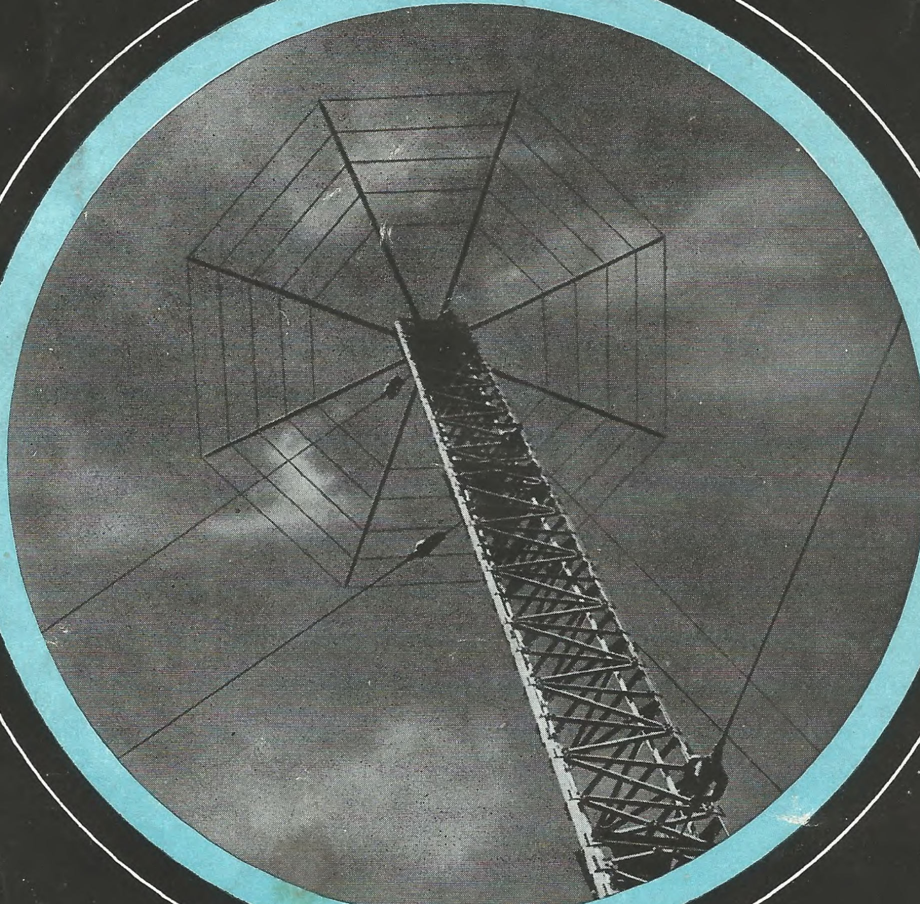
Wireless World

RADIO • ELECTRONICS • ELECTRO-ACOUSTICS

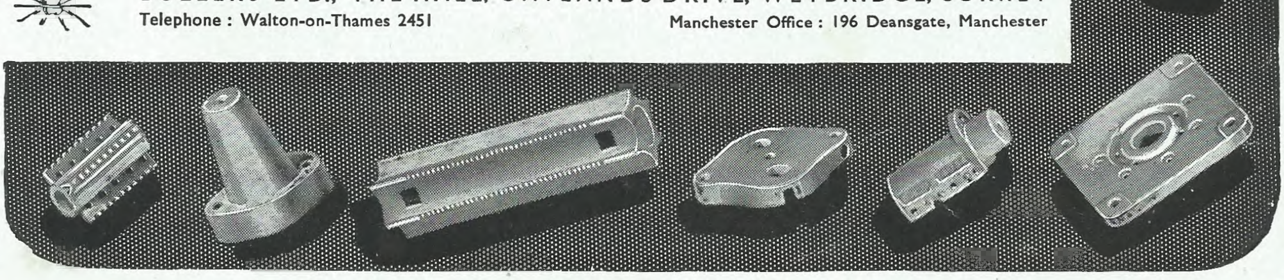


JUNE 1942

1/3

Vol. XLVIII No. 6

SCREENING PROBLEMS ✧ REALISTIC REPRODUCTION



Make a Note of it!

PUBLICATION C-111-A

INSTRUMENT DIALS & CONTROL KNOBS

Our latest catalogue, Publication No. C-111-A, fully illustrates and describes over 60 different Dials, Drives, Scales, Knobs and Miscellaneous Parts which are of vital interest to designers and manufacturers of electrical instruments.

REMEMBER—PUBLICATION C-111-A

A copy will be supplied on request

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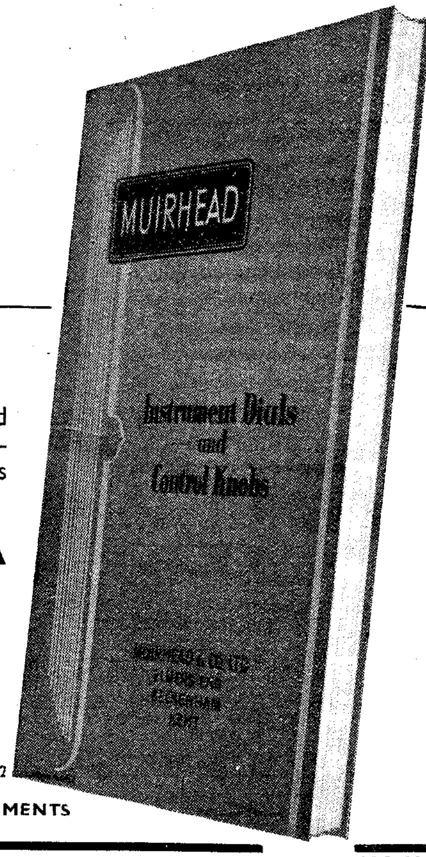

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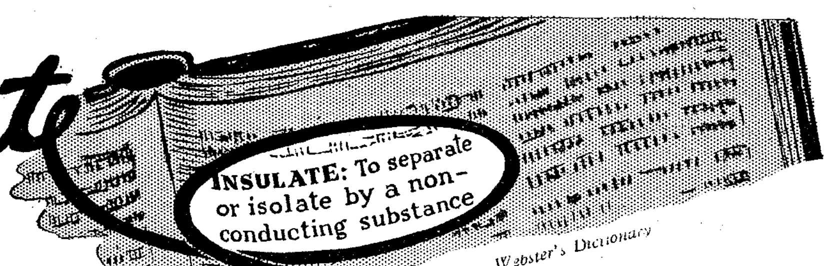

Practically all waxes are used to "separate or isolate," but the degree of insulation provided by the different types of waxes varies enormously.

There is obviously no higher degree of insulation required than that of electrical components and apparatus in intense electrical fields, especially in the extremes of conditions to which they are subjected to-day.

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DUBILIER
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C.R.C.163

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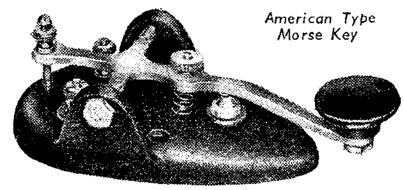
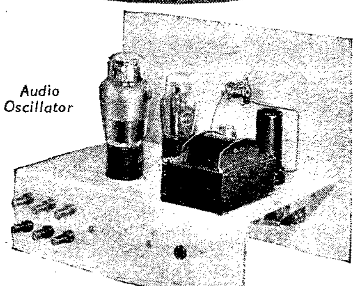
Schools, Instructors and those training as operators will find a wide range of Morse Equipment in stock at Webb's Radio. Some of this equipment is described here, including an exact replica of McElroy's famous streamline key at 8/6, and two very useful Audio Oscillators. Many other lines are generally available. Send us your requirements or call at our depot, 14, Soho Street.

AMERICAN TYPE MORSE KEY (illustrated). A British-made version of McElroy's famous streamline key is now available. Solid cast base, plated fittings, silver contacts. Beautifully balanced and light in operation. Price 8/6.



American Type Morse Key



Audio Oscillator

AUDIO OSCILLATORS. Model O.A.1. For private use. Drives one or two pairs of 'phones—1,000 cycle note, A.C. mains operated, £2/5/-, including two valves. Model O.A.2. Produced for class training, it has alternative outputs for 20 or 50 pairs of high-resistance headphones, or two loudspeakers. The *note* is variable in pitch and volume. Entirely A.C. mains operated. Supplied complete for £7/10/-.

MORSE KEYS. Our range includes British-made Bar-type Keys of standard "Post Office" pattern. We list three types available in quantities from stock. SCHOOL pattern in chromium-plated brass on polished wood base, at 8/6. HEAVY DUTY model in solid lacquered brass on wood base, 15/-. SPECIAL model, with heavy contacts back and front, lacquered brass, wood base, 28/-.

HEADPHONES. Webb's have available a special lightweight headphone manufactured for training purposes by Messrs. S. G. Brown solely for Webb's at 17/6 a pair. All other popular headphones are available from stock, including the famous Brown's "A" adjustable reed, at 57/6.

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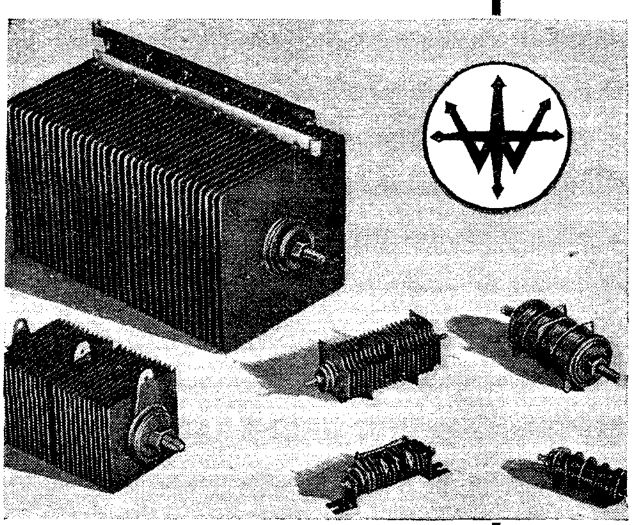
WEBB'S RADIO, 14, SOHO STREET, LONDON, W.1. *Phone : GERrard 2089. Hours of Business : 9 a.m.—5 p.m. Sats. 9 a.m.—12 noon.*

The sign of a **GOOD RECTIFIER**



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Westinghouse Brake & Signal Co., Ltd.
Pew Hill House, Chippenham, Wilts.

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MIDGET VALVES

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Greenhill Crescent, Harrow on the Hill, Middx.
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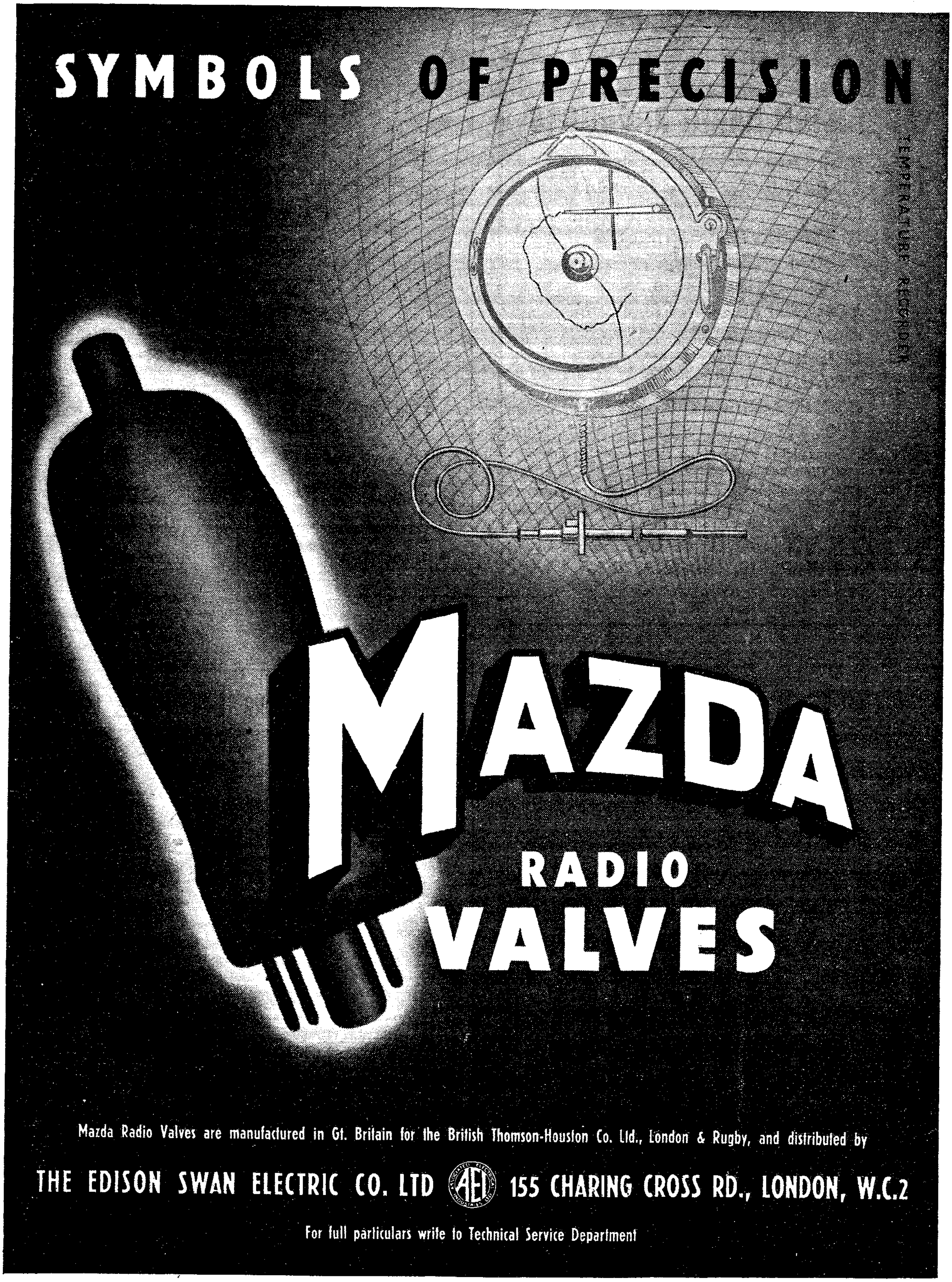
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MAZDA
RADIO
VALVES
Mazda Radio Valves are manufactured in Gt. Britain for the British Thomson-Houston Co. Ltd., London & Rugby, and distributed by
THE EDISON SWAN ELECTRIC CO. LTD
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For full particulars write to Technical Service Department

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★ VIBRATORS
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TRANSMITTING CONDENSERS
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will again be available to suit your most exacting needs as soon as circumstances permit.

Until further notice Import Licences must be obtained before orders can be entertained.

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Represented exclusively in Gt. Britain by
FRANK HEAVER LTD., Kingsley Rd., Bideford, N. Devon, Eng.

WODEN TRANSFORMER CO.
Thornley St., Wolverhampton
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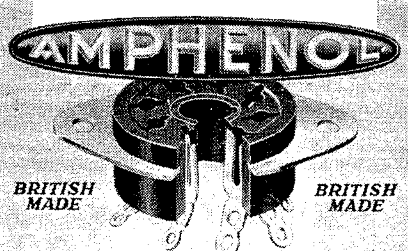
MAKERS OF TRANSFORMERS, POWER PACKS, AND SPECIAL RECEIVING AND TRANSMITTING APPARATUS

CELESTION

CELESTION-AMPHENOL valveholders are preferred by radio engineers because of their Strength, Efficiency, Uniform Contact and exceptional Insulation.

All standard British and American types are available.



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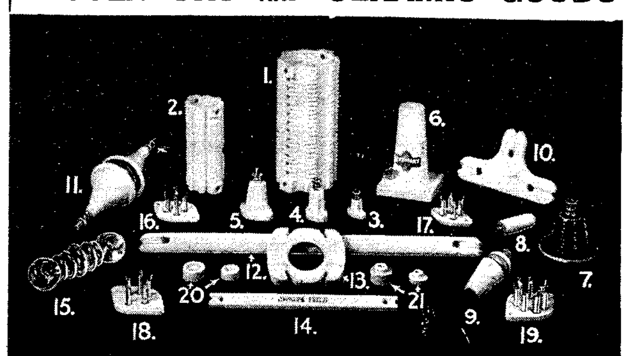
INSULATORS AND CERAMIC GOODS



Our range of Insulators and Ceramic goods is most extensive. The selection available is not just confined to the 21 different lines illustrated above.

As a matter of general interest in these troublous times, item No. 13 shows our Type TB Transmission Blocks as supplied to the Cunard White Star Liner "Queen Mary."

Enquiries invited and promptly replied to.

Enquiries which are *not* from Government Departments and Traders should be accompanied by a stamped addressed reply envelope.

RAYMART
CRAFT A CREED

48, HOLLOWAY HEAD, BIRMINGHAM, 1
Cables: Raymart, Birmingham. *Telephone: Midland 3254.*

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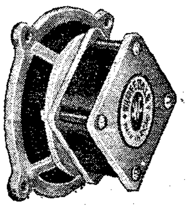
PRE-EMINENT IN PEACE
INDISPENSABLE IN WAR

ADVERTISEMENT OF THE TELEGRAPH CONDENSER CO., LTD.

G.P. 5254

WHARFEDALE

MIDGET 3½-inch UNIT



ALCOMAX MAGNET

Flux Density 8,00) lines.

Speech Coil 15 ohms or 2/3 ohms. The first Wharfedale Unit using the new ALCOMAX magnet steel which gives extremely high flux density with small size. Designed for use as Microphone or Midget Speaker. Very sensitive.

Supplies are available for PRIORITY ORDERS ONLY

PRICE **28/6** (list)

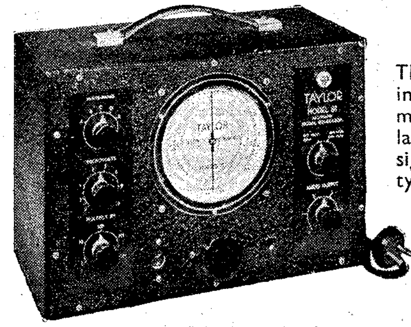
WHARFEDALE WIRELESS WORKS

(SOLE PROPRIETOR: D. E. BRIGGS)

HUTCHINSON LANE • BRIGHOUSE • YORKS

PHONE: BRIGHOUSE 50 'GRAMS: "WHARFDEL"

TAYLOR ALL-WAVE (6.5 to 3,000 metres) SIGNAL GENERATOR



This Taylor Model 60A instrument provides modulated or unmodulated Radio frequency signals for tests on all types of receivers.

FREQUENCY RANGE. 6 wave bands covering from 100 Kc. to 46 Mc.
CALIBRATION. The dial is directly calibrated and no graphs or charts are required.
ATTENUATION. Both coarse and fine attenuators are supplied, both calibrated approximately in micro volts and together giving a range of from 0-100,000 microvolts output.
MODULATION. The Radio output can be supplied either Unmodulated or Modulated to 30% at 400 cycles, or modulated by an external audio generator.
400 CYCLES. Audio output at 400 cycles of good waveform is separately available and variable from 0 to 5 volts.
SCREENING. The instruments are very thoroughly screened and the use of an effective mains filter prevents any appreciable direct radiation.

TAYLOR MODEL 60A

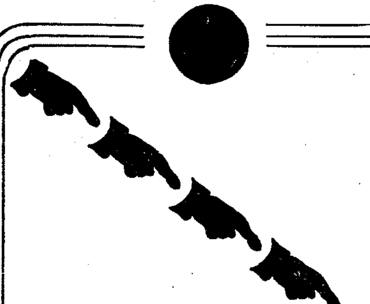
Operates on 200/250 volts A.C. 40/100 cycles.

Supplied complete with screened output lead, instruction book and frequency conversion table.

£14.14.0

British made by TAYLOR

TAYLOR ELECTRICAL INSTRUMENTS LTD.
Instrument Sales and Service Department
148a, High Street, Slough, Bucks.
Telephone: Slough 21383



POINTERS

Even the most cursory glance at any item of R.S. Equipment provides a pointer to its proved reliability, inherent quality and unsurpassed performance. As for appearance, this of course, speaks —or should we say, "looks"?—for itself.

