace a circuit for which the manufacturer has omitted to paste a diagram of connections inside the cabinet, or an experimenter looking in a box of assorted resistors for something that will do for, say, a grid-leak, what one *first* wants to know is the range of the resistor; i.e., if it is between 1,000 and 10,000 ohms, or between 100,000 ohms and a megohm—information only to be obtained from the colour of the "dot," often invisible in the receiver or apparatus, even with the aid of a dentist's mirror. Only of secondary importance is the first figure, now the "body" colour; and with the existing wide tolerance a knowledge of the reputed

Letters to the Editor—

second figure (now "tip") is normally useless.

Suppose that instead of reading the colour-code in the order "body-tip-dot" as at present, the order were "tip-dot-body," i.e., tip=first figure, dot=second figure, body=number of zeros.

It would be much easier to trace an unknown circuit; the body-colour strikes the eye immediately; and we can be almost certain that a green body is a grid-leak, an orange body an anode load, a brown body a self-bias resistor, and so on.

Having noticed a green body we suspect a grid-leak, and the tip—always visible in the wiring but less obtrusive than the body—being, say, red, tells us that it is 2MΩ (or possibly 2.7 nominal). If we have a resistor of small tolerance it *may* be worth looking to see if it has a dot; for many purposes it does not matter.

C. R. COSENS.

Cambridge University Engineering Laboratory.

"Aesthetics of Sound Reproduction"

IN the second paragraph of his article in the July *Wireless World* H. A. Hartley states that he is "no longer an exponent of plain, unadulterated high-fidelity reproduction." May I express the opinion that he has not so much altered his views as widened his definition of high-fidelity reproduction to incorporate the fact that the reproduction system includes *all* the steps from the instruments to the listener's ear. All measures taken under the headings "Doctoring" or "Electrical Synthesis" are, I believe, not so much attempts at the artistic side of music-making as rather brutal efforts to correct for faults in the system which, at the moment, one cannot correct otherwise.

Mr. Hartley explains, in an admirable manner, why a distortionless and wide-band amplifier is not the sole requirement of high-fidelity reproduction and that the microphones, pick-ups, loudspeakers, cabinets and listening-room acoustics are all part of the system. When we have failed to improve some part of the mechanical system any more, we may still do much towards high-fidelity reproduction by electrical means in the amplifier; e.g., by neutralising the speaker resonance with a dip in the frequency-response curve. We are not synthesising a new kind of music, but bringing the system, as a whole, nearer to true high-fidelity.

Similarly, the full band-width of the amplifier will not necessarily give the best reproduction if there are imperfections in other parts of the apparatus. Suppose the pick-up produces a scratch, then above some frequency the scratch will be greater than the programme level and we find it more tolerable to cut out these high frequencies altogether rather than put up with the addition of an objectionable noise. But here again we are not synthesising a better kind of music so much as ensuring that what went into the microphone comes out of the speaker with a minimum of interference and without the addition of intolerable noises. If we had a perfect reproduction system throughout, then there would be no question of cutting the top or using any other dodges, but since some of the major components of our reproduction system are so bad, the best we can do is to try to neutralise those faults in the easiest way, which nearly always happens to be in the amplifier itself.

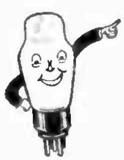
Some degree of correction will probably always be necessary, if only for the listening-room acoustics, but I do emphasise that we must not try to build anything new from a programme; we must ensure that studio sounds are reproduced as accurately as possible in the listener's ear. Should any other balance of sound be more pleasing to the ear than the original orchestra, I feel that the instruments would have been designed by the musicians through the ages to give this improved balance. There does not seem to be much dissension amongst the musicians about which sounds are musical and can be combined in musical works when listening to the original instruments, and I believe that there will be the same sort of agreement amongst them when listening to high-fidelity reproduction sounds.

Mr. Hartley writes on the æsthetics of sound reproduction as a competent authority, but I do deprecate any arguments which seek to justify distortion of any kind. V. W. GREENHOUGH.

Derby.

H. L. KIRKE, the new chairman of the I.E.E. Radio Section, joined the B.B.C. in 1924 and in the following year was appointed to his present position as head of the Research Department. For a few years prior to his B.B.C. appointment he was in Marconi's Wireless Telegraph Co.

Angles on BRIMAR PRESTIGE



It's not unusual to find that fitting Brimar Valves gives an added "punch" to radio reception. This is because they work to very close limits given with unfailing reliability.

BRIMAR
BVA
VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP. KENT.

PENTODES AS DYNATRONS

Summary of the Negative Resistance Characteristics of Various Commercial Pentodes

By G. A. HAY, B.Sc., Assoc.Brit.I.R.E.

RECENT work on the transitron oscillator has diverted attention somewhat from the use of the dynatron, both as a source of signals and as a measuring instrument at audio and low radio frequencies. The working of both oscillators depends on the connection of a negative resistance, produced by the valve, in parallel with the positive dynamic resistance of a tuned circuit. The latter is thereby neutralised, and in the absence of effective circuit resistance oscillations are produced.

The simple theory of the dynatron has been adequately dealt with elsewhere;[1] it is sufficient to say here that its operation depends on secondary emission from the anode of a tetrode, and is therefore considered to be not so stable as the transitron, which does not depend on secondary emission. The production of secondary electrons is so liable to be affected by the surface conditions of the emitting electrode that the stability of the arrangement suffers.

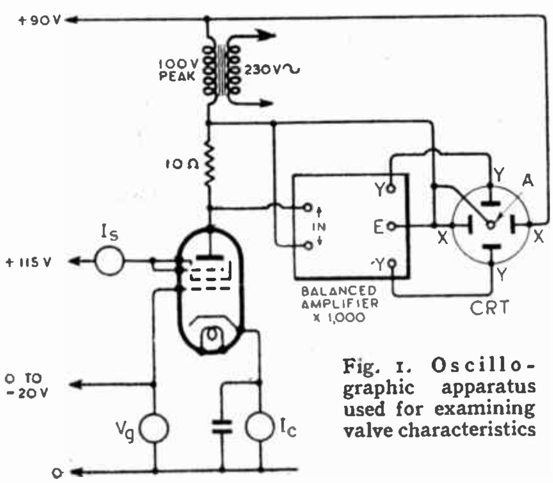


Fig. 1. Oscillographic apparatus used for examining valve characteristics

On the other hand, the negative resistance produced by the dynatron is wholly independent of coupling circuits between two electrodes (c.f. the transitron), and is also easily controllable by varying the control grid bias. It is therefore invaluable for measurement purposes,[2] particularly where comparisons are wanted between two quantities, and when adjusted correctly its waveform is practically sinusoidal. Moreover, it is the writer's experience that the unreliability of the dynatron as a signal source is very much overrated; it is also thought good enough for incorporation in a well known precision beat-frequency oscillator and heterodyne wavemeter. Like other valves of orthodox construction, its working is materially affected by transit time and other related effects; it can, however, be relied on up to about 10 or 15 Mc/s, depending on the valve chosen and its associated voltages and circuits.

It is generally recognised that the best all-round dynatron oscillator is the Mazda AC/S2 screened tetrode, while for special purposes where low anode-earth capacitance is wanted the Mullard S4VA is useful. Both valves are now relatively inaccessible, and in this article will be shown how modern RF pentodes may be used in their stead; the optimum working conditions for various applications will also be discussed.

In the RF pentode, which is, of course, a development of the screened tetrode, the harmful effects of secondary emission are eliminated by interposing between screen and anode a suppressor grid, which is earthed and has the effect of producing a region of low potential which the slow moving secondary electrons cannot penetrate. These, therefore, return to the anode; the primary electrons are not appreciably affected as they have considerable kinetic energy due to the high screen voltage. If now the suppressor grid is disconnected from earth and given the same order of potential as the screen, the two grids can be treated as one for all cases where transit time is negligible, and the characteristics

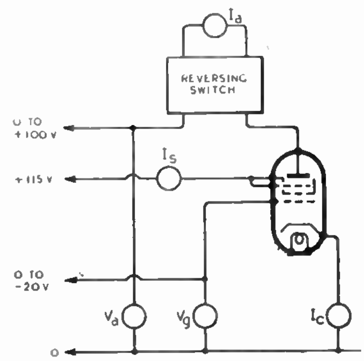


Fig. 2. Circuit used for measurement of valve characteristics.

obtained will be those of a tetrode.

Generally speaking, the best valve for dynatron purposes will be that which gives the numerically lowest negative resistance, as this will then neutralise a low value of positive dynamic resistance, corresponding to a poor tuned circuit. Given a satisfactory valve in this respect, preference must then be given to the valve which shows a long, straight negative resistance curve, as this will give an output of high amplitude and good waveform. Accordingly, several pentodes used as described above were examined and compared with the Mazda AC/S2. The V_a–I_a curve was traced on a cathode-ray tube using the apparatus outlined in Fig. 1. This method was used as it enabled a quick and convenient selection to be made. Of all the valves examined, the following

[1] M. G. Scroggie: "Applications of the Dynatron," *Wireless Engineer*, Vol. X, p. 527, 1933.

[2] M. G. Scroggie: "Radio Laboratory Handbook."

were found useless as dynatrons: Brimar 6K7G, 7B5E, Mullard EF36, EF38, EF39, VP4A, VP4B, Osram MSP4; while promising results were obtained from Brimar

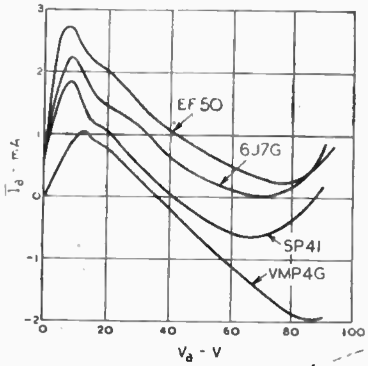


Fig. 3. Characteristics of pentodes: $V_s = 115$V; $I_c = 5$mA.

Valve	$-R_a$ (ohms)
EF50	28,000
6J7G	29,000
SP41	26,000
VMP4G	21,000
AC/S2	29,000

Table 1: Values of R_a calculated from Fig. 3 at $V_a = 35$ V.

6J7G, Mullard EF50, Mazda SP41, Osram VMP4G. The latter group were then investigated by the point-to-point method, using the circuit shown in Fig. 2. It was soon found that the outstanding valve in this class was the Osram VMP4G, and this was made the subject of more detailed tests later. It has the additional advantage of having a top-cap anode, and compares in characteristics very favourably with the AC/S2, the shape of the curve being very similar.

For a fair comparison between different valves, it was necessary to decide on some standard conditions. The cathode current I_c was finally taken as the critical factor, as it will be shown later that the negative conductance $1/R_a$ is directly proportional to I_c, and almost independent of the screen voltage V_s. In Fig. 3 are shown the negative resistance characteristics of the four valves 6J7G, EF50, SP41 and VMP4G, at a cathode current of 5 mA, and screen voltage of 115 V. The calculated values of R_a at an anode voltage of 35 V. are shown in Table 1, together with the value for an average AC/S2. It will be seen that the first three are similar in that they show numerous bends and have a relatively short negative resistance region: whereas the VMP4G suffers from neither of these defects. The choice of a valve will depend on the particular purpose for which it is required. If the valve is wanted for negative resistance measurements where the grid bias is to be measured accurately, the VMP4G is ideal, as it has a long grid base, and adjustment of bias will be easy. On the other hand, if an oscillator is required as a signal source with automatic amplitude control, a short grid base is wanted so that the control exercised will be more critical.

The VMP4G has one rather important disadvantage. It has been stated above that the negative conductance is approximately proportional to cathode current, and so for bad tuned circuits a high cathode current is wanted. This current divides into two, part returning via the screen, and part via the anode, so that $I_c = I_s + I_a$. Now if I_a is sometimes zero or negative, as in the VMP4G, then I_s will be equal

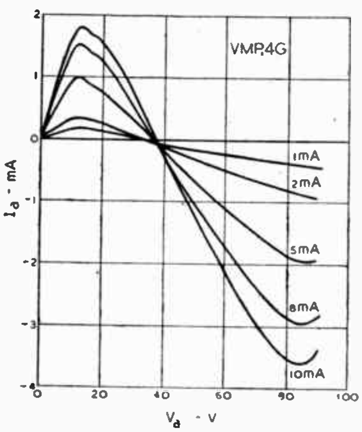


Fig. 4. Characteristics of VMP4G at various cathode currents: $V_s = 115$V.

I_c (mA)	$-R_a$ (ohms)
1	125,000
2	53,000
5	21,000
8	13,300
10	10,500

Table 2: Values of R_a for the VMP4G calculated from Fig. 4 at $V_a = 35$ V.

to or greater than I_c. The limit to the negative resistance attainable is thus set by the power dissipating properties of the screen. This, of course, is also an argument against an excessively high screen voltage (see later). On the other hand, if I_a is always positive, then I_s will be less than I_c, and the latter can be increased to a greater value than before without fear of overheating the screen wires. (It is assumed that the maximum dissipation permissible at the anode is far in excess of that at the screen.) For

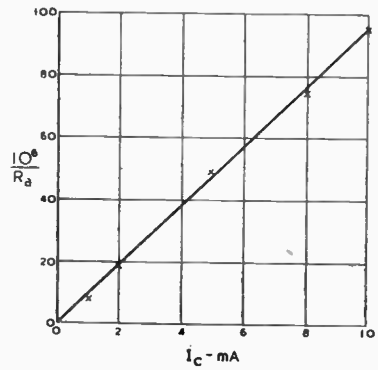


Fig. 5. Relation between R_a and I_c from Fig. 4.

this reason the EF50 or SP41 might be considered as alternatives to the VMP4G where straightness and length of characteristic are not important.

In Fig. 4 are shown characteristics of the VMP4G at cathode currents of 1, 2, 5, 8 and 10 mA. From this the corresponding values of R_a were calculated for $V_a = 35$V: these are shown in Table 2. In Fig. 5, $10^6/R_a$ is shown plotted against I_c, and the proportionality is quite apparent. So we may conclude that $R_a = k \cdot \frac{1}{I_c}$ where k is a constant, approximately equal to 1.05×10^6 for this particular valve, at $V_s = 115$ V. and $V_a = 35$ V. The makers quote a maximum safe screen and suppressor grid current of 7 mA, but the author has had specimens running continuously with no apparent deterioration on currents of the order of 20 mA. Much depends on the particular specimen selected. Incidentally the variation in "goodness" of different valve specimens is much less than might be expected. Out of ten valves selected at random from a stock, four showed characteristics similar to those shown, one was slightly worse, three very much better, and only two definitely were useless for this particular application.

The variation of negative resistance with screen voltage V_s was then investigated. It is generally believed that the negative resistance decreases with increasing screen voltage. This is true only when V_s is comparable with V_a, i.e. when the secondary electrons are equally attracted by the anode and screen. Under conditions where the secondary electrons are nearly all attracted back to the screen ($V_s > 2.V_a$), the negative resistance is practically independent of screen voltage, *provided the cathode current is kept constant by alteration of grid bias.*

Fig. 6 shows the static characteristics of the VMP4G for various screen voltages, I_c being kept constant at 5 mA. It will be seen that for $V_s > 60$ V. R_a is substantially constant. The only advantage at normal frequencies conferred by a high screen voltage is in the length and straightness of the curve obtained. Although this enables greater amplitudes and powers to be generated, the condition is to be avoided if possible, as with constant screen current the power dissipated is proportional to the screen voltage, and may therefore become dangerously high. It is best to work with a screen voltage of

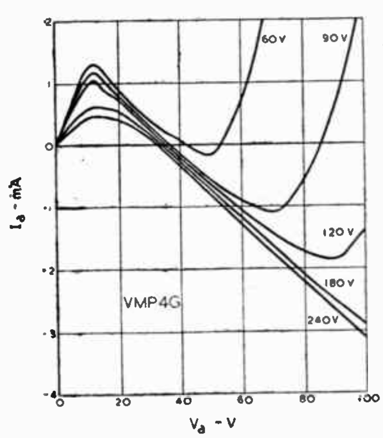


Fig. 6. Characteristics of VMP4G at various screen voltages : I_c = 5mA.

about 120 V. as this is roughly the makers' maximum figure, and it is sufficiently high to ensure that the majority of the secondary electrons are collected by the screen.

The choice of anode voltage to be used in any given case depends mainly on the amplitude required. If V_a' is the voltage at which the upper bend occurs (normally about 10 V.) then the amplitude of oscillation is given approximately by $V_{peak} = V_a - V_a'$, as the oscillation is first limited by the upper bend. For example, if $V_a' = 10$ V. and an amplitude of 20 V. peak is wanted, V_a will be $V_{peak} + V_a' = 30$ V. If oscillation is also limited by the lower bend in the characteristic this relation does not hold. It must also be remembered that a low anode voltage means a high anode current, and hence a smaller screen dissipation for a given cathode current.

Although this investigation is by no means exhaustive, it is hoped that it may serve again to draw attention to the dynatron, particularly for laboratory work, and to point out that excellent results may be obtained with valves which are easily accessible at the present time.

BOOK REVIEW

Porcelain and Other Ceramic Insulating Materials; Vol 1. By E. Rosenthal, Pp. 287. Chapman and Hall, 11, Henrietta Street, London, W.C.2. Price 28s.

THE announcement of a book on ceramic insulating materials in two fairly high-priced volumes by Dr. Ernst Rosenthal gave rise to hopes that we should have an authoritative standard work on the subject, comprehensive, and up to date: and it is a little disappointing to find that Dr. Rosenthal has apparently not aimed so high. He has set out to provide a readable and well-illustrated introduction to the subject for the benefit of engineers, electrical and chemical manufacturers, and users of ceramic materials generally; an excellent aim in its way, but one for which a single modest volume would have been more suitable. However, we must not be ungrateful for what we have. The first volume now before us does give a good general idea of modern methods for the manufacture of ceramics for electrical purposes, including the differences between British, American and Continental practice, the nature of the raw materials as well as the finished products, and the methods for the testing of both.

"Wedging and slapping consists of cutting the body into pieces with a copper wire, throwing these pieces with great force against each other, and finally beating them with a wooden appliance similar to a long-handled hammer having a large flat face at the end. This instrument is called a maul."

This quotation is given because it is curiously representative of both the merits and defects of the book. It is interesting, but not too wel constructed, and leaves you not entirely satisfied that you have really got to the bottom of the matter.

As to construction, a strictly logical order is no doubt unnecessary in a work of this kind, but it is disturbing to the general reader to find an introductory chapter followed immediately by one of two pages only on sparking plugs, with one of twenty-odd pages on raw materials, and another of over a hundred pages on manufacturing methods much later in the volume. The third chapter discusses the influence of glazes on the characteristics of the material.

Once the reader has become resigned to this looseness of construction he is able to appreciate the good points of the work. It bears the stamp of a man who knows the ceramic industry from the inside, and is fully alive to the factors which determine the electrical behaviour of his materials and the means by which these factors are controlled in manufacture. The materials are throughout presented as consisting of minute crystals of one kind or another embedded in a glassy matrix, and the discussions of the formation of this glassy phase and the changes in crystal size and uniformity which may occur on firing are most interesting to any experimenter who has met the differences in electrical and mechanical characteristics ascribed to these changes. The detailed tests of both raw materials and finished products, and the elaborate means of controlling the drying and firing processes show how important is the scientific side of the industry. Nevertheless, there are still so many stages at which it is said that no definite rule can be given, experience is the only guide, that it becomes clear that the manufacture of ceramics is an art not to be acquired by reading books, instructive though they undoubtedly are.

It is at first sight surprising that only 35 pages of a two-volume work should be devoted to high-frequency ceramics, but there is a good and well-illustrated account of those materials and products that have become standard practice, and a brief reference to the newest developments which include a material with a permittivity as high as 1,200.

L. H.

RADIO HEATING EQUIPMENT

V.—Designing a Small Experimental Dielectric Heater

By
L. L. LANGTON,
A.M.I.E.E.

AN outline for Class "C" oscillator design was discussed in Part I of this series (April, 1944, issue), and it is here proposed to consider its application to the design of a small experimental radio heater, capable of heating limited quantities of thermosetting moulding material. This is not a constructional article specifying components to be used and giving detailed layouts, but it seeks to summarise the "raison d'etre" for the selection of component values and circuit arrangement.

The paper design of a power oscillator forms a sound basis upon which to commence construction, but it must be remembered that the final adjustments are governed by measurements taken under working conditions. It is well to limit the endeavour to a small equipment using relatively cheap components, so that the results of "experimental error" are not likely to be financially catastrophic.

The choice of an oscillator valve is of first importance and the Osram DA41 has been selected, owing to its robust nature and the fact that it is no larger than valves with which most readers will have had experience. This valve may be operated with zero bias at full anode voltage without damage occurring due to excessive currents. No precautions need be observed to ensure the safety of the valve should the automatic grid leak bias be removed due to cessation of oscillation.

