Wireless World

RADIO AND ELECTRONICS

FEB. 1948

1/6

Vol. LIV. No. 2

IN THIS ISSUE: ELECTRONICS AND ATOMIC ENERGY


FIT ROLA AND RELAX
A radio receiver is judged by the quality of its reproduction more than by any other single factor. That is why the speaker is such a vital part of any set. No wonder so many Planning Engineers decide on Rola speakers for all their models. They know they can fit Rola and relax!
ROLA SPEAKERS
THEIR QUALITY SPEAKS FOR ITSELF
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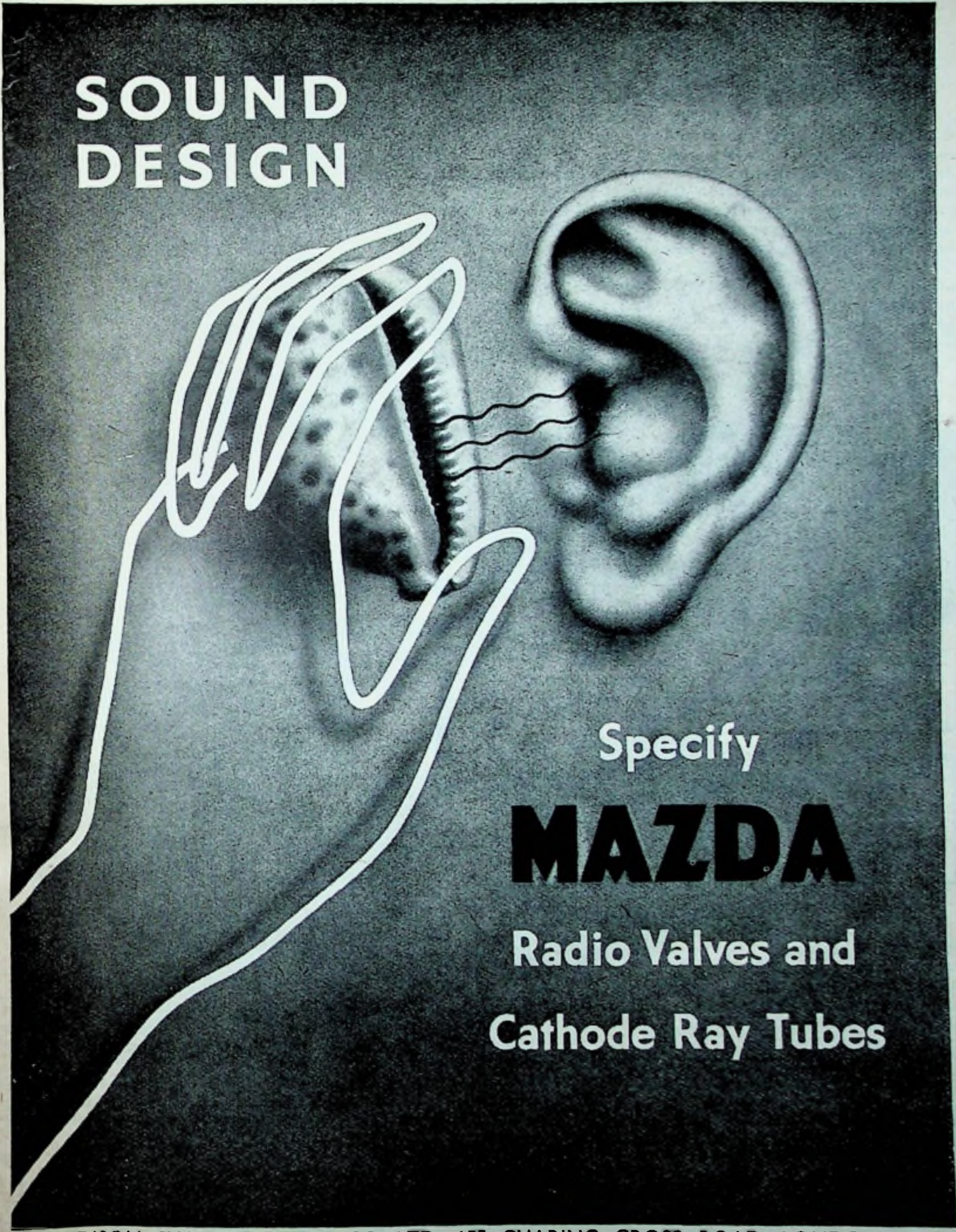

THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2

R.M.52

Technically

We believe that the only way to build a receiver is to begin at the beginning with a sound circuit design—a design that's been tested and re-tested—a design that will stand up to the most critical examination. From this design a prototype is constructed in which every component receives the same rigorous testing. We leave the experts to pass judgment on the resulting Sobell receivers. We are confident that for ease of control and absolute fidelity of reproduction these models will be found to have no equals—that, in fact, you will pronounce them to be 'technically outstanding'.

Outstanding

SOBELL MODEL 516 T.G. TABLE RADIOGRAM

Roll top gives easy access to gramophone turntable. The receiver is a 5-valve super-het. operating from 200/250 volts, 40/100 cycles per second A.C. supply. Wave range: 16-50 metres; 193-577 metres; 800-2, 140 metres.

SOBELL MODEL 717 7-VALVE RECEIVER

Built with a push-pull output stage giving 8 watts undistorted output. Incorporates a 10" loudspeaker. Covers long, medium and two short wave ranges. Voltages as for 516 T.G.

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TWO YEARS' FREE ALL-IN SERVICE IN THE HOME

Advt. of Sobell Industries Ltd., Langley Park, near Slough, Bucks. 8S-3

SENSITIVITY 10,000 OHMS PER VOLT

Designed to meet the demands of Service and Plant Engineers, also Radio Amateurs, **21 Ranges**:—Volts: A.C./D.C. 10, 25, 100, 250, 500 and 1,000.

Microamps: A.C./D.C. 0—100.
Milliamps: D.C. 2.5, 10, 25, 100 and 500.
Ohms: 0/10,000 and 0/1 Megohm.

All voltage measurements A.C. and D.C. are at **10,000 ohms per volt,** to comply with the requirements of modern radio and electronic equipment, where tests have often to be made across high impedance circuits. Price: **£10. 10s.**

Immediate delivery from wholesale stockists.