R S *Amplifiers Limited*

3-4, Highfield Rd., Shepperton, Middlesex
Telephone: Walton-on-Thames 1019

VALVES

English and Octal Types. Many of those listed last month are *still available.*
English Battery Types. Mullard Nos. quoted, but some may be equivalent valves in other B.V.A. makes. FC2, **12/10**; FC2A, **12/10**; VP2, **11/-**; VP2B, **11/-**; SP2, **11/-**; PM12, **11/-**; PM12A, **11/-**; PM12M, **11/-**; TDD2A, **9/2**; TDD2, **9/2**; PM1A, **5/10**; PM1HF, **5/10**; PM1LF, **5/10**; PM2DL, **5/10**; PM2A, **5/10**; PM2, **7/4**; PM202, **14/-**; PM22, **20/-**; PM22A, **11/-**; 22D, **11/-**; PM2B, **12/10**; PM2BA, **12/10**; QP22A, **15/3**; QP22B, **15/3**.
Mazda Octals. Mullard E & C Types; English AC and universal types. Most numbers in stock, lists in future announcements.
Rectifiers. Non B.V.A. replacement types all at **14/6** each. Replacements for: American, 80, 5Y3, 5Z4; Marconi Osram, U50, U10, U12, MU12; Mullard, IW2, IW3, IW4, DW2, DW3; Cossor, 442BU, 506BU; Brimar, R1, R2, R3; Phillips, 1821, etc., etc.

SPARES

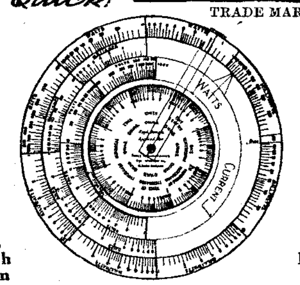
Line Cords. 110-230, **6/6** each; uncut lengths, 2-core 60Ω per foot, **3/-** per yd.; 3-core ditto, **4/-** yd.; 5-core 125Ω per foot, **5/-** yd.
P.M. Speakers. 4in. Rola dustproof with output trans., **21/6**; without, **17/6**.
Transformers. Fully shrouded 350-0-350 120 ma.—6.3 v. 3 amp., 5 v. 2 amp. for 200-250 mains, **22/6** each.
Wire Wound. Replacements for Cl and CIC, **6/-** each; voltage droppers for most popular sets, **4/6** to **11/6**, depending on type.
Resistors. ½ watt **6d.**, 1 watt **9d.**, 2 watt **1/-**, 10 watt, **2/6**.
Accessories. Insulated tape, **6d.** roll; connecting wire, **2/-** ½lb. reel; sleeving, **4d.**, **5d.** and **6d.** yd.; screen sleeving, **8d.** yd.; push back wire, **6d.** coil, resin cored solder, **1/-** coil; valve holders, chassis type, English, 4.5 and 7-pin, **8d.** each; American and Octals 4-, 5-, 6-, 7- and 8-pin, **1/-** each.

Terms: Cash with order or C.O.D. Postage, etc., extra on orders under £3. Callers and 'phone orders are not welcomed. Please post your order.

J. BULL & SONS
Radio House, Melthorne Drive, RUISLIP, MIDDX.

FLIK-O-DISK *Answers! Quick!*

TRADE MARK



100% British Design **100% British Made**

Answers all OHM'S LAW problems—for example:

What will be the voltage when current I flows through resistance R?
What will be the voltage with watts value W and I current flowing?
What is the current flowing where watts value is W and voltage is E?
What current will flow through R resistance where voltage is E?
What will be the resistance where current I flows at voltage E?
What will be the resistance where watts W is at voltage E?
What will be the resistance where watts W is at current I?
What is the wattage at voltage E through resistance R?
What is the wattage of current I through resistance R?
What will be the wattage of I current at E voltage?

The scales read from 1 millivolt to 1,000 volts. From 1 ohm to 1,000,000 ohms. From 1 milliamp to 10 amperes. From one-tenth of a milliwatt to 10,000 watts.

FULL INSTRUCTIONS WITH EACH INSTRUMENT

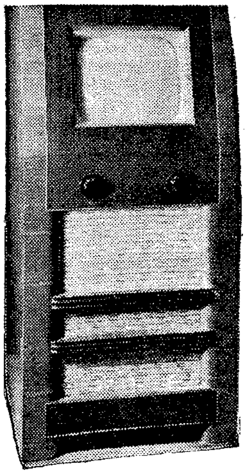
PRICE 4/6 Postage 3d.

Order at once whilst deliveries are good

IONIC COMPUTORS

514, Ipswich Rd., Trading Estate, SLOUGH, BUCKS. ENG.

Offered at the cost of parts only!!



Final Delivery of
BAIRD
Model T26 - - - Brand New
TELEVISION RECEIVERS

Here is an excellent opportunity! Every receiver is in perfect working order. Cabinet dimensions 3ft. 4in. high, 20in. wide, 17in. deep. Picture screen size 10in. by 8in. Pick-up sockets are fitted enabling it to be used as a Gramophone Amplifier. Extra loudspeaker sockets. 14 valves.

Simple to operate. Only two main controls, one for picture contrast and the other for sound broadcast. The Vision Receiver is a straight set with 2 R.F. stages, diode detector and one V.F. stage with secondary emission valves.

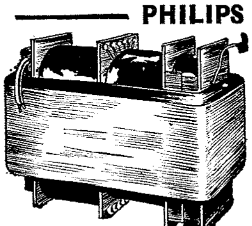
Price £35.10.0 Carriage extra

A new delivery of
BAIRD TELEVISION POWER PACK & AMPLIFIER CHASSIS

Includes heavy mains transformer 350-0-350, 120 m.a. with 4 tappings. High voltage transformer for supplying C.R. tube. Various condensers including 16×16 mfd. 550 v. working, 1-16 mfd. 450 v. working, 50×50×2 mfd. B.I. Electrolytics, etc. Pentode output transformer; chokes; resistors; trimmers; bias electrolytics; mica and tubular condensers; short-wave coils, etc. Workmanship and components are of the highest quality. Valve diagram free. Carriage forward. Add 2/6 for packing. **£3.17.6**

- **SMALL TRICKLE CHARGERS,** Skeleton Type. Metal rectification. Input 200–220 v. A.C. Output 2 v. ½ amp. Reliable and Shockproof ... ... Price **17/6**
  Similar to above, but in metal case for mounting ... ... Price **19/6**
- **G.E.C. MOTORS,** 1/100th H.P., A.C. 225 v. 50 ~ **47/6**
- **SINGLE R.A.F. EARPHONES,** resistance 750 ohms D.C. approx., **4/-** each; ex-Govt. low-resistance single earphones, **2/6** each; microphone buttons, well-known make, **2/-** each.
- **MAINS TRANSFORMERS.** Originally made for Television Power Packs where accuracy and robustness are essential. Weight 12 lb., size 5⅜in.×4¼in. overall. 350–0–350 v. 120 m.a. Tapped. 4 v. 2 a.; 4 v. 8 a.; 3 v. 3 a.; 20 v. 1 a. Diagram free. Post and packing 1/6 ... ... **25/-**
- **HEAVY DUTY MAINS TRANSFORMER.** Input 240 v. A.C. One tapping at approx. 5,000 v. max. 3 m.a., and one for supplying filament of Mullard HVR 2 (6.3 v. at .65 amp.). Shrouded in metal box. Car. fwd. **10/6**
  Also input 200–250 v. A.V., approx. 6,500 volts. Shrouded in metal box. Car. fwd. **20/-**
- **CELESTION 8in. P.M. SPEAKERS,** brand new, boxed, complete with universal transformer ... ... Each **25/6**
- **B.I. CONDENSERS.** .1×.1 mfd. 7,000 volts D.C. test, with porcelain insulators **30/-**

PHILIPS TRANSFORMERS AND CHOKES



HIGH VOLTAGE TRANSFORMERS
These transformers are robust in construction and weigh approximately 13 lbs. Dimensions: 5⅜×5¼×4¼in. Specification: 350–0–350 v., 70 m.a. Four tappings giving 4 v. 3 amps., 6.3 v. 4 amps., 4 v. .65 amp. and 4,000 v. at 3 m.a. Input 100/250. Carriage forward ... ... Price **32/6**

SPEECH TRANSFORMERS
Ratio approx. 40 : 1 with feed-back windings ... ... Price **4/6**

SMOOTHING CHOKES. 60 ohms D.C. resistance. 100/120 m.a. Core size 2¼in.×2¼in.×1¼in. Price **5/6**

SMOOTHING CHOKES. 400 ohms D.C. resistance. 60 m.a. Core size 1¼in.×1¼in.×⅝in. ... Price **3/6**

See last month's advertisement for other interesting offers.

PLEASE NOTE

Write your name and address in Block Capitals ● You should order only from current advertisement, as many lines soon go out of stock. ● No orders can be sent C.O.D. ● Orders cannot be accepted from Eire or Northern Ireland. ● Postage must be included with all orders.

LONDON CENTRAL RADIO
Opportunity Column

STANDARD TELEPHONE L.T. METAL RECTIFIERS, 12 volt 1½ amp. New. Price **12/6.** Also 12 v. 5 amp. **45/-.**

SCREENED WIRE, 7/026 SWG, rubber covered, **1/9** per yard.

ASSORTED RESISTORS, 3/6 per dozen.

REACTION CONDENSERS. Mica spaced. 0.0003 mfd., 2in. spindles. **2/-** each.

TELEVISION DIODE VALVES, unused Mullard EA50 69 mm. × 12 mm., overall, 6.3 v. heater at 15 amp.; **10/6** each.

VALVES are in short supply; stock of Mullard T.S.P. 4's and H.V.R. 2's to be cleared at **15/-** each; first come, first served.

CONDENSERS.—Special offer of metal-cased paper condensers, 300 v. working, all brand new and unused, 2 mfd. **2/-,** 1 mfd.×1 mfd. **1/9,** 1 mfd. **1/9.**

VARIABLE CONDENSERS, well made heavy 3-gang superhet condensers, die cast frames in first class condition. **5/6** each.

BULGIN HIGH VOLTAGE ANODE VALVE CAPS, 9d. each.

DECORATIVE CABINET GRILLS, 4-bar 14¼in.× 1¾in. wide. Solid brass chrome plated. **2/6** each.

PHILIPS HIGH VOLTAGE CONDENSERS. .1 mfd. 5,000v. D.C. working. **10/6** each.

PUSH-PULL INPUT TRANSFORMERS
by well-known maker, nickel iron core, in metal case, size 2in.×1⅝in.×1¼in. high, ratio 6 : 1. Price **6/6.**

TRIMMERS.—Twin trimmers on ceramic base, brand new; to clear, **6d.** each; **5/-** doz. also Bakelite Strip containing 5 Postage Stamp Trimmers, **2/6.**

TUBULAR WIRE-END CONDENSERS, brand new, first quality components, 0.0003 mfd., **8d.;** 0.005 mfd., **9d.;** 0.01 mfd., **10d.;** 0.1 mfd., **1/-** each.

ELECTROLYTIC TUBULAR CONDENSERS, 25 mfd., 12 v.; 25 mfd., 25 v.; 50 mfd., 25 v.; 50 mfd., 12 v., **2/6** each. .5 mfd., 350 v. D.C. working, **2/-** each.

COIL FORMERS, cardboard and paxolin, assorted sizes, useful for experimenters; **1/6** doz.

CHASSIS.—Beautifully finished, highly polished, new cadmium-plated Chassis. Superbly made. 12in.×8½in. ×3in. Drilled for 5 valves, transformer, etc., **4/-** each. Also heavy gauge metal Chassis, finished battleship grey, 12in.×5½in.×2½in., **1/3** each. All drilled for valves, etc.

ACCUMULATORS.—Ediswan 2 v. 60 amp., brand new, in ebonite cases, size 8in.×4¼in.×2½in.; callers only; **17/6** each.

MORSE KEYS.—Don't confuse these with inferior junk; it's a super job; **8/6** each.

YAXLEY TYPE SWITCHES 2-bank, 3-way, **2/-.**

MOVING COIL METERS
A large selection of Ferranti and other well-known makes are offered to CALLERS ONLY.

OUTPUT TRANSFORMERS, primary 300 ohms D.C., secondary 0.5 ohm D.C., brand new, manufacturer's type, **5/6;** also new chokes, 30 henry, 150 ohms, **5/-** each.

ELECTRO-MAGNETIC COUNTERS, resistance 500 ohms, from **1–12,999,** size 4½in.×2in.×1¼in., ex-G.P.O., invaluable for countless purposes, **9/6** each; a smaller type, 1–1,999, size 4¼in.×1¼in.×1¼in., **5/6.**

RELAYS.—Small relays for operation on 2 v. D.C. with 6-way make and break switches, brand new; **5/-** each.

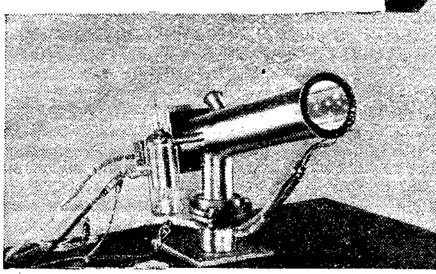
FLEXIBLE DRIVES, well made, shielded cable drives for remote control, ideal for radiogramophones, approx. 2ft. long; to clear, **4/-** each.

MIDGET VOLUME CONTROLS, 5,000 ohms, **3/6** each.

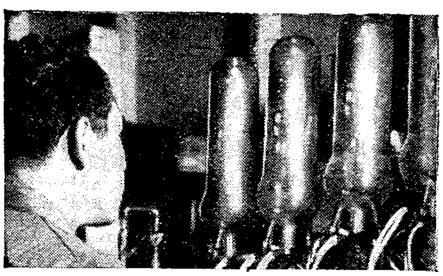
VOLUME CONTROLS without switch, 1 meg., 1¼in. spindle, **4/6** each.

LONDON CENTRAL RADIO STORES
23, LISLE STREET, LONDON, W.C.2. ***Telephone: GERrard 2969.***

Filament Emission
Makes the Modern World Go Around



Close observation of the flow of electrons from a heated filament is made possible with this Electron Microscope. This instrument, designed and constructed in the Eimac laboratories, virtually gives a motion picture projection of the electron movement.



Before filaments are sealed into the triode they are placed in a temporary vacuum where they undergo their first emission test. Thus faulty filaments may be weeded out without further processing.

THE LIFE of radio communications hangs by a tiny thread of filament wire. If the steady flow of electrons from the vacuum valve filaments ceases, the transmitter is off the air no matter how excellent the other components may be performing. To assure peak emission under the most severe operation conditions, many exacting tests are conducted during the process of manufacture.

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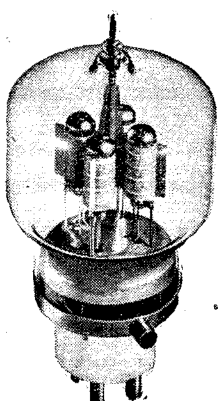

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Radio ● Electronics ● Electro-Acoustics

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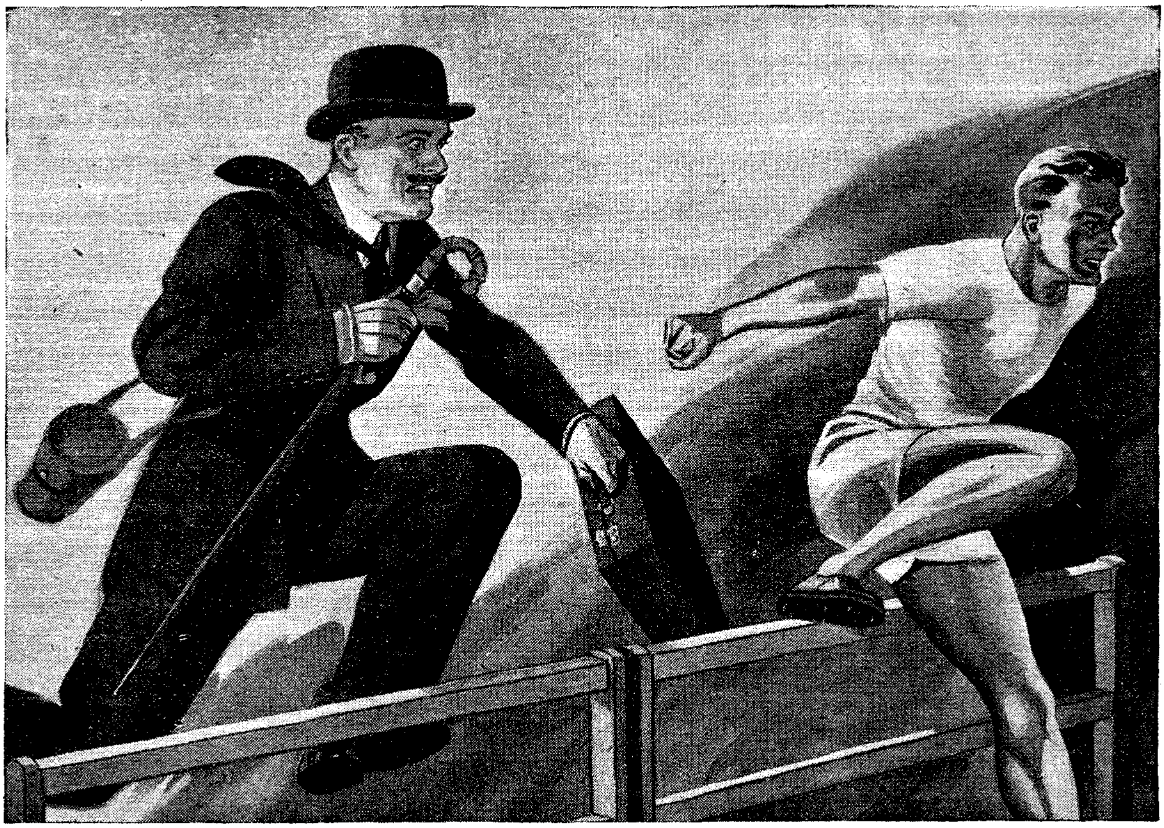

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P.5.

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Post-war Planning

Matters that Should be Considered Now

THE 1941-42 session of the Institution of Electrical Engineers has just closed, so far as the Wireless Section is concerned, with a discussion on "Post-war Planning in Radio Communication." Many of the points that were raised are of the greatest importance to the future of wireless, and we propose to touch upon those matters that, in our opinion, deserve special consideration. As Col. Sir A. Stanley Angwin said in opening the debate, the resumption of normal services after the war will give an unrivalled opportunity for removing many of the handicaps under which wireless has suffered in the past. Not only will it be possible to standardise components and accessories on a national or international basis, but it will be easier than at any other time to make any sweeping changes, such as in systems of broadcasting—FM, UHF, etc.—that may be considered desirable. More than purely technical considerations are involved in most of the matters that should be considered, but discussions now will reduce delays when the time comes to put changes into effect.

In matters pertaining to the reception side of broadcasting, perhaps valve standardisation is the most important. Few will disagree with the opinion expressed during the discussion that, the war having enforced a reduction in valve types, the situation must not be allowed to deteriorate after the war. Receivers for specialised uses must be developed more intensively, and it was urged that the really portable "personal" receiver should, thanks to increased knowledge of the manufacturers of miniature components and valves, become an accomplished fact after the war.

Re-starting Television

Regarding television, perhaps one of the most important points on the broader issue is that, as a result of wartime developments in manufacture, cathode-ray tubes should be cheaper, and so it should be possible for the service to be resumed on a much wider basis than before. The question of technical standards for the resumed service presents a problem. Suggestions carrying much weight have already been made to the effect that the service should restart with new standards, but at the I.E.E. discussion it was proposed that the London station should temporarily resume work at its pre-war standards. Any improved standards, or improved system of transmission that might be decided upon for the permanent future service would be used for the provincial stations. Though this scheme is open to obvious criticism, it seems to us to offer the attraction that the service could be restarted with a minimum of delay. On the important question of feeding the provincial television stations, the view was expressed that after the war UHF developments will make radio links more attractive than cables. As one speaker put it, the principal wireless development of the last war was the valve; of this war it is the extension of the usable frequency spectrum.