Cathode Emission

A knowledge of the total emission of which the filament is capable is helpful in commencing paper design. This is not usually given by manufacturers for smaller valves, as tungsten is the only filament material having reasonably stable emission, and its use is restricted to the larger types of transmitting valve. When thoriated tungsten wire is used for the filament, as in the case of the DA41, the conditions existing at the surface of the filament are somewhat variable and the emission consequently erratic. If an oxide coated filament is used, emission stability is even worse, as comparatively turbulent conditions exist on the emitting surface.

A value of total emission for thoriated or oxide coated filaments may usually be computed from such data as is published concerning the valve. The value obtained is much less than the emission of which the filament is capable, for, owing to unstable operation, a considerable safety factor is involved.

In the case of the DA41, the published figure for anode dissipation is 40 watts and the maximum HT voltage 1,000. When the valve is used under Class "C" conditions, with an operating arc of 140 degrees, the ratios of DC and AC valve currents to total emission current are 0.22 and 0.39 respectively. Assuming a grid current of 20 per cent. of the anode current, the ratios for DC and AC anode currents become 0.176 and 0.302. Selecting a reasonable value of E_a min. of 200 volts, the working total emission may be found, as explained in Part I of this series, by equating power output and anode dissipation to power input at the anode.

$$0.176I \times 1000 = 40 + \frac{800 \times 0.302I}{2}$$

$$I = 725 \text{ mA}$$

For this value of total emission the alternating anode current will be $725 \times 0.302 = 220$ mA. The DC anode current will be $725 \times 0.176 = 128$ mA, and the DC grid current $725 \times 0.049 = 32$ mA. The output power is seen to be $\frac{800 \times 0.22}{2} = 88$ watts and the input $1000 \times 128 = 128$ watts, giving a power efficiency of 69 per cent.

The use of two valves may be expected to give an output of about 170 watts and, while push-pull operation is usually to be preferred, there are factors which militate against its use in the present case. The valves employed are normally used for low-frequency power amplification, and the interelectrode capacities are higher than would be found in more expensive valves of equivalent power, specially designed for high-frequency operation.

The comparatively high anode-cathode and grid-cathode interelectrode capacities form a potential divider of relatively low reactance at high frequencies, with the common point at cathode potential. This arrangement forms a Colpitts oscillator, and the position of the grid tap will not be the only factor controlling the amount of feedback in a conventional push-pull circuit. It is also improbable that an indiscriminate pair of valves of the type specified would have sufficiently similar characteristics for satisfactory push-pull operation at high radio frequencies.

Circuit Details

A circuit diagram of the equipment is shown in Fig. 1. Two valves are operated in parallel, and the interelectrode capacities (shown dotted) form the feedback circuit. The RF current flowing in the feedback circuit will not be the total circulating current, as most of this will flow in the "work" circuit, which will be of lower reactance.

Under these conditions, the feedback energy is less than could be obtained with the cathode taken to the common electrode of a split tank condenser and the "Q" of the loaded tank circuit should not be too low, as there would then be insufficient feedback to maintain oscillations. A loaded "Q" figure of 40 will prove satisfactory in the present case.

The optimum anode load is given by $\left(\frac{E_b - E_a\text{min}}{\sqrt{2}}\right)^2 \div P$ and for two DA41's in parallel = 1,870 ohms. This load value, divided by the working "Q" figure, will indicate the optimum value of inductive reactance in the tank circuit. This will be 46.8 ohms and, at an operating frequency of 30 Mc/s, the required tank inductance is

$$\frac{46.8}{18.9 \times 10^7} = 0.25\mu\text{H. (approx.)}$$

"Work" is contained between electrodes which are connected across an extension of the tank coil. The extended coil will, with the "work" capacity, largely determine the frequency of operation and its inductance to cover a reasonable range of "work" should be 1μH. When centre-tapped as in Fig. 1 the inductance included in the anode circuit will be 0.25μH, since the inductance varies as the square of the turns.

Coil Design

The optimum shape for a coil to give the highest "Q" is obtained when the ratio of length to diameter is about 0.8. This would, for our present case, give a coil of large diameter and about two turns, and such an arrangement would be awkward in making the adjustments which will be later described.

Taking a length to diameter ratio of 3, the inductance of a coil is given closely by the expression $L = 0.007.N^2.D$, where N is the number of turns and D the mean diameter of the coil in inches. With copper tube of 3/16in. outside diameter (having a wall gauge of 18 SWG) wound on a $1\frac{1}{4}$in. former, the mean diameter of the coil would be $1\frac{7}{16}$in. and, for an inductance of 1μH,

$$\sqrt{\frac{1}{0.007 \times 1.437}} = 10 \text{ turns are}$$

required. Tubing of this thickness wound on to a $1\frac{1}{4}$in. former, should be annealed immediately prior to winding, to obviate the risk of the tube collapsing.

For a frequency of 30 Mc/s, the LC multiple is approximately 28μH . μμF, so that stray and "work" capacities together should amount to 28μμF. The frequency of operation will be modified should such capacities be different from this figure, and the possession of an absorption wavemeter, covering the range 25–50 Mc/s, is advantageous in carrying out adjustments.

An expression for the value of grid bias voltage for Class "C" operation was given in Part I of this series. When applied to the case of the DA41, having values of $E_a$min. and E_g max. of 200 and 150 respectively and an operating arc of 140 degrees, the required bias is 90 volts and, for a grid current of 64mA, the bias resistor is 1,400 ohms. A fixed resistor of this value should be used in series with a variable resistor of equal or greater value as a protective measure, mentioned later. No grid condenser is wired directly in parallel with the grid resistor, as the coupling condenser between the tank coil and grid serves the purpose of maintaining the DC potential of the grid, and its reactance is of a suitable value.

"Work" electrodes can be copper discs of about 3in. diameter, perforated with small holes to allow the escape of gas, or they may be made of copper gauze. It is convenient to remember that the capacity of a parallel plate condenser, such as these electrodes form, is given with fair accuracy by the expression :—

$$C = \frac{2}{9} \times \frac{A}{D} \mu\mu F$$ where A and D are the area in square inches and the separation distance in inches. The capacities will, of course, be increased proportionally to the dielectric constant of the "work" included.

Strips of stiff paper of width varying from $\frac{1}{4}$in. to 1in. and having a length of about 9in., may be bent into circles and the ends stuck to form a range of cylinders to act as electrode separators and to contain such "work" as bakelite powder. The very minimum of fish glue should be used in sticking the ends, otherwise burning is likely to occur at the joint.

Adjustments

The valve is tapped across five turns of the tank coil to give the required loading if the operating frequency is 30 Mc/s. Should the frequency be higher, the tapping position may be taken down the coil to maintain ωL at the optimum load value. For depths of bakelite powder of $\frac{3}{4}$in. to 1in., the "work" is situated across the

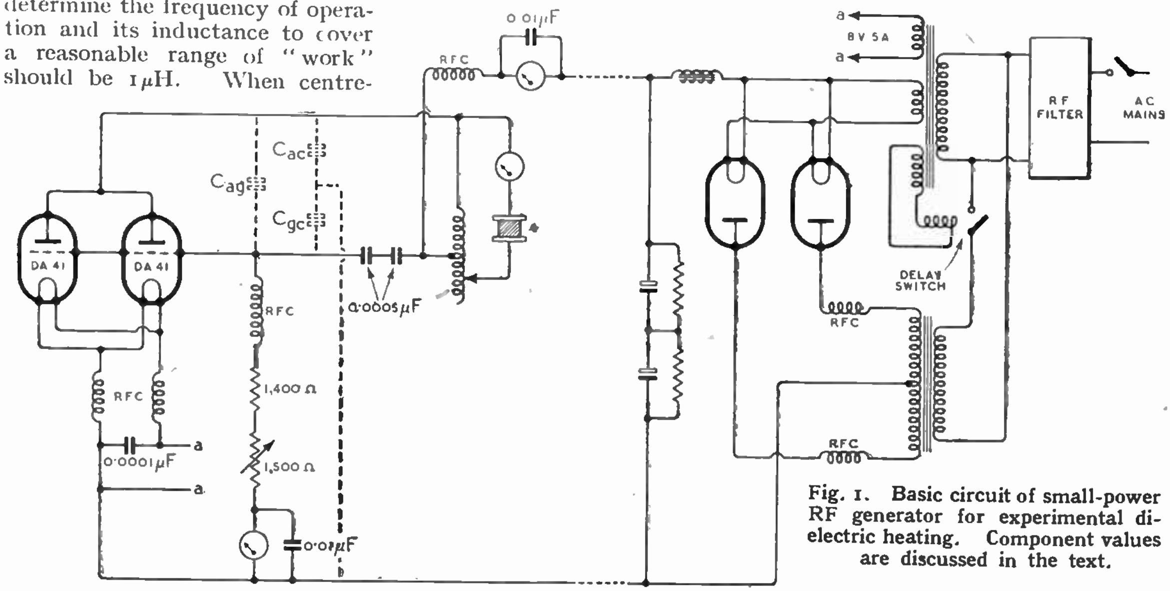


Fig. 1. Basic circuit of small-power RF generator for experimental dielectric heating. Component values are discussed in the text.

Radio Heating Equipment—

whole 10 turns of the coil, but when the depth of "work" is reduced to about ⅜in., it should be across only 5 turns.

The quality of all components in the oscillator must be of high grade, and particularly does this apply to the grid condensers, in which position several should be tried and those which overheat rejected. The grid and anode current meters are shunted by condensers, for should a large RF current flow through the meter it would be destroyed due to the temper of the hair-spring being impaired by heating.

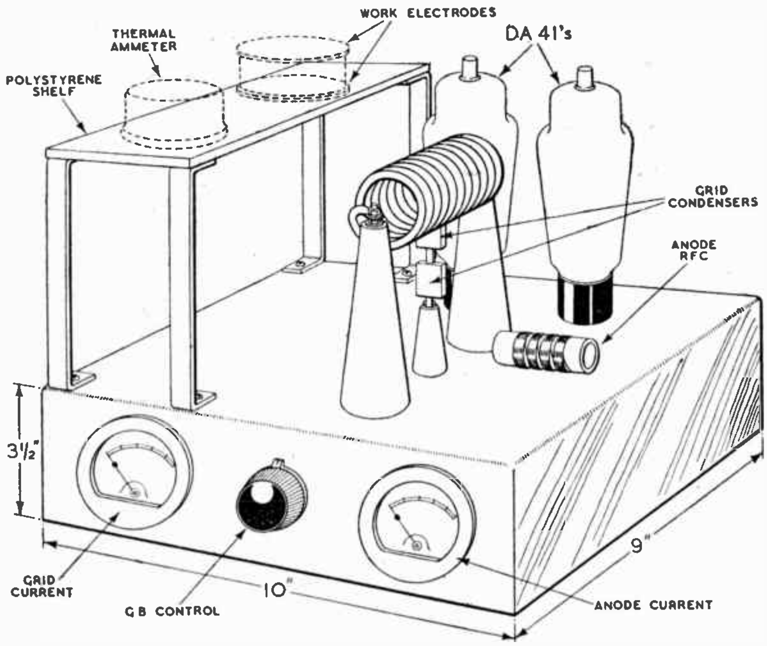


Fig. 2. Suggested chassis layout. The grid RFC must be mounted below the chassis to avoid coupling with the "tank" circuit tuning coil.

The inclusion of a thermal ammeter of 0–10 amps. range in the "work" circuit is essential in making adjustments for maximum efficiency and, when read in conjunction with the grid and anode current meters, it enables a complete assessment of operating conditions to be formed. It is very necessary, when making adjustments, not to exceed a grid current of 64 mA, or the valves are likely to suffer damage. Points to be watched in connection with this are that there is plenty of inductance in the "work" circuit relative to the depth of work and that the grid resistor should be as high as is consistent with efficient operation. It is a good plan when including unknown "work" to commence operations with maximum grid resistance in circuit.

The RF chokes should be of the UHF type, capable of carrying 260 mA in the anode circuit and 64 mA in the grid circuit. They should be of sufficiently low self-capacity to present a predominantly inductive impedance at the frequency of operation. Those in the filament leads should consist of 2½ yds. of 20 SWG wound as self-supporting coils having a diameter of 1in. and a winding length of 2½in. Their resistance will be approximately 0.06 ohms and the filament voltage dropped across them will be 0.6 volt.

Earth connections should be taken to a common conductor of copper tube or copper braid, and this may be joined to the chassis at one point. Connections to the "work" electrode should be of copper braid, so that the large RF currents will be carried with low loss.

A suggested chassis layout is shown in Fig. 2. Every effort should be made to introduce no avoidable stray capacities between the anode, grid and cathode circuits. It is wise to keep the "work" leads short to minimise I^2R losses and to rely on adjustment of the tap position to achieve matching. Grid chokes should be mounted in a position where they are screened from the tank coil, as any RF voltage induced into them will influence feedback and modify the grid drive voltage. With the grid connection to the tank coil removed, there should be no trace of grid current.

The "work" electrodes may be supported upon a platform made of polystyrene or some similar material of extremely low loss. Neither electrode is at earth potential, so that care should be observed in their arrangement. The RF ammeter may also be mounted on the platform adjacent to the "work."

Screening

Screening must be thorough for equipment of this type which will operate over a fairly wide frequency band, owing to the varying tank capacity formed by different shapes of "work." The most convenient method is to contain the entire equipment within a screened cubicle which conforms to the recommendations of Post Office Engineering Instructions, Radio Interference, C1101, which is obtainable from the Engineer-in-Chief's Office (Radio Branch), G.P.O., Harrogate. With this arrangement, one is able to concentrate upon the adjustments being made without continually having to rescreen the "work" and equipment.

In cases where it is inconvenient to install a screened cubicle, a rectangular metal frame, supporting well bonded wire gauze or mesh of 25 SWG or larger diameter, and having apertures not exceeding ¼in. × ¼in. may be placed over the oscillator and "work." The clearance between the screen and the "work" circuit should preferably not be less than 6in., and the bottom of the frame should be flanged and screwed to a copper sheet under the oscillator. It is well to screen the power supply unit in a similar fashion and to use screened supply leads to the oscillator. A filter of the type indicated in the P.O. leaflet C1101 should be mounted in the screen at a point where the mains leads enter.

The power unit should be

capable of delivering 300 mA at 1,000 volts for HT, and 5 amps at 8 volts for the oscillator filaments.

The rectifier shown to the right in Fig. 2 employs hot-cathode mercury-arc rectifiers, connected in a single-phase full-wave circuit. The RMS voltage of a transformer secondary between centre point and one end is 1.11 × the DC output voltage and the peak reverse voltage across the rectifiers 3.14 × the DC voltage. Average and peak rectifier currents are respectively 0.5 and 1.0 × the DC current.

Smoothing is of the choke input type, and this component should have a minimum inductance of 7 henries and a DC resistance not exceeding 50 ohms. The condenser may have a value of 3 to 4 μF and can consist of electrolytic condensers connected in series with a resistance of about 100,000 ohms in parallel with each, to equalise the voltage distribution across them.

A thermal delay switch controls the main supply to the HT transformer primary to obviate the risk of flashback when switching on. The user must also ensure that the valve is operated at a temperature within the limits prescribed by the manufacturer. UHF chokes are connected in the anode circuit of each rectifier to prevent parasitic oscillation.

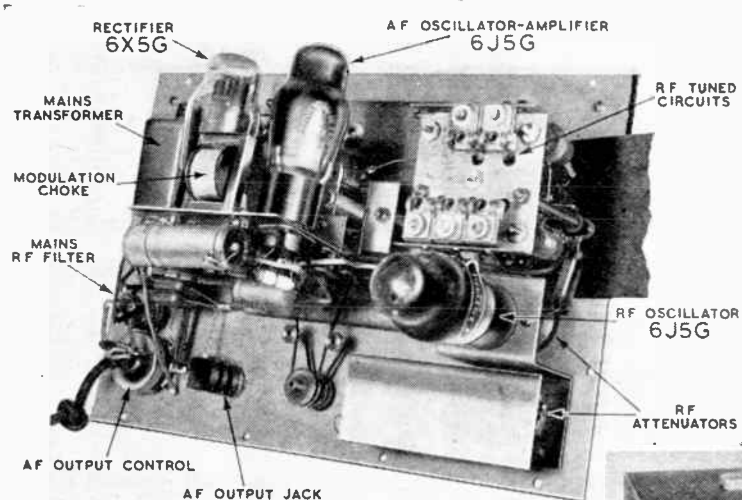
A refinement of great value is the inclusion of a "Variac" autotransformer to control the voltage applied to the primary of the HT transformer. Where this can be done, the power supply unit may be somewhat larger and capable of delivering 1,500 volts at 350 mA. With the added control which this refinement gives, the oscillator may be operated with more than 1,000 volts, provided that adjustments are such that the grid and anode currents are not greatly exceeded.

Before undertaking the construction of any RF heating equipment the permission of the G.P.O. must be obtained, and they must be satisfied with the screening measures proposed.

TAYLOR SIGNAL GENERATOR

An AC-operated Modulated Test Oscillator for Receiver Alignment

THE basic circuit of this instrument consists of a 6J5 triode RF oscillator, anode-modulated at 400 c/s by a similar valve with common choke coupling. There are five ranges giving fundamental frequencies from 100 kc/s to 23 Mc/s and a sixth scale on the dial enables the first harmonic to be used for television frequencies up to 46 Mc/s.



A stepped attenuator in conjunction with a continuously variable potentiometer gives a range of RF output from 0 to 0.1 volt. Both controls are calibrated and the output in microvolts is given approximately by multiplying the settings of the two dials.

The depth of internal modulation is fixed at approximately 30 per cent., but there is provision for external modulation when the modulating valve is used as an AF amplifier. Alternatively the modulator may be used as a 400 c/s source with an output range of 0 to 1 volt.

The instrument is well screened and a test with the output leads removed at a distance of about a foot from an average 4-valve superheterodyne receiver working at full sensitivity showed no detectable radiation. The low radiation is in part due to the provision of an efficient RF filter in the mains leads.

A 6X5 valve is used as a power rectifier and the total consumption of the instrument is about 15 watts. The mains voltage adjustment covers 200-250 volts.

The instrument weighs 10½ lb. and the dimensions of the steel case are 12½in. x 8½in. x 6in., so that although intended primarily for the test bench it is not unduly bulky if required for a service call to a house where AC mains are known to be available.

The price is £14 14s. and the makers are Taylor Electrical Instruments, Ltd., 419/422, Montrose Avenue, Slough, Bucks.

Exterior and interior views of the Taylor Model 65A signal generator, showing principal circuit components.

TOWARDS SYNTHETIC MUSIC

Avoiding Intermediate Processes

By PATRIC STEVENSON

In this article, arising out of H. A. Hartley's contribution on "Aesthetics of Sound Reproduction" in our July and August issues, the author urges the claims of truly synthetic music as opposed to "doctored" receiver response.

IT would almost appear that H. A. Hartley and others have discovered, albeit late in the day, that something "other than high-fidelity reproduction" can be æsthetically satisfying. But this "something" is nothing less than an artistic *imitation* (as opposed to something aiming at being an exact *copy*, or facsimile, of the original) and its successful creation depends upon the observance of principles which were discerned and formulated by the best critical and philosophical minds many generations ago. Materials and mediums may change—the subtle movement of an artist's brush may give way to the magnetically induced excursions of a coil of wire through a magnetic field—but the basic laws governing the means by which man's spirit is moved and his deepest emotions stirred remain immutable from one age to another.

In this arrogantly mechanistic era it is regrettably necessary to stress that the ultimate source of all æsthetic experience is the divinely creative urge in the individual human being, whether he be the creator of the work of art, the interpreter, or the recipient. The quantitative, linear perfection of the straightest-of-straight high-fidelity apparatus is of no avail if the effect of its performance lacks the one spark capable of firing the æsthetic emotions. Science most certainly becomes abortive without a qualitative aim. A world devoid of value is meaningless.

Second-rate Art

It is important also to emphasise that electrical imitation can never become a great art. In his address to the Brit. I.R.E. on March 20th, Dr. Malcolm Sargent pointed out that his art—the art of musical interpretation and performance—was itself a reproduction, a process of transforming printed notes into sound. What we hear from our loudspeakers is, therefore, a reproduction of a reproduction. As such it cannot claim equal status with the fine arts. Ruskin put this clearly by saying: "No great art ever was, or can be, employed in the careful imitation of the work of man as its principal subject. . . . Art which reduplicates art is necessarily second-rate art"[1].

For electronic technique to become a direct medium for great art we must wait for the arrival of the truly synthetic score. Only then will the composer be brought into line with other artists, and, working directly upon the ultimate sound material itself, build up his synthetic track for reproduction by apparatus of predetermined characteristics, secure in the knowledge that no middlemen in the shape of performers will come between him and the distortionless impact of his vision on the world.