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Series 100

MULTI-RANGE TEST SET

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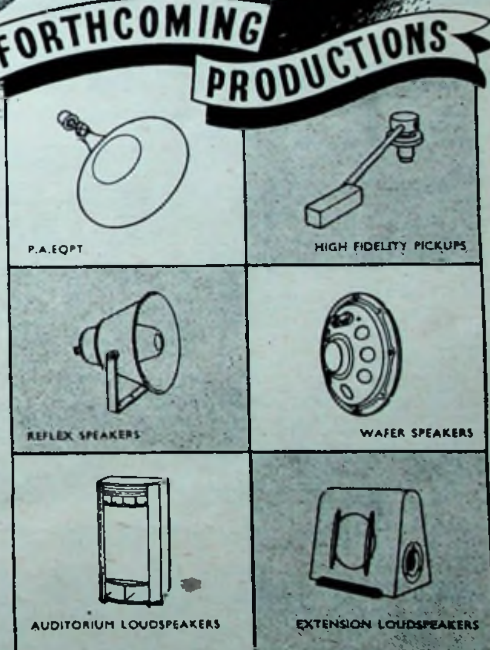
Address all enquiries to Dept. J, Electrin Works, Winchester Street, Acton, London, W.3. *Telephone: Acorn 4651-4*

MIP LTD



"Monobolt" speakers, the first of the new Truvox radio range, are now available from all radio dealers. Quality enthusiasts, and all those who want "the best," will welcome this news. If you require fuller details than are given below—a postcard will bring them.

Model BX 50	5in.	8,500 lines	£1	1	0
Model BX 52	5in.	10,000 lines	£1	4	6
Model BX 60	6½in.	8,500 lines	£1	2	6
Model BX 62	6½in.	10,000 lines	£1	6	0
Model BX 80	8in.	8,000 lines	£1	4	0
Model BX 82	8in.	10,500 lines	£1	10	0
Model BX 100	10in.	8,000 lines	£1	10	0
Model BX 102	10in.	10,500 lines	£1	17	6

New products, as illustrated above, are well under way. Full details will be announced as they become available.

TRUVOX

TRUVOX ENGINEERING CO., LTD., EXHIBITION GROUNDS, WEMBLEY, MIDDLESEX.

TWO OUTSTANDING MODELS FROM THE WODEN RANGE OF QUALITY AMPLIFIERS

WODEN TRANSFORMER CO. LTD

15 Watt Quality Amplifier Special Amplifier designed primarily for the high quality reproduction of Gramophone records. Incorporating a built-in variable scratch filter, bass and treble lift controls and negative feed back. A maximum output of 15 Watts is obtained, but low average listening levels may be run without deterioration in quality. The valve line up is :—2 ECC 32 Twin Triodes, 2 EF 50 Pentodes, 2 EL 37 Pentodes 1 5U4G Rectifier.

Price £29 . 15 . 0

The Rad. 20 model illustrated is ideal for Schools, Clubs, Hotels, etc., where high quality reception of the normal broadcasting programmes is required. A Three wave band superhet radio unit of the very latest design is incorporated, and provision is also made for microphone and gramophone inputs. Available for 200 250v. A.C. mains.

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have the following first-class, brand new Radio and Laboratory Material available for immediate delivery from stock. All prices nett.

MICRO-AMPERE METERS (new, ex-A.M.) 0/100 micro-amps, 1st grade m/coil, 2½in. scale. 3in. flush mount. Int. res. 175 ohms (average), by prominent maker. **37/6.**

INSTRUMENT RECTIFIERS (full-wave) 1 m.a. only, **5/-.**

VARIAC TRANSFORMERS. Essential for correcting mains fluctuations, maintaining constant voltage (manually operated by knob) Model "A," input 200/240 v. 50 c., output 220 v. 50 c. Loading 1.65 kva., **£7/10/-.** Model "B," input 200/250 v. 50 c., output 230 v. 50 c., loading 1.01 kva., **£6/10/-.** Voltages are infinitely variable within limits stated. (Despatch p. train, either 3/6.)

PRECISION VOLTMETERS (suitable for use with variacs) 3½in. flush panel mount. 0/250 v. A.C., rectified moving coil, **76/6.**

E.H.T. VOLTMETERS, m/coil, by best makers. 0/3500 volts D.C., 3½in. dia. Projection 4in., with internal series resistance, **47/6.**

G.E.C. EXTRACTOR FANS, operation 6/12 v. D.C. or 50 v. A.C., 7½in. impeller, very well made in die-cast chassis 9½in. sq. by 6½in. overall. These can be used either as extractor or cooling fan, **35/-.**

L.T. RECTIFIERS, full-wave, bridged, selenium, S.T.C., all for charging up to 12 v. At 1.5 amp., **12/6.** At 4-amps., **25/-.** At 6/8 amps., **39/6.** At 10/12 amps., **49/6.** Also for D.C. delivery up to 30 v. 4 amps., **45/6.**

STEP-DOWN MAINS TRANSFORMERS to suit above rectifiers. All primaries tapped 200/220/240 v. 50 c. and secs. tapped for 6 and 12 v. charge. For 1.5 a. Rect., **23/6.** For 4-amp., **38/6.** For 6/8 amp., **55/-.** For 10/12 amp., **77/6** (des. 2/6). For the 30 v. 4 amp. rect., **57/6** (des. 2/-).

SHORT-WAVE RECEIVERS. Last few of the excellent B2 Mk. III Receivers and Power Packs. Operation any A.C. mains and 6 v. D.C. Range 3.1 to 15.5 mc/s. Superhet with B.F.O. Compact and highly efficient set with all leads, phones, etc., in waterproof steel transit case. **£7/17/6** (des. p.t. 5/-). We have the coils for the B.2 Transmitter at **10/6** the set of four.

MASTER CONTACTORS, suitable for process timers, or darkroom work. Spring driven, impulse every half-second with closed circuit. Precision made, in teak transit box, **25/-.**

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CENTRIFUGAL BLOWERS (G.E.C.). Operation 6/12 v. D.C. or 15 v. A.C. Intake 2½in. Outlet 1½in. Height overall 8½in. Suction and blast greater than average vacuum cleaner, **57/6** (des. 2/-).

H.T. RECTIFIERS. (S.T.C. selenium). D.C. delivery up to 350 v. 120 m.a. in half-wave or voltage doubler (two can be bridged for 300 m.a.) Very special offer **7/6.**

HEAVY DUTY OUTPUT TRANSFORMERS, improved "W.W." spec. Providing 11 ratios from 12/1 to 75/1 with C.T. for push-pull. Handling up to 25-watts at high-fidelity. Weight 7½ lbs. **59/6** (des. 2/-).