Conserving Frequency Channels

In the field of communication, it was emphasised that the channels available are rapidly becoming filled to capacity. One of the first tasks for a world in which international co-operation becomes possible will be to organise the use of these channels for the greatest benefit of all. It is not too early to plan the general principles on which allocation of frequencies shall be made. One of the principles that we consider should be always kept to the fore is that frequencies with a world-wide range should be reserved more strictly than at present for long-distance communications. Local services will doubtless make a wider use of UHF.

It is all to the good that the most valuable of all the raw materials of post-war reconstruction—the human element—was not neglected. It was admitted in the discussion that many wartime entrants into wireless must eventually pass into other walks of life, in spite of the application of wartime wireless developments to peacetime needs. But the interest of many of them would be retained as amateurs, and so the question of amateur status will become a matter of urgency after the war. Questions with regard to the training and status of technicians are always important, and we are particularly sympathetic towards the views expressed that, if the status of servicing can be improved, many men with high qualifications will be absorbed into that sphere. They will find work worthy of their mettle in maintaining the apparatus of the future

POWER AND REALISM

Estimating the Watts Required for a Given Sound Intensity

By

G. E. MORISON, A.M.I.E.E.

(H. D. Moorhouse & Co., Manchester)

IN an article some time ago[1] there was some discussion of the probable power required to reproduce sound at natural levels in a room and other enclosures, taking into account the efficiency of ordinary speakers and the increase of sound level due to reflection in the enclosure. The formula under discussion led to figures which, in the opinion of the writer of that article, do not bear out the observations of practical experience, an opinion which will be shared by many. Yet in these days when much more use is being made of reproduced sound in mass listening in factories, canteens, theatres, etc., the equipment has been installed too often, judging by results, without considering what power is required to meet conditions.

It is the purpose of this article to offer a guide to the estimation of power requirements for any conditions, starting from first principles. The formula given previously was:—

$$I = \frac{WT}{11.4\,V} \quad \cdots \quad \cdots \quad \cdots \quad (1)$$

This states that if a sound is radiated continuously in an enclosure until the steady state has been reached, then the sound intensity I is proportional to the watts W radiated and to T the reverberation time in seconds and inversely proportional to V the enclosure volume in cubic feet. This is another way of saying that in the steady state the power radiated is exactly equal to that absorbed by the enclosure boundaries, which is self-evident. The same formula appears elsewhere in other forms; for instance, T may be eliminated by substituting for it the right-hand side of

$$T = \frac{0.05V}{Sa} \quad \cdots \quad \cdots \quad \cdots \quad (2)$$

(the original Sabine formula for reverberation time T which defines the time T seconds required for a sound of normal intensity level 60 db. above the threshold of audibility to die away to 0 db. (0.0002 dyne/cm.^{2} or 10^{-16} watts/cm.^{2}) in a reverberant room, the sound source having been cut off. S is the total interior surface of the enclosure and *a* the average absorption coefficient of all surfaces). From this an expression can be derived for W in terms of I, the dimensions of the enclosure, and the factor *a*. All formulæ of this type are open to suspicion in that they rely too much on an illusory steady state, which can be produced, but is not what we are dealing with in ordinary listening.

When sound is radiated in an enclosure there is a period from the moment radiation begins (when the intensity is zero) to that time when the steady state may be said to be reached, during which the intensity is increasing exponentially. The intensity at any moment, in Figs. 1 and 2, is that due to the accumulation of energy, from an ideal source filling the space uniformly with sound by reflection in the enclosure. To find the true intensity at a point in the enclosure we would require to add the direct radiation from the source and to know the particular manner of this direct radiation.

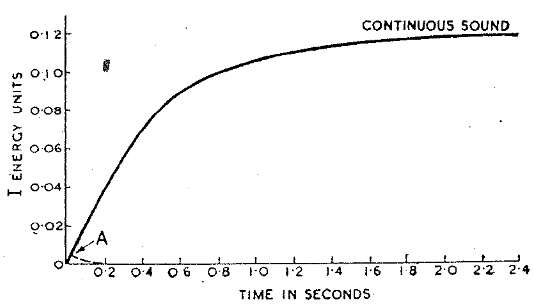


Fig. 1. Building up of sound energy in a reverberant room having T=6 secs. Point A is the level reached by transient sound of 0.02 sec. duration.

Consider for the moment only the intensity to reflection indicated in Figs. 1 and 2, since this is all that is included in expressions of the type (1). The period required for I to approach its maximum may be called the building-up time and may be quite long, as much as 1 sec. in a reverberant enclosure having T = 6 sec. For a more absorbent enclosure with T = 1 sec., the building-up time is still considerable, being 0.2 sec. These are the times required for the intensity to reach 0.9 of its maximum, this being, to the ear, indistinguishable from maximum intensity. A limit of this kind is necessary, since I never quite reaches I_{max}.

Now, in listening to speech or music we appreciate the whole by hearing, in proper form, intensity and sequence, the successive sounds which make up syllables or musical sounds, including many of a quite transient nature. It is accepted, for instance, that the duration of the average syllable in English speech is 0.2 sec., and of some consonants only 0.02 sec., while the diversity in music is even greater. That being so, it is clear that the briefer sounds can never reach the steady state intensity implied in the formula (1) unless the enclosure is quite remarkably "dead," and if it is so, then the building-up process, by reflection, can hardly be said to function with any effective increase of sound level. The use of formula (1) is thus not justified for power calculations and must give results showing less than the true power required for a given intensity.

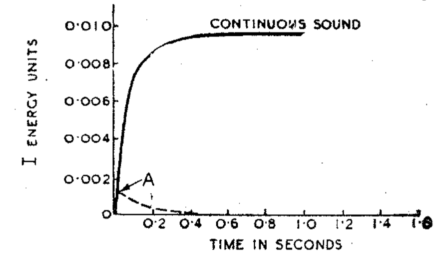


Fig. 2. Building up of sound energy in an average living room, T=1 sec. Point A is the level reached by transient sound of 0.02 sec. duration. Note reduced energy scale.

There are also other objections. If we assume that in an enclosure the absorption is increased so that T tends to zero, then if W is unchanged, according to (1) the intensity I vanishes, whereas actually I remains finite, being the intensity due to direct radiation from the source in free air, the enclosure having been removed. The fact is that formula (1) does not even measure the steady state intensity in *any* enclosure but only that in an enclosure where the average absorption is low, when we may assume that a large number of reflections take place, and that therefore the space is uniformly filled with sound after a measurable time. That this

[1] *Wireless World*, March 10th, 1938. "Loudspeaker versus Orchestra."

condition does not apply in the ordinary living room is easily proved by simply moving nearer to the loudspeaker in action; or from its axis to one side. The sound level quite audibly changes from point to point, which indicates much larger changes in intensity, since the ear is estimating logarithmically.

The same limitations apply for formula (2) in which reverberation time which is approximately true only for enclosures having T more than about 2 sec., whereas in home reproduction T is less than 1 sec. (0.6 sec. is a fair figure at 500 cycles in an average living room). The reason for this failure of the Sabine formula (2) is the same; it assumes a large number of reflections per second in the enclosure, and that the space is uniformly filled with sound.

Nevertheless, the fact still remains that to enclose a radiating loudspeaker in a room does increase somewhat the sound level over that which would exist in free air, provided that the individual sounds persist for an appreciable time. Figs. 1 and 2 show that the relative importance of reflected sound depends not only on T but very much on the duration of the sound, and that for very brief sounds the sound level practically is that due to direct radiation only.

Modifying Factors

Listening in the ordinary room there are three primary conditions which impair the validity of any calculation which is made on the assumption of a steady state and spherical radiation. These are: (1) the individual sounds heard are of short duration; (2) the loudspeaker radiation is of the type which fills a limited solid angle, as distinct from uniform spherical radiation; (3) the average boundary absorption is such that the energy density in the enclosure is never uniform, and least of all for sounds of very short duration. All these factors are such as to make the effective intensity at a point more nearly equal to that due to direct radiation only than to that due to reflected energy. Formula (1) fails as it exaggerates reflected energy.

There are also physiological factors which reduce the importance of reflected energy. It has been shown[2] that in listening with two ears the apparent loudness of direct radiation is greater than that of diffuse, many times reflected radiation of the same intensity. Again, in the case of sounds of short duration the ear will accept and add together two wave trains quite considerably displaced in time or phase, but this accommodation extends only to identical sounds which arrive at the ear with a time difference not more than about 1/20 second. Beyond this the ear begins to hear two distinct sounds. Therefore no reflected radiation in a room which arrives with a delay of more than 1/20 second can be accepted as adding usefully to the sound level. In this time sound travels $\frac{1125}{20} = 56$ft.

Taking the average living room, say 18ft. × 14ft. × 10ft., the distance between reflections, the mean path, is on average 4V/S (V total volume, S total surface as before). This is less than the distance between walls because it takes account of short path reflections as at corners. For this room 4V/S = 8ft., so that useful reflections will include all those which happen to reach the listening point, even after seven (56/8) reflections. However, since the intensity is reduced by a factor of about 75 per cent. average at each reflection (boundary absorption), those waves reaching the listening point by a roundabout route involving several reflections will be reduced in intensity to insignificance. Yet a little consideration will show that most reflections must belong to this class, as first and even second reflections to a given point can only be very limited.

We have to remember, too, that the source radiation is divergent and therefore decreases in intensity with distance; this applies without change to reflections from plane walls, etc., so that reflections arriving at a given point are less by a further factor. The complete determination of the precise gain in energy level, due to reflection, at a given point in our average room is practically beyond calculation if we limit the time to 1/20 sec. as required, but by using several approximations we find that the energy gain may be between 100 and 200 per cent. or 3 to 4.7 db. above that due to direct radiation at a distance of eight feet. If the listener is nearer the source it is less, and conversely.

Direct Radiation

It has been shown elsewhere[3] that in a similar room, 20ft. × 15ft. × 10ft. high at 500 cycles, the increase of sound energy due to reflection is not more than 3 db. for sounds of the duration considered. It may be more below 200 cycles, where the reflection factor increases rapidly. Thus, for a given sound level in such a room, the (transient) power required is 50 per cent. of that in the open air; but for shorter sounds or higher frequencies the economy of power due to reflection in the room decreases rapidly.

We may conclude that a better starting point for power calculations would be to find what power is required to produce a given sound level at the listening point by direct radiation only. Then the assistance by reflection in a room becomes a small "factor of safety" which we can accept as good engineering practice, having just sufficient power available without it, the addition being in any case small and difficult to estimate. If this power is provided then we know that if any sound is re-radiated by the loudspeaker, however transient it may be and whatever the room boundary absorption, there will be sufficient energy to establish the required sound level at the listening point. This makes reproduction real in the power sense, for in listening to original sound, if it is transient, then the intensity level is that due to direct radiation with no appreciable sound reinforcement by building up of repeated reflections. This is particularly true of orchestral performances which are normally heard in an enclosure where the "building-up" time is appreciable.

Power Calculations

Once the idea is accepted that for realism a reproducer must be capable of producing at the listening point the required real sound level directly or "instantaneously" (which is the same thing) the maximum power required can be calculated if the intensity level relative to 10^{-16} watt/cm.^{2} is given, in decibels. According to the article "Loudspeaker versus Orchestra," the highest steady intensity level is about 100 db. To produce this there is required about 10^{-6} watt/cm.^{2}. The total acoustic watts is then $A \times 10^{-6}$ where A is the area across the power flows at the point chosen. To determine A we require to know the distance from source to listening point, and the solid angle which includes all the radiated power. This angle will vary with frequency and type of speaker, and an average must be taken unless the angle is known for a particular case. The average domestic receiver placed near a wall and with a back-damped cabinet will radiate usefully about 120 degrees. The radiation at the point P (Fig. 3) is across the curved spherical segment XPY. The angle 120 degrees is subtended by the area

$$A = 2\pi(\mathrm{OP})^2(1 - \cos\frac{\theta}{2}).$$

For $\theta = 120°$ this area is $\pi(\mathrm{OP})^2$.

In the example considered (Fig. 3)

[2], [3]. "Applied Acoustics." (Chapter on Architectural Acoustics), by Olsson and Massa.

Power and Realism—

which is similar to the small room in "Loudspeaker versus Orchestra" we have

$OP = 8ft. = 240$ cm. and $\pi(OP)^2 = \pi \times 576 \times 10^2 = 1.8 \times 10^5$ (approx.)

The total acoustic power required for 100 db. level at P is thus $1.8 \times 10^5 \times 10^{-6} = 0.18$ watt.

The electrical efficiency of small moving coil speakers working in a baffle is about 5 per cent., hence the electrical power to be delivered to the speaker is twenty times this, that is 3.6 watts. In order to take care of peak levels as given at 105 db. for orchestral music, the undistorted power required becomes $3.162 \times 3.6 = 11.4$ watts, where 3.162 is the factor for 5 db. increase.

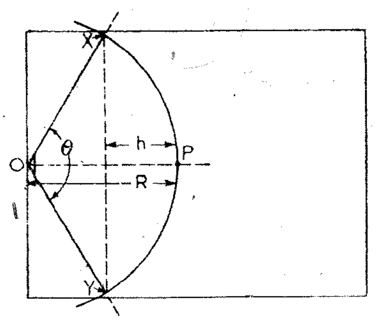


Fig. 3. Direct radiation in small room from loudspeaker at O to a listening point P ; the energy is spread over the spherical area XPY.

We can now calculate for comparison what the output in acoustic watts would be for an instantaneous level of 100 db. in a concert hall similar to the Queen's Hall. Here we may assume that the radiation at low frequencies, where most power is delivered, is over 300 degrees for most instruments, but that the arrangement of the orchestra near one end wall makes this only 180 degrees so far as listeners are concerned, at a normal listening position some distance from the orchestra. Taking an average position for P at 50ft. from the mean source O we have thus $A = 2\pi(OP)^2 (1 - \cos\frac{180}{2}) = 2\pi(OP)^2 = 14.14 \times 10^6$ cm.^{2}. The total acoustic power required for 100 db. sound intensity level at P is then $14.14 \times 10^6 \times 10^{-6} = 14.14$ watts and for peak levels of 105 db. the radiated power required is $3.162 \times 14.14 = 44.7$ watts. The same orchestra playing in the open air with full audience at ground level would require twice this power for equivalent levels, that is about 90 watts for 105 db. level.

It will be seen that these power requirements agree fairly well, in small rooms, with what experience shows to be necessary for reproduction at realistic sound levels, free from distortion of course, and in larger enclosures the agreement between accepted power output of large sources and sound level is also good.

A great deal of practical experiment has been done in working out the power required for satisfactory reproduction in cinemas. The empirical formula found by trial is as would be expected, one which requires more power for larger enclosures, but the relation is not a straight line. The power required is found to be proportional to $V^{2.5/3}$. In this article the more general formula starts from the dimension (half length of enclosure)^2 $= OP^2$ which is proportional to $V^{2/3}$, a very good agreement. The actual power required in watts delivered by cinema amplifiers is less than that calculated for 5 per cent. speaker efficiency because modern cinema compound reproducers have efficiencies up to 40 per cent., offset by a slight loss due to transmission through the screen which is about 2 db. Further, film recording volume limits are not yet life size. The upper intensity limit at present is 90 db. above zero level, which limits the highest power reproduced, unless the fader is pushed up at the peak of loudness.

The magnitude of these upper intensity levels in terms of loudness can be expressed by writing phons for decibels, since they are equal, in the range here considered, between 90 and 110 db., where the ear, like a measuring instrument, is "straight line." Thus the formula used finds in watts the power required for a given intensity, an arbitrary number, but this number is also the value which gives the practical measure, the resulting loudness, in phons.

The suggested formula agrees also with practice in that it supposes in a large and therefore wide enclosure the radiation angle will be large, and conversely for small or narrow enclosures. It fails only for extremes in shape or extremely long reverberation times, neither of which conditions should exist in enclosures intended for good audition.

So far as home listening is concerned the importance of wide distribution for all frequencies is evident, if sound levels are not to be distorted by concentration. It is also evident that, although the room reflection at 500 cycles (0.6 sec.) is not an important factor, it may be so at low frequencies when the reverberation time of the same room may be 1.5 sec. This would affect the relation of power to sound level for sustained low notes (e.g., cathedral organ). For the practical calculation of power required in watts we need to know only two variables: the length in centimetres from the speakers to the mean listening distance, which we call OP; and the average angle radiation of the loudspeaker used called θ. The general formula is then:—

Radiated watts required

$$= \frac{(OP)^2 2\pi(1 - \cos\frac{\theta}{2})}{10^6}$$

The following table gives values for

$$\frac{2\pi(1 - \cos\frac{\theta}{2})}{10^6}$$

for various values of θ so that calculation is simple having estimated θ and measured OP. For further simplicity the table has been worked out using another multiplier (107.6) to convert to linear feet. The required watts (radiated) is then the appropriate last column value multiplied by $(OP)^2$ where OP is measured in feet. If a single speaker will not cover the many area required reasonably, find how many are needed, and multiply again by that number. Finally, to find amplifier output watts divide by $\frac{X}{100}$ when X is speaker efficiency, per cent. The power arrived at is that required for a loudness level of 100 phons.

Angle θ covered by one speaker (Degrees)	$\text{Cos}\frac{\theta}{2}$	$1\text{-Cos}\frac{\theta}{2}$	$2\pi(1\text{-Cos}\frac{\theta}{2})$	Combined constant to be multiplied by OP^2(ft.)
45	0.924	0.076	0.477	0.00044
60	0.866	0.134	0.842	0.00078
90	0.707	0.293	1.830	0.00170
120	0.500	0.500	3.140	0.00291
150	0.259	0.741	4.654	0.00432
180	0.000	1.000	6.280	0.00583

APPENDIX

To find the total area across which energy from a loudspeaker flows, given the listening point distance R, and the distribution angle θ. See Fig. 3. Sound source is O; listening point P.

The area required is that of the spherical section XPY cut off by XY. From any geometry text book this is $2\pi Rh$.

But $2\pi Rh$ is required in terms of R and θ. Let $a = \frac{1}{2}XY$, then

$\tan\frac{\theta}{2} = \frac{a}{R-h}$ and $\sin\frac{\theta}{2} = \frac{a}{R}$

from which $R\sin\frac{\theta}{2} = R\tan\frac{\theta}{2} - h\tan\frac{\theta}{2}$

and $h = R - R\cos\frac{\theta}{2}$ or $R(1 - \cos\frac{\theta}{2})$

The spherical area across which the energy flows from a sound source at O, having a distribution angle θ, is then given in terms of the distance R and the angle θ by eliminating h, and is

$$2\pi R^2(1 - \cos\frac{\theta}{2}).$$

WIRELESS IN THE *LUFTWAFFE*

More Details of the Equipment Used in German Aircraft

A GENERAL description of the standard communication and direction-finding apparatus installed in German aircraft was published in our issue of November, 1940. At that time it was not possible to give more than a brief outline, but information now released by the Ministry of Aircraft Production enables us to fill in some details of the more interesting parts of the gear.

One of the most interesting and unconventional features was the iron-cored direction-finding loop. This is mounted on the outside of the aeroplane skin and is covered by a streamlined Perspex housing. A flexible drive coupled to a handle on the compass repeater and bearing indicator rotates the loop through a worm gear in the base. The shaft runs on ball bearings, and a 360 degree scale is attached to the main gear wheel for checking agreement with the scale on the repeater compass.

The aerial coil former is made of bakelised fabric ¼in. thick and 13in. long. It is of oval section measuring 3in. on the vertical and 4in. on the horizontal axis. The windings consist of eight turns of Litz wire approximately 0.08in. in diameter, wound symmetrically on each side of the former and connected in parallel to give an inductance of 3.2 μH. Inside the former the iron-dust core is built up of ring sections placed coaxially. The core material has been taken out and measured, and its permeability is of the order of 60.