That such an idea is more than a dream was evidenced by the description of Rudolf Pfenniger's synthetic sound system.[2] In addition, the latest possibilities in the way of stereophony (possibly accomplished by artifically produced phase differences?), synthetic reverberation, "sound dubbing," "subsonics," etc., are unbounded.[3] Indeed, the merging of composition and performance in one technique would be but the logical culmination of present tendencies. Critical appreciation of the gramophone is gradually reducing the number of executants whose skill is deemed worthy of perpetuation on the wax.

The next step is to abolish the ambiguous score and fallible performer. We can visualise the future composer abandoning all study of conventional notation and instrumentation for the meticulous and microscopic analysis of sound-wave patterns. He will buy his "tone stencils" from composers' "tonemen" much as artists now buy pigments from artists' colourmen, and spend his creative hours in an electro-acoustic laboratory surrounded by cathode-ray tubes, harmonic analysers, frequency meters, reels of sensitive film, photo-electric cells, standardised reproducers, and innumerable other devices. Once he has "written" his "score" he can rest content (presupposing unlimited facsimiles) that everyone who runs his film through the standard type of reproducer will hear exactly what he intended them to hear; exactly what he has put on the record.

Instant "Playback"

In addition to knowing that no unsympathetic interpretation of his music can mar its presentation to the public, the composer will have the great advantage of being able to hear his work, in its full colours, bar by bar, as it is written. There will be no long waiting for a first performance after which he may have to re-score his composition.

Initially, no doubt, the synthetic composer will create in traditional symphonic tone colours—much as early motor car designers were hypnotised by the form of existing horse-drawn vehicles and took time before they evolved a shape really suited to mechanical propulsion. But after a while he will arrive at new combinations of stencilled wave-forms giving rise to novel tone colours and effects of unexampled beauty without precedent in the history of music. By painstaking comparative analysis of wave forms and the delicate manipulation of

[1] "The Harbours of England."

[2] *Wireless World*, Feb. 3rd, 1933. See also an article by the present writer in *The Musical Times* for Sept. 1936, entitled "Exit the Performer?"

[3] See "Theatrical Uses of the Remade Voice, Subsonics and Reverberation Control," by Harold Burris-Meyer. *Journal of the Acoustical Society of America*, 16–19 July, 1941. Also "Synthetic Reverberation," *Wireless World*, May 11, 1939.

stencils he will be able to produce a more perfect tone than that of a Stradivarius in the hands of a Kreisler, or, if he so desires, conjure up the sound of sixty strings all played by instrumentalists of this calibre. The oboe of a Goossens, the horn of a Brain, the trumpet of a Hall, will be there at his command whenever required. No passages he may conceive will fail through overstepping the powers of human lungs and vocal chords, and the choral finales of yet unwritten Ninth Symphonies will soar effortlessly through the upper limits of hearing without any feeling of discomfort or strain.

Disney Technique — in Sound

Should the composer's genius lean towards caricature and the expression of caustic wit, what unlimited opportunities await exploitation in the distortion of typical waveforms! The range of expression open to him, from the bizarre and macabre to ethereal evocations of ineffable beauty, will far exceed anything we can at present imagine.

Before the evolution of this composer's El Dorado, however, there will certainly be a period providing ample scope for electronically synthesised music of the kind advocated by Mr. Hartley. And until the emergence of synthetic sound as a first-hand medium for artistic creation it may well happen, as Dr. Sargent believes, that music will be written for existing instruments, *but* expressly designed for calculated electronic eduction by means of predetermined reproducing channels, thus forming a half-way house between old and new. Ernest Newman has seen other potentialities in broadcasting and studio technique, namely, the opportunity to produce masterpieces like the Berlioz *Requiem* in such a manner as to bring off triumphantly all the effects which misfire under normal concert conditions.[4] The success of any innovation like this calls for close co-operation between musician and engineer. Eloquent pleas for such co-operation were made at the Brit. I.R.E. meeting, and it is to be hoped that much liaison work will be done in the future.

[4] See, for example, *The Sunday Times*, Dec. 19th, 1943.

STANDARD FREQUENCY TRANSMISSIONS

ADDITIONS and alterations having recently been made in the standard frequency transmissions broadcast by the U.S. National Bureau of Standards, we give below details of the revised schedule. This service is broadcast continuously by the Bureau's station WWV at Beltsville, Maryland, near Washington, D.C.

At least three carrier frequencies are now transmitted at all times to ensure reliable coverage. They are:

2.5 Mc/s broadcast from 2300 to 1300 GMT.

5 Mc/s broadcast continuously throughout the 24 hours.

10 Mc/s broadcast continuously throughout the 24 hours.

15 Mc/s broadcast from 1100 to 2300 GMT.

Two standard audio-frequencies, 440 c/s, the standard musical pitch corresponding to A above middle C, and 4,000 c/s are broadcast continuously on 10 and 15 Mc/s. Both are also transmitted on the 5 Mc/s carrier frequency in the daytime but only the 440 c/s from 2300 to 1100 GMT. The lowest radio frequency (2.5 Mc/s) carries the 440 c/s only.

The audio frequencies are interrupted precisely at the hour and each five minutes thereafter for one minute during which the station's call letters are given in morse except at the hour and half-hour when a detailed announcement is given by 'phone.

The accuracy of all the frequencies is one part in 10^7. The time interval, marked by the pulse every second, is accurate to 0.00001 second.

Information on how to receive and utilise this service is given in the Bureau's pamphlet "Methods of Using Standard Frequencies Broadcast by Radio," obtainable on request from the National Bureau of Standards, Washington, D.C. The Bureau welcomes reports of difficulties, methods of use, or special applications of the service.

BAIRD "TELECHROME"

A DEMONSTRATION of the latest system of stereoscopic colour television was given recently by J. L. Baird. It employs a special double-beam cathode-ray tube with a 10-inch internal mica screen coated on one side with blue-green and on the other with red-orange fluorescent material. Colour pictures are seen directly without the aid of revolving filters or lens systems, and for stereoscopic effects the picture is viewed through coloured glasses.

We hope to give a more detailed account of this new development in our next issue.

WORLD OF WIRELESS

IN DEFENCE OF FM

IN a letter to the Editor of *Broadcasting*, Dr. Edwin Armstrong corrects a statement which recently appeared in that journal. The statement was "the facts are that it costs every bit as much to install and operate an average FM station as it does an AM."

Dr. Armstrong states in his letter: "From the very start of FM the initial cost of equipment and the cost of operation have been substantially less than AM. These costs will steadily decrease with the coming of large-scale manufacture, and with the introduction of unattended remote controlled transmitters advantageously placed to dominate the surrounding terrain.

"It has long been practical to operate stations of moderate power in this way. In fact the more exacting requirements of the State police systems have been met for years in precisely this manner. I believe that the time is not too far distant when transmitters covering local areas will be switched on and operated with as little concern and attention as is given to the public-address systems which are now standard equipment for every large hall."

SPONSORED PROGRAMMES

IT was recently reported in the London *Evening Standard* that the B.B.C. Listener Research Department was "testing public opinion on the question of the introduction of commercial broadcasting after the war."

The Listening Panel, a cross-section of about 500 listeners, were invited to state whether they would or would not favour the introduction of commercial broadcasting in either or both of two forms. One was that time should be sold to advertisers in exchange for allowing them to mention their products in the programmes and the second that Parliament should permit one or more commercial stations, financed by advertisers, to operate in competition with the B.B.C.

It was later reported that the project had been cancelled!

SCIENTIFIC RESEARCH

IN the belief that "academic and industrial research are interdependent and complementary and that substantial advances in industry cannot be looked for without corresponding advances in academic science," the directors of Imperial Chemical Industries have offered to provide eighty Fellowships, to be held by senior workers in certain sciences at nine universities in Great Britain. The Fellowships will be of the average value of £600 per annum.

The subjects prescribed in the scheme, which is to operate for an initial period of seven years, are physics, chemistry and the sciences dependent thereon, including chemotherapy; that is to say, any branch of physics or chemistry may be included as well as applied sciences such as metallurgy and engineering.

COMMERCIAL TELEVISION

AN indication of the growing interest in, and potentialities of, television in the United States is given by the issue of a brochure on the planning of commercial television programmes by the RKO Television Corporation. This corporation has been formed to "make available to the producers of television a complete programme-building service." Behind it are the vast resources, equipment, studios and research facilities of RKO-Radio Pictures and Pathé News.

Of the fourteen licensed television stations in the United States, nine are now operating regularly in five cities—some for seven days a week. There are also fifteen licensed experimental relay stations. In addition there are 31 applications pending for commercial stations covering another 13 cities.

OBITUARY

WE regret to announce the death, by enemy action, of F. J. Mortimer, Editor of *Amateur Photographer*, which is issued by our own Publishers. He was a Past President and Honorary Fellow of the Royal Photographic Society and had a long and distinguished career in photographic art and specialist journalism, having edited *Amateur Photographer* for nearly 40 years.

One of the early phases of wireless development is recalled by the recent death in France of J. Bethenod. From 1907 onwards he worked on RF alternators, and a 350 kW machine of his design was installed at the La Doua transatlantic long-wave station, near Lyons, in 1920, replacing the Poulson arc formerly used.

FREQUENCY ALLOCATIONS

SOMETHING approaching the interim international conference on frequency allocation for which *Wireless World* has pleaded is foreshadowed by a recent announcement from Washington. An inter-American radio conference has provisionally been arranged to take place in Rio de Janeiro next spring, to which all countries in the Eastern Hemisphere will be invited. Post-war communications problems, including the allocation of frequencies in the Western Hemisphere and the reorganisation of the International Telecommunications Union, will be considered by the delegates.

In view of the growing demands on the higher frequencies for aviation and marine communications and for long-distance telegraphy and telephony, a proposal has been made in the States to discontinue international broadcasting as at present undertaken and thereby make available many more channels. It is further suggested that international broadcasting should be limited to point-to-point relay systems.

I.E.E. "RADIO" SECTION

IT has been announced by the Council of the Institution of Electrical Engineers that on the recommendation of the Wireless Section Committee it has decided to change the name to Radio Section. The rule dealing with the scope of the Section has been modified to read as follows:—

"The Section shall include within its scope all matters relating to the study, design, manufacture or operation of apparatus for communication by wave radiation, for high-frequency and electronic engineering, or for the electrical recording or electrical reproduction of sound."

WHAT THEY SAY

SWORDS INTO PLOUGHSHARES.—This young industry has men of great ability in the leading positions. If in peacetime they can do for the public what in wartime they

"WHAT HATH GOD WROUGHT?", the message sent by Samuel Morse when he demonstrated his system of telegraphy on May 24th, 1844, is featured on this U.S. postage stamp issued to mark the centenary of the event.

did for the Services, there is no doubt that—given anything like reasonable support—they can well be left to look after the future.—*Sir Thomas Polson, Pye, Ltd.*

FREEDOM OF THE ETHER?—It should be an offence for any British subject to promote, or assist in promoting, any broadcast affecting Parliamentary elections from wireless stations outside the United Kingdom.—*The Speaker's Conference on Electoral Reform.*

AMERICA'S RADIO OUTLOOK.—Progress of the invasion is the key to future trends in radio production. If results are good, our present military-radio surplus will be ample, and civilian radios can be scheduled as 1945 opens. But if the invasion slows down, another two billions of military radio may be immediately called for, deferring any civilian-radio schedules. — *Editorial in "Electronic Industries," New York.*

RELAYING TELEVISION.—General Electric engineers have invented a revolutionary electronic tube, now being widely used in war applications, which will make possible radio relaying of television programmes for quick post-war expansion of the service.—*General Electric Company, Schenectady.*

PERSONALITIES

Dr. Edwin H. Armstrong, the FM pioneer, has been awarded the first Certificate of Appreciation given by the U.S. Chief Signal Officer "for loyal and patriotic services rendered the Signal Corps of the Army of the United States in the accomplishment of its vital mission during a period of national emergency." It is understood the Signal Corps is now making extensive use of frequency modulation.

Samuel Ruben, of New Rochelle, N.Y., has also been awarded the U.S. Chief Signal Officer's Certificate of Appreciation for his work which has resulted in the increased durability and reduction of size of dry batteries.

Edward R. Murrow, who is in charge of the London office of the C.B.S., has been awarded the Peabody Radio Award for outstanding reporting of the news. The Peabody Awards are made annually in recognition of "the most disinterested and meritorious public service rendered each year by the broadcasting industry."

Rene Morin has resigned the chairmanship of the Canadian Broadcasting Corporation and is succeeded by Howard B. Chase. Mr. Morin is remaining on the Board of Governors. Dr. Augustin Frigon, assistant general manager of the Corporation, is continuing to act as general manager.

Dr. A. Hoyt Taylor, head physicist at the U.S. Naval Research Laboratories, has been awarded the American Medal of Merit. The citation reads "Dr. Taylor laboured tirelessly in a course of intensive research and experimentation which eventually resulted in the discovery and development of radar."

IN BRIEF

U.S. Signal Equipment.—During the current financial year the U.S. Signal Corps has an appropriation of $2,130,000,000 for radio and radar equipment. This is 83.7 per cent. of the Corps' total allocation. Over half the expenditure is for airborne equipment.

Wired Wireless.—A significant amendment in the renewed ten-year agreement between the Norwich City Council and Norwich Relays, Ltd., is that "should the Council during the period of the agreement desire to use its electricity mains and services for the purpose of a relay service it may do so at any time after two years' notice to that effect."

Security Ban Lifted.—South African radio stations are again announcing their identity. For 2½ years they have remained anonymous to prevent hostile aircraft from identifying particular radio stations; now the ban is removed.

New Address.—The temporary address of the Radio Component Manufacturers' Federation is 22, Surrey Street, Strand, London, W.C.2. Emergency telephone calls only should be made to Temple Bar 1641.

I.E.E. Council.—The following officers were elected at an Ordinary Meeting of the Institution of Electrical Engineers to fill the vacancies on the Council occurring on September 30th: President, Sir Harry Railing; Vice-President, W. J. H. Wood; Hon. Treas., E. S. Byng; Ordinary Members of Council, H. Bishop (B.B.C.), W. N. C. Clinch, F. C. Winfield and Dr. R. W. Sillars.

I.E.E. Radio Section.—At a meeting held on May 17th last, the following were elected to the Radio Section Committee: Chairman, H. L. Kirke (B.B.C.); Vice-Chairman, C. E. Strong (Standard Telephones and Cables); Ordinary Members of Committee, Dr. J. Greig (Northampton Polytechnic), Dr. S. E. A. Landale (Admiralty Signal Establishment), E. M. Lee (Belling and Lee), S. B. Smith (Marconi's W.T. Co.) and K. J. R. Wilkinson (B.T.-H.).

British Sound Recording Association.—The Hon. Tech. Secretary of the B.S.R.A.—D. W. Aldous, of "Strathdee," Studley Road, Torquay, Devon—informs us that a leaflet is in preparation setting out the objects and future plans of the Association. Interested readers should write for a copy to Mr. Aldous.

Institute of Physics.—At a meeting of the Electronics Group of the Institute to be held on September 19th at 5.30 in the rooms of the Royal Institution, 21, Albemarle Street, London, W.1, Dr. A. Sommer, of Cinema Television, Ltd., will deliver a paper on "Principles of Photo-Electric Emission and Their Application in Photo-Electric Cells."

Institution of Electronics.—A lecture on the Electron Microscope will be given by Dr. D. G. Drummond at a meeting of the North-West Branch of the Institution to be held at 6.30 p.m. on Friday, September 22nd. Non-members can obtain tickets from L. F. Berry, 14, Heywood Avenue, Austerlands, Oldham, Lancs.

RANDOM RADIATIONS

By "DIALLIST"

A π Tip

YOU remember that I gave recently a tip for keeping the reciprocal of π in mind if you have reason to do so; all you have to do is to ask yourself: "Can I remember the reciprocal?" The number of letters in those words give you the answer: 0.318310. A reader tells me that whilst turning over an old French mathematical work he came on a rather remarkable way of remembering the value of π to ten decimal places. The aid to memory here is the sentence: "Que j'aime à faire connaitre ce nombre utile aux sages," which may be Englished as "How I love making known this number useful to the wise." The numbers of letters in the French sentence (but not in its translation) give you 3.1415926535. I can hardly imagine any ordinary person needing to memorise π to ten places. Here's an English jingle that gives it to eight:

See π here I state
Correctly to places eight.

Pinning it Down!

Would you believe that in quite recent times an attempt was made to enforce legally the all-too-round figure value of 3 for π? It was in that queer part of the United States where they stand so four-square for the literal interpretation of the Bible that a schoolmaster was prosecuted—you may recall the case—for teaching the elements of the Evolution Theory. In the matter of π it was argued that the Old Testament told of a "sea of brass" in the Temple furnishings whose circumference was 30 cubits and the diameter ten. As the "sea" or basin was stated to be round it followed naturally that the true value of π must be plain three! Actually those who built the Temple probably had π taped to the equivalent of at least two places of decimals through their contacts with the Assyrians and the Egyptians. Either the "sea" was slightly oval or—more probably—the writer of the description was using the approximation for the circumference/diameter ratio generally employed by the non-mathematical of his time.

□ □ □

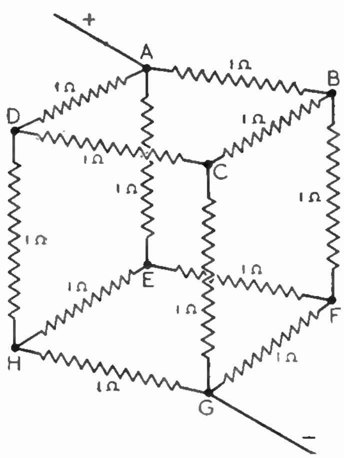
A Little Hotter

IF you happen to live in a place where the mains voltage is at the lower end of one of the ranges for which electrical appliances are rated, you may find that your soldering iron doesn't get hot enough to do neat sound work with wartime solder. Much of this is a good deal harder, owing to the shortage of tin, than the corresponding grades of pre-war days. In fact, even if your voltage is 230 you may feel that you'd be glad of a little more heat in the bit. For most electrical connections, and particularly for those in radio apparatus, I use Multicore solder, which flows readily with a 200-230-volt iron heated from 200-volt mains; but for the harder types I like my bit to be hot enough to singe a piece of newspaper brown when laid for a moment upon it. Here's a way of getting that extra little bit of heat that makes so much difference. The heater element is generally situated near the business end of the iron. Between the housing of the heater and the handle are several inches of metal tube, from which a good deal of heat is radiated and so wasted. Bind this part of the tool with asbestos string (I untwisted a piece of asbestos string about as thick as a cigarette and used two strands) and protect this with a binding of ordinary string. Besides increasing the temperature of the bit by a small but appreciable and useful amount the binding serves another purpose: you don't burn your fingers if in a moment of a absent-mindedness they stray from the handle on to the metal part of the iron.

□ □ □

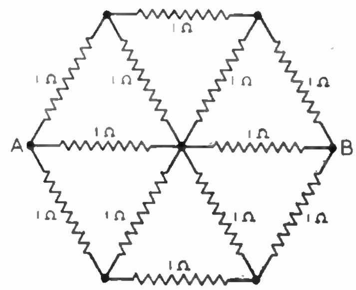
Network Problems

A FELLOW soldier sends me a resistance network problem which has apparently caused some argument in his unit, though it



The cube problem.

seems fairly straightforward. Here it is: twelve one-ohm resistors are connected in the form of a cube; what is the resistance between opposite corners such as A B in Fig. 1? You can make the problem a bit more tricky by wiring up the twelve



Another arrangement of resistors.

resistors in the way shown in Fig. 2. Neither will puzzle the initiated; but beginners may find them amusing.

□ □ □

Riveting

EVER tried your hand at riveting? Small jobs, I mean; not the sort that occur in shipbuilding or boilermaking. It is a fascinating art and a very useful one to acquire for both construction and repair work. Actually it's not a bit difficult, and if you try it you'll find a good deal of pleasure in the neat jobs that you can turn out. I've been a rivet addict for years and riveting has saved me a lot of bother time and again. Here's a typical job. To an existing pressed steel radio chassis I wanted to fix an extension measuring 4in. × 4in. to hold some additional components. You *can* solder steel, but riveting is simpler and makes a very strong job. The first thing to do was to cut out a piece of metal 4in. × 4¾in. to allow for the overlap. Close to one edge of this were drilled five holes which were just a push fit for the rivets.

Doing the Job

Actually I had no ready-made rivets of suitable size in stock and they aren't easy to obtain nowadays. But I had some ¾in. nails made of softish brass with round heads. One of these was passed through the drill plate and the appropriate drill chosen. The plate was drilled as already described and corresponding holes were drilled in the chassis. One of the nails was put through the middle hole in both plate and chassis and shortened with end cutters so that about $\frac{1}{16}$in. was left protruding. The work was now placed on a block of steel, the head of the nail resting on the block and the cut-off end pointing upwards. The next process was to deliver fast, light blows on the end of the nail with the round end of a small ball-pane hammer. This burred over the end of the nail, shortening it and forming a second head. The two pieces of sheet metal were thus drawn together, and when they were nearly tight the second rivet was put in in the same way. The job was finished by a tightening of all the rivets and the neat shaping of their second heads with the ball-pane hammer.