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The G.E.C. 9″ diameter cathode ray tube 6501 is intended for high quality television reception, and is magnetically focused and deflected. The screen fluorescence is white.
The tube end is made by a special moulding technique, which produces a screen face nearly flat, and more constant in production than is normally possible with bulbs made by the usual blowing technique.
A picture size of approximately 200x160 mms. is obtainable with slight masking of the edges and corners.
The bulb is made of high insulating glass giving a minimum of screen charging effects.
The electrode gun is designed to give a high picture brightness, with excellent definition for a relatively small voltage drive to the modulator.
Detailed technical data sheet available on request.

Osram PHOTO CELLS | G.E.C. CATHODE RAY TUBES | Osram VALVES

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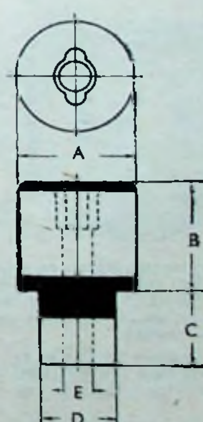
R.50650 R.50764 ★R.50844 ★R.50855

TYPE	A mms.	B mms.	C mms.	D mms.	E mms.
R.50650	9·5	9·5	6·4	6·25	2·75
R.50764	9·5	16·7	6·4	6·25	2·75
★R.50844	9·5	12·7	9·5	6·25	2·75
★R.50855	12·7	22·2	12·7	9·5	3·9



★ Recent additions to the range

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STEATITE & PORCELAIN PRODUCTS LTD.

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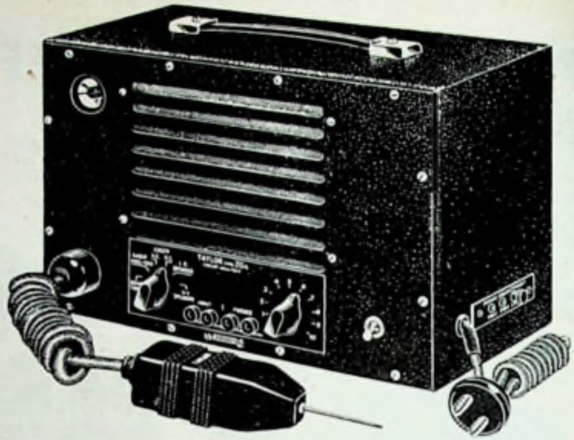
Fault finding Simplified

The New Taylor CIRCUIT ANALYSER Model 20A



The 20A traces the signal through the receiver stage by stage from aerial to loudspeaker. A midget pentode detector is contained in the probe, used for R.F., oscillator and I.F. checks, followed by an amplifier and loudspeaker in the instrument with a "magic eye" to give visual indication of signal strength. The latter is used for D.C. checking on A.V.C. lines or oscillator self-bias. For A.F. Checking the input is taken directly to the amplifier which can be switched to feed either the loudspeaker or the magic eye. The selector switch enables the internal speaker to be used separately for test purposes either as low or high impedance. A.C. mains operated, 110 volts and 200/250 volts, 40/100 c.p.s.

Taylor *Best for* TEST EQUIPMENT

PRICE £15-15-0

HIRE PURCHASE TERMS

£1.10.5 DEPOSIT & 11 MONTHLY PAYMENTS OF £1.10.2

EARLY DELIVERY

TAYLOR PRODUCTS INCLUDE: MULTIRANGE A.C. D.C. TEST METERS ● SIGNAL GENERATORS ● VALVE TESTERS ● A.C. BRIDGES ● CIRCUIT ANALYSERS ● CATHODE RAY OSCILLOGRAPHS ● HIGH AND LOW RANGE OHMMETERS ● OUTPUT METERS ● INSULATION TESTERS ● MOVING COIL INSTRUMENTS

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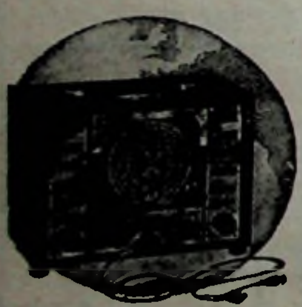
SPHERE INSTRUMENTS



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ALL WAVE SIGNAL GENERATOR TYPE 505

A portable Signal Generator for AC. Mains operation. Specially developed by SPHERE as a high class instrument, for general Laboratory and Workshop use, it is the ideal instrument for the aligning and testing of radio receivers and amplifiers.

This is a specially designed Generator embodying several new and unique features and improvements, which radio engineers will find invaluable.

All "SPHERE" Test-Instruments are entirely British made with highest quality materials and workmanship and carry a SIX Months' guarantee.

- Continuous Frequency coverage from 110 Kilocycles to 56 Megacycles, in six bands.
- Exclusive "SPHERE" "SEE AT A GLANCE" Band and Attenuator indicators.
- Built in ladder attenuator, with fine control, giving 1 Volt maximum, in five steps, in multiples of 10 Microvolts.
- Radio and Audio Frequency Voltages can be switched via single Test-lead.
- Variable control of 400 C.P.S. audio, from 0 to 1 Volt.

FOR RADIO SERVICE, RADIO ENGINEERING AND LABORATORY USE.

Write for List No. 505 S.G.

SPHERE RADIO LIMITED
Radio Instrument Manufacturers
HEATH LANE, WEST BROMWICH

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NEW VIBRATION ELIMINATORS

"EQUIFLEX" PATENTED AND FOREIGN PATENTS PENDING MOUNTINGS

AN (AN) PRODUCT

"Equiflex" Mountings are invaluable for the mounting and suspension of machines, equipment, instruments, electrical apparatus, motors, etc., and wherever elimination of vibration and shock is required.

SPECIAL FEATURES

Flexible in all directions at an equal deflection. Can be loaded on any side, thus eliminating vibration in Vertical, Horizontal and Longitudinal planes employing best quality natural rubber spring elements and complete with snubbing device. Special Fittings made to suit customers' requirements.

Also available as previously advertised, the ALL-METAL construction comprising an ingenious Damped Spring System.

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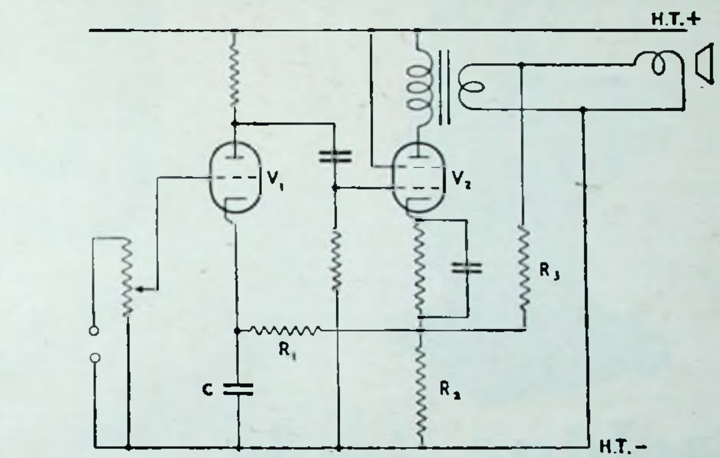
'Phone : Larkswood 2691

We'd like you to know—

NEGATIVE and POSITIVE FEEDBACK on the FERRANTI 347

'Quality' enthusiasts have long regarded the pentode or tetrode output valve with suspicion. Yet the pentode has two advantages which have made it universal in broadcast receivers — it gives high output with economy in H.T. consumption and it requires quite a small input signal. It also has the useful quality of giving a relatively greater amplification of high notes than a triode, which helps to make up the loss due to the selectivity of the I.F. circuits.