Connection to the receiver is made through a screened twin cable with a characteristic impedance of about 30 ohms. The cable is ½in. in diameter and is divided in the centre by $\frac{1}{16}$in. insulating material. Each half is occupied by a semicircular conductor of tinned copper braid.

DF Loop Performance

The performance of the loop aerial has been checked, and it is found to give a polar diagram of normal type. For purposes of comparison a second loop aerial was constructed without an iron core, and the turns adjusted to give an inductance equal to that of the original. The energy pickup of the two loops was measured by interchanging, and the iron-cored loop gave an increase of 10 db over its air-cored equivalent. The iron core greatly increases the weight, and the loop is actually 3 lb. heavier than the DF receiver itself.

Figures which have now been made available show that the communication receivers in the FuG.10 radio equipment have a very high performance. In the long-wave receiver (0.3 to 0.6 Mc/s) an output of 50 mW. is given for an input of 1 microvolt with a signal/noise ratio of 20 db. The overall band width for 6 db down is 1 kc/s and the second-channel ratio 78.5 db. The short-wave receiver gives 2.5 mW. for 1 microvolt with 17 db signal/noise ratio and the second-channel ratio is 70 db.

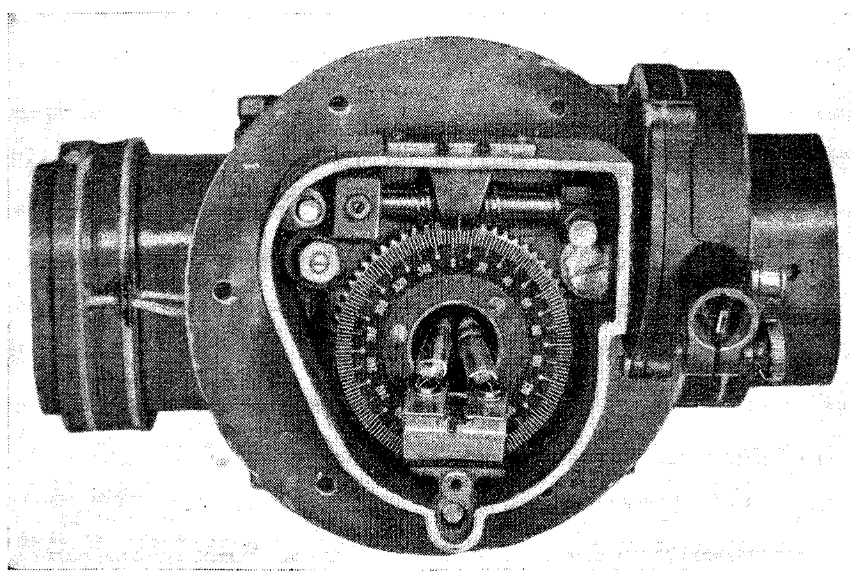
The superhet circuit comprises eight valves starting with a stage of RF amplification, followed by a separate oscillator with injection to the grid circuit of the mixer valve. There are two IF stages, the output of which is rectified by an anode bend detector and then passed to the AF output stage. A heterodyne oscillator is coupled to the grid of the detector and is adjusted to beat at 1,000 c/s with the intermediate frequency. This is 140 kc/s and 1.4 Mc/s in the long-wave and short-wave receivers respectively. Sensitivity is adjusted by varying the bias applied to the grids of the RF and first IF amplifiers. There is no AVC.

All RF coils have closed iron-dust cores and the inductance is adjustable by means of a threaded end section. Fixed ceramic condensers are used to tune the IF circuits, and a combination of positive and negative temperature coefficient ceramic condensers are used in the oscillator circuit associated with the frequency changer.

The valves throughout are all Telefunken type RV 12 P 2000, as described in the earlier account. Their basic function is that of an RF pentode, but they are also used as triodes with the suppressor and screen connected to the anode. Each valve requires a heater current of 68 mA at 12 volts, and the LT power is drawn from the aircraft 24-volt battery with the heaters connected in series-parallel. HT is supplied from a motor generator, the current being 40 mA at 200 volts.

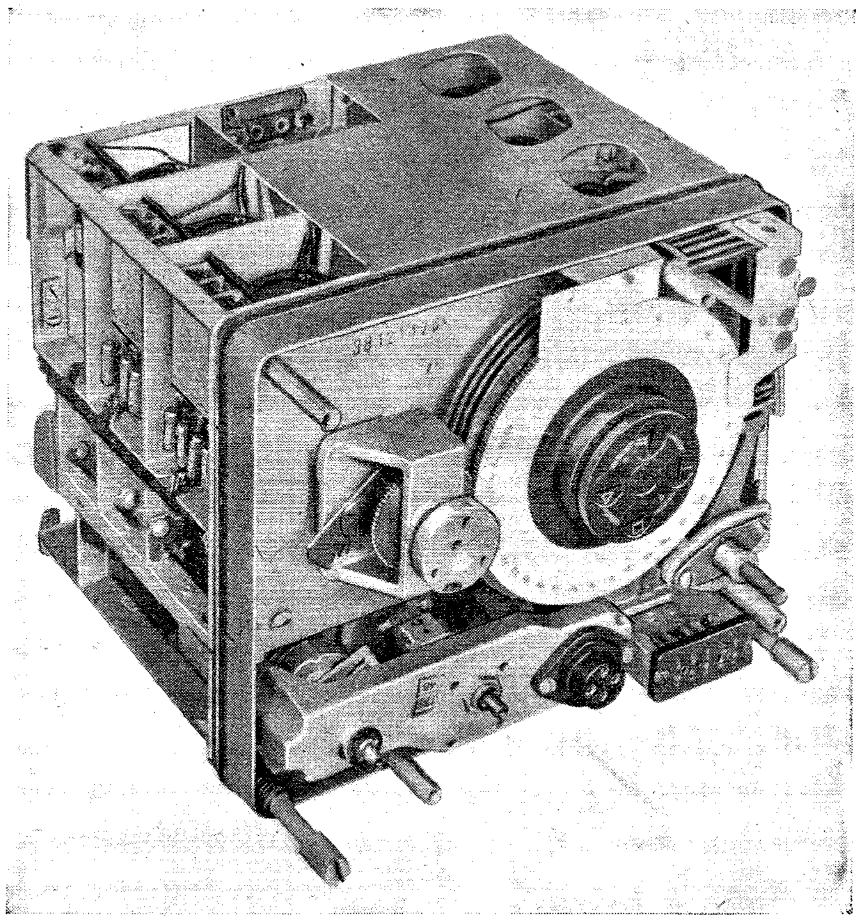
Mechanical Construction

Screening between stages is very efficient and accounts for the high overall gain. The chassis is of die-cast construction, and the compartments are arranged round the four sides of a central three-gang condenser. The fixed plates are earthed and the rotors, which are mounted in a ceramic spindle, are live. Location of the tun-



Underside of iron-cored DF loop showing gear box and worm drive for the flexible cable drive.

Wireless in the *Luftwaffe*—
ing condenser for operation on "spot" frequencies is effected by means of discs mounted behind the dial. Each disc has a notch which engages a projection on a spring-loaded lever. The common spindle for the four levers is mounted eccentrically and provided with a knob. Thus all four spot frequencies can be varied simultaneously over a small range. Four locking screws passing through the main timing knob permit independent adjustment of the setting of each disc, and a mechanical indicator system shows which spot frequency is in use.



Communication receiver unit with front cover removed to show the locking discs for the four fixed operating frequencies.

Everything about the receiver, and indeed the equipment as a whole, is very heavy and expensive, and gives the impression of being designed by a radio engineer with a ground station outlook rather than one who has specialised in aircraft design. The FuG.10 equipment is, however, designed as a complete installation, and the units fit together to occupy very little space with short interconnecting cables. The latter are easily replaceable when shot away, and the units themselves are simple to dismantle and reassemble for servicing.

NEW BOOKS

Practical Sound Conversion for Amateurs.
By F. G. Benson. Pp. 31 ; 11 figures. BCM/VALU, Monomark House, W.C.1, or direct from F. G. Benson, 88, Greenfield Avenue, Carpender's Park, Watford, Herts. Price 5s. 6d., post paid.

This well-printed book, with its clear diagrams, is an attempt by the author to offer sufficient practical information and suggestions that will enable an intelligent cine-amateur possessing mechanical ability to convert almost any make of silent projector (9.5 mm., 16 mm., or 35 mm.) to successful operation with the appropriate sound-film. That it has achieved its purpose is suggested by the fact that it has reached an amended second edition.

Emphasis is rightly laid on the necessity for absolutely steady, continuous film motion if reproduction of tolerable quality is to be obtained, and various methods of eliminating speed variations in the film drive are discussed. No mention is made of modifying projector picture-gates, etc., to prevent abrasion of the soundtrack, and a reference to the use of a centrifugal ball-governor (gramophone spring-motor type) to control AC/DC motors and so overcome aurally distressing slow changes of speed might have been useful. The term "warble" is employed when "wow" would be preferable. Accurate foot-note definitions of "wow" (*i.e.*, slow changes in reproduced sound, up to 6 per second) and "flutter" (fluctuation changes between about 6 to 30 per second) and, perhaps, "gargle" (fluctuation changes between about 30 to 200 per second) might with advantage be included in any future editions. D. W. A.

Radio Simply Explained, by John Clarricoats.—After a brief excursion into history, this book deals with waves both in the air and the ether, and shows the relationship between their length and the frequency of vibration of the instrument which produces them. Modulation is then explained, and after that the writer deals with elementary electrical theory, and proceeds thence via alternating current to wireless proper. After dealing broadly with various types of circuit, a simple explanation is given of the action of the Heaviside and Appleton layers. Pp. 44. 24 diagrams. Published by Sir Isaac Pitman, Parker Street, Kingsway, London, W.C.2. Price 6d.

Physics for Engineers, by Sir Ambrose Fleming.—This little book may perhaps be best described as a brief outline of physics. All branches of physics are dealt with, and a chapter is given describing the latest developments in atomic disintegration. Pp. 232. 89 illustrations and diagrams. Published by George Newnes, Ltd., Southampton Street, London, W.C.2. Price 7s. 6d.

The Radio Amateur's Handbook. Special Defence Edition, by the Staff of the American Radio Relay League.—Since the entrance of the U.S.A. into the war the American Radio Relay League has found it necessary to publish a special edition of the well-known Radio Amateur's Handbook, the 1942 edition of which was announced in these columns as recently as April. This emergency edition is intended as a compact and inexpensive textbook for the hundreds of radio training classes in course of formation all over America, and includes specially written chapters. Pp. 288, with 1,410 illustrations and diagrams. Published by the A.R.R.L. Inc., West Hartford, Connecticut, U.S.A. It may be obtained in this country from Webb's Radio, 14, Soho Street, London, W.C.2.

INTER-CIRCUIT SCREENING

Survey of the General Principles

By

M. REED, Ph.D., M.Sc., A.M.I.E.E.

EVERYONE who is concerned with the use or construction of wireless apparatus should understand why screening is necessary and the electrical principles underlying the design of suitable screens. It is the object of this article to give this information in a simple non-mathematical form.

The necessity for screening arises from the fact that it is, in general, impossible to assemble a number of circuits together in a wireless equipment without introducing stray couplings between them. Such couplings may be due to stray capacities, to stray mutual inductances, or to a combination of both; and their effect is to transfer energy from one circuit to another when either such a transfer is not required or when it is desired to effect the transfer by a path other than the one provided by the stray coupling.

Stray capacity coupling is commonly referred to as "electrostatic" because the interaction is caused by the existence of an electrostatic field which is common to the circuits under consideration. As an example of stray coupling of this type, consider the two tuned circuits L_1C_1 and L_2C_2 shown in Fig. 1 (*a*). A voltage E is introduced into the first circuit and it is desired to avoid any transfer of energy from this circuit to the second one. In general, there will exist stray capacities between the two circuits which, for our purpose, can be assumed to be concentrated in the two capacities C_A and C_B connected to the extreme points as shown. The system will then resemble the ordinary direct-coupled circuit, and we can expect energy to be transferred from L_1C_1 to L_2C_2. Suppose now that the capacities C_A and C_B are split up into two equal condensers in series, as in Fig. 1 (*b*), and that the junctions A and B are connected by a wire of zero resistance (i.e., by a short-circuit). The transfer of energy from L_1C_1 to L_2C_2 will then be prevented because there will be no potential difference between the points A and B. Such an arrangement would operate in practice if it were possible to localise all the stray capacities between the circuits in this way. As this is not possible, it is necessary to provide a short-circuit across every possible stray capacity between the two circuits. In practice, this is accomplished by enclosing the circuit L_1C_1 completely in a metal box. In this way, the necessary short-circuits are provided at every point between the circuits in the way indicated by Fig. 1 (*c*).

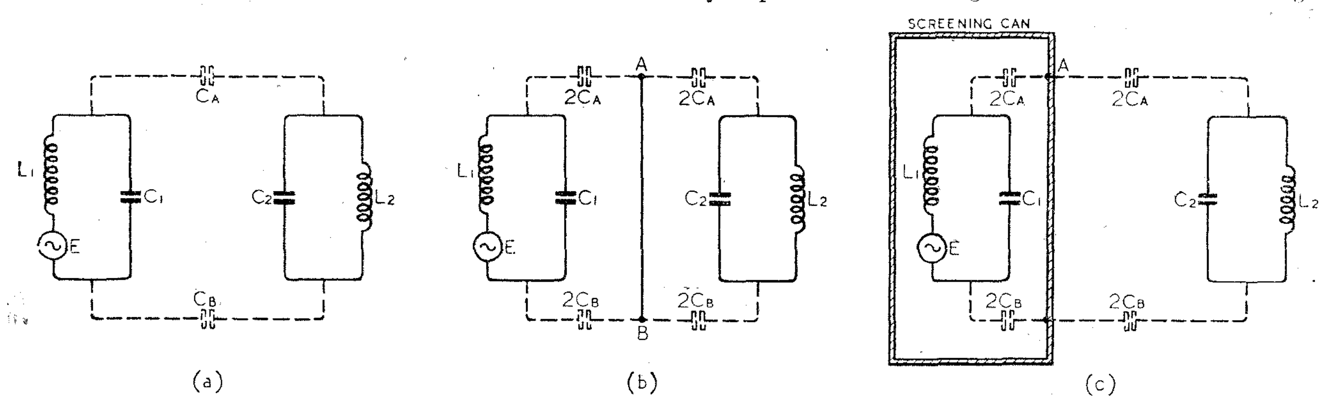


Fig. 1. Stray capacity coupling, and how it is obviated by screening.

Capacities to Earth

In addition to the stray capacities between the circuits, the second circuit and the can enclosing the first circuit will have stray capacities to earth, as shown diagrammatically in Fig. 2 (*a*). For convenience one end of the first circuit is shown connected to the can at B. If this connection is not made, it can be replaced by the stray capacity between this end of the circuit and the can. Fig. 2 (*a*) shows that, although there are numerous stray capacities between the various parts of the system, it is not possible to transfer energy to the circuit L_2C_2 because the can, acting as a short-circuit between the points H and B, prevents the establishment of a voltage between the points B and D. Therefore, so long as the circuit L_1C_1 remains completely isolated from any external influences the box will provide a perfect screen between the two circuits.

In practice, it is unusual to find such a completely isolated circuit, as it is generally necessary to bring external wires into the box to provide battery supplies or to link the circuit with other parts of the system. In such cases it may be impossible to avoid some stray capacity between these leads and earth, with the result that a voltage will be established across the points B and D via C_H, in the way indicated by Fig. 2 (*b*). This voltage will then produce a transfer of energy to the circuit L_2C_2 via such stray capacities as C_E, C_D and C_G. In practice, this condition is avoided quite simply by connecting the point B to earth, and so providing a short-circuit across the points B and D. It follows that this connection should be made by as short a route as possible, so that the connecting lead should have as low a resistance as possible.

There is an additional difficulty introduced by the external leads arising from the fact that voltages may be induced in them from the circuits inside the box. These leads may then transfer energy to other circuits either through the stray capacities existing between them and these circuits, or by stray magnetic couplings. The methods employed to avoid this depend on whether the leads are required to carry power supplies into the box or to connect the circuits inside the box to other circuits outside the box. In the former case the leads will not normally carry high-frequency currents, so that pick-up on them can be minimised by the use of a filter consisting of a screened high-frequency choke L and a condenser C connected in the way shown in Fig. 3 (*a*). In this diagram it is assumed that the lead goes to the tuned circuit via some other part of the system which does not concern us. As an additional precaution the leads can be run in an earthed metal sheath. This sheath can be regarded as an extension of the metal box, and it provides the short-circuit necessary to neutralise the effects of stray capacities from the leads. Also, the eddy currents set up in the sheath in the way to be described later in connection with electromagnetic screening at high frequencies will reduce considerably the magnetic field produced by the leads outside the sheath. In the case when the leads inter-connect the circuits they normally carry high frequencies, so that the LC filter cannot be fitted. There is then no alternative but to run the leads in an earthed sheath to avoid undesired interaction between the circuits.

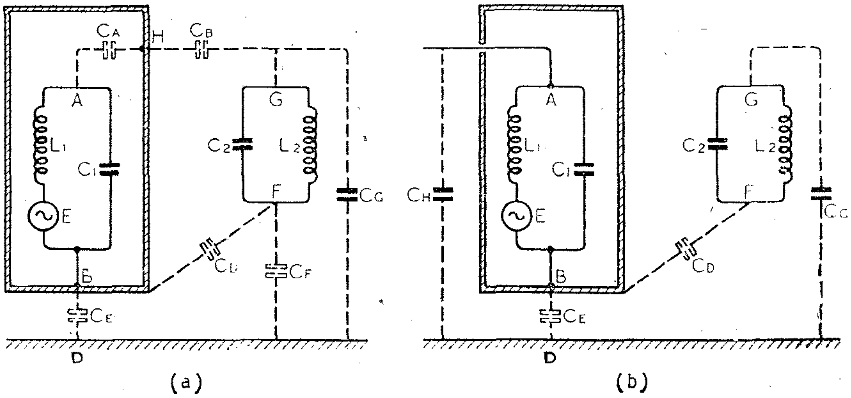
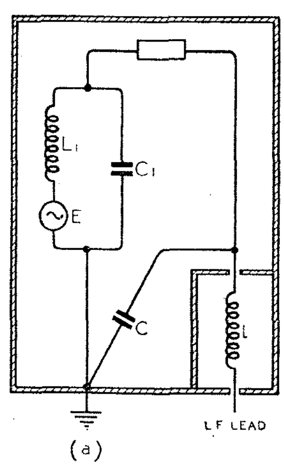


Fig. 2. **Diagram (a) shows stray capacities between the screening can and external objects. Diagram (b) illustrates the effect of an external lead.**

Double Screening

In some cases, particularly at very high frequencies, the use of a single screen as described above is still insufficient to meet the requirements of the equipment. As it is impossible to build a screen of zero resistance, there will always be a voltage set up between any two points, such as A and B of Fig. 1 (*c*), whose magnitude will depend on the resistance between these points. For most purposes this resistance is not large enough to prevent the box acting as an effective screen, but at very high frequencies, when the resistance is correspondingly increased, this may not be the case. To overcome this difficulty it is necessary to provide a second screened box enclosing the first one and clearing it at a distance of not less than an inch in the way indicated by Fig. 3 (*b*). With this arrangement a fraction of the voltage set up across points such as A and B can be transferred to the second screen directly via stray capacities of the type indicated by C_1 and C_2 in the diagram, or by the mutual coupling between the screens, or both. As the voltage between A and B will in a practical case already be quite small, the voltages which it can in turn induce in the second screen via the stray couplings should not be large enough to prevent adequate screening. It follows that if the capacities C_1 and C_2 are short-circuited by joining the two screens at A and B, the voltage across A′ and B′ will be the same as across A and B, and the advantages derived from having a second screen will be lost. When low-frequency leads are connected to the circuit an additional LC filter can be fitted between the screens in the way shown in the diagram. All high-frequency leads must be run in a sheath which is connected to *both* the inner and outer screens, so as to neutralise all possible electrostatic couplings. For the reason given above every precaution must be taken to insulate the inner screen from the outer one to ensure that no additional contact is made between the screens. Also, as no two positions on the inner screen can be regarded as being at the same potential, all points in the circuit which require "earthing" should be connected to the point of contact between the two screens as indicated in Fig. 3 (*b*). In this way the circulation of currents between parts of the system which should be at the same potential will be avoided.