Useful Tips

Here are one or two tips that you may find useful if you haven't tried riveting before. First, the holes drilled must be a close fit for the rivets; if the rivets aren't tight in their holes you can't do sound work. Second, if you can't get proper rivets use nails of softish brass or copper—you can usually buy flat-headed copper tacks ⅜in. long from ironmongers. Third, don't leave too much protrusion when you snip off the end of your rivet. Last, don't use too heavy a hammer and remember that many fast, light blows are far more effective and make for much better work than a few hard ones.

□ □ □

Three-phase in the Home

THE recent article in *The Electrician* (quoted in last month's *Wireless World*) on the virtual elimination of the most poisonous types of interference with wireless reception by the adoption of the three-phase motor for domestic appliances made good reading. As the writer says, the installation of three-phase circuits in our houses could lead to the disappearance of that kind of interference as we know it nowadays; it had in fact done so in Germany before the war. The Germans are canny folk in some ways, even if they are crassly stupid in others. They foresaw that man-made interference in wartime might cramp the style of various military radio devices and they decided to do away with it. I don't know how long ago three-phase supplies came into regular domestic use in that country, but I do recall that the radiation of interference was made a punishable offence in Hitler's Reich in 1937 or '38. Our outlook is different: there is no war *motif* underlying the bulk of our legislation; but we might well take a leaf out of their book by outlawing interference and by introducing domestic three-phase circuits. Certain it is that the development of short-wave wireless and of television will suffer in this country if we don't.

Could it be Done?

The present voltage limits for household purposes date back to a time when wiring systems, switches and safeguards were not nearly as good as they are now. As "Supervisor" pointed out in *The Electrician*, there is little, if any, more risk of accident with 400-volt three-phase than with 230-volt single-phase supplies. The objection may therefore be ruled out. Probably the chief kick against the compulsory use of three-phase motors in domestic appliances would come from manufacturers, on the grounds that they have to cater for customers who have DC supplies and must therefore use universal motors. It is only a matter of time for all supplies to become standard AC and, so far as we can see, progress in this direction should be rapid when the war is over. The case could be met by making it an offence to use any but a three-phase motor on AC mains after a certain date. I believe, though, that the best results could be achieved not by legislation but by the influence of the manufacturers themselves, in whose interest it would be to educate the public up to the enormous advantages of the three-phase motor, which is much more sturdy and reliable than its universal counterpart. The latter would then die a natural and unlamented death, as more and more of the still existing DC supplies are changed to AC.

□ □ □

Resonance?

A CORRESPONDENT, who is at pains to point out that he makes no claim to be psychic or anything of that kind, writes to tell me that he has the curious gift of being able to tell whether 50-cycle AC is flowing by merely touching the insulating covering of a conductor. "If, for example," he writes, "I put my finger on a pear switch or a torpedo switch, I can feel the current when it is in the 'on' position." I can only deduce that my correspondent's natural frequency is 50 c/s and suggest that when opportunity arises he should plot his response curve, carefully examining it for peakiness or signs of hump should he be feeling under the weather! A fellow I know used to claim that his natural frequency was that of the local broadcasting station and that he could enjoy the programmes by holding a crystal lightly between his teeth. When he had his appendix removed he feared that the loss of a turn might necessitate recalibration; but all was well, for he found that reduced inductance had been offset by increased capacity and he soon became used to his new L/C ratio.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

AIRCRAFT INSTALLATIONS

IN order to minimise the risk of collision and to facilitate traffic control in conditions of low visibility an aircraft radiates a carrier wave the frequency of which is controlled through a variable condenser geared to the moving part of an aneroid, so as to indicate automatically the instantaneous altitude of the machine. Simultaneously a modulating note, indicative of the direction in which the craft is travelling in azimuth is superposed on the carrier through a coil, the effective inductance of which depends upon the instantaneous angle between the fore-and-aft line of the craft and the N-S line of a magnetic compass associated with the coil. This controls a modulator which provides a distinctive frequency for any particular course, a change of direction from N to S through east being distinguished from the direction N to S through west, by sub-modulation.

A receiver is also provided for picking up signals radiated from any other aircraft in the vicinity. Reception is synchronised to occur only during the intervals between transmission on any given machine. The receiver may also be used to give an indication of the relative distance, based on signal strength, of the machine with which it is co-operating.

Square D Company. Convention date (U.S.A.) February 5th, 1941. Nos. 559243 and 559259.

CATHODE-RAY TUBES

THE fluorescent screen of a cathode-ray tube is liable, in the course of scanning, to be injured by various forms of ionic bombardment. Negative ions come from the cathode and are subject to the same deflecting fields as the electrons, but respond differently, owing to their smaller charge-to-mass ratio. For this reason, they travel in a substantially straight line and so always strike against the centre of the screen, thereby causing what is called "ion-spot." Positive ions may also be attracted towards the screen by local potential gradients created by secondary emission; these cause small blemishes known as "smudge."

According to the invention, the screen is covered, on the side facing the "gun," by two separate protecting layers, the combined thickness of which is still permeable by the normal scanning stream. The first layer consists of pure aluminium, five to ten molecules thick, and the second of aluminium oxide which is made at least double the thickness of the first. The oxide layer serves to absorb the energy of the negative electrons, whilst the metal layer prevents the migration of local positive ions to the sensitive surface of the screen.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of R. R. Law). Convention date (U.S.A.) May 9th, 1941. No. 559331.

TELEVISION AERIALS

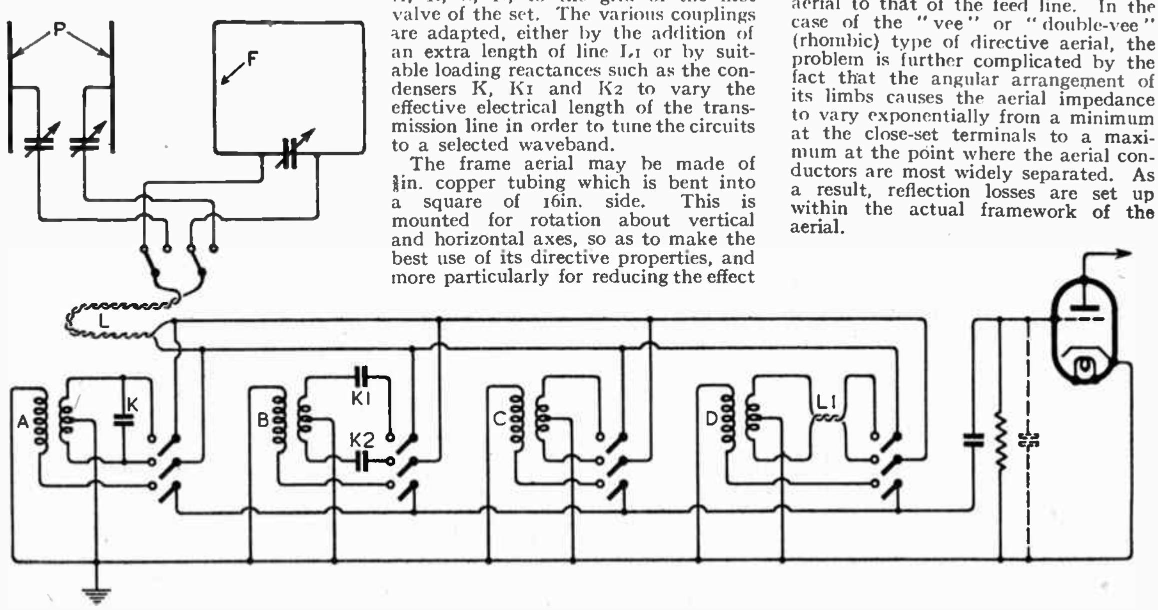
THE aerial for a television receiver is mounted inside the cabinet, so that it can conveniently be re-tuned when necessary, and its directional properties utilised.

As shown in the diagram, either a pair of dipoles P or a frame aerial F can be switched at choice into circuit with a transmission line L, which is terminated by different input couplings A, B, C, D, to the grid of the first valve of the set. The various couplings are adapted, either by the addition of an extra length of line L1 or by suitable loading reactances such as the condensers K, K1 and K2 to vary the effective electrical length of the transmission line in order to tune the circuits to a selected waveband.

The frame aerial may be made of ⅜in. copper tubing which is bent into a square of 16in. side. This is mounted for rotation about vertical and horizontal axes, so as to make the best use of its directive properties, and more particularly for reducing the effect of local sources of disturbance. The overall length of the two dipoles is, say, 17in., and they also are rotatably mounted. The frame aerial is screened at the high-potential parts, whilst the dipoles are capacity-loaded at each end.

The smallness of the aerials is offset by their high "Q" factor, which ensures sufficient damping to cover a six-megacycle channel on each of the available tuning switches.

Philco Radio and Television Corpn. (Assignees of W. H. Newbold). Convention date (U.S.A.) December 14th, 1940. No. 559423.



Aerial system designed for installation inside a television receiver cabinet.

BATTERY VOLTAGE INDICATOR

ALTHOUGH the end of the useful life of a high-tension battery is generally indicated well in advance, by the usual symptoms of falling voltage, these are apt to be ignored by the optimistic listener until the set finally gives up the ghost at some inconvenient or critical time. Failing a voltmeter it is hard to know when, for instance, a nominal 120-volt unit has dropped 30 volts and is ripe for replacement.

An ordinary incandescent lamp connected across the cells is not easily adapted to give the indication required, whilst its current consumption would prove a heavy drain. Instead, the inventors use a small gas-filled glow lamp to serve as a permanent watch-dog. A tube of this kind can be designed to quench at a voltage of, say, 25 per cent. below the ignition voltage, and to consume less than one-tenth of a watt.

Akt. Electrod. Convention date (Sweden) November 15th, 1938. No. 559513.

DIRECTIVE AERIALS

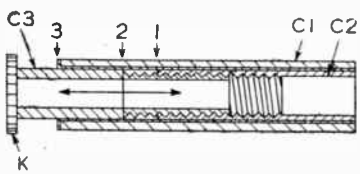
TO prevent undesired reflection effects, it is necessary, in the first place, to match the impedance of the aerial to that of the feed line. In the case of the "vee" or "double-vee" (rhombic) type of directive aerial, the problem is further complicated by the fact that the angular arrangement of its limbs causes the aerial impedance to vary exponentially from a minimum at the close-set terminals to a maximum at the point where the aerial conductors are most widely separated. As a result, reflection losses are set up within the actual framework of the aerial.

According to the invention, each limb of the aerial consists of a hollow "cage" or "sausage" made up of, say, six identical wires. These are threaded through supporting rings so that each cage is of circular cross-section throughout, though the diameter of the cage increases from one end of each "vee" limb to an intermediate point, and then decreases to the opposite end of the same limb. This ensures a smooth gradient of impedance along the length of the aerial, and so reduces losses due to internal reflection.

Standard Telephones and Cables, Ltd. (Assignees of C. R. Burrows). Convention date (U.S.A.) July 2nd, 1941. No. 559886.

VARIABLE CONDENSERS

AN outer tube C1 is insulated from two inner coaxial tubes C2, C3. C2 is fixed and is threaded to allow C3 to be screwed in and out by means of a control knob K. This alters the effective area of overlap 2, 3 between the outer surface of C3 and the inner surface of C1, thus varying the overall capacity of the unit. It should be noted that the gap 1, 2 formed when the unit is partly unscrewed, as shown, has no appreciable capacity effect, because the external screw thread on the tube C3 is too widely separated from the outer electrode C1. The arrangement gives a comparatively large tuning range to a condenser having small dimensions.



Compact capacitor.

Two or more similar units may be combined or interleaved to form one coaxial assembly, with ganged control from a single tuning knob. The single unit shown can be applied to a nominally "fixed" condenser, in order to compensate for changes in temperature or humidity.

A. Faber. Application date August 26th, 1942. No. 559627.

FM TUNING INDICATOR

THE tuning of a frequency-modulated receiver is complicated by the fact that three widely separated resonance peaks occur within each signal waveband, the presence of the two outer ones being due to the slope of the detector characteristic. At the same time the full benefit of the high signal-to-noise ratio given by this type of modulation can only be secured when the set is accurately adjusted to the true or centre peak of resonance.

To simplify the problem an auxiliary AF note is deliberately introduced during the process of tuning, by switching in a tapping from the mains-supply transformer to the screen grid of the last IF amplifier. It is known that the ordinary balanced diode type of frequency discriminator acts automatically to wipe out any amplitude modulation that may be superposed on the signal, provided the circuits are accurately tuned to the centre frequency of the signal carrier, but not otherwise. The set is accordingly adjusted until the sound of the mains "hum" disappears, whereupon the tapping from the mains transformer is switched off, leaving the set ready for reception.

Philco Radio and Television Corpn. (Assignees of C. T. McCoy and P. McF. Craig). Convention date (U.S.A.) October 21st, 1941. No. 559555.

CHASSIS CONSTRUCTION

TO facilitate inspection and repair the component parts of a wireless set are distributed over the four shelves or panels provided by a cross-shaped carrier or supporting member. This is conveniently made by joining together two L-shaped metal plates, which give the required cruciform cross-section. The carrier is mounted between two rectangular end pieces, so that the whole forms a rigid assembly.

When withdrawn from its outer casing the carrier can be turned to rest firmly on any one of the four sides of the rectangular end pieces, thus allowing the operator to bring any selected component into the most convenient position for servicing.

The cruciform shape of the internal carrier also serves to divide the outer casing into four separate rectangular compartments, which are mutually screened from each other.

Stratton and Co., Ltd., and H. A. J. Laughton. Application date September 5th, 1942. No. 559877.

BEAM AMPLIFIERS

RELATES to the focusing and deflecting plates or electrodes of a cathode-ray type of tube, particularly when used as a beam amplifier.

It is pointed out that if the electron stream is allowed to fill substantially the whole of the space between the focusing plates, a high degree of aberration will occur because, in effect, the full aperture of the lens is being used.

According to the invention the plates on opposite sides of the stream are set parallel to each other, as usual, for most of their length, but their ends are flared outwards to double the normal separation. The axial length of the flared part is made equal to the transverse distance between the parallel parts of the plates. The result is to double the effective aperture of the flared portion, or lens, relatively to the normal width of the electron stream, and to reduce the aberration ratio substantially to unity. In this way the stream can be concentrated into a narrow ribbon in the vicinity of the twin output anodes or targets.

Input signals are applied across one of the pairs of focusing plates, which then serve as deflecting electrodes to sweep the beam from one to the other of the two anodes, the resulting changes of potential across the latter providing the amplified output.

Western Electric Co., Inc. Convention date (U.S.A.) May 31st, 1941. No. 560453.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

New Thoughts on VOLUME EXPANSION

Contrast Should be Proportional to Size of Room

By THOMAS RODDAM*

QUITE a lot of effort among devotees of high-quality reproduction is now going into the construction of circuits for contrast expansion. In the view of the writer, this effort is misdirected, and it is the intention of these notes to make a case against contrast expansion for broadcast listening. There is, of course, the normal reasoning that as the compression of the programme is not effected by a simple electrical device, restoration cannot be so effected. This is a well-known argument and the usual reply of expansion enthusiasts is that inaccurate expansion is better than none at all.

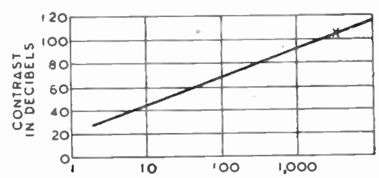
A second, and in my view wholly satisfying, argument against expansion is also known. The environment of the average listener is not a silent one. Passing traffic, bird singing, the noise of the fire, and of the movements of other members of the household; all these produce an ambient noise level which serves as a distraction and as a desensitising influence to the ear. For comfortable listening, the lowest levels of programme should be about 10 db. above the level of the click of Aunt Fanny's knitting needles. The average level, however, should be such that the voice of the announcer is at ordinary speaking level. Orchestral *tutti* should not completely deafen the listener. In fact, however, even without expansion, the range transmitted is such that a fixed volume control setting means that on a summer evening a concert will be forced on a silent neighbour, or drowned by the lawn mower of an energetic one. This, then, is the practical case against contrast expansion. The answer to it is usually produced by some fortunate individual who lives in the heart of the country, with no traffic, no neighbours, and no Aunt Fanny; he can say quite truthfully that he thinks these factors are over-rated.

Expediency is a bad master, and the two anti-expansion arguments given above will not apply to the happy listener who receives, in a quiet and lonely room, a programme compressed from its original 60, 80 or even 120 db. range to possibly 30 or 40 db. by an electrical device. Such a listener, if the field strength at his receiver is high, will say that by expansion complementary to the original compression he can restore the programme to its full original, limited only by the linearity of the intervening circuits and the absence of binaural effects. The writer believes that this is not so, for reasons which he has never seen given elsewhere.

Audience : Contrast Ratios

Let us consider the raw material with which we are dealing. The material which merits most attention is music written and played for concentrated listening, and we should also consider talks and public speeches. In considering musical programmes we shall exclude broadcasts of piano music; the piano can be played as a chamber music solo instrument or as a partner of an orchestra, and its range is completely under the control of the player. With strings the contrast is produced by variations between small groups of players and the whole orchestra. In general, we find that the contrast of our material is related to the size of the audience for which the music was written. The contrast of which a large orchestra is capable is of the order of 80 to 120 decibels; this corresponds to an audience of several thousands; the music itself, if early 19th century, was written for a smaller orchestra, but concert halls, too, were smaller, and the composer's expectation of 70 to 90 decibels contrast is in proportion. At the other end of the scale, the family group listening to a sonata will not expect more than about 20 decibels contrast. Between these two extremes we have the quintets, octets and small string orchestras, which, playing at parties (or should one say receptions?) have an effective audience of the order of 100. Turning to individual performances, the range of levels in a "fireside chat" is small—the listening group is the family; for the larger audiences at Nuremburg rallies, vast changes of levels were adopted to produce the desired effects.

We judge numbers logarithmically; we talk of half-full theatres, of there being twice as many people as usual at a meeting. Let us plot range against audience size using a logarithmic scale for the size of audience. We can see that a linear relationship is probably correct, so far as the word "correct" can be used of such intangibles.



Contrast range plotted against size of audience.

The size of the audience is an index of the size of the room. No one likes to live, like Citizen Kane, in a room far too large; no one really likes a room which is too small to move about in. Thus, as the contrast is proportional to the size of audience, we can say that the contrast should be proportional to the size of the room.

This, then, is the conclusion reached. If the receiver is so designed that any desired contrast, compressed or expanded, can be obtained, abandon all academic ideas about the contrast needed in the place where the performance is actually taking place. The defining quantity is the size of the listener's room and the contrast should be controlled to suit this.

Usually compression rather than expansion will be needed.

There is no reason to fear a loss of emotional values. Twenty decibels in the home is worth sixty in the concert hall. The writer has spent some time listening to programmes with greatly compressed range. His experience showed that quite quickly the ear grows accustomed to weighting changes of level, and to regarding, say, 10 db. change as something really important, and the effects of, say, 30 db. crescendo in the original are appreciated with much smaller level changes in the home. Just as we can graduate from the pentatonic scale of the bagpipes to the subtleties of quarter-tones, so, very quickly if broadcast listening is our main source of music, we can derive full enjoyment from very compressed programmes.

The advantage of compression in the home is not confined to serious listening. Music used as a background gains as well. The function of background music is to provide a level of non-significant sound which will mask significant and disturbing sounds. If the level is too low it fails to provide full masking; if it is too high the music insists upon being itself significant. By compression we can reduce the intervals in which either outside sounds or the protective screen obtrude and thus improve the efficiency of our background.

For those who wish to test the soundness of these proposals, the following course is recommended. Construct a compressor by modification of your present expansion circuits. Listen seriously to this for a few days with a compression ratio of, say, 3 : 1 (60 db. reduced to 20 db.). Then increase the range slightly, say, by bringing the compression ratio down to 2 : 1 (60 db. reduced to 30 db.). Regarding this as the final answer, listen to it with the enhanced level sensitivity that the high-compression listening has produced. This second period should enable a decision to be made.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

UNBIASED

By

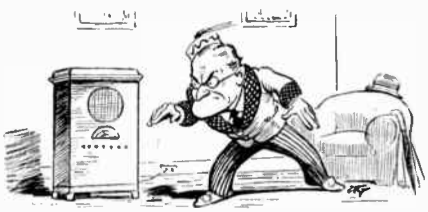
FREE GRID

Dream Jet

CAR manufacturers used to spend a lot of money in research work during the last peace in an endeavour to produce a vehicle which was absolutely womanproof, or, in other words, so absurdly simple to drive that even a woman would be hard put to it to muck things up, but needless to say they never succeeded. Even had they produced a truly "one-knob" car either it would have been woefully inefficient or the innards would have become prohibitively complicated. One of these two things nearly always occurs when an attempt is made to produce a piece of mechanism which is excessively simple to operate. The one exception to the rule seems to be the push-button wireless set, of which I have always been so strong a champion, so far as the ordinary listener is concerned.