The disadvantages of the pentode or tetrode are that the high power levels, which are apt to occur in the lower audio frequencies of a programme, can cause unpleasant distortion; and that it does not damp the 'boom' which arises from the bass resonance of the loudspeaker.



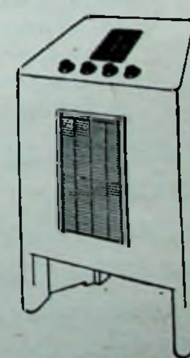
TECHNICAL EXPLANATION

Feedback voltages are developed across R_2 and applied to the cathode of V_1 through R_1. Negative feedback is applied from the secondary of the output transformer through R_3 to R_1. Positive feedback is developed across R_2 by the cathode current of the output tetrode V_2. Normally the feedback voltages are equal and cancel each other, but if there is distortion or 'boom' from the loudspeaker, the feedback voltages are unbalanced and a correcting feedback voltage is applied to the cathode of V_1. The condenser C decouples the feedback circuit on high notes when its operation is not required.

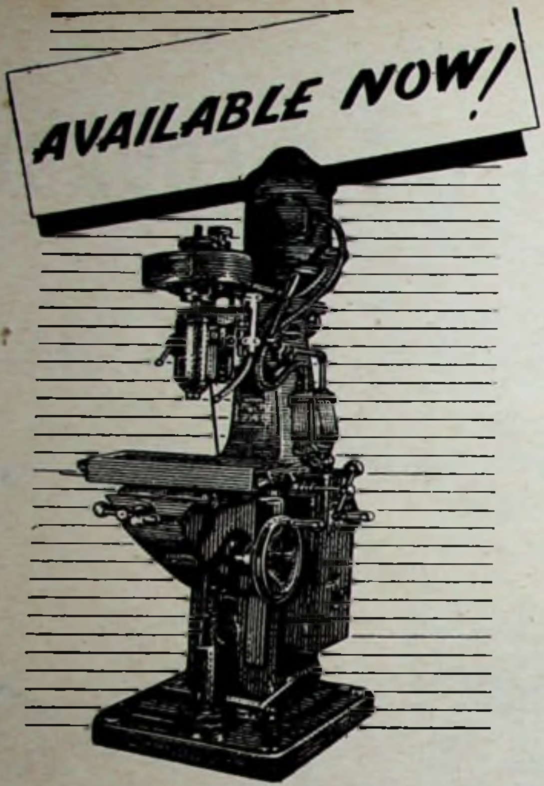
The pentode can be made to behave like a triode by negative feedback; but amplification is lost, which reduces the sensitivity of the receiver and makes the use of a pick-up difficult. The useful 'boost' of high frequencies is also lost. We have, therefore, introduced a system in which negative feedback is used to give the advantages of a triode in handling the low notes and cutting out boom. The loss of gain is made good by the use of positive feedback. The circuit is so arranged as not to operate on the high notes, which do not require feedback, and so the increased high note amplification of the pentode is unimpaired.

This system combines the advantages of pentode economy and triode quality. It is used in the Ferranti 347 Console Receiver with a generously designed output transformer and a 10" high flux density P.M. loudspeaker.

Model 347 Console Receiver. 5-valve, 3-waveband A.C. superhet. Pre-set tuning on 2 switch-selected stations. 10" energised permanent magnet speaker. Variable tone control. Figured walnut cabinet. Retail price £46.4.8. (Inc. £11.4.8 tax.)



Ferranti Ltd MOSTON MANCHESTER 10; & 36 KINGSWAY LONDON W C 2



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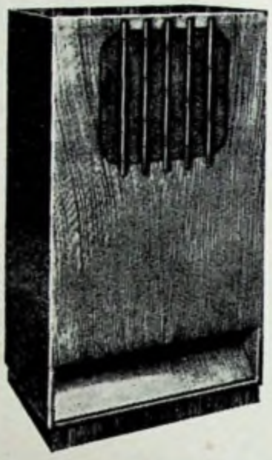
The ARDENTE LABYRINTH LOUDSPEAKER



Exceptional frequency response and power handling capacity; 12″ heavy duty, permanent magnet, moving-coil unit gives finest possible reproduction of speech and music. Specially designed walnut cabinet brings out sounds from the back of the loud-speaker cone in phase with the frontal waves.

Ideal for theatres, dance halls, ice rinks, etc.

● *Details/demonstrations from :*

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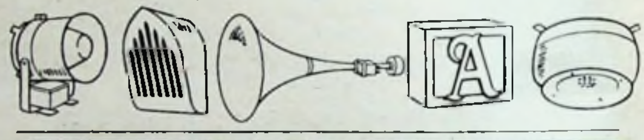
Makers of all types of speakers for indoor, outdoor and mobile use



THE "PYROGRIP"

(Patent Applied For)

Every Radio, Electrical, Motor and Model Engineer hates those fiddling small screws in awkward corners! Here's the perfect solution—fits any screwdriver $\frac{5}{32}$ in. dia. approx., holds the screw snug and straight, slips up the shank when not required.

6d. EACH from Hardware Shops Everywhere.