So far the circuit L_1C_1 has been considered as the only source of energy. As the circuit L_2C_2 will in turn become the source of possible disturbance when it is provided with energy, it is the usual practice to enclose this circuit in a can (or cans) as well. When more than two circuits are involved, exactly the same principles apply, and they should all be provided with cans.



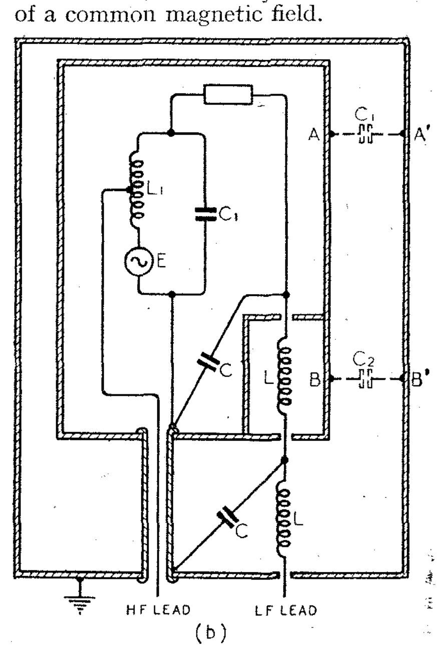


Fig. 3. **Illustrating the use of "de-coupling" filters and double screening.**

Magnetic Couplings

Stray mutual inductance coupling, which may now be discussed, is generally referred to as "electromagnetic" because the interaction is, in this case, caused by the existence of a common magnetic field.

The underlying principles are somewhat different from those which have just been considered, although the methods employed to neutralise the stray mutual coupling may appear to be the same. Actually, the methods

Inter-circuit Screening—

employed when the coupling is of the mutual type depend on the frequencies under consideration. There are two methods, one for low frequencies and the other for high frequencies.

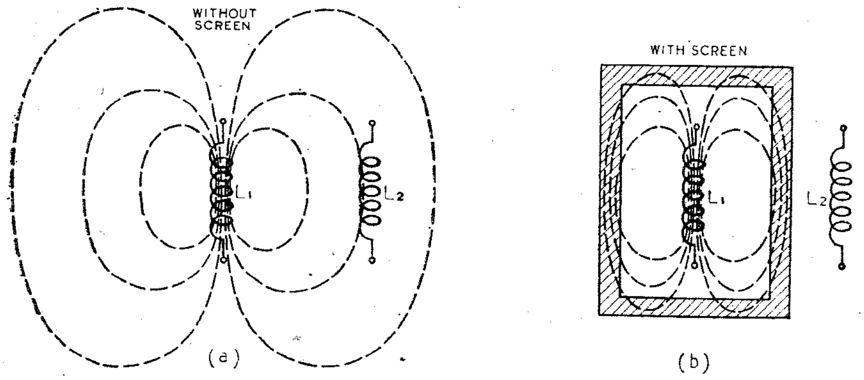


Fig. 4. **Electromagnetic coupling at low frequencies, and how the field is restricted by screening.**

At all frequencies the coupling arises from the fact that some of the magnetic lines established by the current in the first circuit link the second circuit. It is, therefore, necessary to screen this circuit completely from the influence of the magnetic field associated with the first circuit. This can be done at low frequencies by enclosing the first circuit completely in a box made of high permeability ferromagnetic materials. The lines of force associated with the coil will then crowd into the magnetic material, as they will prefer this path to the air surrounding the outside of the box. No magnetic lines will therefore appear outside the box and the second circuit will be completely screened from the first one. The action of a magnetic screen is illustrated in Figs. 4 (*a*) and (*b*). This method of screening is commonly used for frequencies up to about 15 kc/s.

RF Screening

At high frequencies effective shielding is provided by employing a different principle which depends on the fact that, when an alternating current flows in a circuit, the resulting electromagnetic field induces a current in another circuit mutually coupled to it. This current in turn produces a magnetic field whose direction is such as to oppose the magnetic field produced by the current in the first circuit. Thus, in Fig. 5 (*a*) a current flowing in a coil L1 in the direction shown will induce a current in the closed loop L2 flowing in the opposite direction so as to produce an opposing magnetic field. If there were a number of loops similar to L2 disposed symmetrically along the axis of L1, each loop would have a corresponding induced current. We should then find that, given a sufficient number of closed loops, the resultant magnetic field at points not too close to the coil assembly will be negligibly small. At points near the coil assembly, the value of the resultant field will depend on the relative distances of the point under consideration from the coil L1 and the loops L2. For example, for points in the interior of L1, the value of the field will remain comparatively uninfluenced by the loops L2, whereas for points near the loops the resultant field will be very small.

In practice, the loops are replaced by a single box made of aluminium or copper which encloses the coil L1. Circulating currents are induced in the can in exactly the same way as in the loops, and these currents give rise to the neutralising magnetic field. In fact, the box can be regarded as a rather thick loop. The currents set up in the can are known as *eddy currents*. The resultant magnetic field produced inside the can is indicated in Fig. 5 (*b*); the field outside the can is negligibly small.

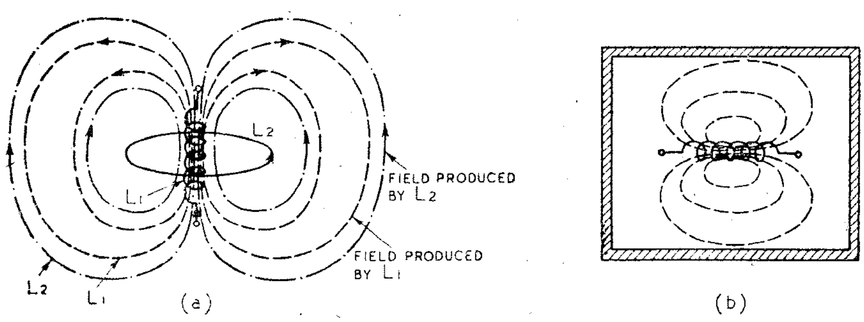


Fig. 5. **Electromagnetic screening at high frequencies.**

The shielding effect produced by the can increases with frequency and with increase in the conductivity of the screening material. As the efficiency of the screening depends on the ease with which the eddy currents can flow, all joints in the screening can must be electrically perfect.

The similarity in the action of the screening can and the closed loops of Fig. 5 (*a*) suggests that the influence of the can on the properties of the coil L1 can be analysed by treating the problem on the same lines as the simple mutually coupled circuit, i.e., the transformer.* If such an analysis is made it will be found that, owing to the presence of the can, the apparent resistance of the coil L1 will be increased and its apparent inductance reduced. The efficiency of the coil (given by $\frac{\omega L}{R}$) will therefore be lowered. To avoid an excessive loss in efficiency, it is usual to employ screening material of the highest conductivity possible and to space the coil from the walls of the screen by a distance not less than the coil radius. As in the case of stray electrostatic couplings, it is usual to provide a screen for every coil in the circuit. Also, the methods employed to deal with external leads apply equally well here.

Practical Considerations

In practice, it is usually necessary to guard against stray couplings of the electrostatic as well as the electromagnetic type. From the foregoing it follows that, for high frequencies, the screening box employed to avoid the effect of stray magnetic fields will also avoid the effects of stray electrostatic fields provided the can is connected to earth. The ferromagnetic screen which has to be used for low frequencies will also provide protection against stray capacities when it is earthed.

There are cases when it is desired to screen a coil from electrostatic fields and, at the same time, not to prevent it from being influenced by magnetic fields. The action of the screen in the two cases is quite

* G. W. O. Howe, *Wireless Engineer*, July, 1934.

Inter-Circuit Screening—

different, electrostatic screening requiring the provision of short-circuit paths in a direction parallel to the axis of the coil and electromagnetic screening requiring the provision of continuous circular paths whose planes are perpendicular to the coil axis. It is therefore necessary to construct a screen which has longitudinal continuity without circular continuity. One way of making such a screen is indicated in Fig. 6, where metallic strips are fixed to insulated end rings and arranged to form a squirrel cage.

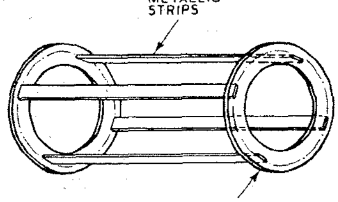


Fig. 6. A type of screening that permits electromagnetic coupling but prevents unwanted stray capacity effects.

In this way the strips screen the coil against the stray capacities without providing a complete metallic circuit in which the eddy currents can flow. The efficiency of the arrangement will depend on the closeness of the spacing between the strips.

The main points which have been considered can be summarised as follows:

(1) Electrostatic couplings in the case of isolated circuits can be neutralised by the use of metallic boxes without an earth connection.

(2) An earth connection is essential when there are leads connected to the circuits. High-frequency filters may also be necessary.

(3) At very high frequencies or in cases where a very high order of screening is required two metal boxes may have to be used. These boxes must not have more than one point of contact.

(4) Electromagnetic screening at low frequencies can only be achieved by using a box made of high-permeability ferro-magnetic material.

(5) Electromagnetic screening at high frequencies is achieved by the use of a metal box made of high conductivity material.

(6) Combined electrostatic and magnetic screening is achieved by earthing the box employed in the latter case.

(7) Electrostatic screening without magnetic screening is obtained by using a metal cage which has longitudinal but not circular continuity.

Wireless World: Increase in Price

It is regretted that rising costs of production compel our Publishers to increase the price of this journal from 1*s*. to 1*s*. 3*d*. The increase takes effect with the present issue.

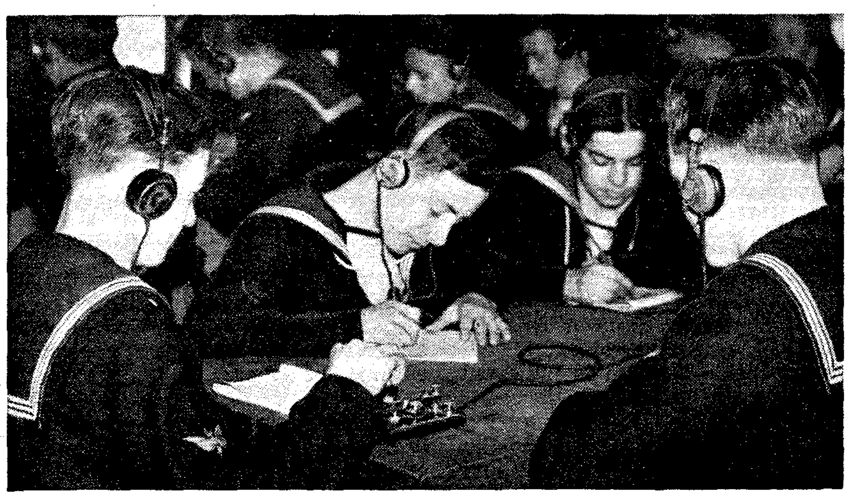
Glass-Insulated Wire

Continuous Operation at Temperatures up to 140 deg. C.

WINDING wires insulated with glass fibre have been introduced recently by British Insulated Cables, Ltd., Prescot, Lancs. The primary object of this new insulating material is to enable windings to be run safely at higher temperatures than could be possible with conventional materials such as cotton; indeed, the upper temperature limit (approximately 140 deg. C.) is set not by the insulation but the possibility of oxidation of the copper. The high temperature rating combined with increased thermal conductivity in the covering enable very economical designs to be evolved.

The covering consists of alkali-free glass filaments impregnated with a special varnish and stoved to produce a smooth, dense layer well bonded to the conductor. In the "Fine" covering, which adds about 3 to 5 mils to the diameter of the wire, a single layer of glass yarn is used, while in the "Standard" covering two layers applied in opposite directions give an increase of diameter of 6 to 8 mils.

Gauges at present available range from 8 to 33 SWG in high conductivity copper, but the covering can be applied to other conductors in special cases. Magnet strips insulated with "B.I. Glass," as the new covering is called, can be supplied in a limited range of sizes.



NAVAL TELEGRAPHISTS IN THE MAKING.—Sea cadets on board the "Bounty," where they receive preliminary training in morse and naval wireless procedure.

Training Young Telegraphists

MANY Sea Cadets are now being trained as telegraphists for the Navy on board the "Bounty," a sailing brig of the last century. The scheme, conducted by the Navy League, is for lads of 16 years upwards who have reached a prescribed standard of telegraphy in Sea Cadet units. Entrants have the advantage, provided they succeed in qualifying, of joining the Navy at the age of 17—a year earlier than through normal channels. Further, there is a reduction in the time, as compared with normal entrants, that "Bounty" cadets are required to spend in Naval training establishments before going to sea.

B.B.C. Handbook, 1942.—The main theme of this handbook is the ever-increasing expansion of the B.B.C.'s war activities, not only in the realm of broadcasting in foreign languages, but in home programmes also. The handbook records that there has been a great increase in the transmitter strength of the stations dealing with oversea programmes. The number of foreign languages being used has increased also.

Among the many articles which the handbook contains the one which is of special appeal because of its technical interest is "Wartime Studios," by the chief of the programme engineering department. Interesting and informative data are given concerning the subterfuges that had to be adopted in using makeshift studios.

INSTRUMENTS : *Test and Measuring Gear and Its Uses*

By W. H. CAZALY

III.—Valve Voltmeters

THE special property of the valve voltmeter is its very high input impedance. That means that the reactance or resistance existing across its test terminals, due to stray capacities, resistances in the circuit of the valve voltmeter, the effects of any valves employed, and such factors, is extremely great. This is a very desirable quality in any voltmeter, since its connection to the circuit under test should make the least possible difference to the working conditions being examined. It must, however, be remembered that this excellent property of the valve voltmeter is obtained at the expense of cheapness, strength, reliability, simplicity and freedom from the necessity for power supplies, which are usually the benefits enjoyed by the use of well-made rectifier-type meters. Nor is the valve voltmeter very sensitive with low inputs, save in special laboratory forms unsuitable for general use. But the high input impedance of the valve voltmeter, especially when dealing with radio - frequency circuits, makes it almost indispensable in certain kinds of measurement. If a valve voltmeter does not possess a high input impedance, or if the circuit under test is of low frequency and impedance itself, there is no point in using a valve voltmeter at all; it comes into its own only for measurements in circuits of high impedance themselves involving frequencies so high that even small capacities introduced by the measuring instrument would act as an appreciable shunt and seriously upset the working conditions.

It may be best, perhaps, to begin by examining the skeleton circuit of a very commonly used valve voltmeter, such as is given in Fig. 1. Although it looks, to a novice, a rather complicated arrangement, it may actually be divided for the purposes of study into five main sections, each of which is in itself quite simple to understand. These five sections may consist—referring to Fig. 1—of (a) a diode rectifier with a high value of load resistance; (b) a triode to the grid of which the voltage developed across the load resistance is applied, thus altering the conductivity of this triode; (c) a "bridge" circuit including the triode as part of the network, of which the function is to prevent the indicating meter having to carry the anode current of the triode, thus enabling a more sensitive meter to be used for indicating the unbalancing of the bridge when the conductivity of the triode changes; (d) a cathode resistance variable in steps that, in a way to be explained in due course, changes the range of measurement; (e) a potential divider across HT positive and negative that provides a potential for the triode grid enabling it to operate in this circuit over the straight part of its anode current - grid voltage characteristic, giving linearity of scale indication throughout the range and maximum sensitivity.

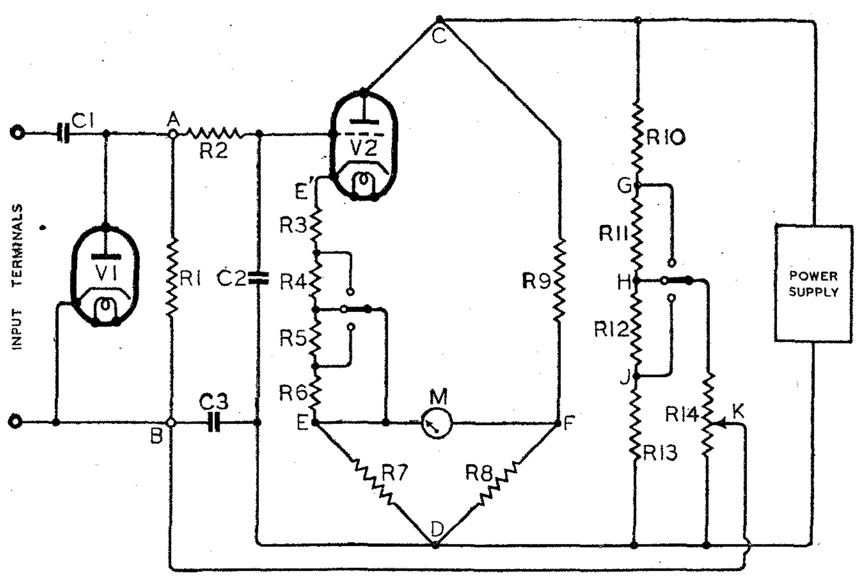


Fig. 1. Skeleton circuit of a commonly used form of general purpose valve voltmeter.

These five sections are shown separately for reference purposes in Fig. 2, and slight alterations have been made in order that their individual actions may not be confused. When the behaviour of each section is studied individually and its function is understood, their action in combination will be made clear.

Rectification

Fig. 2 (a) shows the diode rectifier and its load, R1, and the feed condenser C1. With no alternating voltage across the input terminals a very minute potential difference, if any at all, exists across R1. If an alternating voltage is developed across the input terminals, however (it will be assumed that it is of sine wave form), the diode will pass current during the positive half-cycles only. Now, an easy way of remembering the sign of the voltage polarity in any electrical circuit is to say "P, Positive, Poor in Electrons — N, Negative, Numerous Electrons." The anode side of the condenser C1 begins by being neutral — i.e., having its correct complement of electrons — but when the positive half-cycles of voltage occur on the input side of the condenser, the electrons in the anode side are strained towards the input side; the diode anode, which is connected to the anode side, thus acquires a positive potential in respect to cathode, during the positive half-cycles, and electrons from the cathode are attracted to it during these periods. Having once reached the anode, they cannot get off it again (because the anode, unlike the cathode, is not hot and emissive) save through the resistance R1. If R1 is of high value—and it is normally made anything from 5 to 100 MΩ—they do not get through it easily and remain crowded—numerous—on the anode side of the condenser C1. Thus the anode acquires, with each succeeding positive half-cycle, an increasing *negative* potential; this goes on until the negative potential so developed at this point *equals the peak voltage of the positive half-cycles*. If this voltage can be measured the RMS value of the alternating sine-wave voltage across the input terminals A B can be derived by multiplying by 0.707.