In the case of push-button tuning of the correct type the set can not only be made adbsurdly simple to operate but it can be allowed to have far more efficiency-producing complications than would be feasible in an ordinary knob-tuned set. Without push-button tuning such a set would tend to become reminiscent of a government department, bristling all over with controls. If push-button tuning is adopted we can, by the use of a sufficient number of cams on the push-rod associated with any particular station, cause the set to have optimum circuit coupling and, in fact, optimum everything else for the most efficient reception of the particular station concerned. There is nothing new in this suggestion, since I myself as well as others have advocated it again and again in this journal.

The thing which brings the whole idea to the forefront once again, however, is the article on voice-controlled devices which appeared in the August issue of this journal. By



Shuffling over in your carpet slippers.

the adoption of this excellent idea the one remaining objection to my ideal push-button set is removed, namely, the necessity of shuffling over in your carpet slippers to the set in order to prod one of the buttons. When this idea gets to the production stage it will only be necessary to bawl at the set and the appropriate station will be tuned in. If a crooner or other offensive noise butts into the programme a curt order to "put a sock in it" will be all that will be needed.

It does seem, however, as if there is still one small point which has been overlooked, and that is that unless the microphones associated with the apparatus are not to be made unduly sensitive they will have to be mounted near our armchairs. A multi-wire cable link to the receiver is unthinkable in a wireless household; it would be no better than the armchair push-button controls with which some set makers used to supply us before the war. The only solution is a miniature wireless transmitter linking microphone and receiver, and until this is produced I for one will have nothing to do with voice control.

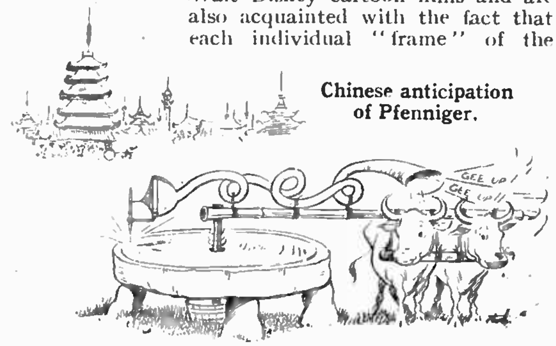
Echoes of 1940

SINCE it seems to be the fashion nowadays for people in high places to tell us all about what a close shave we had in 1940, and how near we came to the brink of the abyss, I see no reason why I should not follow suit and reveal to you a certain radio aspect of Adolf's preparations for the invasion of Britain.

As you well know, quite early in the crisis period of the war the B.B.C. started to prepare against sudden invasion by getting us acquainted with the tonal idiosyncracies of their announcers by causing them to tack their names on to each news bulletin. The B.B.C. authorities are as a matter of fact still doing this; no doubt they know their own business best.

Unfortunately for the B.B.C., their well-meant precautions would have played right into the hands of the Germans, had they invaded us. Hitler's technical experts had made elaborate preparations so that well-known voices like those of Alvar Liddell and his fellow-announcers would have been replaced by others, the imitated accent being so perfect that even the announcers' wives would have been deceived. Believe me, that is saying something, as any of you married fellows know.

One cannot help but admire the ingenuity of the scheme and the painstaking way in which it had been prepared. As in the case of most great schemes, the basic idea was absurdly simple. I suppose that all of you are familiar with the Walt Disney cartoon films and are also acquainted with the fact that each individual "frame" of the original is not drawn personally by Walt Disney. Such a thing would be almost impossible for one man to accomplish and, of course, a team of artists is employed under his direction.



Chinese anticipation of Pfenniger.

In this case the magic name is not Walt Disney but Rudolf Pfenniger, who, as described many years ago in *Wireless World*, succeeded in making reproductions of the human voice and of other sounds, not by recording them in the ordinary way, but by studying sound tracks of ordinary records and then copying them manually, eventually learning what kind of indentation was made by each delicate and subtle tonal shade in the world of sound.

Actually Pfenniger was not the first in the field by any means, and in *Wireless World* of January 12th, 1934, I produced evidence that the system was used for a utilitarian purpose by Chinese farmers, and I reproduce herewith the sketch I made at the time, which is, I think, self-explanatory, an interesting point being the substance of which the diaphragm of the reproducing sound box was made, namely, a tightly stretched missionary skin.

It was indeed fortunate that Adolf did not actually invade, as when I laid my information before the Ministry of Home Security they failed utterly to appreciate its importance.

CLASSIFIED ADVERTISEMENTS. Rate 6/- for 2 lines or less and 3/- for every additional line or part thereof, average lines 5-6 words. Each paragraph charged separately. Press Day: October issue, first post Friday, September 8th, one day earlier at branch offices. Box Numbers 2 words, plus 1/-. Deposit System: particulars on request. No responsibility accepted for errors.

NEW RECEIVERS AND AMPLIFIERS

QUALITY amplifiers, ac 200-250v, 4½w, 6gns.; 11w, output imped. to requirements, 11gns.; s.a.e. for leaflet.—John Brierley, 1, St. Paul's Ave., Lytham St. Annes.

HENRY'S offer.—Ac/dc Mid. T.R.F. kit of parts, med. wave, complete with chassis, valves, speaker and circuit, nothing else to buy, excellent results, £8/10; carr. pd., c.w.o. only.—Henry's, 5, Harrow Rd., Paddington, W.2. Pad. 2194. [2992

AMPLIFIERS.—Complete equipment for P.A. industrial, dance and stage installations and portable apparatus from 15 to 150w; early deliveries; illustrations and spec. on request.—Broadcast and Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [2963

£24/10 only.—New 7-valve "Wireless World" Quality amplifier with tone control stage, 8watts push-pull triode output, price includes super Quality triple cone, 12in permanent magnet speaker with large matched output transformer and all valves; as above but with 15watt tetrode output, £25/10; ideal for realistic reproduction for public address, limited number available.—Bakers Selhurst Radio, 75, Sussex Rd., S. Croydon. Tel. Croydon 4226 for demonstration. [2772

H.P. RADIO SERVICES, Ltd., offer Philips 11v television chassis, complete less valves, £12/10; new radio chassis, comprising 7 screened coils, 31 cond., 30 res., 8 oct. v.-holders, vol. cont., etc., 29/6; 5w ac/dc amplifier, 3valve chassis type, including valves, £6/10; new Crosley 6v car radio, 2 wavebands, push buttons and manual control, all suppressors and fitments complete, 16gns.; Ward under-car aerials, 18/6; car plug and distributor suppressors, 2/6; dynamo condensers, 3/-; vibrators, 6v, 4- or 6-pin, 15/-; we now again offer few Rothermel crystal gramo. p.u., without priority, £3/18/9; civilian wartime receivers, ac, £12/3/4; battery, £10/19; customers are invited to register their names with us for early delivery; no cash acceptel; Meico m.c. mike and trans., £5/10; 8in p.m. speakers, 19/6; also few 10in, 11in and 12in p.m. heavy duty spkrs., price on application; cathode ray tubes, 9in magnetic, £5; electrostatic 3in, 4gns.; mains trans., 350-0-350 4v or 6v heaters, 29/6; standard 4v or 6v replacement bobbins, 19/6; 0.5amp 3-core line cord, 5/- yd., 70 ohms per ft.; Bell trans., 5/11; high grade ac eliminators, 4gns. (no charger); S.H. Elliott, 30-0-30 m.a. meter, 4in dial, £3; Elliott switchboard, 0-60 voltmeter, 7in (res. 150,000 ohms), £6, as new; a few precision 0-1ma meters occasionally available, £3/13/6; Dubilier 2mfd 650v metal box type, 4/-; vol. contls., 3/6; with switch, 5/6, all values available; dual range coils, a. and h.f., with reaction (circuit supplied), 12/6 pr.; valves, British and American, most types, list prices; Radio Valve Manual, 3/6; 120v h.t. batts., 15/6; 2v 45amp glass accums., 11/-; 1,000w kettle immersion elements, 19/6; s.a.e. with enquiries; over £4 carriage paid; satisfaction guaranteed.—H.P. Radio Services, Ltd., 55, County Rd., Walton, Liverpool, 4. Tel. Aintree 1445. Establishel 1935. [2965

RECEIVERS, AMPLIFIERS—SECOND-HAND

TROPHY 6 Communication receiver, as new; £15.—41, Ashenden Rd., Guildford. [2998

HMV Auto-radiogram, Hallicrafters' 5×28 receiver both good condition.—Box 3181.

EDDYSTONE Communications receiver, with speaker to match, perfect condition; offers.—Graham, 5, Bilton Rd., Rugby. [2984

HALLICRAFTERS Sky-Buddy and two-stage pre-selector, spare valves; £14.—Martin, 3, Cliff Ave., Loughborough, Leics.

W.W. PX4, PP, Quality amp., as new, with valves and elec. gram. motor; £26.—Filmer, 138, Chastilian Rd., Dartford. [2967

14W rack built high fidelity triode p.p. amplifier, tone correcting stage, 2 pick-up input channels, 2 meters, 4ft high; £21.—Box 3188. [2955

10-12-WATT amplifier and gram unit, A.C.2 speakers and m.c. mike with floor stand; £35, complete.—Bridger, 77, Mexfield Rd., Putney, S.W.15. [2973

SOUND Sales, D.X. Plus Quality receiver and amp. units, Voigt speaker, corner horn and energiser, hardly used, demonstration Voigt Quality; offers.—Box 3194. [2968

FOR sale, one 7-valve "Wireless World" quality amp., with tone control, including valves, £17; excellent cond.—Write Charlier, South Croft, Buxton, Derbys. [2880

W.W. Q.A. Super receiver, £12/10; W.W. Quality amplifier, £17/10; both complete with valves and in perfect order; R.K. Senior speaker, £8; offers.—Box 3197. [2994

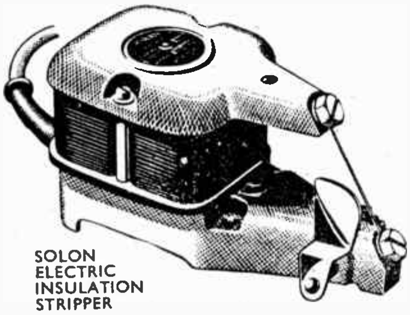
PORTOMATIC Auto-Radiogram, in hide suitcase, by General Radio, Inc. (U.S.A.), takes 8 10in or 12in records, 90v to 250v ac/dc, short and med. wavebands, in perfect order; £55.—Harris and Gillow, 93-5, Wardour St., W.1. [2988

Advertisers and buyers are reminded that under Defence Regulations 1939, Statutory Rules and Orders 1940, Number 1689, a permit (T 99 G) must be obtained before sale or purchase of certain electrical and wireless apparatus, particularly such valves and apparatus as are applicable to wireless transmission.

SOLON

TRADE MARK

INDUSTRIAL ELECTRIC APPLIANCES



SOLON ELECTRIC INSULATION STRIPPER

The SOLON Electric Insulation Stripper provides a quick method of severing the insulation neatly without damaging the conductor, by means of an electrically heated wire. Full details are given in Folder Y.9, which also describes the range of SOLON Electric Soldering Irons and the SOLON Electric Solder Pot.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED, WESTCOTT • DORKING • SURREY

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post coupon now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE
2 The Mall, Ealing, W.5

(Post in unsealed envelope, 1d. stamp.)

Please send me free details of your Home-Study Mathematics and Radio Courses.

NAME...

ADDRESS...
W.W.32

WIRELESS set, brand new McMurdo Silver 15-17, wonderful job, the Rolls-Royce of the wireless world; what offers? expert will understand.—Reply Mills, 7, Valentia Rd., Hoylake, Wirral.

PRIVATE owner offers R.G.D. 26-valve television apparatus, complete and perfect last time used; the instrument, serial number 30003, new 1939, in cabinet (which is not for sale) cost over £100; price 30gns. or nearest.—Lethbridge, "Brackenedge," Ashtead, Surrey. Tel. 328. [3014

McMURDO-SILVER Auto Radiogram. 22 valves, special gramo. pre-amplifier, hypersensitive p.u., many features, massive cabinet; Voigt corner unit, all accessories; Avo 7 meter, valve tester, bridge, etc.; H.M.V. record player, ac, with special p.u.; s.a.e. details.—Offers to Gordon, 83, The Hill, London, S.W.19. [3004

Wanted

WANTED, Philips car radio.—Details and prices to Conway and Cutts, High St., Ecclesfield, Sheffield. [2962

WANTED, McMurdo-Silver or Scott radiogram or radio.—John Steel, Longwood Hall, Bingley, Yorks. [2876

AMPLIFIER (230v ac), 2 microphones, 1 loudspeaker, suitable for operating small p.a. system.—Box 3186. [2952

WANTED, Hallicrafter, National, or R.C.A. with matched speaker.—37, Cranborne Rd., Potters Bar, Middx. [2997

WE offer cash for good modern communication and all-wave receivers.—A.C.S. Radio, 44, Widmore Rd., Bromley. [1541

WE buy all types of used radiograms, radios, amplifiers, converters, test meters, motors, pick-ups, all radio and electrical accessories, etc.; we call and pay spot cash.—Tel. Eust. 1966, or Ger. 4447. University Radio, Ltd., 238, Euston Rd., N.W.1. [2993

NEW LOUDSPEAKERS

NEW Broadcast P.M. loud-speakers, 3 models; 12in. 12watt 15,500 lines, 1¾ dia. voice coil; 12in 25watt 18,000 lines, 1¾in dia. voice coil; 15in 40watt 18,000 lines, 2½in dia. voice coil; machined and precision built instruments, Ticonal magnets, detachable diaphrams, die-cast chassis, uniform response, accuracy, tonal quality, appearance and finish; superior standards in fidelity, sensitivity, prompt deliveries; specifications and illustrations upon request.—Broadcast & Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich. [2537

£5/15 only.—Brand new Baker super Quality 12in Auditorium permanent magnet speaker with triple cone, manufactured by Bakers Selhurst Radio, the pioneer manufacturers of moving coil speakers since 1925, wide frequency range, even response, ideal for quality reproduction, fitted with magnet having exceptionally high flux density in the air gap, suitable for public address equipment when quality reproduction is first consideration; send 2½d. stamp for leaflet giving details of above and constructional details of a new acoustic chamber designed to extend loud speaker frequency range; also constructional details of an infinite baffle cabinet; every music lover interested in realistic reproduction should write for leaflet.

£8/15 only.—Brand new Baker super power cinema permanent magnet speaker with 18in triple cone of new design, giving wide frequency response free from objectionable resonances; speech is clear and natural and music is reproduced with exceptional realism; fine engineering job, extremely sensitive, ideal for public address equipment when power handling capacity plus realistic reproduction is required.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. Tel. Croydon 4226 for demonstration. [2773

LOUDSPEAKERS SECONDHAND

B.T.H. RK, 10in cone, 15ohms speech, built-in rectifier, 200-250v ac; £6/10.—Fairbank, 271, Grovehill, Beverley. [2971

ROLA G.12, 15ohm, 2,000ohm and field supply unit, 200-250v ac mains, as new; offers.—Stoyle, 5, Burlington St., Bath. [2978

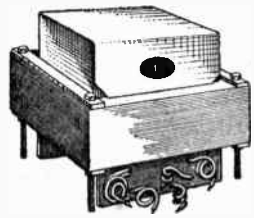
M.C. speakers, Ferranti 8in, 6-12v field; Webson 10in, 200-250v field; also capacity resistance bridge, with Magis Eye and 0.5mA meter and power supply; offers.—Service Engineering Co., St. Asaph, Flints. [2950

DYNAMOS, MOTORS, ETC.

E.D.C. converters, 11v input, output 500v, 80mA, with filters, as new; £5/10.—Henry's, 5, Harrow Rd., Paddington, W.2. Pad. 2194. [2991

ALL types of rotary converters, electric motors, battery chargers, petrol-electric generator sets, etc., in stock, new and second-hand; supplied against priority orders only. WARD, 37, White Post Lane, Hackney Wick, E.9. Tel. Amherst 1393. [1988

G.L. PRODUCTS



TRANSFORMERS

Sub-chassis mounting completely shrouded.

Revised Prices

TYPE		
A	350v. 100ma., 4v. 2a. and 4v. 4a. ct.	28/6
B	350v. 100ma., 5v. 2a. and 6.3v. 4a. ct.	28/6
S	350v. 100ma., three 4v. 2a.	30/-
T	350v. 120 ma.(3) 4v. 2a. and 4v. 4a.ct.	36/6
W	425v. 150ma. (2), 4v. 2½a. and 4v. 6a. ct.	45/-
X	350v. 120ma., 4v. 2½a. and 4v. 6a. ct.	39/6
Y	350v. 120ma., 5v. 2½a. and 6.3v. 6a.ct.	39/6
Z	500v. 150ma., 4v. 3a. and 4v. 6a. ct.	43/6
AZ	500v. 150 ma., 5v. 3a. and 6.3v. 6a.ct.	43/6
K	450v. 200ma., 0/4/5v. 3a., 6.3v. 6a. ct.	45/-
E	200v. 60ma., 4v. 2a. (eliminator)	21/-
LT4	Valve heater only, 4v. 6a. ct......	30/-
LT6	Valve heater only, 6.3v. 6a. ct....	30/-
OP12K	Multi-ratio output. 50 watts...	47/6
KIV3	Intervalve driver. 3/1	35/-

Surface mounting types, ask for "C" range.

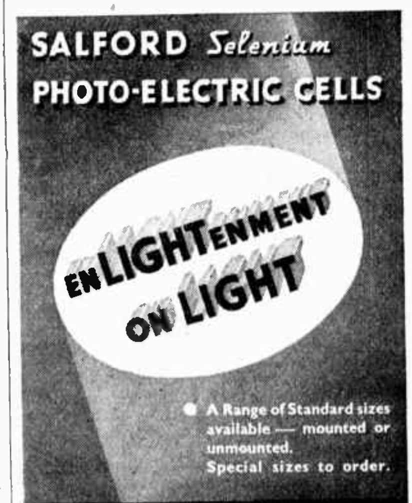
Complete catalogue and data charts available. (2½d.)

THE RADIO INSTRUMENT CO.
(G. L. PRODUCTS)
294, BROADWAY, BEXLEYHEATH, KENT
Bexleyheath 3021

TESTOSCOPE

indispensable to Radio Service Engineers. Makes 20 tests. Interesting Booklet on request. From all Wholesalers or direct. Send for leaflet R14.

RUNBAKEN -- MANCHESTER -- 1



Please address enquiries to:-
SALFORD ELECTRICAL INSTRUMENTS LTD.
PEEL WORKS, SALFORD, 3
Telephones: BLAckfriars 6688 (6 lines). Telegrams and Cables: "SPARKLESS, MANCHESTER"
PROPRIETORS: THE GENERAL ELECTRIC CO. LTD., OF ENGLAND

ELECTRADIX dynamos and motors at bargain prices, dynamos, ht and lt G.E.C. double current, 6v and 600v, weight 17lb. 37/6, pkg. and carr. paid; supplied Eng. and Wales only; refund 5/- on returned cases; D.C. motors, 1-5th hp and 1¼hp dc motors, enclosed, silent, 220 to 250v, 1,500 revs, double-end ½in shaft, first grade make, guaranteed, 1-5th hp, £3/10 each; ¼hp, £4 each; all carr. paid Eng. and Wales; others in stock.—Electradix, 214, Queenstown Rd., Battersea, London.

ROTARY converters in stock.—E.D.C., inputs 36v, 50v, 110v dc, output 230v ac, 250w, £12/10; Janette, 110v dc to 110v ac, 500w, £15; Crypto, 200v dc to 110v ac, 500w, £15; Crypto, 75v dc to 230v ac, 1,500w, £25; Crypto, 250v dc to 110v ac, 1,500w, £25; Crypto, 200v ac to 100v dc, 100w, £4; Neco, 220v dc to 12v 12a dc, £4; Neco 200v ac to 16v 24a dc, £15; Crypto, 240v ac to 15v 5a dc, £8; also others; send stamp for lists, which are available under following sections: Battery Chargers; Dynamos; Transformers; Generating Sets; Rotary Converters; Starters and Resistances; Radio and Switchoard Meters; Switchgear.—Harris, Strouds, Bradfield, Berks. [2987

TEST EQUIPMENT

AVOMETER, Model 40, good condition; best offer secures.—Box 3198. [2995

WEARITE oscillator and ac/dc Multimeter, as new; £20 the two.—Box 3199. [2996

METER, Heayberd, 3a, 3-30-300mA, 6-60-240v; £4/15.—14, Windsor Bridge, Salford, 5.

STANDARD oscillator unit 401; output meter 402, disposal.—Uplands 2525. [2977

AVO model 40, 1943, perfect; £18; no offers.—Box 3195. [2976

MITCHAM (MULLARD) service sig. generator, type G.M. 2880F, as new; £20.—11, Hawthorn Rd., Ashington, Northumberland.