THE ACRU ELECTRIC TOOL MFG. CO. LTD
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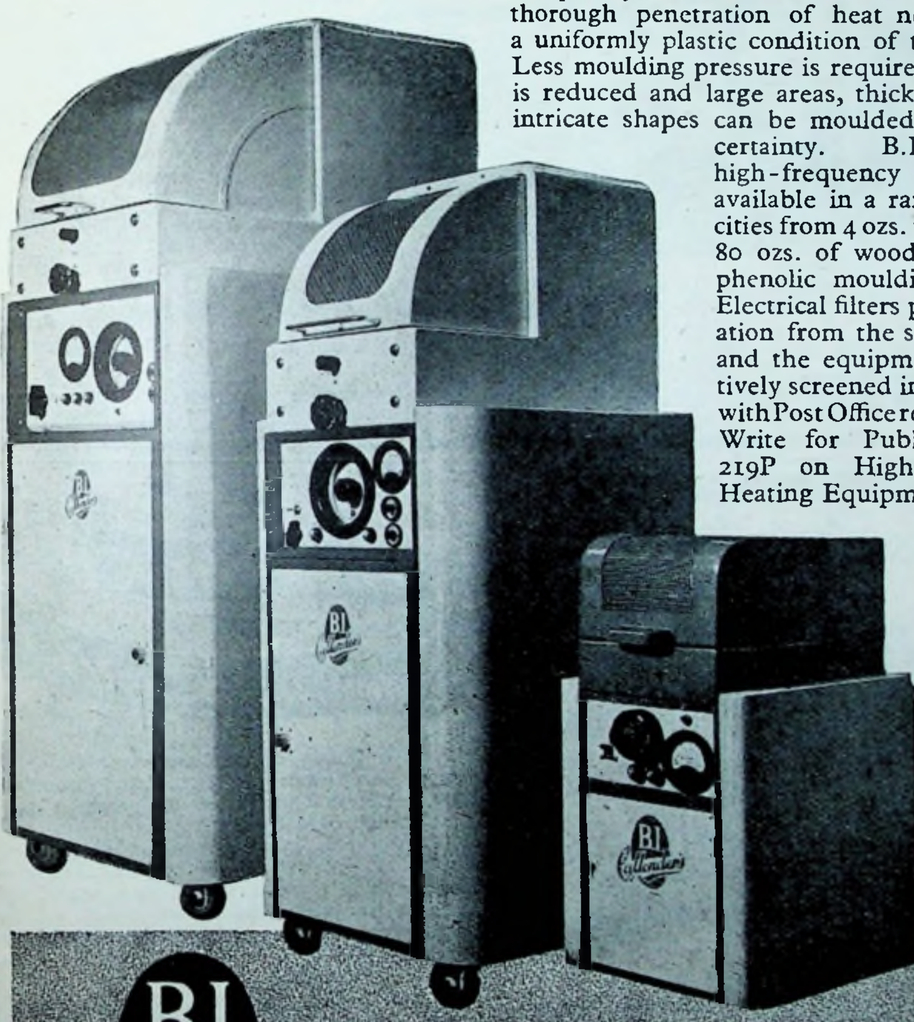
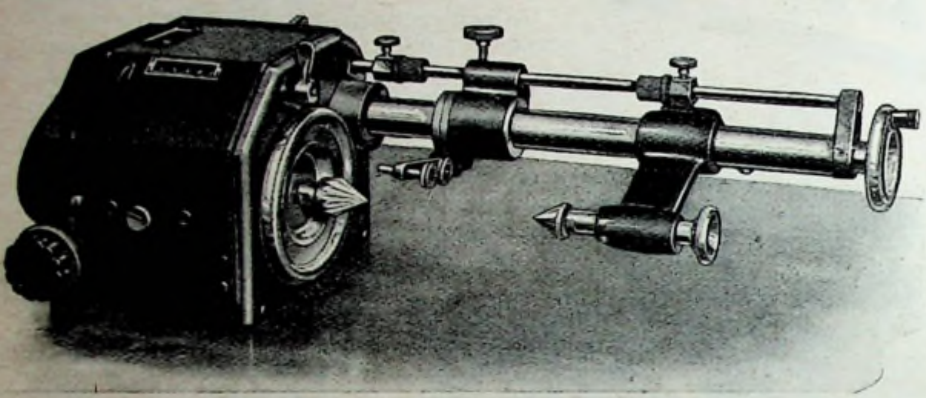


THE NEW KOLECTRIC HIGH SPEED PRECISION AUTOMATIC COIL WINDING MACHINE

Type AI 1



A few features :

- Totally enclosed headstock.
- Ease of operation and setting.
- Winding of 2 coils simultaneously if required.
- Infinitely variable micrometer wire gauge adjustment.
- Wire gauges 25-50 S.W.G.
- Winding Speeds up to 3,000 R.P.M.
- Carriage setting handle.
- Enclosed drive, with pedal control.

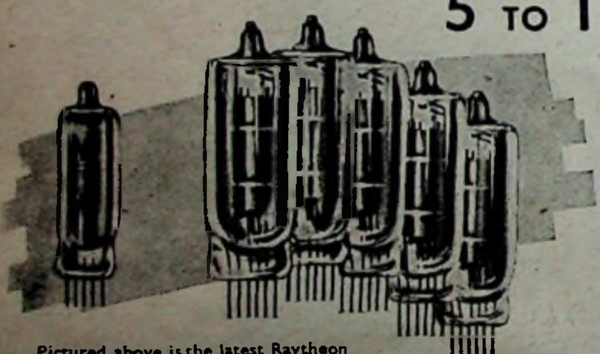
Write us for full information of this NEW DEVELOPMENT IN COIL WINDING.

KOLECTRIC LTD 20, Avonmore Road, LONDON, W.14

RAYTHEON CONTRIBUTIONS to development of Hearing Aids

Little valve outlasts big one...

5 TO 1



Pictured above is the latest Raytheon Flat Hearing Aid Valve . . . the CK512AX . and a group of the earliest Raytheon Hearing Aid valves.

Apart from the improvement in hearing qualities, just look at the difference in size ! Though less in height and of much smaller cross section, the present Raytheon Flat Valve provides five times the life.

This is but one of many developments which have made Raytheon the leading Hearing Aid Valve . . outnumbering all other makes combined by nine to one !

Ask for complete information. Address your inquiry to Submarine Signal Company (London) Ltd., Artillery House, Artillery Row, London, S.W.1. England, or to :

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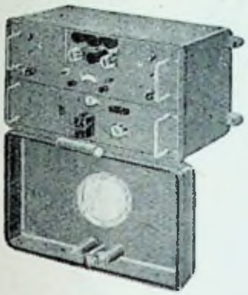
The only Manufacturers of OAK Switches under Patent Nos. 478391 & 478392

Announcing... SIX ENTIRELY NEW ELECTRONIC INSTRUMENTS

by CINEMA-TELEVISION LIMITED



INDUSTRIAL ELECTRONIC METAL DETECTOR

An automatic inspection equipment for the detection of ferrous and non-ferrous metal particles of all kinds in non-metallic substances such as foodstuffs, plastics, textiles, tobacco, timber, pharmaceutical products, etc.

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A high speed electronic counter of particular appeal to the industrialist. Facilities are provided for batching, selective counting etc., the maximum counting-speed for the equipment being 30,000 per minute.