Now, since R1 is a comparatively high resistance, no ordinary moving-coil and resistance type of voltmeter will be able to indicate the potential difference across it satisfactorily, because even the best of this type of voltmeter has an input resistance of only a few score thousands of ohms, which would act practically as a short circuit across R1. If, however, R1 is made to act as the "grid-leak" of a triode valve, the voltage across it can be made to affect the anode current of this triode valve in an easily observed way. This is shown in Fig. 2 (b), where the differences between this arrangement and Fig. 1 are shown in dotted line. If the triode valve starts by passing, say, 5 mA when there is no voltage across R1, the development of a voltage across R1, by the action of an alternating test voltage applied across the valve voltmeter input terminals to the diode as explained above, may cause the anode current of V2 to change to 1 mA, which is readily seen on an ordinary meter. Since the voltage at the diode anode is negative, no grid current will pass through R1, and hence no power will be used, and the only resistance across R1 will be that of the insulation between V2 grid and cathode, which will be of the order, normally, of thousands of megohms. If the grid of V2 were connected directly to the diode anode, the grid-cathode and grid-anode capacities and the stray capacities of the wiring might, at really high radio frequencies, enormously reduce the input impedance of the valve voltmeter—even 10 $\mu\mu$F offers reactance of only 1,600 Ω at a frequency of 10 Mc/s. Hence, R2 is included, to provide adequate impedance to the alternating voltage input that is to be measured. The grid of V2 may then be safely rid of any RF by the by-pass condenser C2. There is no voltage drop through R2 because no grid current is being passed; what gets to the grid of V2 is the full voltage developed across the resistance R1.

It is easy to observe, on an ordinary meter, a comparatively large change in the Ia of V2. If, however, small changes, caused by small test inputs, must be read easily, this meter must be a sensitive one—say a microammeter. But such a meter cannot carry the standing Ia of V2, which may be of the order of 5 mA. For this reason, a bridge circuit is employed, as shown in Fig. 2 (c). In this V2 forms one of the resistive paths in the bridge network, and the meter is used only to indicate when the bridge is out of balance. At other times it remains at zero. R7, R8 and R9 are of such values that when V2 is passing 4.5 mA (which will be assumed to be when its grid is 1 volt negative with respect to the cathode of V2) it acts as a resistance that completes the exact balance of the bridge. Now if a voltage is developed across R1, the conductivity of the valve is altered and the bridge is thrown out of balance. The sensitive meter M indicates readily the slightest unbalance of this bridge, and if its scale is suitably calibrated, the precise amount of the unbalance, which in turn depends on the voltage across R1, which is equal and opposite in polarity to the peak of the positive half-cycles of test voltage. Hence the meter M may be calibrated for sine-wave inputs in terms of RMS values.

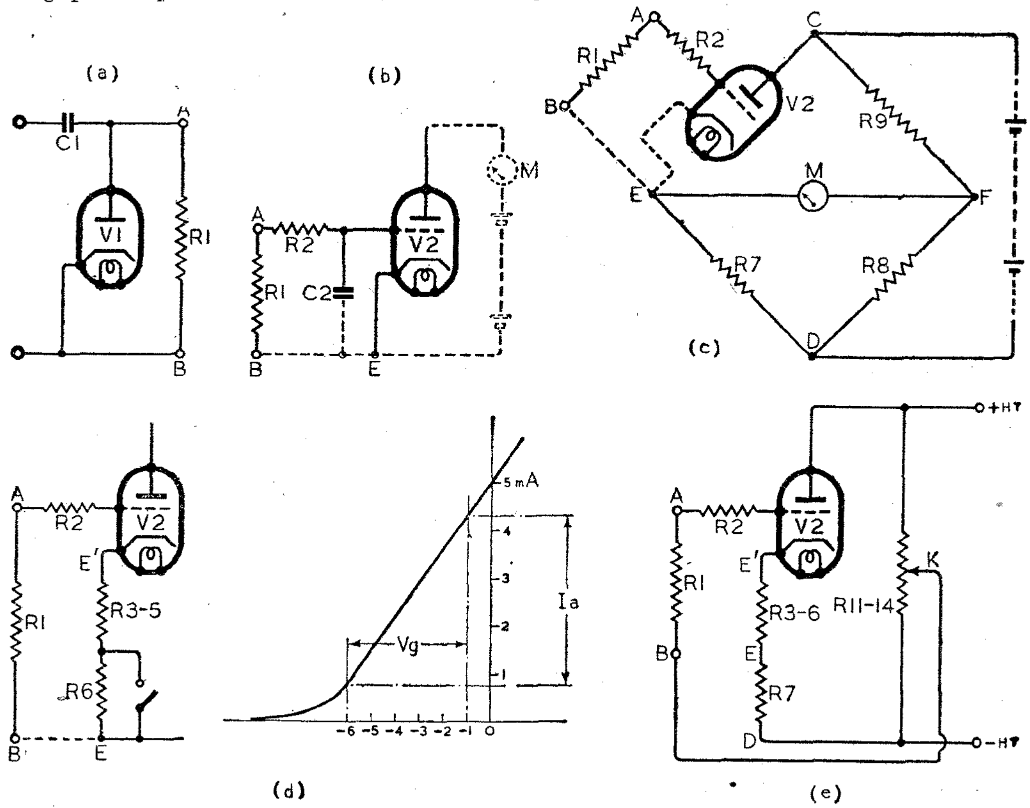


Fig. 2. Five separate functions are performed by the circuit of Fig. 1, which is here dissected into its constituent parts.

Referring to the Ia/Vg curve shown in Fig. 2 (d), it will be seen that the amount by which the grid potential can change toward negative with respect to the valve cathode is strictly limited, in this case to about −6 volts; beyond that, it runs into the curved part of the characteristic, which renders scale indications no longer linear—i.e., the divisions can no longer be evenly spaced—and, further still, it runs to "cut-off" and no indications are obtained at all. It is theoretically possible, of course, to measure up to quite high test voltages by taking bits of it at a time, say every

6 volts, but this is an impracticable and unnecessary method.

From Fig. 2 (d), it will be seen that resistance is included in the cathode circuit, i.e., R3—5 and R6. If V2 passes 4.5 mA of Ia, the passage of this current through the cathode resistances sets up a voltage across them. This is well known as the principle of "automatic bias" in domestic receivers. The cathode, E′, will be positive with respect to E. Hence if R1 is connected to E, as shown for the sake of argument in the dotted line, the potential of the grid will be negative with respect to E′, or, E′ will be positive with respect to the grid by an amount depending on the Ia of V2 and the ohmic value of the cathode resistances. If a voltage is developed across R1, then the Ia of V2 will change—and so, therefore, will the voltage across the cathode resistances. If the point A becomes negative, V2 will pass less Ia. Hence, E′ will become less positive with respect to E, and therefore with respect to the grid of V2. Which is much the same as saying that instead of the grid becoming negative with respect to E′ by the full amount of voltage across R1, which would happen if the voltage across the cathode resistances remained constant, it becomes negative by some amount *less* than the full voltage across R1. Plainly, the larger the ohmic value of the cathode resistance, the greater is this effect. If the cathode resistances are made, say, of the order of many thousands of ohms, the voltage across R1 can become quite large before the *net* change in the grid potential of V2 with respect to the cathode E′ of V2 is such as to extend beyond the lower end of the straight part of the Ia/Vg curve. This means that the test voltage input to the valve voltmeter can be measured over a wide range in one sweep, and changes in the range of measurement of which the valve voltmeter is capable can be made very simply by altering the value of the cathode resistance. In this case, referring to Fig. 1, it is done by switches and a chain of resistances.

Range Switching

The last portion of the circuit to be studied presents no difficulties if the foregoing has been understood. It is plain that if the "earthy" end of R1, the point B, were taken to E, the effective potential of the grid of V2 would settle down to some value dependent on the magnitude of the cathode resistance in circuit, and would therefore change with each movement of the range switch; the Ia of V2 would also change, and the bridge would have to be balanced by altering the ratio of R9 to R8 each time. Again, if B were connected to D this point is so far negative with respect to E′ that very little Ia would be passed by V2 and again the bridge would be difficult to balance save by considerable alterations in the bridge elements. Hence, the point B is connected to the slider of a potential divider across HT positive and negative. If only one range of test voltage were to be measured, the slider could be set at some one point only. But since several ranges are involved, each demanding a different initial potential for the grid of V2 in respect to cathode, the potential divider is made up of a chain of resistances, and the correct working potentials selected by a switch ganged to the range switch. Final adjustment is made by a slider on a main potential divider, R14. The potential of the point K is made (in this case) just one volt less positive in respect to HT negative than E′, which means that the steady (no input) potential of the grid of V2 will be −1 volt with respect to E′, and V2 will pass the current required for balancing the bridge.

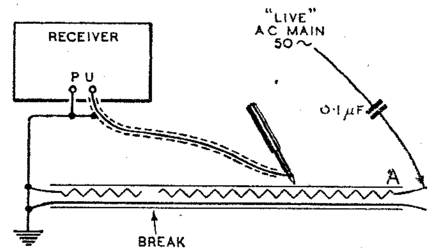
Finally, mention may be made of the means whereby the input impedance is kept high even at high radio frequencies. The diode V1 is usually an acorn type and is carried in a low-loss holder on which are mounted also R1, R2, and C1. This holder or "probe" is connected to the triode and bridge circuits and the power supply, which are all mounted in a separate casing, by a flexible cable that contains the leads from the cathode of V1, the heater or filament leads, and the lead from the grid (V2) end of R2. By this means, the diode anode feed condenser can be brought right up to the circuit being tested and leads to it kept as short as possible, which reduces the capacity across the input terminals and the inductances of these leads to the minimum. The calibration of such a well-constructed valve voltmeter is extremely simple. Since the input impedance is so high at all frequencies, it may be calibrated with 50 c/s mains supplies, the voltage being reduced by suitable combinations of step-down transformers or resistive potential dividing networks, with an ordinary metal-rectifier type of AC meter as the voltage standard. Calibration of the valve voltmeter obtained thus will hold good at frequencies up to the order of 20 or 30 Mc/s and even beyond with reasonably small errors if used with care. There are several other kinds of valve voltmeter, of course, both commercial and laboratory, but if the one here described is clearly understood, little difficulty should be experienced in grasping the principles of the other types.

Line Cord Repairs

Locating Breaks Without Damaging the Wire

WITH the shortage of cord resistances of the type used so much in AC/DC sets, the repair of these essential components may be necessary if the set is to be put back into service. The job is three-quarters done if the break can be located easily and accurately.

The following method of location has been used with every success. The scheme is shown in the diagram.



Fault locating circuit for testing broken line cord resistances.

The through wire is earthed, as is one end of the broken resistance wire, the other end is joined to a source of AC, such as the unearthed phase of a 240V, 50-cycle supply, through an isolating condenser of about 0.1 mfd. A screened lead from the grid side of the pick-up terminals of a wireless set is connected to the blade of an insulated screwdriver; a better tool is the metal tip of a trimming tool. The set-up is now complete.

To use, the screwdriver blade is slid along the wire, from the point A, when a loud 50-cycle hum will be heard from the radio set. The moment the blade passes the break, this hum will drop nearly to inaudibility, depending on the efficiency of the earthing and screening arrangements. Even if these are scanty, there will be no difficulty in noticing the drop in volume. The position of the break can be easily found to within 0.1in. W. O'D. W.

Wireless World

Brains Trust

Problem No. 1

MY AC mains-operated broadcast receiver, though apparently in perfect order, hums while it is warming up. Why? (*Solution on page* 149.)

THE WORLD OF WIRELESS

RECEIVER PRODUCTION

THE recent announcement by Mr. Hugh Dalton, President of the Board of Trade, that "some 125,000 wireless sets for the civilian population are in process of manufacture," and that the production of a utility receiver is under consideration, has caused considerable speculation on the part of the lay Press. Mr. Dalton, in reply to a question regarding a standard set, stated that the quickest and most economical results will be achieved by completing the 125,000 sets rather than by embarking at this stage on the production of a utility receiver.

The facts appear to be that the industry's output for the year from April, 1942, to March, 1943, will not exceed 125,000 receivers. These will *not* be utility or austerity sets, but simply the partly completed receivers which are awaiting the release of further components, etc. They will, in most cases, be from the manufacturers' 1940 ranges, some may even be of 1939 design. It is, of course, unlikely that they will appear in cabinets exactly as illustrated in the catalogues of those years, and it may be this fact that has given rise to the suggestion put forward by some writers that cabinets will be of asbestos, cardboard, etc.

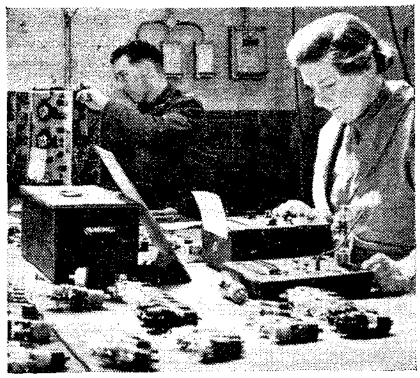
The figure of 125,000 receivers, which will be entirely for the home market, represents approximately a tenth of the industry's pre-war annual output.

It will be recalled that the Scottish Radio Retailers' Association put forward the suggestion of a standard receiver last November, the main reason being the ease of servicing due to the use of standard components.

AMATEUR TRAINING IN U.S.

ALTHOUGH handicapped by the absence of 15,000 of the most active amateur radio operators on naval and military communications duty, the American Radio Relay League is providing training for American youths who will shortly be eligible for national service.

The courses aim at qualification for the amateur Class B licence. It is interesting to record that no one may enlist in the Signal Corps unless he holds an amateur or commercial licence. In the U.S. Navy the rating of radioman second class is offered to holders of amateur Class B licences.



A TRAINEE A.T.S. wireless mechanic testing valves in one of the repair bays of an R.A.O.C. wireless workshop.

SECOND-HAND SETS

AN Order which comes into force on May 25th prohibits the sale by dealers of any second-hand price-regulated goods, which includes broadcast receivers, at a price exceeding that of comparable new goods.

The "first-hand price," as it is termed, is defined as either (a) the price at which the same or comparable goods are being lawfully sold new at the date of the sale of the second-hand goods or within six months prior thereto, or (b) the estimated price at which it would have been reasonable for such goods when new to be sold in the course of a similar business during the six months prior to September 3rd, 1939.

Commenting on the Order, the *Wireless Trader* writes, "It is obviously not going to be easy for dealers selling second-hand radio sets, which are very often of obsolete design, to arrive at 'the price at which similar or comparable goods are being sold new,' and it is to be hoped that further guidance will be forthcoming."

PURCHASE TAX CHANGES

THE increased rate of purchase tax imposed on radiogramophones and their accessories is, by implication, confirming the Government's decision that broadcast sets and accessories (on which the tax is unchanged) are necessities and not luxuries. Purchase tax at the rate of $66\frac{2}{3}$ per cent. of the wholesale value is now chargeable on radiogramophones and records. Special records and gramophones for the use of the blind remain tax free.

It is understood that the heavier tax on radiogramophones is not regarded very seriously in the industry, as production is negligible.

WOMEN WIRELESS MECHANICS

AN innovation introduced by the Officer Commanding the South-Eastern Command is the employment of members of the Women's Auxiliary Territorial Service to work side by side with the men as Wireless Mechanics in the Royal Army Ordnance Corps wireless workshops. These girls, who, when sufficiently proficient will be graded as wireless mechanics, a grade only just approved by the War Office for the A.T.S., will be paid at the rate of 60 per cent. of that received by the men.

Their jobs include the repair of field wireless and line communication gear. Although they have not so far been put on the task of fault-finding, they are doing a certain amount of routine testing. Some of the tasks on which they were found to be engaged during a recent *Wireless World* visit to the R.A.O.C. South-Eastern Command Headquarters included meter repair work (such as replacing thermocouples), valve testing, continuity testing of faulty communication receivers and line telephone repairs.

After a period of a few months in the workshop, the routine work of which was described in *Wireless World* of March, 1941, the girls are given a course on theory, which includes mathematics, in the R.A.O.C. school.

The girls who are at present undergoing training have volunteered for the special course, most of them having previously been storewomen or orderlies. They are not to be confused with the many A.T.S. Radio Mechanics whose job is associated with radiolocation.

In the tank-fitting shops one of these girl wireless mechanics was working side by side with the men in fitting and wiring receivers into Mark IIA. tanks.

TRANSOCEANIC TELEPHONY

THE competing claims of wire and wireless for long-distance transoceanic telephony were discussed at the recent I.E.E. Kelvin lecture by Dr. O. E. Buckley, of the Bell Telephone Laboratories, New York. As the author could not be present, his paper was introduced by a short talking film, and then read by Col. Sir A. Stanley Angwin, Engineer-in-Chief of the G.P.O.

Discussing the possibilities of long- and short-wave radio, Dr. Buckley concluded that increasing demand on transoceanic telephone channels would sooner or later result in a close approach to the ultimate physical carrying capacity; interruption by ionosphere disturbances would then become much more serious. This led to an exploration at length of the possibility of laying transoceanic cables to provide extra channels.

The type of wire conductor envisaged by Dr. Buckley would include intermediate valve repeaters, built into the cable and mounted inside cylindrical housings, articulated so that they could be coiled up with the cable. The valves, fed through the telephone cable with DC at 2,000 volts, would necessarily have a life of many years, as they would be inaccessible on the bed of the ocean. Such a cable would carry twelve telephone circuits, each 4 kc/s wide.

AMERICAN PRODUCTION

THE order prohibiting American manufacturers from producing civilian receivers after April 22nd included a proviso which permits the completion of receivers on which production had been started prior to that date. The total value of the materials (excluding cost of wooden cabinets) to be used on these receivers by each manufacturer must not exceed $500.

Some idea of the immensity of the task being undertaken by the mobilised American radio and telephone industry in war production is given by the announcement of the War Production Board that production of communications equipment is expected to exceed $125,000,000 worth this year.

The output of valves alone is expected to total $90,000,000 worth, compared with $11,000,000 in 1941.

WOMEN'S TECHNICAL SERVICE REGISTER

THE calling up of men with technical qualifications and the continued expansion of industry to meet the requirements of the Forces are giving rise to vacancies which will have to be filled by women. To meet the anticipated demand the Ministry of Labour and National Service is opening a section of the newly formed Appointments Register which is to be called the Women's Technical Service Register.

Women who have passed the School Certificate with credits in mathematics, physics or chemistry, or any higher examination in which one of the subjects is included, can apply for enrolment on the Register. Training for the post may be given by the future employer or in a Government Training Centre or Technical College. It is understood that a radio fault-finding and testing course is in operation in certain localities.

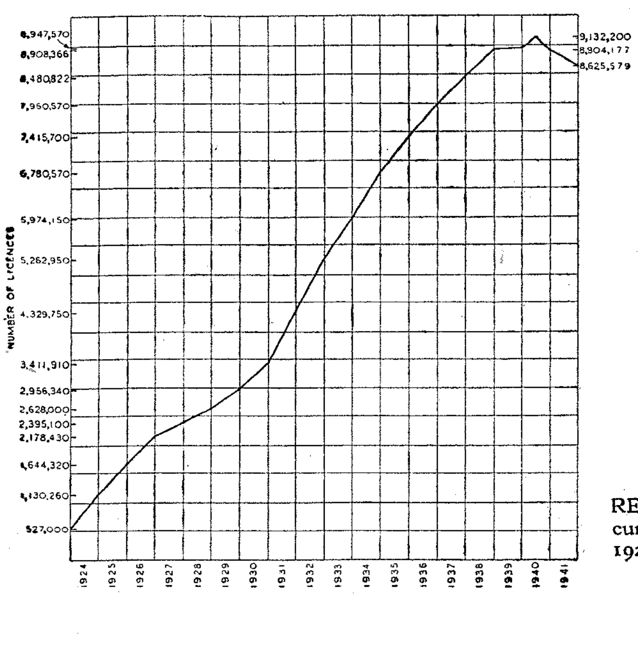
A leaflet, describing the occupations handled by the Register, which includes laboratory assistants for radio and other branches of research, has been issued, and copies of this can be obtained at any Employment Exchange.

LICENCES DECREASING

THE following figures recently quoted by the Postmaster-General, Mr. W. S. Morrison, in the House of Commons, showing the number of receiving licences issued during the past few years revealed a sudden drop in the previously maintained steady increase. The figures are: 1939, 8,947,570; 1940, 8,904,177; 1941, 8,625,579.

The decline is, however, even worse than that revealed by these figures. It may be remembered that it was announced in 1940 that the approximate number of licensed listeners at July 31, 1940, was 9,132,200. This peak and the subsequent decline is shown on the graph reproduced on this page.

There have been many contributory



RECEIVING LICENCE curve from January, 1924, to December, 1941.