0-1mA, 2¼in Taylor, as new, 70/-; 0-1mA, 3¼, Power Equip. Co., unused, 65/-; Weston galvo., 30-0-30, 30/-; Ferranti AF3, 15/-; AF5, OPM3, 20/-.—Box 3200.

FERRANTI radio meter, type No. 20 S.P., 7.5 and 150v, 200ohms per v, 30mA, portable, with switch and leads, in case, as new; what offers?—76, Burghfield Rd., Reading.

TESTOSCOPE, indispensable to radio service engineers; makes 20 lists; interesting booklet on request; from all wholesalers or direct; send for leaflet "R.1."—Runbaken, Manchester, 1. [2702

45-RANGE ac/dc Multimeter kits, with 1,000 o.p.v. meter; would the many enquirers for these kits please note that a further limited number will be available at an early date?

OTHER test apparatus in kit form: RF oscillators, R. & C. bridges, valve voltmeters, signal tracers, etc. To ensure prompt reply, please state requirements, enclosing s.a.e.—Maclachlan and Co., Strathyre, Perthshire.

FOR sale, Philco all-purpose tester, model 048, in perfect condition, £18; Ferranti 2½in 500 microamp meter, perfect, £3/15; 4 doz NSF 0.1 condensers, 350v, £1/5; Ferranti 2in 0-50mA m.c, £2.—Box 3183. [2948

Wanted

AVOMETER 7, in perfect condition; c.o.d.—Eastholme, Bigby Rd., Brigg. [2983

AVOMINOR universal meter required.—Particulars, Biggs, 37, Bentley Rd., Nuneaton.

CAPACITY and inductance adaptor for Model 83A Taylormeter wanted.—Box 3196. [2986

S.T.C. c.r. tube, 4050AG or similar, 4½in dia. 12¼in long; sig. gen., all wave.—Box 3205 [3013

AVO Model 7, urgent, R.A.F. ex-Serviceman offers £20.—Rosedene, Scagglethorpe, Malton, Yorks. [2981

OSCILLOSCOPE sig. generator, a.c., and set analyser, with all adaptors.—Griffin, Torbay, James St., Earl Shilton, Leics. [2966

NEW MAINS EQUIPMENT

VORTEXION mains transformers, chokes, etc., are supplied to G.P.O., B.B.C., L.P.T.B.; why not you? Imitated but unequalled; orders can only be accepted against Government contracts.

VORTEXION, Ltd., 257, The Broadway, Wimbledon, London, S.W.19. Lib. 281.

Wanted

FOR Heayberd charger, new or good second-hand gas discharge rectifier valve, Tungar catalogue No. 68535, type 35, or 68534, type 34.—Box 3191. [2960

GRAMOPHONE AND SOUND EQUIPMENT

COILS for filters, tone controls, etc., transformers and chokes wound to your specification.—R. Clark, 30, Langland Crescent, South Stanmore, Middx. [2888

HEAVY p.a. equipment.—Transformers, 105-245v secondary, 500-0-500v, 7.5v, 6v, 4v, 0.306 kvA (Zenith); 240v sec., 1000-0-1000, 100mA, 10v 3a, 2.2v 5a (Philips); output 6,000w, loading 100mA, 6 sec. taps, 18w (Philips), choke 90hy 14w; nearest £30 plus carr., or individual offers invited.—V. R. C., 170, London Rd., Leicester. [3007

AUSTERITY RADIO LIMITED

CONSTRUCTORS' KITS

Delivery approximately One Month.

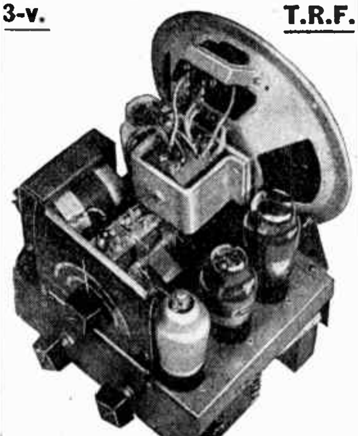
New Litz-wound coils are now supplied with these Kits which, when assembled, give good quality reception of B.B.C. programmes. Complete with chassis 8in. × 6½in. × 2½in., Valves, M.C. Speaker and wiring diagram. (Regret, no cabinets.) 3 controls.

A.C. 3-V. (+ RECTIFIER) KIT. V.M.H.F. Pen., Triode, L.F. Pen., Rectifier, M.C. Speaker. Price 10 gns. Post 1/1, plus 3/6 packing (returnable).

BATTERY 3-V. KIT. V.M.H.F. Pen., Triode Detector and Output Tetrode. P.M. Speaker, Price £7. Post 1/1, plus 3/6 packing (returnable).

Call and hear demonstration model.

3-V. T.R.F.



A.C. Kit Assembled. *No C.O.D. for Kit.*

ALL-WAVE PERMEABILITY OR MANUAL TUNED 10-way PUSH-BUTTON UNITS, complete with buttons. Superhet 465 Kcs. Now supplied with Colour Code and Blue Print. 30/-.

COILS. MIDGET AERIAL AND OSCILLATOR COILS, 465 Kcs. 10/6 per pair.

***SMALL AERIAL AND H.F. COILS.** Long and medium waves, with reaction. 10/6 per pair.

***SMALL AERIAL AND H.F. TRANSFORMER.** Long and medium waves (no reaction). 10/6 per pair.

*Circuit of 3 Valve Mains or Battery set given with each pair of coils.

MIDGET A. AND H.F. TRANSFORMER. Med. waves only, coil connections given. 8/6 per pair.

L.F. CHOKES, 50 m.a., 380 ohms, 6/-; 60 m.a., 500 ohms, 8/6.

PARALLEL FEED TRANSFORMERS. Midget ratio 3½ : 1, 6/-; 4 : 1, 6/-.

W.B. VALVE HOLDERS. 7-pin, chassis mounting. 10½d.

PAXOLIN PANELS. 12 × 9 × ⅛in. approx., 3/6.

2-GANG CONDENSERS. Standard .0005 mfd. Ceramic insulation. 12/6.

SHORT-WAVE COILS. 3 bands covering 12-50 metres. Aerial and H.F. mounted on screened switch. Wired up to terminal output connections. All numbered. 1½in. spindle. Complete with circuit. 20/-.

465 KCS. L.F. TRANSFORMERS. Iron-cored, unscreened, small, 15/- pair.

MAINS TRANSFORMERS. 350-0-350; 4v. 4 amp., 4v. 2 amp. Heater windings, centre tapped, shrouded, chassis mounting type. 30/-.

VOLUME CONTROLS. 10,000, 100,000 ohms, ¼, ½, 1 and 2 meg., with switch, 6/6 each. 5,000, 10,000, 25,000 and 50,000 ohms, less switch, 4/- each.

CHASSIS. Undrilled steel, painted, new, 10½ × 8 × 2½in., 7/6; 8 × 6 × 2½in., 4/6 each.

OCTAL CABLE PLUG AND SOCKET, 2/-.

TOGGLE SWITCHES. Miniature On-off, single pole, 2/6. Double pole, 3/-, also Radio-gram change-over switches, 2/6.

MAINS VOLTAGE DROPPING RESISTANCES. .2 a. 1,000 ohms overall, 6/-; .3 a. 750 ohms overall, 7/-, both with two variable sliders and feet.

307, HIGH HOLBORN, LONDON W.C.1. *Phone HOLborn 4631*

Wanted

HMV hypersensitive or similar gramophone pick-up.—Box 3204. [3010

HIGH-GRADE pick-up, needle armature or moving coil preferred.—Box 3202. [3005

H.M.V. or Marconi hyper sensitive needle armature (miniature needle type), pick-up.—Paterson, 47, Moor St., Coventry. [2972

MORSE EQUIPMENT

MORSE practice equipment for class-room or individual tuition; keys, audio oscillators for both battery or main operation.—Webb's Radio, 14, Soho St., London, W.1. Tel. Gerrard 2089. [2291

VALVES

ONE Gebescope photo-electric cell; £10.—Box 3187. [2953

COULPHONE RADIO, New Longton, near Preston, for a better valve service; all Tungsram and B.V.A. valves at present manufactured in stock; list prices. [2821

OUR adaptors will help in replacing unobtainable valves; send 7d. for interesting booklet on valve replacements; trade enquiries invited.—V.E.S., Radio House, Ruislip. [1885

VALVES. B.V.A., non-B.V.A., and American, list plus tax; many types in stock. The Simplex Four, theoretical circuit diagram of 4-valve m. wave, ac/dc, midget receiver, with all component values, standard material as offered, 1/6; midget aerial and h.f. high gain m. wave t.r.f. coils, 9/- pr.; midget, s.w., aerial transformer, and h.f. coil with reaction, mounted stand-off pillars, 5/6 pr.; standard coils, t.r.f. reaction, m. and l. boxed, with circuit, 12/6 pr.; midget chassis, de luxe, 10½×6½×2in, drilled 4 valves, sprayed grey, 9/6; standard ditto chassis, 10×4½×2in, 5/6; midget l.f. chokes, 50-60 mA, 7/6; heavy duty, 80mA 30 hy, 12/6; 120mA 25hy, 15/-; 300mA 30hy, 45/-; 0.5hy, c.t., 25/-; standard 2-gang, 0.0005mfd, var. cond., ceramic insul., A1 job, 12/6; paper block cond., high volt., 10mfd, 1,500v working, 20/-; tubular electrolytics, 2mfd, 350vw, 4/6; 12mfd 50vw, 2/6 50mfd 50vw, 3/6; paper, 1mfd, 10d., 9/- doz; 0.01mfd, 8d., 7/- doz.; midget speaker trans. (Pen), 7/6; heavy duty, 10w, 20/1, 10/6; line cord, 60 ohms foot, 0.3amp, 3-way, 6/6 yd.; 2-way ditto, 5/- yd.; heavy quality 5-way flexible cable, 1/6 yd.; droppers, 1,000 ohms. 0.2amp, var. taps, 4/6; 750 ohms 0.3a, 5/6; wire wound potentiometers, 2,000 ohms, 6/6; dials in colours, all-wave, 7×4in, 1/6; nuts, screws, 4BA brass, round heads, 7/- gr.; knobs, midget and standard, black or brown, 9d., 8/- doz.; brown, 2½in milled edge, 1/6; field coils, 400 ohms, 5/-; toggles, s.p.d.t., 3/6; d.p.d.t., 4/-; on-off, 3/-. Licence N. Ireland. 2½d. comprehensive list; s.a.e. enquiries; postage on all orders.—O. Greenlick, 34, Bancroft Rd., Cambridge Heath Rd., London, E.1. Stepney Green 1334.

Wanted

NEW boxed valves wanted, any quantity, dealers' and service men's complete stocks bought.—J. Bull and Sons, 246, High St., Harlesden, N.W.10. [2155

COMPONENTS—SECOND-HAND, SURPLUS

RADIOSALES, BCM/Sales, London, W.C.1, offer, post extra (list 1d.):—

RESISTANCES, all popular valves, ¼ watt, 4d; ½ watt, 6d; 1 watt, 9d each.

CONDENSERS, tubular, 0.0001 to 0.005, at 9d; 0.01 to 0.05, 1/-; 0.1 at 6d.

VALVE holders (Paxolin, chassis type), octal, 7-, 9-pin, 9d, 4- and 5-pin 6d.

VOLUME controls, 5,000, 10,000, 25,000, ¼, ½ M, without sw, 4/6, with 5/-.

MAINS droppers (with sliders), 1,000ohm 0.2amp, at 4/6; 750ohm 0.3a, 5/6.

MIDGET chokes, 15h 60mA, 7/6; Midget pentode speaker transf, 6/-.

SPEAKERS, 8in p.m., with transf, 30/-; Midget 3½in p.m., no transf, 30/-.

LINE cord, 0.2amp, 180ohms yd. per yd., 5/6; Systoflex, 4 yds 1/-.

CONDENSERS, 50 asstd, £1; resistors, 50 asstd, 15/-; pop. valves only. [2942

EXPERIMENTERS' surplus for sale, many useful components, cheap.—Box 3201.

PRICE list 1d., unequalled range; example, Yaxley 4-bank 6-way switches, 5/6.—Taylors, Macaulay St., Huddersfield. [2980

300 YDS 0.3amp 3-way line cord, perfect, 60ohms ft, 3/11 yd, plus postage; coil winder, valve tester, service gear, etc.; selling up. Box 3182. [2947

G. A. RYALL, 69, Wharfdale Gardens, Thornton Heath, Surrey. Goods advertised previous issue still available; mail order only; no c.o.d. under 20/-, please. [3008

A.C. mains 5-valve superhet chassis, push button, 1940 model, with speaker, less dial, £12; straight 4-valve chassis only 30/-. A.F.5 15/-; 5 waveband coils with switch and 3 gang condenser, 465 kcs. new, 35/-; all carr. extra.—Nightingale, 31, Barmpton Lane, Darlington. [3011

SEXTON'S for SALES, SERVICE, SATISFACTION

"Here it is." Build the "WIZARD FOUR" radio receiver. No Mains Transformer, no chokes, no line cords. All components are readily obtainable from practically any radio dealer. Why wait until after the war? The "WIZARD FOUR" can be built at home without any previous knowledge of radio construction. Explicit instructions are given, theoretical circuit, point-to-point wiring diagram, component layout, and diagram for using alternate valves, 7-pin or octal base, showing readily the necessary connections and list of components with the correct specified values that are necessary to construct this "WIZARD FOUR." This circuit has been tested to the full and we recommend the "WIZARD FOUR" to you with every confidence. Send for complete instructions, 5s. post paid.

EXTENSION LOUD SPEAKERS. "Rola" 3 ohm. voice coil, size 5in., with trans., 29/6. "Rola" 3 ohm. voice, less trans., size 8in., at 24/-. "Celestion" 8in., with trans., at 29/6 each. "Goodmans" 3½in. 12 ohm. voice coil, ideal for microphones, communication sets, etc., at 30/- each. "Celestion" 10in. mains energised Speakers, 2,000 ohms field, 45/- each.

AMERICAN RADIO VALVES. At Board of Trade controlled prices. Types as follows: 25Z6GT, 5Y3, 80, 1N5, 6D6, 6C6, at 11/- each. 12Q7GT, 6Q7, 75G, at 11/7 each. 12SF5GT, 6F5GT, 6J5GT, 12J5GT, 1H5GT, at 9/2. 6L7G, 42, 43, 6F6, 6K7GT, 25A6GT, at 12/10 each. 6K8G, 6SA7, 6A8GT, at 14/- each, 6G5 (Magic Eye), at 14/8 each. Postage 4d. extra.

ELECTRIC IRONS. 200-250 volts AC/DC mains, 3-3¼ lbs. in weight, strong wooden handle, with plated dome, connector guard and rest, ground and polished sole plate, complete with 6ft. heavy flex, at 28/6 each. Please state voltage when ordering, very limited quantity available.

HOT NEWS. American Service manuals: Volume I, Sparton/Emerson. Volume II, Crossley/Belmont. Volume III, Crossley/Belmont (continuation): each volume contains comprehensive circuit diagrams and alignment sheets; complete with all particulars these booklets contain a large range of popular models exported to this country; all orders will be treated in strict rotation—quantity limited; 12/6 per volume.

TERMS: Cash with Order only. Send 1d. stamp and S.A.E. for latest list of electrical and radio accessories.

J. E. SEXTON & CO., LTD.
164, Gray's Inn Road, London, W.C.1.
Tel.: Terminus 1304 and 4842.

AFTER THE WAR!

The advance in Radio Technique after the war will offer unlimited opportunities of high pay and secure posts for those Radio Engineers who have had the foresight to become technically qualified. How you can do this quickly and easily in your spare time is fully explained in our unique handbook.

Full details are given of A.M.I.E.E., A.M.Brit.I.R.E., City & Guilds Exams., and particulars of up-to-date courses in Wireless Engineering, Radio Servicing, Short Waves, Television, Mathematics, etc., etc.

We Guarantee "NO PASS—NO FEE"

Prepare for to-morrow's opportunities *and post-war competition* by sending for your copy of this very informative 112-page guide NOW—FREE.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 388)
Stratford Place, London, W.1

SPEAKER REPAIRS—*by Specialists*

TRADE ONLY

Send trade card and 1d. stamp for current list published monthly.

We hold an export licence for Northern Ireland.

A.W.F. RADIO PRODUCTS
Borough Mills, Sharpe Street, Bradford, Yorks.
Tel.: 11926.

—WANTED TO PURCHASE—

A small or medium-sized Cycle and Radio Business (retail). Any district considered if well populated and with good post-war prospects. Full particulars in first instance to Box 3119, c/o *Wireless World.*

CHARLES BRITAIN RADIO (K. H. Ede) offers interesting bargains in radio.
SERVICE kits.—No 1, 1 8mfd 350v wkg. tubular and 4 of ea. 0.04, 0.01, 0.002 tubulars, 11/6; kit No. 2, 2 16mfd 350v tubulars, 1 60mA choke, 1 0.3 mains drop'r and 6 res., 30/6; kit No. 3, 2 8mfd 350v tubulars, 2 16mfd ditto, and 2 4mfd 500v ditto, 12 asstd. Mansbridge and 12 asstd. tubular cond., 45/-.
PUSH button units, 12-way, complete with knobs and escutcheon, 6/6 ea.; Midget t.r.f. coils, 8/6 pair; trimmers, 40-50mmf, single, 4/- doz., double 6/- doz.; tuning condensers, 0.0005 3-gang American and 4-gang Plessey, 8/6 ea.; Yaxley type wavechange switches, 3-pole 4-way, 2-pole 3-way and 4-pole 2-way, 3/6 ea.
PLATE glass dials, Cossor 3-band, 13½×5½, 2/6 ea.; H.M.V., 7¼×4½, 1/6 ea.; Cossor celluloid 3-band, 1/6 ea.; Midget dials, 3×4, 9/- doz.; chassis drilled for 4 valves, 10×4½×2, 5/6; chokes, 360 ohm 120mA, 9/6 ea.; vol. contls. less switch, 5,000, 10,000, 50,000, ¼, ½, 1 and 2 meg. (mostly Dubilier, 3/- ea.; ¼, ½, 1 and 2 meg. Morganite and Centralab, with switch, 5/6 each.
KNOBS, 1¼in dia. Brown, best qual. brass bush type, 7/6 doz.; Cossor knobs (no grub screws), 5/6 doz., or £3 per gr.; Multicore solder, per 1lb reel, 5/3; tinned copper wire, in ½lb reels, 16, 18, 20 and 22 s.w.g., 2/6 ea.; solder tags, 2, 4 and 6 B.A., 1/6 per gr.; tubular condensers, prices per doz.: 1,000v test 0.1, 9/-; 0.05, 0.02, 0.01, 7/6; 0.005, 0.002, 5/6; mica conds., 0.01, 1/-; 0.002, 0.001, 7/-; 0.00015, 0.0001 and 0.00005, 6/-; valve-holders, British 5.7 and oct., American 4, 5, 6, 7 and oct., 7/6 doz.; grid clips, 1/- doz.; Telsen S.M. disc drives, 2/- ea.; Telsen speaker units, 5/- ea.; heavy duty spkr. trans., 8/6.
THIS month's special offer: 10-way push-button units, complete with all-wave coils, trimmers and padders, ex R.G.D. (few only), 25/- ea. Terms, cash, or c.o.d. over £1.—Charles Britain Radio (temp. address), "Eureka" Surrey Gardens, Effingham, Surrey. [2979

LASKY'S RADIO.—Small screwdrivers for grub screws, etc, 4in blades, 1/3; 1-watt resistances, 36 on a card, from 250 megohms to 1.8 meg, 22/6 card; 3 gang condensers, mounted on push-button unit with 8 buttons, few only, 27/6, as new; 2mfd 700vw condensers, block paper type, 2/6; 0.3A mains droppers with fixing feet, 800 megohms, variable, 5/9; 0.2A, 5/6; 1,000 megohm; knobs all sizes in stock, 7/6 and 8/9 doz; 1oz reels, ½ and 1in insulating tape, 9d. reel; and many other items, mains and speaker transformers, etc.; 1d. stamp for price lists.—Lasky's Radio, 370, Harrow Rd., Paddington, W.9. [2893

B.A. thread screws and nuts, 1 gross asstd., useful sizes, 2/6; ditto brass washers, washers, 1/6 gross; fibre washers, 1/6 gross; asstd. solder tags, 2/- gross; asstd. small eyelets and rivets, 1/3 gross; rubber-covered stranded copper wire, 1d. yd; heavier quality, 1½d. yd; very heavy quality, 2½d. yd; ideal for aerials, earths, etc.; tinned copper connecting wire, 20ft coil, 6d.; ditto, rubber-covered, 10ft coil, 6d.; braided twin electric cable, 6d. yd.; finest quality resin-cored solder, ½lb 2/-; Wood's metal stick, 2½in×¼in, 1/-; cotton-covered copper instrument wire, ¼lb reels, 18, 20, 22, 24 gauges, 1/6; 26 gauge, 1/9; 42 gauge, d.s. covered, 2oz reel, 2/-; 36 gauge ditto, 1/9; sensitive permanent crystal detectors, Tellurium-zincite combination, complete on base, guaranteed efficient, 2/6; reliable crystal with silver catswhisker, 6d.; reconditioned headphones, complete, 4,000 ohms, 12/6; all postage extra.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [2896

ELECTRIO soldering irons, pencil bit, 12/6; resin cored solder, 1lb 4/6; 18g tinned copper wire, ½lb, 2/-; 2mm sleeving, 2/9 doz yds; pushback wire, 1/9 doz yds; heavy twin mains flex, 7/6 doz yds; rubber-covered 3mm flex, 1/9 doz yds; 50mfd 12v electrolytics, 2/-; 10mfd 50v can type, 2/9; 0.2 amp 1,000 ohm droppers, adjustable, 4/-; 0.3 amp 750 ohm, adjustable, 5/6; American octal valve-holders, 8d.; British 7-pin, 8d.; 0.1mfd 350v condensers, 6/6 doz; black set knobs, 7/- doz; solder tags, 2/- gross; "Clix" 2-pin plugs, 5 amp, 1/-; 3-pin 5 amp, 1/3; 3-pin 15 amp plugs, 2/6; BC adaptors, 1/3; volume controls, long spindles, all usual values, 3/6; with switch, 4/6; top cap connectors, 1/- doz; screened type, 8d. ea.; octal or standard; insulation tape, ¼lb 1/-; speaker cabinets, leatherette covered, smart job, 12in×10in×5in, 22/6; p.m. speakers, 8in, no trans., 22/6; 8in, with pentode trans., 30/-; midget smoothing chokes, 60ma, 7/6; "Meico" moving coil microphones, £5/5; 100ma 20h chokes, 10/6; large stocks American valves, etc.; mail order only; orders above 10/- post free.—"A. H.," Hazeljohn, Crofton Lane, Orpington. [2927

SPECIAL AUTUMN PRICE OFFERS!