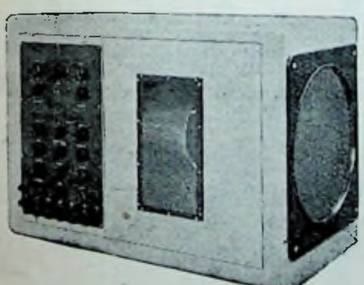
UNIVERSAL OSCILLOSCOPE

A unique instrument meeting fully the requirements of the serious users of oscilloscopes for laboratory and industrial purposes, arranged to permit readily the assembly of suitable units to fulfil every application. Complete range of units is available, e.g. stabilised time base, A.C. and D.C. amplifiers, 5 beam switch unit etc.

LABORATORY OSCILLOSCOPE

A high grade 6" screen oscilloscope expressly designed for laboratory use, incorporating hard valve linear time base, 3 megacycle "Y" amplifier and 1 megacycle "X" amplifier. Cupboard and trolley are available if required.

DEMONSTRATION OSCILLOSCOPE



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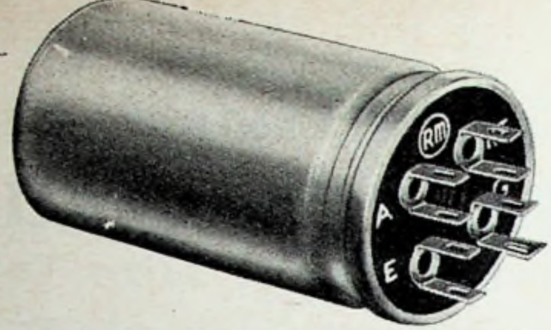

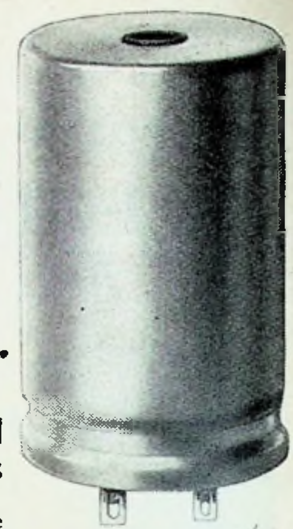

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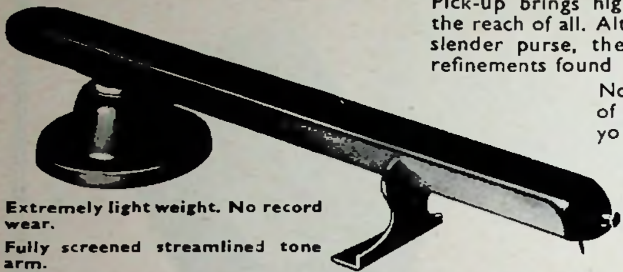

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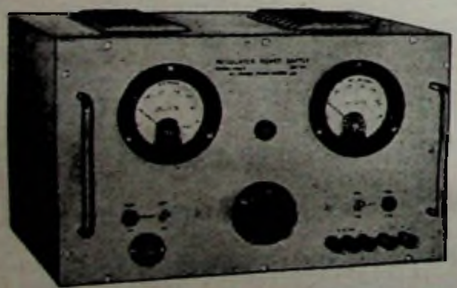

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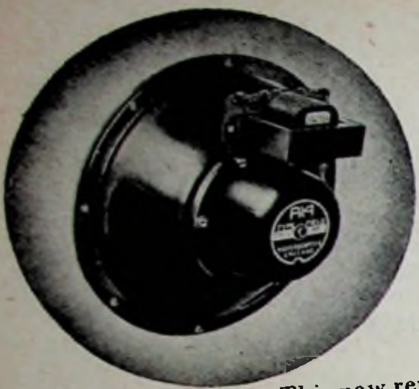

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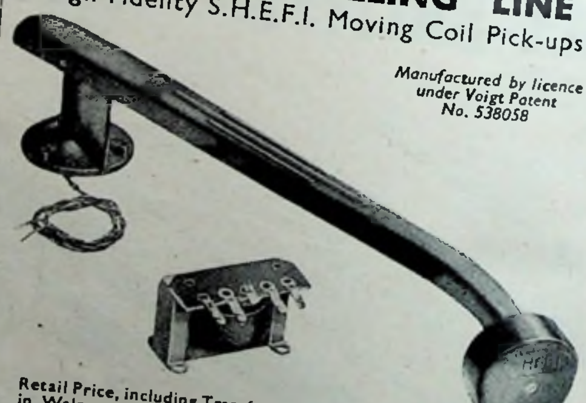

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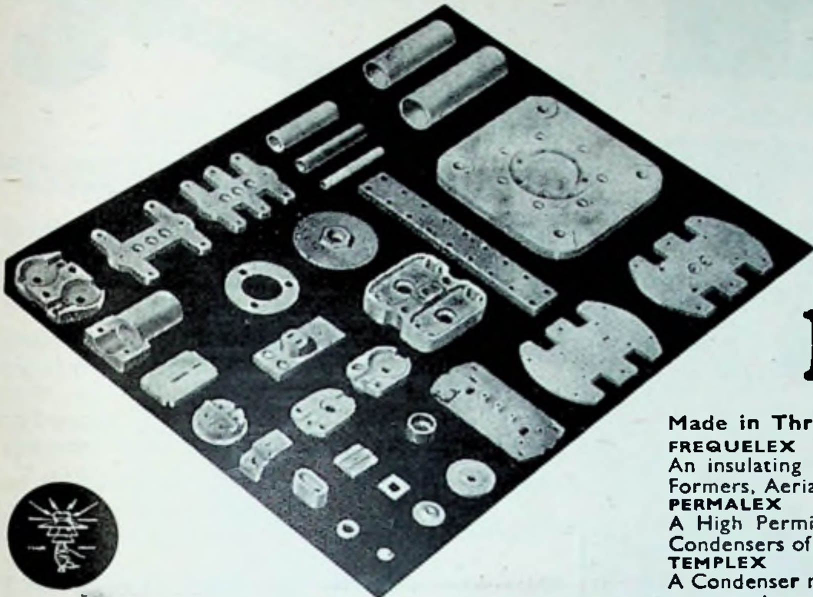

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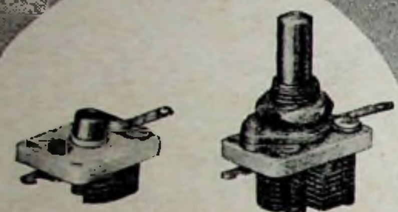