World of Wireless—
causes to this decline, probably one of the largest being the breaking up of many homes as a result of the war.

IN BRIEF

Record Production

To release labour and materials for the war effort the manufacture of gramophone records in the U.S.A. has been ordered to be reduced immediately by 70 per cent. It is understood that stocks of raw materials for record manufacture in Great Britain are adequate at the moment, but the recent reduction in new record releases is due to the control of output by the Limitation of Supplies Regulations, as the major record companies have nearly come to the end of their quota. Manufacturers will be prohibited as from June 1st from supplying records (except under licence) in the manufacture of which they have carried out a process.

"A Hundred Years of Morse"

A short film with this title is being shown in many cinemas throughout the country. Illustrating the progress in telegraphic communication during the past hundred years or so, it carries the viewer from the days of Samuel Morse's invention to the present-day world-wide network of communications, with views in a modern oversea telegraph office.

Radio Industries Club

The report of the chairman of the Radio Industries Club at the recent annual general meeting revealed that the membership had increased during the year by 43 per cent. Major V. Z. de Ferranti was elected president for the ensuing year.

English News for the World

Among the news bulletins transmitted by the B.B.C. in 40 languages during its 231 broadcasting hours to oversea listeners each week the following are in English. The times quoted are BDST.

0045: 31.32, 30.53, 25.53.
0300: 31.32, 30.53, 25.53.
0445: 49.10, 31.32, 30.53, 25.53.
0630: 49.10, 31.32, 25.53.
0815: 49.10, 42.46, 31.55, 31.25, 25.53. 19.60.
1000: 49.59, 48.43, 42.46, 41.96, 41.49, 31.55, 30.96, 25.53, 24.92, 24.8, 19.82, 19.60, 19.49, 19.42, 16.84.
1300: 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1500: 25.53, 19.82, 19.49, 16.84, 16.77, 16.64, 13.97.
1800: 25.53, 19.82, 19.66, 19.49, 16.84, 16.77.
2000: 31.55, 25.53, 19.82, 19.66, 16.84.
2245: 31.25, 19.82, 19.49.
2315: 31.32, 31.25, 30.53, 25.53, 19.82.
2400: 49.59, 48.54, 48.43, 41.96, 41.49.

B.B.C.'s £10,000,000

An increase in the grant of £3,100,000 to the B.B.C., which the Financial Secretary to the Treasury explains is needed for developments in oversea services, is to be given for the current year. Last year's final figure was £6,900,000.

An Innovation

It is reported from America that a tunnel near Pittsburgh has been equipped with a re-radiating aerial along its whole length to avoid the "black-out" experienced by owners of car sets when passing through tunnels.

A.T.S. Want Sets

The Commanding Officer of some isolated A.A. defence sites, largely manned by A.T.S., appeals for four broadcast receivers (two battery and two mains). Offers sent to this office will be forwarded.

Time Bases

At the next meeting of the British Institution of Radio Engineers, which will be held at 21, Tothill Street, London, S.W.1, at 6.30 p.m., on Friday, May 29th, O. S. Puckle, A.M.I.E.E., will read a paper on "Time Bases."

Radio Paris Dynamited

The German-controlled 450-kW long-wave broadcasting station Radio Paris has been silenced by an act of sabotage. It will be remembered that this powerful transmitter, which is situated at Allouis, near Bourges, was completed just prior to the war. It was equipped with a quadruple aerial system which reduced vertical radiation, reinforced horizontal radiation, and was virtually omni-directional.

"Business as Usual"

It is apparent from a recent issue of *QST* that the American amateur is not going to be put off by the legislation prohibiting transmission. "There are a myriad of other ways," of communication other than radio, states the writer. Among the suggestions for continuing amateur communication systems are: buzzer lines, carrier current, induction transmission and modulated light beams.

Discussion on Electronics

The inaugural meeting of the Electronics Group of the Institute of Physics will be held at 2.30 p.m. on Wednesday, May 20th, at the Royal Institution, Albemarle Street, London, W.1, when a discussion on "Amplifiers for Measurement and Control" will be introduced by C. A. A. Wass, B.Sc., A.M.I.E.E., of the Post Office Research Station. All interested in electronics, whether members of the Institute of Physics or not, will be welcome at the meeting.

Obituary

It is with regret we record the death at the age of 53 of Patrick Kelly, managing director of the Edison Swan Electric Company. Prior to his appointment fourteen years ago as managing director, he had served with the British Thomson-Houston Company and the International General Electric Company.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BDST)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 5.0‡, 7.0.
WRCA (Bound Brook)	9.670	31.02	8.0 a.m., 10.45 a.m.
WRCA	15.150	19.80	4.0‡, 5.0‡, 7.0.
WGEO (Schenectady) .	9.530	31.48	10.45 a.m., 10.0†, 11.55§‡.
WGEA (Schenectady) .	15.330	19.57	3.0, 4.0, 8.45§‡, 10.55§‡.
WBOS (Hull)	11.870	25.27	1.0 a.m.
WBOS	15.210	19.72	4.0‡, 5.0‡, 7.0.
WCAB (Philadelphia) .	6.060	49.50	7.0 a.m.
WCBX (Wayne) ..	11.830	25.36	12.30 a.m., 8.30‡, 9.15†, 9.45§‡.
WCBX	15.270	19.65	1.30, 4.30, 8.30‡, 10.30.
WRUL (Boston) ..	9.700	30.93	1.15 a.m.‡.
WRUL	11.730	25.58	1.15 a.m.‡.
WRUL	11.790	25.45	12.30 a.m.‡, 10.30‡.
WRUL	15.350	19.54	12.30 a.m.‡, 6.0*, 10.30‡.
WRUL	17.750	16.90	6.0*.
WLWO (Cincinnati) ..	15.250	19.67	7.0 a.m., 8.0 a.m., 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0.
China			
Chungking	5.950	50.42	4.0, 6.15.
	9.410	31.88	4.0.
	11.900	25.21	10.0 a.m., 10.30 a.m., 11.30 a.m., 12.15, 1.30, 2.0, 4.0, 6.0, 9.15.
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	9.45.
India			
VUD4 (Delhi)	9.590	31.28	10.0 a.m., 2.30, 5.50.
VUD3	11.830	25.36	2.30.
VUD3	15.290	19.62	10.0 a.m.
Sweden			
SBO (Motala)	6.065	49.46	11.20.
SBT	15.155	19.80	5.0.
Turkey			
TAP (Ankara) ..	9.465	31.70	9.15.
U.S.S.R.			
Moscow	6.977	43.00	1.0, 7.0, 9.0, 10.30, 11.45.
Vatican City			
HVJ	5.970	50.25	9.15.
	6.005	49.96	9.15.

MEDIUM-WAVE TRANSMISSIONS

Ireland	kc/s	Metres	
Radio Eireann	565	531	2.40‡, 7.45, 10.0.

It should be noted that the times are Double Summer Time—**two hours** ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of the page.
* Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

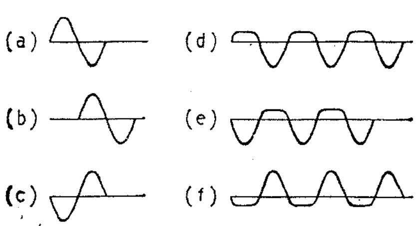
Letters to the Editor

Equivalent Circuits : Hearing Aids : Training Technicians

Valve Equivalent Circuit

If Fig 1 (b) in Mr. Boyland's article in your May issue really is, as he says, widely employed in teaching the action of the valve, then to say that it has limitations and shortcomings is to put it mildly.

It would be interesting to know where this "equivalent" is widely employed, as its absurdity is painfully obvious. Putting the alternating generator μV_g outside the valve altogether, in the place of the HT supply (having explained, no doubt, that the alternating voltage there is reduced to practically nil by a large condenser) is not likely to "get past" a reasonably alert class.



The equivalent circuit that I have been fortunate enough to have been brought up on consists of a generator with EMF numerically equal to μV_g, with internal resistance r_a. (If sign relative to V_g is wanted the EMF must be given as $-\mu V_g$. In a diagram, to remove any possible excuse for misunderstanding, it is a good thing to draw a dotted line enclosing μV_g and r_a, and to mark the emerging lines "cathode" and "anode." Then the difficulties set forth by Mr. Boyland do not arise, and the whole thing can be clearly visualised on the same lines as any other generator or battery. There is no need to confuse the student's already reeling brain with a new and difficult concept, "dynamic impedance," which shows no advantage in working out such problems as condition for oscillation.

Further confusion can be avoided by attention to some other points in the same article. To state that certain valve voltages are 180 deg. out of phase is not helpful to a student who has been correctly taught that phase is a *time* relationship. He is likely to be given the impression that the valve introduces a time lag equal to half a cycle. If one sine wave (my diagram (a)) is applied to the grid, and the anode voltage were 180 deg. out of phase, the result should be (b), which is quite different from what actually emerges—(c). If it is objected that there is no practical difference when the waves are repeated indefinitely, compare (d) (e) and (f). (e) is 180 deg. out of phase with (d), but it is not what one would expect to get from the anode as a result of applying (d) to the grid.

The output voltage of an anode resistance-coupled valve is opposite in sign, or inverted, compared with the grid voltage, but is not shifted in phase unless the load is reactive.

In Fig. 2 (b) the HT voltage is not OC as stated, but OD. This, however, and one or two other slips, should be obvious from the context.

Mr. Boyland alternates freely between E and V_g as the voltage input to the grid. Is it not time this was standardised? To the best of my belief E stands for EMF and V for volt, but, as voltage is not always EMF, V is useful as a symbol for potential difference, to distinguish (for example) the voltage at the terminals of a battery from its EMF, the difference between them being the drop due to internal resistance.

Mr. Boyland has, however, shown how the valve problem can be approached from a different angle. The more ways in which a problem is viewed the better it is understood.

"CATHODE RAY."

In the above article, published in your May number, it is stated that "the valve circuit (a) is conventionally represented by the equivalent circuit (b)." The author then proceeds "to explain certain points which invariably present difficulty to the beginner, and which receive but scant treatment in most textbooks."

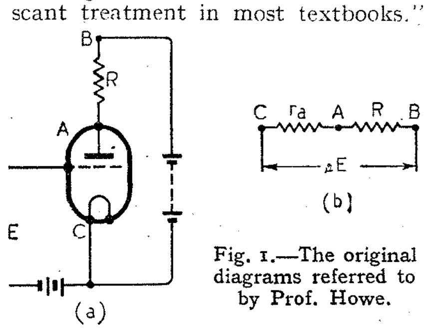


Fig. 1.—The original diagrams referred to by Prof. Howe.

The author's diagram is reproduced herewith (Fig. 1). Now, in my opinion, Fig. 1 (b) is not the conventional

Letters to the Editor—

equivalent circuit of the circuit shown in Fig. 1 (a), and if it is represented as such I am not surprised that the beginner finds himself in difficulties. Neglecting the resistance of the battery, the points B and C have a fixed PD, and consequently there is no alternating PD between them, however large the alternating current may be. The *raison d'être* of the alternating current is inside the valve itself. The correct equivalent circuit is as shown in my accompanying Fig. 2, and its adoption in place of Fig. 1 (b) removes most, if not all, of the differences and difficulties that are discussed in the article. It may be objected that, since the battery is the source of all power, the AC generator must be regarded as being external to the valve as shown in Fig. 1 (b), but this is quite fallacious. Although the battery is the ultimate source of power, it is incapable of generating an alternating EMF, and it gives out the same amount of power whether an alternating EMF is applied to the grid or not If we wish to regard the alternating current as being produced by an alternating EMF we must look inside the valve; that is, between the points A and C in Fig. 1 (b) for this EMF, and not outside in the battery connection. Instead of an AC generator requiring a supply of mechanical power, we must picture the valve acting as a converter, or rather as an inverter—a grid-controlled inverter—taking a constant supply of DC power from the battery, and converting a portion of it into AC power, the amount being controlled by the amplitude of the alternating voltage applied to the grid. When we are interested only in the alternating component we can neglect the battery and its constant supply of power to the valve and to the load resistance R, and consider only the current produced by the alternating EMF μE, but we are not justified in removing this EMF from the valve, and inserting it, as Mr. Boyland does, in the external circuit. Such a step is bound to confuse a student, or anyone else, and this probably explains why the difficulties caused thereby "receive but scant treatment in most textbooks."

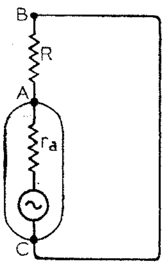
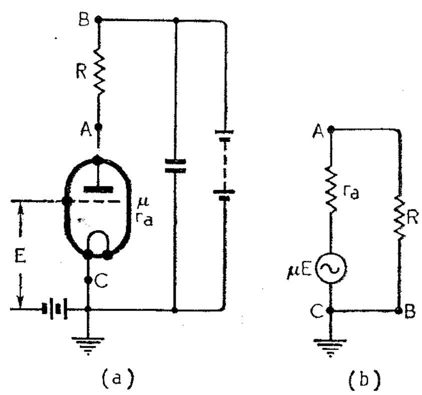


Fig. 2.—Circuit to replace Fig. 1 (b).

G. W. O. HOWE.

The University, Glasgow.

MR. BOYLAND'S article provides a useful reminder that the valve equivalent circuit has its limitations, particularly as regards the omission of DC components; but the equivalent circuit shown in his Fig. 1 (b) introduces unnecessary difficulties which can be avoided by using the equivalent shown in the accompanying diagram. In the actual circuit, (a) the HT battery is shown shunted by a condenser; since AC components only are concerned, this condenser can be made large enough to be equivalent to a short-circuit between the points B and C. In the equivalent circuit, (b) the fictitious EMF equal to μE is shown *within the valve*, instead of being external to the valve as in Mr. Boyland's circuit; an earth connection to C is shown as a reminder that potentials are normally measured from cathode as zero point, but of course this will sometimes have to be modified. It is then obvious that the voltage drop in R, since it must be in opposition to the source of EMF, which is driving the current through R, will be in opposite phase to μE. With careful application of this circuit there need be no appearance of impedances with spurious negative signs.



Valve circuit with its equivalent as advocated by Mr. D. A. Bell.

While on the subject of valves, if I may dare to criticise so eminent an author as "Free Grid," I would like to ask who invented so cacophonous a word as "Katahode," which no self-respecting Greek would ever have uttered. If the aspirate must be retained in Anglicising the Greek words, the correct version would be "Kath'-hode," since "kata" was abbreviated to "kath'" before an aspirate. But as the Greeks were so casual about their aspirates that they hadn't a letter to represent them, why should we put in h's which they would certainly have omitted in compound words?

D. A. BELL.

London, N.21.

"Hearing Aids for the Million"

I WOULD like to add a point to Mr. Balbi's timely article.

In my opinion, not only should a separate section of the wireless industry be created to manufacture hearing aids on mass-production lines, but there should also be a new branch of service-men formed to maintain these instruments. I contend that no ordinary service-man accustomed to dealing with six-valve superhets would feel "at home" when servicing a midget hearing-aid. Moreover, one has only to take note of the distressingly large percentage of hearing aids installed in churches and halls which are not in working order to see that a new branch is required to deal with these instruments.

O. P. ALEXANDER.

Glasgow, E.2.

Technical Training

AN analysis of correspondence recently published in *Wireless World* on Technical Training demonstrates beyond doubt the need for greater educational facilities in radio and electronic engineering. Recognition of this need will only be obtained when the industry as a whole recognises the entity of radio and allied engineering as a separate profession and not simply as a specialised branch of electrical engineering.

Mr. D. A. Bell (February *Wireless World*) gives the complete answer to those idealists who envisage a University training for all. Mr. Bell recognises the practicability of a scheme providing for a study of, first, physics, secondly, application of physics to radio engineering, thirdly, radio engineering, and lastly, specialisation; this is, in effect, the scheme of the Brit. I.R.E. Graduateship Examination, and it is important to note that this scheme of examination has been evolved after nearly fifteen years of setting an examination twice yearly in order to test the suitability of candidates for election to membership of this Institution.

Your correspondents who would have every prospective radio engineer devote five or more years to study of pure physics should be referred to the following editorial statement made in the August, 1937, issue of *Wireless Engineer*:—

"Many of our difficulties, when teaching the elements of the subject . . . are due to the fact that we do not distinguish clearly enough between things which can be proved and things which we have agreed to assume. This distinction is very important when dealing with the foundations of science, since every proof is built upon certain agreed assumptions."

Civil, mechanical, structural, electrical, automobile and radio engineering are all inter-related; in fact, all engineers have the basis of their profession in applied mathematics, physics and other ancillary subjects. In training himself for an electrical engineering career, the student does not worry himself with the mechanical engineer's problems, nor the mechanical engineering student with the civil engineer's problems. Likewise, the radio engineer in professional relationship with the electrical engineer is not concerned with the specialisation of an electrical engineer, but agrees to assume that where the supply of electrical power is required, the electrical engineer will perform his specialised professional work.

Recognition of these assumptions have in the past led to recognition of the need for specialised educational facilities in automobile and aeronautical engineering long after recognition of general mechanical engineering as a profession, whilst the need for specialised training in the professions of sanitary and structural engineering, etc., was recognised long after the establishment of general civil engineering as a profession.

The Institution of Civil Engineers is, of course, our oldest professional examining body and its Charter is all-embracing: but in so recognising the general art or science of engineering, the Charter has given impetus to the development of various specialised branches of engineering. Recognition of those specialised branches have led to the establishment of the professions of mechanical, electrical, structural, automobile, aeronautical and radio engineering.

G. D. CLIFFORD,
General Secretary, The British Institution of Radio Engineers.

Qualifications of Wireless Engineers

WITH regard to the various letters that have appeared lately concerning the status of the radio engineer, it seems to me that the term radio engineer has yet to be defined.

Most of your contributors seem agreed that the bona fide engineer must be a man who has made an intensive study of the sciences which he applies to radio engineering practice. Mr. Dalton has, perhaps, overstated the case, but surely he is much nearer the mark than the many who, describing themselves as radio engineers, have only a good practical knowledge of a few commercial receivers and are able to locate and repair the faults that occur in these sets.

Between these we have designers, production managers, broadcasting station engineers, amateurs and many others, some with and some without recognised technical degrees or diplomas. Then there are some with technical qualifications who are employed only on wireless telegraphy operating or control jobs and as such are not regarded as radio engineers.

It seems that for the term radio engineer to have any weight only those who are members of recognised institutions or possess technical degrees or diplomas, of which the lowest should be the City and Guilds Radio Communication, Grade III, should be allowed to so call themselves.

For the practical man who is unable or does not aspire to the title radio engineer, the passing of a suitable servicing examination should entitle him to call himself a radio service engineer or radio mechanic.

These classifications are needed, for after the war the radio industry is going to be faced with applications for jobs from the many now being introduced to wireless for the first time by the Services. With all due respect to these men, in few cases can their knowledge be equal to that of the pre-war radio man. I say radio man, for unless they take steps to qualify themselves they will have no real proof of their capabilities.

There is, therefore, a great need for recognising the difference between a qualified radio engineer, a qualified service engineer, and a man who just tinkers with radio.

C. S. FOWLER.
Swindon, Wilts.

"Wireless World" Morse Chart

THE Chart announced in our last issue is now ready. Designed to meet the needs of A.T.C., Home Guard, or other small groups undergoing wireless training, it includes the morse code, numerals and other signs printed in large type. Information is also given on learning the code, key manipulation and the wiring of morse practice sets. The Chart costs 6d., or 7d. by post from Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Mounted on card, varnished and corded, the price is 2s., or 2s. 6d. by post.

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

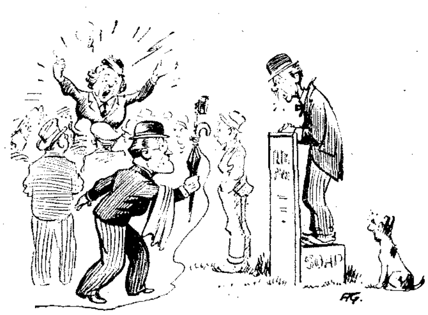
FREE GRID

Scientific Selling

IT is extraordinary what a poor imagination and an equally poor knowledge of human nature is possessed by sales managers of certain big firms; the very people, one would think, who ought to possess these admirable qualities in full measure and flowing over.