New Series of Transformers exclusive to Waveband Radio.

AUTO Transformers, 75 watt, ONLY 19/6 ea.

AUTO Transformers, 100 watt, ONLY 22/6 ea.

Replacement Transformers of very finest manufacture:—

350-0-350v., 4v. 4a., 4v. 2½ amp. at 120mA., 35/-; at 80mA., 31/- (worth double this price. Quantity limited). 6v. Heaters also available at same prices.

HEAVY DUTY CHOKES, 30hen. 120mA., 14/6. 30hen. 60mA., 7/6.

KITS of brand new wire-end **CONDENSERS,** all values up to .5 mfd. Full guarantee with every Condenser KIT of 50, for 30/-.

VOLUME CONTROLS. Every value in stock. With switch, 5/9; Less switch, 3/6. Bakelite knobs for these, with grub screw, 8d.

SLEEVING. Metal braided sleeving, 8d. yard.

DROPPER RESISTORS with 2 var. sliders and feet, .3 amp., 5/9; .2 amp., 5/-.

RESISTORS from 25 to 2,000 ohm, 5 watt, 1/6; 10 watt, 1/9.

TOGGLE SWITCHES. Single hole, 3 amp., "ON-OFF," 2/6. S.P. Change-over, 3/-. D.P. Change-over, 5/-. D.P. "ON-OFF," 4/9.

CROCODILE CLIPS, per dozen, 4/6.

Technical Publications. *See page 26, Aug. issue.*

EXCLUSIVELY MAIL ORDER.

WAVEBAND RADIO LTD.
Egyptian House, Piccadilly, London, S.W.I

—"UNIVERSAL CIRCUITS"—

by R. S. Roberts, M.Brit.I.R.E., A.M.I.R.E.

Three folders and a thirty-six page booklet, presenting the main principles of radio circuit operation in a concise and convenient form for the pocket.

I. The Transmitter.
II. The T.R.F. Receiver.
III. The Superheterodyne Receiver.

By means of hinged flaps, the charts give a large number of recognised alternatives for each stage. To assist the student in memorising and understanding these, a logical five-colour scheme has been adopted throughout.

"Grid Leak" says: "The Charts and Notes are really intended for students and teachers of radio, but are extremely useful to every radio engineer."

Price complete **6/3** *post free, from*

The Bookstall
NORTHERN POLYTECHNIC
HOLLOWAY, LONDON, N.7

During part of September we shall be closed for a well-earned rest.

VOIGT PATENTS LTD.

REWINDS

MAINS & OUTPUT TRANSFORMERS, FIELD COILS, PICK-UP COILS, ARMATURES PROMPTLY EXECUTED

Philips and Ekco D.C. Converters bought, sold and exchanged. Valves, B.V.A. and American, good stocks. Send stamped addressed envelope for price list

A.D.S. Co. 261-3-5, Lichfield Road, ASTON, BIRMINGHAM, 6

RI Transformers

FAMOUS THROUGHOUT THE WORLD

There is a type for every radio purpose, and it is the right type. Satisfaction assured if it bears our name.

RADIO INSTRUMENTS LTD.
Purley Way, Croydon.

YOUR Speeds?

Should you chance to be one of those unfortunate W/T Operators who despite hours of long practice cannot raise your w.p.m. speed beyond a certain point, then you will be doing yourself a good service by writing for the CANDLER "BOOK OF FACTS." This gives full details of the Candler System of Morse Code training ; it is Free and does not place you under any obligation.

YOU will be interested in the ADVANCED COURSE. Read the following extracts from three Candler students' letters.

"I can now read plain language at about 30 w.p.m. and copy at this speed. . . . My ability to copy behind has also increased lately, and copying press is now a pleasure instead of a somewhat trying job." *J. E. L. Ref. 152.*

"I can now send at a comfortable 30 w.p.m. and can read quite long sentences at a speed just under that." *J. C. B. Ref. 8794.*

"My code speed has increased 8 w.p.m. and my sending is more regular. I can copy four letters behind now, and it comes in very handy at busy times." *M. B. W. Ref. 1447.*

NOTE.—This student has just completed the fourth lesson of the Advanced Course.

Originals of above may be inspected at London Office.

THERE ARE CANDLER MORSE CODE COURSES FOR OPERATORS AND BEGINNERS.

(For further details see advertisement, p. 26, August issue.)

Send for free 'Book of Facts.'

THE CANDLER SYSTEM CO.
(Room 55W), 121 Kingsway, London, W.C.2.
Candler System Co., Denver, Colorado, U.S.A.

HENRY'S offer.—T.C.C. 2mfd 1,000v wkg, 7/6; T.C.C. 1,000mfd, 25v wkg, 10/-; T.C.C. 1mfd 200v wkg, small type, 2/-; 1mfd 400v, wkg, 3/-; T.C.C. block con., 450 v wkg, 4×4×2×2×2×1×0.5mfd, 17/6; 3in wire-wound instrument rheostats, 500 ohms, 8/6; small 3-gang 0.0005 ceramic ins., 10/-; 2-gang ceramic ins., 12/-; med. T.R.F. coils, med. wave, 6/6 pr.; med. and long wave, 8/6 pr.; twin mains h.f. sup. chokes, 3/6; Goodmans 3½ft. p.m. speaker, 27/6; trans. to match, 7/6; 0.2 line-cord, 2-way, 750 and 900 ohms lengths, 10/-; trans. for midgets, input 110-230, output 170-0-170v., 6.3v and 5v, 25/-; all the above new and unused.—Call or write, Henry's, 5, Harrow Rd., Paddington, W.2. Pad. 2194. [2990

MATHEW BROS. offer rubber covered flexible wire: 9-30 single-tinned copper, insulated para rubber and vulcanised, 3mm o.d., 5/- per lb, 90ft to a lb; 14-30 single-tinned copper, insulated vulcanised rubber, 3mm o.d., 5/- per lb, 85ft to a lb; 44-30 single-tinned copper, insulated vulcanised rubber 4mm o.d., 2/6 per lb, 35ft to a lb; in coils of 50ft to 500ft; not less than 8lb in one lot, reduction for 1cwt lots.—Mathew Bros., 25, Sandy Lane North, Wallington. Tel. 4050.

COULPHONE RADIO, New Longton, nr. Preston.—New goods only; all Tungsram and B.V.A. valves at present manufactured; mains transformers, interleaved impregnated windings; screened primaries, 350-0-350v 100mA, 4v 6A, 4v 2½A, or 6.3v 3A, 5v 2A, 33/6; bobbins only, windings as above, 17/6; 425-0-425v 150mA, 4v, 8A, 4v 4A, 4v 4A, 52/6; smoothing chokes, 25Hy 150mA, 21/6; speaker field coils, 2,000 ohms, 9/6; speakers, p.m., less trans, 5in 21/6, 6½in 22/6, 8in 24/-, 10in 35/-; with transf, 8in 30/-, 10in 45/-; output transf. power-pen, 40mA, 8/6; push-pull power-pen, 80mA, 18/6; push-pull extra H.D., 100mA, 37/6 Rola push-pull, 15/6; mains dropper resistors, 800 ohms 0.3A, 2 varitaps, 5/6; push-back wire, 50ft 3/-, 100ft 5/6; tinned copper wire, ½lb, 2/3; 2mm sleeving, 3d; resin-cored solder, lb 4/6; bias condensers, 25mfd 25v, 50mfd 12v, 2/-; 12 mfd 50v, 2/-; 4mfd 1,000v dc working paper condensers, 12/6; tuning condensers with trimmers, 0.0005, 2-gang 10/6, 3-gang 12/6; screened M. and L. wave coils, t.r.f., 6/6; Parafeed l.f. transf, 4 : 1, 6/6; quality p.-p. l.f. transf, split secondaries, 2 : 1, 22/6; h.f. chokes, 1/9; carbon resistors, 50 ohms to 5 megohms, ½w 6d, 1w 9d; switch cleaner, 2/6 bottle; vol. controls, less sw, 4/9; with sw, 5/9; Pyrobit pencil bit electric soldering irons, 21/-; grid clips, 8l doz; valve-holders, Eng. and Amer., 1d per pin; smoothing iron elements, 450w, 2/3; fire spirals, 750w 2/-, 1,000w 2/6; shaft couplers, 6d; 1in knobs, 9d; single-screened cable, 10d yd; all sizes tubular and mica condensers, limited quantity, 3¼in dial, 0-1mA m.c. milliammeters, B.S. 1st grade, 70/-; send s.a.e. for the best service list available; no c.o.d.; all orders over 5/- post free, post 6d extra under 5/-.

SOUTHERN RADIO'S wireless bargains.—Standard Telephone carbon microphone inserts, 4/- each; screws and nuts, assorted, gross of each (2 gross in all), 10/-; soldering tags, including spade ends, 6/- gross; 2mfd condensers, Post Office upright, paper type, used, but fully guaranteed, high working voltage, 12/6 each; Philco 3-point car aerials, excellent for short-wave and home aerials, 7/6; limit tone arms, universal fitting, for sound boxes and pick-up heads, 10/-; Ace P.O. microphones, complete with transformer, ready for use with any receiver, 7/6; Erie resistances, brand new, wire ends, ¼, ½, 1 and 2 watts, mostly low values but a very useful selection, 100 resistances for 30/-; Multicon mica master condensers, 28 capacities in one, from 0.0001, etc., etc., 4/- each; special offer of latest radio publications; "Radio Valve Manual," equivalent and alternative American and British types, with all necessary data, 3/6; "Radio Circuits," fully illustrated, receivers, test equipment, etc., etc., 2/-; "Services Signalling Manual," international code, Morse, etc., etc., 1/-; "Radio Manual," formulas, tables; colour code, etc., 1/-; crystals (Dr. Cecil), 6d.; with catswhisker, 9d.; complete crystal detectors, 2/6; Telsen reaction condensers, 0.0001, 1/9; Telsen large disc drives, complete boxed (type W184), 2/6; 25 yards push-back insulated wire, 5/-; insulated sleeving, assorted, yard lengths, 3/6 doz.; single screened wire, dozen yards, 10/-; metal cased condensers, 0.1, 0.1, 0.1, 2/6; power rheostats, Cutler-Harmer, 30ohms, 4/6; push-button switches, 3-way 4/-, 8-way 6/- (complete with knobs); bakelite escutcheon plates for 8-way p.b. switches, 1/6; knobs for p.b. switches, 6d.; coil formers, ceramic and paxolin, 12 assorted sizes, 7/6; 20 assorted tubular condensers, up to 0.1, 15/-; 24 assorted mica condensers, 12/6; hundreds more bargains.—Southern Radio Supply Co., 46, Lisle St., London, W.C. Gerrard 6653.

— ELECTRADIX —

LAB. AND TEST GEAR

OMNISELECTOR VALVE TESTER, AC/DC 18 ranges, 8 valve sockets, single meter. **READ-RITE TESTER,** 9 ranges AC/DC and ohms, 3 meters, 4 valve sockets, 5 valve plugs and selector **SIEMENS TESTER,** 6 ranges AC/DC volts, and m/a, one meter. **PYE TRIMEASY** Signal Gen, 12/3,000 metres. **STANDARD TELEPHONES** Impedance matching test set.

L.R. BRIDGES, .05 to 100 ohms. G.P.O. **LAB. RES. BOXES,** as illus., 10 to 4,000 ohms and 20 to 8,000 ohms. **MIRROR GALVOS.,** reflecting suspension by Sullivan and Tinsley, with scales. **SIEMENS** High Speed Relays, new fine work. Complete range of small relays. **G.P.O.** vertical circuit test Galvos., 35/-. A few Bridge Meggers with decade 10,000 ohm res. boxes, all need reconditioning. New "Avo" A.C. Bridge Res. and Capacity. **RADIOGONIOMETER** Direction Finders and Morse recording tape inkers. Elliott Testers, 0-3 amp., moving coil with rheostat in case, 55/-. **CAMBRIDGE TOWNSEND BUZZERS** are difficult to get. The highest note and smallest Buzzer made, used by Government on wavemeters, ample platinum contacts, 10/-. **Other Buzzers:** Practice, bakelite-cased, 3/6. Square metal-cased buzzer, 7/6. **G.P.O.** round Desk Bells, 10/-.

INSTRUMENT CASES, metal, with hinged lid, 8¾"×4¾×5¼", well finished, ex-W.D., 10/-. Base covers, light ventilated metal, arched, contains 6¼"×5" with terminal extension, 3/6. Leather cases for galvos., etc., various sizes, 2/9.

POWER TRANSFORMERS. 150 watt Foster 400 cycles, 230 volts to 15 volts C.T., 10 amps., £3. 500 watt Foster, 440 volts 50 cycles to 110 volts, 5 amps., £4/15/-. 1 kW Powquip, 250 volts 50 cycles to 50 volts, 20 amps., £9. 3 kW Metvick, 400 volts 50 cycles to 600 volts, oil, £9/10/-. 4.3 kW Foster, 400 volts 50 cycles to 60 volts to 72 amps., £12.

TEST TRANSFORMERS, 5 watt 110/220/1,000 volts, 10/-. **Deaf Aid** ten guinea sets, S.H., for reconditioning, Ardente and other first class makes, less battery and plug cord. **Lapel Mike** and earpiece, etc., in pocket case, 45/-. **Marconi Otophone** 2-valve voice amplifier, S.H., with valves ; list £25, less batteries, £5.

FUME EXTRACTOR AIR PURIFIERS, 25 cub. ft. approx., with large filter chamber, all steel, 15½"×20½"×14", with intake down shaft. Geared hand drive or 1/6th h.p. motor. Suit laboratory or works.

MOTOR PUMPS. We can give immediate delivery of the famous Stuart Turner 12-volt D.C. motor pumps ; 120 galls. per hour, 84/-. Same type but for A.C. mains, 136/-. Pumps only : R type twin-piston rotary for ¼ h.p. motor drive, £3/5/-. Aquarium aerators, £5.

AUTO SWITCHES, magnetic trip thermal delay, 10 amps., double or triple pole, 25/-. 250 amps., £4. Battery auto cut-outs, 8 amps. 6 volts or 12 volts, Lucas, 10/6. Contactors and other autos quoted for.

SWITCHES. G.P.O. Lab. Switches, D.P., fine job, up to 10 amps. reversing, 4" base, 7/6. Knife A and E type, single pole C.O., 1/6. Double pole On-Off, 1/9. Double pole C.O., 2/6. 100 amp. S.P. with fuses, 22/6. 200 amps., 40/-. 5 amp. ironclad tumbler, 2/9. Linked tumbler, 5 amps., 2/6. 10 amps., 3/2. Multi-contact R.I. 7-stud 5 amp. on ebonite panel, teak box base, 4½"×4½", 7/6. Lucas 6-way lever handles in line with box back, 3/-. Ditto 8-way, 3/9. 6-way push button A.M., 2/9. Rotary Hart snap switches, 2-way or On-Off, 10 amps., 4/-; 15 amps., 5/-.

RHEOSTATS "AETNA" panel switch rheos. to 1 ohm and off, 6 volts 3 amps., with bulb in knob, 2/6 each, postage 6d. Slider rheos. for all currents ; heavy grid 40 amp. 10-stud control, 240 volts to 45 volts, 33"×16"×14", £5/10/-; smaller for 110 volts to 45 volts, £3/10/-. Pitkin Lab. rheos., circular 8" glass front, 50 ohms 2 amps., 35/-.

Please include postage for mail orders.

ELECTRADIX RADIOS
214, Queenstown Road, Battersea, London, S.W.8
Telephone MACaulay 2159

LASKY'S RADIO 370, HARROW RD., PADDINGTON, W.6

(Opp. Padd. Hospital.) Phone: Cunningham 1979.

Small 2 mfd. block paper Condensers, 700 v.w., at 2/6 each.

THIS MONTH'S SPECIAL OFFERS

24 assorted Condensers, consisting of 8 mfd. 500 v., 4 mfd. 200 v., 16 mfd. 350 v. (can type), 2 mfd. 500 v., 1 mfd. 500 v., .5 mfd. 250 v., .25 mfd. 350 v., .05 mfd. 500 v., .1 mfd. 350 v., .01 mfd. 500 v., etc., etc. All for £2. Post free.

SATISFACTION GUARANTEED.

3 gang .0005 mfd. Condensers mounted on push button unit with 8 buttons, 27/6, few only. 4 v. mains transformers, 350-0-350, 120 mA., 35/- ea., and 6.3+S volt heaters, 37/6. Small crocodile clips, 3/9 doz. Cards of 114, ½ watt resistors all marked and useful values, £1 12s. 6d. per card.

Servisol at 5/- per tin, Systoflex, assorted, at 2/3, 2/6 and 3/- doz.

Volume Controls, ¼, ½ and 1 meg. less switch, at 2/9 each; with switch, 5/9 each. .2 and .3 amp. mains droppers, 4/9, 5/9 and 7/6 each. .3 amp. 3-way line cord, 70 ohms, per foot, best quality, at 5/9 yd.

Slow Motion Dial and Drive Escutcheon type, 2/6 each. Resistors, assorted, Kit of 48 ¼, ½ and 1 watt, at £1 lot.

Smoothing Chokes, Midget type, 650 ohms 60 mA., 6/6 each; larger type 180 ohms 160 mA., 15/6 each. Medium and long-wave coils with reaction at 10/6 per pair. Universal Speaker Transformers, 7/6; class B and QPP, driver and output types, 9/6. Pentode S/Trans., 5/9 each. Solder, Resistances, tin copper wire, soldering irons, knobs, toggle switches, 2 and 3 gang condensers, etc.

SPEAKERS. Rola P.M., 5in., 19/6; 6½in., 21/6; 8in., 23/6 each. Goodmans 3½in. P.M., 27/6; 10in., 39/6 each.

Celestion 10in. P.M., with Transformer, 45/6. In stock, over 5,000 new boxed English and U.S.A. mains and battery valves at list prices. Send 1d. for our lists of mains transformers, etc.

Send us your requirement C.O.D., BUT CASH WITH ORDER PREFERRED.

FOR THE RADIO SERVICE MAN, DEALER AND OWNER

The man who enrols for an I.C.S. Radio Course learns radio thoroughly, completely, practically. When he earns his diploma, he will KNOW radio. We are not content merely to teach the principles of radio, we want to show our students how to apply that training in practical, every-day, radio service work. We train them to be *successful!*

INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 38, International Buildings, Kingsway, London, W.C.2

Please explain fully about your Instruction in the subject marked X.

Complete Radio Engineering
Radio Service Engineering
Elementary Radio Television

And the following Radio examinations:

British Institution of Radio Engineers
P.M.G. Certificate for Wireless Operators
Provisional Certificate in Radio Telephony and Telegraphy for Aircraft
City and Guilds Telecommunications
Wireless Operator & Wireless Mechanic, R.A.F.

Name.................................... Age.........

Address ....

....