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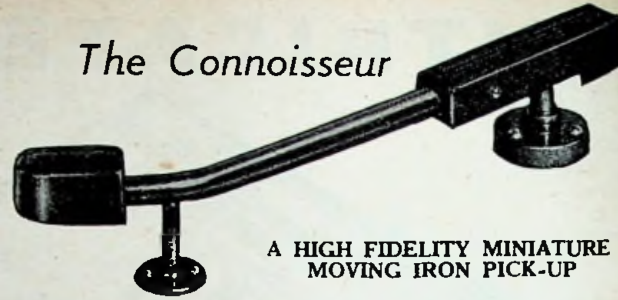

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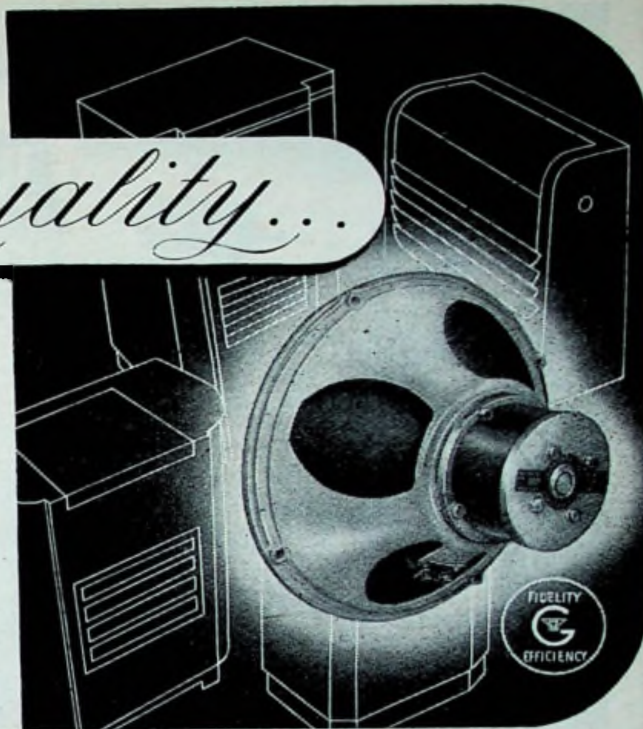

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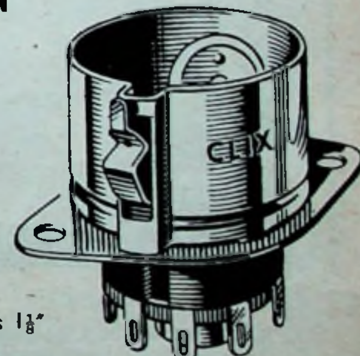

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Wireless World

RADIO AND ELECTRONICS

FEBRUARY
1948

37th YEAR OF PUBLICATION

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In this Issue

VALVES AND THEIR APPLICATIONS

By M. G. SCROGGIE, B.Sc., M.I.E.E.

No. 14: Mullard HIGH-SLOPE R.F. PENTODE EF42 (continued)

LAST month's notes were devoted to constructional features of the EF42; here follow some of the electrical data. As a basis for comparison, the EF50, having been used so widely during the last nine years, is probably the best known; while the EF54 is a more recent type in the same class. Typical operating conditions (250V on anode and screen and 10mA anode current at about −2V grid bias) are similar for all three valves.

The slope of the EF42, 9.5mA/V, is about 50% up on the EF50 and 25% better than the EF54, for practically equal heater rating. Input and output capacitances (9.5 and 4.5pF respectively) are together about the same as in the EF50; C_{in} alone is not quite so good as the EF54's 6.2pF, but $C_{a\text{-}g1}$ is better — <0.005 compared with 0.02pF. Maximum anode dissipation is slightly less — 2.5W instead of 3W in EF50 and EF54. Equivalent noise resistance of the EF42 (750Ω) is about the same as in the EF54 and twice as good as in the EF50. Input resistance at 50Mc/s (5000Ω) is slightly better than the EF50 but only half as good as the EF54.

The upshot of all this is that if the criterion is maximum operating frequency, where $g_m \times$ input resistance is the limiting factor, the EF42 must give way to the EF54, useful up to 250Mc/s. But notwithstanding its miniaturity, at television and f.m. frequencies the EF42 is appreciably better than the EF54 and substantially better than the EF50; enough perhaps to save a whole stage (and, of course, considerable space) in a television r.f. or i.f. amplifier. It is particularly applicable to radar i.f. amplifiers, because they usually work at about 45Mc/s and require an even wider bandwidth.

Though the type specifically for the v.f. stage is the EF55, especially if there is any doubt about sufficiency of output from a smaller valve, in most situations the design can be made to allow the economy of using the EF42 there also.

A demand that is likely to increase is for a valve suitable for r.f. amplification in v.h.f. receivers, especially f.m. The EF42 is eminently suitable for this purpose up to at least 150Mc/s.

Then again, the EF50 has been used in a great variety of special circuits — cathode followers, time base generators, etc. — where its high slope is helpful; and here the EF42 does even better. Its output resistance as a cathode follower is not much more than 100Ω; and the fact that all the electrodes — even the outer screen — are brought out separately allows the maximum adaptability.

So altogether the EF42 looks like being an exceptionally versatile and effective valve, a decided improvement on the EF50, and preferable in some respects even to the EF54.

Mullard

This is the fourteenth of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from the address below. Technical Data Sheets on the EF42 and other valves are also available.

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Wireless World
RADIO AND ELECTRONICS

Vol. LIV. No. 2 February 1948

Short-wave Broadcasting Under Fire

A LETTER from a correspondent, printed on another page, draws attention to a vitally important aspect of the use of communication channels. For some years there has been a growing body of opinion, particularly in America, that short-wave international broadcasting has failed; that it is a gross misuse of valuable communication channels to monopolize them for a service which benefits a negligible proportion of the world's listeners. We believe that it was intended strongly to oppose the allocation of channels for such purposes at the Atlantic City Conference, but apparently other views prevailed, and the H.F. broadcasting bands have actually been widened rather than curtailed.

As an alternative to long-distance H.F. broadcasting for direct reception by the listener, it has been suggested that much better results could be obtained, with greater economy of channels, by distribution over line or radio international communication networks, with subsequent rebroadcasting by the national stations of the country of destination. In addition to the saving of channels it is urged that the use of diversity reception and other methods open to big organizations will ensure a better signal than the "direct" listener can ever hope to achieve.

Since our correspondent's letter was written, strong support for his contentions has come from a leading article in the American journal *QST*. Referring to the Atlantic City Conference, the article says "It is difficult to portray adequately the greed, rapacity and general radio-dumbness of the average foreign spokesman for government broadcasting. With exceptions, of course, he is commonly a rather high-powered political character, not a real radio man and not a technical man, caring less than nothing for the communication services and rioting in the plenipotentiary powers given him by his government. Radio means only broadcasting to him and he doesn't care what happens to other services as long as he gets what he wants."