This strange fact is particularly true of the sales managers of some of the big wireless firms, many of whom started life selling ordinary electrical products of the same firm, and who, when given charge of this new thing, wireless, thought that they had been virtually put on the retired list instead of having been given the opportunity of their lives. "Who on earth wants to buy a wireless set?" was the burden of their cry. It never seemed to occur to them that it was up to them to create a demand and that nobody would ever buy anything unless the originator of it first created a demand for it.

These profound thoughts arose in my mind the other day when I was speaking to the sales manager of one of our large manufacturers of PA apparatus. He was bemoaning the fact that the PA market now appeared to be saturated, and that the outlook for the post-war period was indeed a gloomy one. I know nothing of PA marketing myself, but was able to convince him in a very short period that there were innumerable markets for PA which were as yet quite untapped.



A meek and mild little man.

In order to prove my point I took my friend, together with a transportable PA outfit, to the Marble Arch end of Hyde Park where, in spite of the war, crowds still gather on Sunday, and at other times, to hear the various speakers propound their several panaceas for the world's evils. Having arrived on the spot I speedily got out the loudspeaker tripods and erected them on the outskirts of a small crowd which was listening to the efforts of a rather meek and mild little man who was putting in a passionate plea for men's rights and insisting on the common justice of their being granted the same privileges as are exercised by women. As his pitch was next door to that of a brazen-voiced female who was declaiming to a large crowd on the iniquities of the opposite sex, he obviously hadn't a dog's chance.

Leaving my friend in charge of the amplifier and loudspeakers I edged my way up to him, trailing a length of flex with a mike tied to the end of my umbrella. It was not difficult to get it reasonably close to his mouth, and the next moment the harsh tones of the good lady in charge of the neighbouring meeting were completely drowned out by the raucous roaring of the mild little man's now giant-like voice coming from the loudspeakers.

I need hardly say that interest in our apparatus was immediately created, and if it had not been wartime, with its limitation of supplies, several sales would have been clinched on the spot. As it is, my friend is already making vast preparations for post-war sales, his idea being to sell PA amplifiers of ever-increasing power to the various speakers, so that they can shout each other down.

I have pointed out to him that still further sales of PA apparatus can be effected if he will interest himself in ultra-short-wave transmission, as he can then induce the speakers to invest in the necessary flea-power apparatus to convey their remarks to people in various other parks and open spaces to which can be transported the necessary receiving and PA apparatus. The advantage of this latter scheme is that there would be no heckling at the subsidiary meetings; in fact, heckling might be dodged even at the main meeting by staying at home and using USW.

De Electronibus

AN extraordinary letter, written on what appears to be a piece of scorched parchment, has been sent to me by a man signing himself "Homer," in which he complains bitterly about the use of the word Rhumbatron in recent issues of *Wireless World* to describe certain parts of the klystron valve. Mr. Homer asks somewhat querulously whether we cannot at least be consistent in our inaccuracies and talk of a rhumbus when we mean a rhombus as both words, so he tells me, are derived from the Greek verb rhombein. I have

Dancing the Rumba down in Cuba.

written off to tell him that this is no fault of *Wireless World* as the word was apparently coined by two Americans, namely the brothers Varian, who invented the klystron, and I have sent this part of his letter to them, c/o President Roosevelt.

By far the most interesting part of Mr. Homer's letter, however, is that in which he gives me the views of a friend of his called Alexander, who claims to be a strategist of no mean repute, although which of the Sunday papers he writes for is not mentioned. Mr. Alexander points out the extraordinary resemblance between the tactics used by Hitler's tanks in France in 1940 and the behaviour of the electrons in the klystron. There was, so he states, the same "bunching" and accelerating effect in both cases, and it is obvious, according to him, that Hitler, in concentrating bunches of tanks at certain points in the line and then bursting through with them was merely following the technique of the klystron.

From this he deduces that Hitler obviously worked out all his 1940 tactics from a careful study of the klystron, and we must expect that in 1942 he will also follow electron tube technique, but of a different and unexpected type. In particular, Mr. Alexander warns us that he may be studying gas-filled tube technique. I have sent this part of Mr. Homer's letter to the War Office, who will no doubt appoint a Commission to sit on it.

Wireless World

Brains Trust

Solution to Problem No. 1

(*See page 141*)

YOUR observation applies to all mains receivers, particularly where a directly heated rectifier valve is used, and the effect does not indicate a fault. The same thing also occurs in DC mains operation, although the ripple in the DC mains is small and makes the effect less noticeable. To explain it, it is necessary to examine briefly why directly heated valves are little used with AC heating.

When a filament carries AC, it sets up an alternating magnetic field in the valve, modulating the anode current and producing hum in the loudspeaker at even multiples of the supply frequency. This effect is minimised by a suitable heater geometry, e.g., the hair-pin type of construction, and the use of as small a current as possible. Likewise, the existence of an alternating potential difference across the filament produces an alternating electrostatic field with similar consequences, although in this case the fundamental frequency of the resulting hum is equal to the supply frequency. The electrostatic field is cut down by using as small a heater voltage as possible; but this conflicts with the use of a small current, so screening is essential. Hence the indirectly heated form of cathode, which commonly consists of an earthed oxide-coated nickel cylinder surrounding the filament. This screening is rather incomplete, and AC heating would probably be doomed were it not for the aid of an unexpected ally, namely, the space charge or virtual cathode surrounding the cathode proper.

When a valve is operated properly, emission exceeds the actual anode current and a space charge of electrons collects in front of the actual cathode. The anode draws on this charge for its electrons, while the cathode supplies them continually to the space charge. Now, this charge may be regarded as a conducting sheet, at a definite potential, somewhat negative relative to the actual cathode. Hence, the rest of the valve is screened rather efficiently from the cathode and its residual alternating field.

When the valves are first switched on, the filament is cold, and it takes about one minute for a small valve to reach the required cathode operating temperature of 800 deg. C. or so. In the meantime, too few electrons are emitted for a reserve of electrons to collect, i.e., for a space charge to form. Hence, the absence of the latter with its screening effect explains the hum in the warming-up period. It also is a reason for not underrunning valves. Incidentally, as emission tends to fall off with use it is not surprising to find that valves tend to get noisy with age.

The explanation may be checked by a simple experiment in which it is arranged for the valve heater voltage to be variable. It is then found that on reducing the heater voltage slowly, below 4 volts say, the intensity of the loudspeaker hum first increases while the pitch decreases: this shows that the electrostatic field is principally involved in the action. Below 3.5 volts, there is a decrease of hum as the valves become altogether inoperative.

Books Received

Accumulator Charging, Maintenance and Repair, by W. S. Ibbetson.—The title of this book gives a very fair idea of its contents. It deals with its subject from a practical point of view throughout, as it is intended for those who actually have the maintenance of accumulators in their care. Pp. 165. 42 Diagrams. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 6s.

DF Handbook for Wireless Operators, by W. E. Crook.—The subject of DF is dealt with at considerably greater length than is customary in the ordinary wireless textbook issued for operators. A knowledge of elementary radio theory has been assumed. The treatment of the subject is strictly practical, and it is emphasised that it is written from the point of view of the operator and not that of the engineer. Pp. 63. 86 Diagrams. Published by Sir Isaac Pitman and Sons, Ltd. (address above). Price 3s. 6d.

Rhombic Antenna Design, by A. E. Harper.—This book consists mainly of a compilation of the work, both published and unpublished, of the author's colleagues in the Bell Telephone Laboratories. It has been published chiefly for the benefit of engineers engaged in the design of SW communication networks, and is intended to bring to their notice the advantage of this type of aerial as an efficient SW radiator, and to give practical details of design. Basic theory is not dealt with to any great extent. Pp. 111. 44 Diagrams. Published by D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, U.S.A. Price 4 dollars.

RANDOM RADIATIONS *By* "DIALLIST"

I Fling Down My Gauntlet

ONCE again I find myself compelled to cross umbrellas with my old cell-mate, "Free Grid," who seems to have forgotten most of the Greek that our hardworking form master strove so hard to instil into him when we were fellow-members of the Classical Fifth at Borstal. He would have readers believe that they are perpetrating bloomers in writing "anode" and "cathode," and solemnly suggests "anhode" and "catahode" as the correct forms. Well, well, he was ever a queer lad, evincing, even in those youthful days, a *penchant* for wearing a bowler hat at all hours of the day and night. When, later, we were together at Oxbridge—before graduating at Princetown—he developed a passion for roof-climbing by night and for leaving proofs of his prowess in prominent places. On one memorable occasion it was a bowler hat, and not the domestic utensil to which he referred last month, that had to be shot down by massed rook-rifle fire from one of the pinnacles of a college chapel, unkindly described by Ruskin as resembling a table lying on its back with its four legs in the air. It was this incident that gave birth to the term "high-hatting."

A Matter of Aitches

My old friend's memory is undoubtedly playing him tricks—and one can't wonder, considering the life that he has led and been led. He has forgotten that though you can have aitches galore in Greek by sticking a thing like a single inverted comma over the first letter of a word that begins with a vowel, you can't have them in the middle of a compounded word unless the prefix ends in a *t* or a *p*. Hodos is the Greek word for a path, right enough, but if you want to make it a triple path it becomes triodos, not trihodos. Hence we are correct in writing triode in English. We *ought* to call a five-electrode (not electrhode!) valve a penthode, instead of pentode; but triode, anode and tetrode are correct. So also is cathode, for the "a" of the "cata" is knocked off and the "t" becomes "th." I'm glad to see "Free Grid" having a tilt against the dreadful mixtures of bad Latin and worse Greek that we see in too many of our scientific terms, particularly those coined by the medical profession; but I can't support him in his longing for the aitches that should not be there in wireless words. If, though, he wants to be a real pedant in this matter, he should insist on writing "rhadio" instead of "radio," for the initial Greek "r" has always an "h" following it.

Current Flow

Again I must take exception to his suggestion that our adoption of anode and cathode instead of positive and negative would automatically drive home the last nail in the coffins of the last ditchers for the old positive current. Anodos means a departure; cathodos, a return home. Most unfortunately the early investigator—Benjamin Franklin, I believe—who first tried to determine the direction in which an electric current flowed, made the worst of bad guesses. It was a fifty-fifty chance in those days, and by sheer ill luck he made a bad shot. All books on electricity assumed that current flowed from the positive terminal of a battery through the external circuit to the negative terminal. Masses of formulæ and "laws" were based on this utterly wrong assumption. The discovery of the electron, some forty years ago, showed how erroneous this idea was, but no one had the courage to scrap the old laws and formulæ whilst the going was still good. The result is that most of our textbooks still have to differentiate between the imaginary positive current and the genuine electron current. Even when the wireless valve was invented the old convention still had such a hold that the starting point of current was called the cathode (which really means the homing point), and the point to which electrons flow the anode, which actually means point of departure. As I've mentioned before, I'm glad to find that the Army has abandoned the worn-out idea of a positive current and teaches the theory of electricity nowadays on electron current lines. What the other Services are doing I don't know, but I hope that they're following suit. And I trust that the fine lead thus given may lead to a general scrapping of the old erroneous ideas, which can't be defended on any grounds whatever.

With What?

NOT long before I wrote this note I was engaged in putting certain of the soldiery through what is known as a Trade Test. What this boils down to is that if they pass they are entitled to additional pay as adepts in their own line. To one Scotsman who came before me I showed a secondary cell. "What," I asked, "would you do if this had been subjected to a high temperature and part of the electrolyte had evaporated?" "Top it up, sir." "Yes, with what?" "With diluted water, sir." I couldn't help asking whether in Caledonia stern and wild they diluted their water with whisky!

Non-stop Listening

IN view of the present need for saving coal and electricity, those who use their receivers as a means of providing an incessant and pretty well unheeded background to conversation, bridge, and so on, should really take a pull at themselves. If we allow 35 watts as the average consumption of the mains radio receiver, then 10 hours' use means 0.35 kWh a day for each wireless non-stopper, or 2.45 units a week. In a small town the electricity consumed by 500 thoughtless users of this kind works out at 1,225 units, and if we assume the total number of radio current spendthrifts to be 1,000,000 for the whole country, we have the rather staggering sum of 2,450,000 units a week. I leave it to you to work out how many tons of coal this needs in a year.

"Wireless Engineer"

THE fact has again and again been expressed by readers of our sister journal, *Wireless Engineer*, that it would still maintain its prestige among wireless engineers even if it contained only the Abstracts and References section and ceased to publish original papers. In the May issue this section includes abstracts from, and references to, nearly 300 articles on wireless and allied subjects which have recently been published in the world's technical Press. Some of these abstracts occupy as much as a page.

In addition the articles in the May issue include one on extended aerial systems and another on eddy current tuning.

Published on the first of each month, *Wireless Engineer* is obtainable to order through newsagents, or direct from our Publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d. (including postage).

SOS

AS the war goes on the demands on our shipping space grow greater rather than less, and it becomes all the more urgent to do anything in our power to lessen the strain. One way in which we can help greatly is by saving paper, surely a small thing to ask of anybody and a thing which all of us can do. There is plenty of evidence that there is still far too much of this precious commodity stowed away in old drawers and cupboards, which can only mean that many do not even yet realise how serious is the shipping situation.

RECENT INVENTIONS

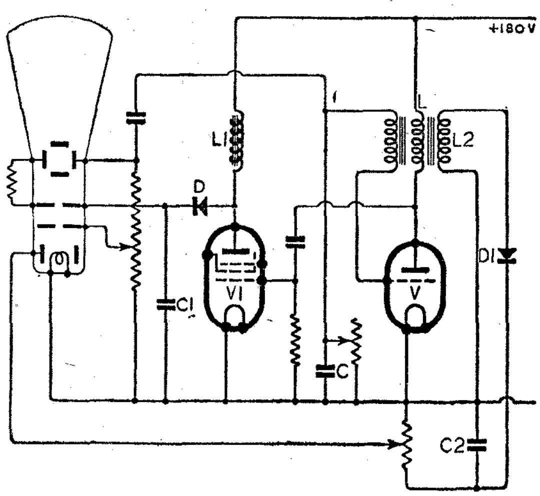
A Selection of the More Interesting Radio Developments

DIRECTION-FINDING

HAVING found the line along which a transmitter lies from the point of observation, the "sense" of its direction is usually ascertained by switching on a "vertical" aerial, which in effect converts the ordinary figure-of-eight response with its 180 deg. ambiguity into a heart-shaped response with only one clear-cut minimum. Although this resolves the previous uncertainty as to direction, it necessitates a readjustment of the search-coil of the radio-goniometer, and various attempts have therefore been made to secure the same result by a suitable switching operation, usually carried out on the fixed field coils, so that the search-coil need not be moved.

Switching of the field coils, however, upsets the electrical balance of the circuits to earth, and is otherwise undesirable. Accordingly, it is now proposed to wind the search-coil in two branches which are equally inclined to a median line. These are first connected in series and a DF reading is obtained. The coil is left in this position, whilst each branch winding is switched into circuit in sequence. The relative amplitude of the two signals thus obtained determines the required "sense" of the distant transmitter.

Standard Telephones and Cables, Ltd. (Assignees of Le Matériel Téléphonique Soc. Anon.) Convention date (France), 3rd June, 1939. No. 541657.



Method of obtaining high voltages for CR tubes.

STEERING FOR SOUND

A MOVING body is automatically steered towards a source of sound by differential gearing, which is operated by one or more pairs of microphones and low-frequency amplifiers. In the case of an aerial torpedo, the microphones are mounted inside flared horns set at the ends of a pair of lateral and vertical fins. The two horizontal microphones control the rudder and the two vertical microphones the elevator of the projectile, until the latter points towards the source of sound, where a state of balance sets in and the projectile continues on a straight course.

W. Shaw. Application date January 25th, 1940. No. 540906.

DC MAINS—OR BATTERY-DRIVEN TELEVISION SETS

THE circuit shown offers one possible solution to the problem of supplying DC voltages of the order of 800 volts for driving the cathode-ray tube of a television receiver when an AC mains supply is not available. It depends upon the rectification and storage of the voltage surges generated across the deflecting coils of the tube by the steep-fronted scanning impulses.

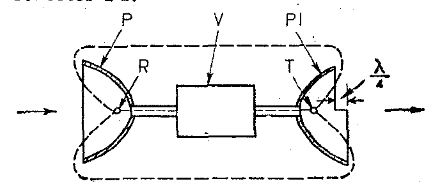
The back-coupled valve V acts as a blocking-oscillator to generate a saw-toothed scanning wave which is applied from time-base condenser C to one of the deflecting plates of the cathode-ray tube. The associated voltage fluctuations across the anode coil L are applied to the grid of the valve V1 and are of a square shape, which keeps the grid at cathode potential for the greater part of each cycle with a sharp crevasse which sharply cuts off the current through the valve. The resulting surges of back EMF across the coil L1 are rectified at D and charge up a condenser C1 to supply the high-voltage operating voltages for the anode and other electrodes of the tube. Simultaneously, voltages developed across a coil L2 coupled to the anode coil L are rectified at D1 and are stored by a condenser C2 which supplies a focusing voltage to the gun of the tube.

Marconi's Wireless Telegraph Co., Ltd.; R. J. Kemp, and S. W. H. W. Falloon. Application date, 28th May, 1940. No. 541531.

POINT-TO-POINT RELAYS

LONG-DISTANCE signalling on ultra-short waves is usually effected by using a chain of automatic relay or repeater stations, each within "optical" range of each other. If the stations are separated by, say, fifteen miles, the relay aerials should be elevated at least a hundred feet above the common ground level, so that it is desirable, for reasons of economy, to mount them both on the same mast. On the other hand, such close spacing naturally increases the tendency for the transmitter to feed back into the receiver, particularly when the signals are passed on from point to point without changing the carrier frequency.

As shown in the drawing, signals received at R are amplified at V and re-radiated at T. Although both aerials are largely screened by their respective reflectors P, P1, some of the outgoing energy will reach and saturate the amplifier circuits V either by refraction or re-radiation from the periphery of the metal reflector P1.



USW repeater.

According to the invention, the upper half of the reflector P1 is cut back to a depth of a quarter-wave, so that energy fed back along the upper path reaches the receiver in phase opposition with that fed back via the lower path, and both cancel out.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of H. O. Peterson.) Convention date (U.S.A.), 30th June, 1939. No. 541796.

INDICATING VERY HIGH FREQUENCIES

A COMMON requirement in testing centimetre-wave transmission gear is to know when the current reaches a definite amplitude. For this purpose it is proposed to make use of the fact that a flash-lamp filament of sufficiently fine gauge to ensure a uniform distribution of current over its cross-sectional area, at the frequency in question, always begins to "glow" at a critical current amplitude. Moreover, the point at which the wire begins to show red heat can be sharply determined even by different observers.

In practice, a small glow-lamp with a straight filament of 0.0004in. diameter is bridged across a current loop in the tuned Lecher wire circuit of a centimetre wave generator, and the point at which it first incandesces is observed through a viewing-tube which is inserted through a small hole in a metal case or screen surrounding the generator.

Standard Telephones and Cables, Ltd., and C. N. Smyth. Application date, 4th June, 1940. No. 541666.

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.

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You'd soon see sparks a-flyin'.
I'd give the Jerries such a smack
As'd set old Gobbels cryin'.

I'd load the Continent with troops ;
I'd pack the seas with mines.
I'd fill the skies with aeroplanes,
An' pulverise the swines.

I'd have our ships all in a row,
And blow the tykes to bits,
Till they 'ollered out for mercy.
I'd show 'em 'ow to blitz.

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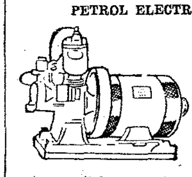

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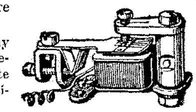

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