FERRANTI transformers, A.F.3 10/, A.F.5, A.F.15C, O.P.M. 1, O.P.M.5, 15/- each; Novotone tone control tran., type M, 25/-; Ferranti p.m. speaker, M.1, £4; Hartley Turner speaker, 2,500ohms field, £5; Mallory Vibrapack, 6v to 250v 60mA, £3; Clarkes' Atlas ac-dc converter, 230v ac to 230v 120mA dc, £3. Moseley, 173, Tredworth Rd., Gloucester.

METAL rectifiers, trickle chargers; l.t. metal rectifier, 2v 0.5amp, complete with suitable trans., makes ideal trickle charger for 2v cell, 13/6, post 7d.; instrument rectifiers for meters, bridge type, bakelite, best make, 1ma, 5ma, 18/6, post 3d.; 10ma, 50ma, 15/6; trans., rectifier, ballast bulb for 2v to 12v 2.5a charger, 59/6, post 10d.; rectifier only, 34/6, post 7d.; trans. and rectifier for 2v to 12v half amp charger, 34/6, post 9d.; rectifier alone, 10/3; trans, rectifier and ballast bulb for 2v, 6v, 2amp charger, 42/6, post 9d.; ditto lamp 34/6, ditto half amp 29/6; rectifier only for 6v half amp charger, 5/9, post 3d.; l.t. trans., prim 230v, sec 10v, 14v, 21v at 2.5 amp, 26/-, post 9d.; Rothermel "Bullet" crystal mikes for stand mounting, reproduction equal to D104, tilting mount, £3, post 9d.; m.c. mikes, very heavy, robust model in plated housing, £5/10; miniature crystal mikes for deaf aids, lapel fitting, 42/6; milliammeter, 1ma, full scale, 65/-.—Champion, 43, Uplands Way, London, N.21.—Tel. Lab. 4457. [3012

Wanted

FORMO 2-coil unit, Max transformer, Contact copy or blue print or 1-V-1 for Merchant Navy seaman. Price to Armstrong, c/o 8, Giffnock Park Av., Giffnock, Glasgow. [2944

REPAIRS AND SERVICE

LOUDSPEAKER repairs, British, American, any make; moderate prices.—Sinclair Speakers, 170, Copenhagen St., London, N.1. Terminus 4355. [2415

ACCURATE radio rewinds, mains transformers, fields, op. transformers, etc., and all loudspeaker repairs.—Southern Trade Services, 297-299, High St., Croydon. [2882

ALL types of radio receivers serviced; Murphy and Pilot specialist; valves in stock; sound repairs for 13 years.—T. E. Fevyer, F.I.P.R.E., 50, Vine St., Uxbridge.

"SERVICE with a Smile."—Repairers of all types of British and American receivers; coil rewinds; American valves, spares, line cords.—F.R.I., Ltd., 22, Howland St., W.1. Museum 5675. [1575

MAINS transformers service, repairs, rewinds, or construction to specification of any type, competitive prices and prompt service.—Sturdy Electric Co., Ltd., Dipton, Newcastle-upon-Tyne. [9651

24-HOUR service, 6 months' guarantee, any transformer rewind; mains 15/6, outputs, 4/-; i.f. transformer, 3/-; all types of new equipment supplied to specification.—Majestic Winding Co., 180, Windham Rd., Bournemouth. [2764

REWINDS mains transformers, field coils and chokes, high grade workmanship, seven to ten days' delivery; new transformers manufactured against Government contracts.—Metropolitan Radio Service, 1021, Finchley Rd., Golders Green, London, N.W.11. [2603

MAINS transformers rewound, better than new, return of post service most common types; machine layer wound, interleaved and impregnated coils on bakelite formers, up to 70 watts, £1, post paid, c.w.o. or c.o.d. (trade enquiries subject); specials quoted by return; replacement bobbins for most popular makes, 15/6, post paid (state inside core sizes and valves when in doubt).—Radio Services, Field St. Works, Blackpool. R.T.R.A. Service members. Tel. 1774. [2985

DEGALLIER'S, Ltd.—"Service with a guarantee." If you cannot get your receiver serviced, let American specialists do the job; first-class workmanship only; specialising in Air-King, Belmont, Challenger, Detrola, deWald, Emerson, Ferguson Garod, Hallicrafter, Hammerlund, McMurdo, Midwest Majestic, Pilot, Philco, Sparton, etc., also any British set. Remember, for 15 years we have handled as distributors American receivers; this is self-explantory; s.a.e. with all enquiries.—Degallier's Ltd., 9, Westbourne Court, London, W.2. [2999

MISCELLANEOUS

WANTED, coil winding machine, with or without paper interleaver.—Details and price to Box 3193. [2961

TIME recorders.—Write for particulars.—Gledhill-Brook Time Recorders, Ltd., 84, Empire Works, Huddersfield. [2419

RUBBER stamps made up to your special requirements and design, typical example, stamp showing name, address and profession; 9/6 post free.—V.E.S., Radio House, Ruislip. [1884

CHASSIS trans. shrouds, clips and many other fittings quickly made on A.A. benders; accurate and inexpensive.—Details from A.A. Tools, 197w, Whiteacre Rd., Ashton-u.-Lync.

WELWYN

HIGH STABILITY CARBON RESISTORS

TROPICAL GRADE
TYPE APPROVED
CLOSE TOLERANCES
LOW TEMPERATURE COEFFICIENT

WRITE FOR CATALOGUE TO-

WELWYN ELECTRICAL LABORATORIES LIMITED
WELWYN GARDEN CITY · HERTS
TELEPHONE: WELWYN GARDEN 3816-8

OR INSTRUMENT MOUNTINGS a few types of which are illustrated, have been specially developed to take care of different frequencies and to control vibration. Types and sizes available to carry varying loads (Rubber to metal bonded)

HARRISFLEX BEARINGS LIMITED
TIDDINGTON ROAD · STRATFORD-ON-AVON

THE NORTHERN POLYTECHNIC, HOLLOWAY ROAD, N.7.

Principal: T. J. DRAKELEY, D.Sc., Ph.D., F.R.I.C., F.I.R.I.

Department of Radio and Musical Instrument Technology.

Head of Department:
S. A. Hurren, M.C., F.Brit.I.R.E.

Full-time Day Courses in

RADIO TECHNOLOGY

in preparation for all recognised qualifications in this subject. Practical laboratory and workshop experience provided.

Prospectus free on application to Secretary
New Term begins September 11th.

VALVES

This is part of our current stock of valves. If all their equivalents were mentioned, it would be found that we can supply either the exact valve or a suitable replacement for almost any type. Wherever possible please order C.O.D. Stamp with enquiries please.

PRICES STRICTLY B.O.T. RETAIL

BATTERY—210HL, 5/10; P220, PM2A, 7/4; 210DDT, HD24, TDD2A, 9/2; 210SPT, 210VPA, 210VPT, 220/OT, KT2, KT24, PM12M, SP2, SP210, VP210, VP2B, W21, Z21, Z22, 11/-; P2, 12/2; 210PG, FC2, FC2A, X24, 12/10.

A/C TYPES—2D4A, 6/9; 354V, AC/HL, MH4, MHL4, 9/2; AZ1, DW2, AZ31, DW4-500, IW4-350, U10, 11/-; 402P, ACO44, MH41, MHD4, PX4, TDD4, 11/7; 42MP/Pen, AC/VP1, AC/VP2, AC/Pen, AC2/Pen, AC5/Pen, KT41, KTZ63, MKT4, MSPenB, MVSPen, MVSPenB, PenA4, Pen4VA, SP4, VP4, VP4B, 12/10; AC/TH1, AC/TP, FC4, MX40, TH4, VHT4, 41MPG, 14/-; KT32, KT33C, PenB4, 14/8; KTZ41, U18/20, 15/3; MP/Pen, 16/6; FW4/500, KT66, PM24A, 18/3; PX25, PP5/400, 24/4; Pen428, 30/5.

UNIVERSAL—2D13A, 2D13C, 9/2; CY1, U31, UR1C, UR3C, U4020, 11/-; 11D3, TDD13C, 11/7; 7D3, 8D2, 9D2, 13SPA, CL4, CL33, Pen36C, SP13, SP1320, VP13A, VP13C, 12/10; CBL1, CBL31, PenDD4020, TH21C, 15/3; TH30C, 14/-.

MAZDA—HL23, 5/10; HL21DD, HL23DD, 9/2; Pen25, UU5, UU6, UU7, U4020, VP23, 11/-; AC/HLDD, HL41DD, HL133DD, 11/7; Pen45, Pen383, SP41, TP23, TP26, VP41, VP133, 12/10; AC/TP, TH41, TH233, 14/-; QP25, PenDD4020, Pen45DD, 15/3.

E TYPES—EM4, 11/-; EBC3, EBC33, 11/7; CL4, CL33, EF8, EF9, EL3, EL33, 12/10; CCH35, ECH2, ECH3, ECH35, EF5, EF6, EK2, EL2, 14/-; EBL1, EB31, 15/3; EL35, 18/3.

BVA AMERICAN TYPES—5U4, 5Z4, 6AG6, 6C5, 6C8, 6C6, 6J5, 6J7, 6K8, 6L6, 6R7, 18, 25A6, 25L6, 25Y5 and 25Z5, conversion, 25Z4, 42, 47 conversion.

AMERICAN—1A4, 1B4, 1C5, 1C6, 1H5, 2A6, 2A7, 2B7, 6A4, 6A6, 6A7 conversion, 6A8, 6E6, 6F5, 6F6, 6J8, 6K6, 6L7, 6P5, 6SF7, 6Z5, 10, 12Q7, 12SF5, 12Z5, 15, 19, 24, 32, 33, 34, 35, 36, 37, 38, 46, 48, 50, 53, 57, 71A, 75, 76, 81, 82, 85, 89, FC141, H141D, Pen141.

TUNGSRAM—EL5, 16/6; LD210, 5/10; P215, 7/4; DD13, 6/9; 6B8, 14/-; 6K7, 12/10; 6K8, 14/; 6Q7, 11/7; 6V6, 12/10; 6X5, 11/-.

VALVES AND ADAPTORS

In the cases where we cannot supply the exact valve or equivalent, we can get your set going with a valve and adaptor, the additional cost being 4/6.

SPARES

TESTOSCOPE, the vest pocket Instrument for tracing faults, enables 20 tests AC/DC, 37/6.
FLIK-O-DISK—Volts, ohms, and watts, calculator, 6/6.
SPEAKERS, 3-inch, 31/3.
LINE CORD—.3 amp., 3 core 60 ohms per ft., extremely good quality, 6/9 per yard. 2-way, 6/-.

J. BULL & SONS

(Dept. W.W.)

246 HIGH ST., HARLESDEN, N.W.10

"ENGINEERING OPPORTUNITIES"

This unique handbook shows the easy way to secure A.M.I.Mech.E., A.M.Brit.I.R.E., A.M.I.E.E., City and Guilds, etc.

WE GUARANTEE—"NO PASS—NO FEE."

Details are given of over 150 Diploma Courses in all branches of **Civil, Mech., Elec., Motor, Aero, Radio, Television and Production Engineering, Tracing, Building, Govt. Employment, R.A.F. Maths., Matriculation,** etc.

Think of the future and send for your copy at once—**FREE.**

**B.I.E.T., 387, SHAKESPEARE HOUSE
17, STRATFORD PLACE, LONDON, W.1.**

WELL-INTRODUCED French manufacturer, highest London references, wishes contact important mftrs. interested French market; immed. post-war develop.—Box 3185.

SITUATIONS VACANT

PLASTIC moulders require representative with first-class connections amongst manufacturers.—Write Box E. 262, Willings, 133, Moorgate, E.C.2. [2974

DESIGNER of specialised radio and p.a. equipment and electronic devices for Lancashire manufacturers of optical and scientific apparatus.—Applicant should outline experience in first place to Box 3184. [2949

MANAGERS and service managers required by radio and electrical retail organisation (not combine or chain store) for West London suburbs and Home Counties; sales and administrative staff will be required later; excellent post-war prospects may make it worth while applying (in confidence) now.—Box 3189.

INSTRUCTORS wanted for the training of students in radio servicing and engineering; must be qualified up to Final City and Guilds Standard and have practical experience of radio servicing; substantial remuneration according to qualifications.—Applications, with full particulars, age, experience, etc., to the Secretary, Elliot Macintosh Wireless College, Crescent House, Windsor St., Dundee.

SITUATIONS WANTED

EXPERIENCED secretary (shorthand-typist) requires post in London district with post-war prospects; thorough knowledge of radio trade.—Box 3203. [3009

TUITION

LEARN Morse code the Candler way.—See advertisement on page 29. [1292

RADIO training.—P.M.G. exams. and I.E.E. Diploma; prospectus free. — Technical College, Hull. [0611

RADIO Engineering.—Television and Wireless Telegraphy, comprehensive postal courses of instruction. Apply British School of Telegraphy, Ltd., 179, Clapham Rd., London, S.W.9 (Estd. 1906). Also instruction at school in wireless for H.M. Merchant Navy and R.A.F. [9249

WIRELESS training, operators and mechanics, urgent demand, land, sea and air appointments.—The North-Eastern School of Wireless, 69, Osborne Rd., Newcastle-on-Tyne. Estab. 1911. Tel. Jesmond 1356. 150 P.M.G. technical questions, 10/- by post. [2864

"ENGINEERING Opportunities" — free 112-page guide to training for A.M.I.Mech.E., A.M.I.E.E., and all branches of engineering and building; full of advice for expert or novice; write for free copy and make your peacetime future secure.—B.I.E.T. (Dept. 387B), 17, Stratford Place, London, W.1.

A POSTAL training in electrical engineering—power or radio; individual correspondence tuition by highly qualified engineers with wide teaching and technical experience. Elementary or advanced courses. Preparation for recognised examinations. Pre-service training specially arranged.—G. B., 18, Springfield Mount, Kingsbury, N.W.9. [1731

THE Tuitionary Board of the Institute of Practical Radio Engineers have available home study courses covering elementary, theoretical, mathematical, practical and laboratory tuition in radio and television engineering; the text is suitable coaching matter for I.P.R.E., Service-entry and progressive exams.; tuitionary fees—at pre-war rates—are moderate.—The Syllabus of Instructional Text may be obtained post free from the Secretary, Bush House, Walton Avenue, Henley-on-Thames, Oxon. [1462

TECHNICAL TRAINING

GREAT possibilities exist for technically qualified engineers, key men in wartime and afterwards. Through the home-study courses of The T.I.G.B. take a recognised engineering qualification, such as A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.S., A.M.I.Chem.E., C. and G., etc., in which examinations the T.I.G.B. students have passed 25 FIRST PLACES and hundreds of passes. Write today for "The Engineer's Guide to Success"—free—containing the world's widest choice of engineering courses covering all branches, including aeronautical, mechanical, electrical, wireless, chemical, etc. THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN, 82, Temple Bar House, London, E.C.4. [1403

BUSINESSES FOR SALE OR WANTED

RADIO and electrical retail and service business required, West London preferred; partnership considered.—Box 3190.

PATENT NOTICES

THE proprietors of British Patent No. 505632 entitled Improvements in and relating to cathode-ray tubes, offer same for license or otherwise to ensure its practical working in Great Britain.—Inquiries to Singer, Ehlert, Stern & Carlberg, Chrysler Building, New York City 17, N.Y., U.S.A. [2885

PREMIER RADIO

PREMIER MICROPHONES

Transverse Current Mike. High-grade large output unit. Response 45-7,500 cycles. Low hiss level, 23/-.

Premier Super-Moving Coil Mike. Permanent Magnet model requiring no energising. Sensitivity 56db. Impedance 25 ohms. Excellent reproduction of speech and music, £5/5/-.

Microphone Transformers, 10/6 each.

Crystal Mike. Response is flat from 50-5,000 cycles with a slightly rising characteristic to 8,000 cycles. Output level is minus 60db. Price 39/6.

Chromium Collapsible Type Microphone Stand, 52/6.

MAINS TRANSFORMERS

Wire-ends. All L.T. Windings Centre Tapped.

SP. 300	300-0-300 v. 60 m.a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a.	25/-
SP. 350A	350-350 v. 100 m.a., 5 v. 2 a. (not C.T.), 6.3 v. 2-3 a.	29/-
SP. 350B	350-350 v. 100 m.a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a.	29/-
SP. 351	350-350 v. 150 m.a., 4 v. 1-2 a., 4 v. 2-3 a., 4 v. 3-4 a.	36/-
SP. 351A	350-350-150 m.a., 4 v. 3 a., 4 v. 2-3 a., 4 v. 1 a., 4 v. 1 a.	39/-
SP. 352	350-350 v. 150 m.a., 5 v. 2 a., 6.3 v. 2 a., 6.3 v. 2 a.	36/-

Auto Transformers. Step up or down. 100-125 v. to 200, 230 or 250 v. A.C., 60 watts, 21/-; 125 watts, 27/6; 250 watts, 37/6.

MATCHMAKER UNIVERSAL OUTPUT TRANSFORMERS

Will match any output valves to any speaker impedance. 11 ratios from 13-1 to 80-1, 5/7 watts, 22/6; 10/15 watts, 30/-; 20/30 watts, 49/6; 50/60 watts, 59/6.

STEEL CHASSIS

Undrilled.

10 × 8 × 2½"	price 7/- each
16 × 8 × 2½"	price 8/6 each
20 × 8 × 2½"	price 10/6 each

NEW PREMIER S.W. COILS

4- and 6-pin types, now have octal pin spacing and will fit International Octal valve holders.

4-PIN TYPE			6-PIN TYPE		
Type	Range	Price	Type	Range	Price
04	9-15 m.	2/6	06	9-15 m.	2/6
04A	12-26 m.	2/6	06A	12-26 m.	2/6
04B	22-47 m.	2/6	06B	22-47 m.	2/6
04C	41-94 m.	2/6	06C	41-94 m.	2/6
04D	76-170 m.	2/6	06D	76-170 m.	2/6
04E	150-350 m.	3/-			
04F	255-550 m.	3/-			
04G	490-1,000 m.	4/-			
04H	1,000-2,000 m.	4/-			

CHASSIS MOUNTING OCTAL HOLDERS
10½d. each.

New Premier 3-Band S.W. Coil, 11-25, 25-38, 38-86 m., 4/9.

2 Push-Pull Switches to suit above, 9d. each.

Bakelite Dielectric Reaction Condensers.

0001 mf. 1/3, 0003 mf. 2/6, 0005 mf.	2/9 each
0003 mf. Differential	2/11 each
S.W. H.F. Choke, 10-100 m.	1/3
Brass Shaft Couplers, ¼in. bore	7½d. each
Flexible Couplers, ¼in. bore	1/6 each

SWITCHES

QMB, panel mounting, split knob type, 2 point on/off 2/- each. Double pole on/off, 3/6 each.

VOLUME CONTROLS

Carbon type, 20,000 and 2 meg., 3/9 each.
5,000, 10,000 and 100,000 } 4/6 each.

Wire Wound Type, 300 and 10,000 ohms, 5/6 each.
Valve Screens for International and U.S.A. types, 1/2 each.
Resin-Cored Solder, 6d. per coil.
Push-Back Connecting Wire, 2½d. per yard.
Systoflex Sleeving, 2 mm., 2/6 per doz. yards.
Screened Braided Cable, Single, 1/3 per yard. Twin, 1/6 per yard.

MOVING COIL SPEAKERS

Goodmans 3½in. P.M. Speaker, 15 ohms voice coil, 30/-.
Rola 6½in. P.M. Speaker, 3 ohms voice coil, 25/-.
Rola 8in. P.M. Speaker, 3 ohms voice coil, 25/-.
Above speakers are less output transformer.
Pentode Output Transformers, 3½ watts, price 10/6 each.
Celestion or Plessey 8in. P.M. Speaker, 29/6.
Celestion 10in. P.M. Speaker, 49/6.
The above speakers are fitted with output transformers.

Premier 1-Valve de Luxe Battery Model S.W. Receiver, complete with 2-volt valve, 4 coils covering 12-170 metres. Built on steel chassis and panel, Bandspread tuning, 55/-, including tax.

I.F. TRANSFORMERS, IRON CORED
450-470 kcs., plain and with flying lead, 7/6 each.

Send for details of other Accessories available.

ALL ENQUIRIES MUST BE ACCOMPANIED BY A 2½d. STAMP.

PREMIER RADIO CO.

ALL POST ORDERS TO:
JUBILEE WORKS, 167, LOWER CLAPTON ROAD, LONDON, E.5. (Amherst 4723.)

CALLERS TO:
JUBILEE WORKS or 169, FLEET STREET, E.C.4. (Central 2833)

CLASSIFIED ADVERTISEMENTS intended for the OCTOBER issue can be accepted up to First Post on Friday, September 8th.

Printed in England for the Publishers, ILIFFE AND SONS LTD., Dorset House, Stamford Street, London, S.E.1, by THE CORNWALL PRESS LTD., Paris Garden, Stamford Street, London, S.E.1. "Wireless World" can be obtained abroad from the following—AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: Imperial News Co.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; William Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co.