Turning to the large number of channels required for international short-wave broadcasting, *QST* goes on to say "It has been reliably calculated by engineers, that it would take about half of the H.F. spectrum to set up, on sound technical principles, an idealized system meeting every nation's ambition of being able to propagandize every other nation."

Obviously, some of those who oppose short-wave broadcasting are actuated by motives of self-interest. Some of the arguments against it carry force; others, such as those based on the present short-comings of the service due to chaotic ether conditions and inadequate receivers, do not. These are defects that can be overcome; they are not fundamental to the issue.

Admission of Defeat

To recommend the total or even partial abolition of S.W. broadcasting would, in our view, be a counsel of despair, and an admission of defeat; an admission that mankind lacks the wit to turn to proper uses a medium of such self-evident potentialities for good. Many years ago, *Wireless World*, campaigning against apathy and even active opposition, urged the setting up of an Empire broadcasting service, and many of the arguments then adduced in support still hold good. But it cannot be denied that S.W. broadcasting has been misused, and also that conditions have changed. Many of the factors involved—social, political and cultural—cannot properly be discussed in a technical journal. Undeniably, such services, like all forms of H.F. long-distance communication, make heavy demands on channels, as it is necessary to cater for diurnal and seasonal variations in propagation conditions. In the case of broadcasting the demands on channels become almost unbearably heavy when the nations seek to use a multiplicity of languages other than their own.

The sole concern of this journal is that radio communication channels should be used to the greatest advantage. We are by no means convinced that H.F. long-range broadcasting represents what is inherently a misuse of valuable channels. But it is perhaps overdone; some of it is ineffective and some is put to base uses. Those who are laying claim to channels and those responsible for the conduct of services must regard themselves as being under an obligation to justify themselves, and see that they have a good case to present.

Electronics and

Techniques Used in Research and Production

BEFORE we can proceed to discuss the part played by electronic techniques in the field of atomic energy* it is necessary to trace the development of the subject from its early beginnings. To examine so wide a field within the confines of a single, short article will necessitate an abbreviated, and in some details, a not completely rigorous treatment.

It has been known since the closing years of the last century that certain heavy elements like uranium and radium are radioactive. Their atoms disintegrate (or split) of their own accord with the emission of ionizing radiations. Energy is liberated during the process as is evidenced by the fact that a lump of radium stays warm and radiates heat continuously. The process is uncontrolled, no efforts of man can increase or decrease the rate at which the energy is liberated, and the elements providing atomic energy in this form are too scarce in nature for them to be useful sources of power.

The ionizing radiations emitted from radioactive substances are of three types. α-particles, which are the central positively-charged cores (or nuclei) of helium atoms, β-particles which are now known to be electrons similar to those emitted from a hot cathode, and γ-rays which are high-frequency electromagnetic waves similar to X-rays but with greater penetrating power.

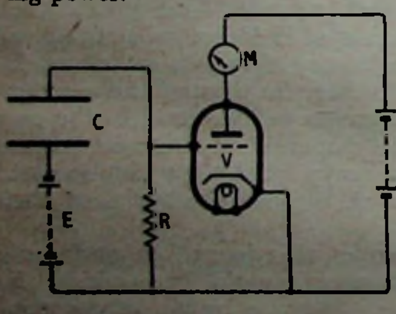

Fig. 1. Schematic diagram of ionization chamber and D.C. amplifier.

*The description "atomic energy," now widely accepted, is somewhat misleading since the term describes energy derived from the nucleus of the atom. A better description might have been "nuclear energy." Atomic energy is released whenever we burn petrol or coal.

Such radiations may be detected and their properties examined by means of an ionization chamber depicted in Fig. 1.

In this case the chamber is a parallel-plate air capacitor C across which a potential E is maintained. α-particles, β-particles or γ-rays passing through the air between the plates produce (+) and (−) ions which migrate under the influence of the electric field and produce a current in the circuit.

Measurement of the change in potential caused by this current flowing through R gives an indication of the strength of the radioactive source. In Fig. 1 the potential change across R causes the bias of V and therefore the current through it to change. This is indicated by the meter M. This technique of D.C. amplification forms the basis of a large number of instruments now in use.

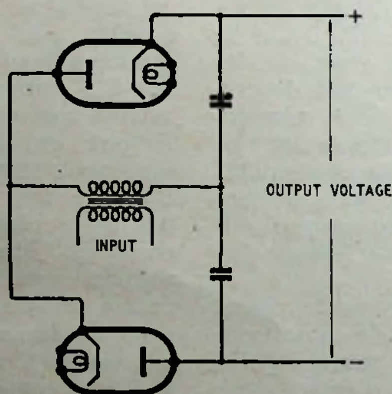

Fig. 2. Greinacher voltage doubler circuit.

The controlled release of atomic energy came as a result of experiments by Lord Rutherford in which, by bombarding the nitrogen atoms in air with the bullet-like α-particles emitted from a mixture of radioactive materials, nitrogen was transformed into a form of oxygen with the emission of a nuclear particle called the proton (which is the nucleus of a hydrogen atom). Rutherford's experiments opened up the whole field of nuclear physics.

Application of electronics in this field came about in two ways. First, it was desired to replace the radioactive source of bombarding particles by a man-controlled source. This led to the development of high voltages for the acceleration of the charged particles to sufficiently high velocities, and therefore energy, to split atoms.

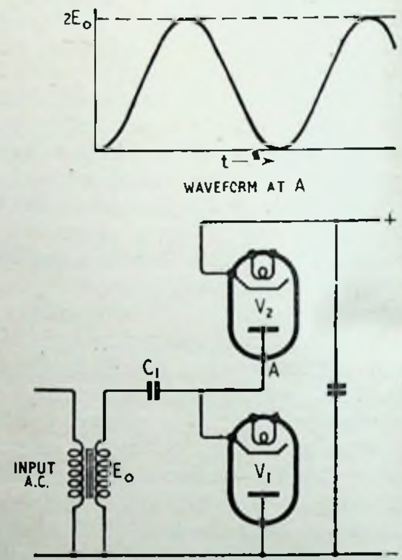

Fig. 3. Cockcroft-Walton voltage doubler circuit.

Fig. 2 shows one of the early circuits—the Greinacher voltage doubler. The circuit is well-known to users of metal rectifiers and it will be seen to be two half-wave rectifier circuits connected back-to-back, so that the outputs are in series.

It was little used for particle acceleration because it is only possible to double the voltage obtained from the transformer secondary.

Atomic Energy

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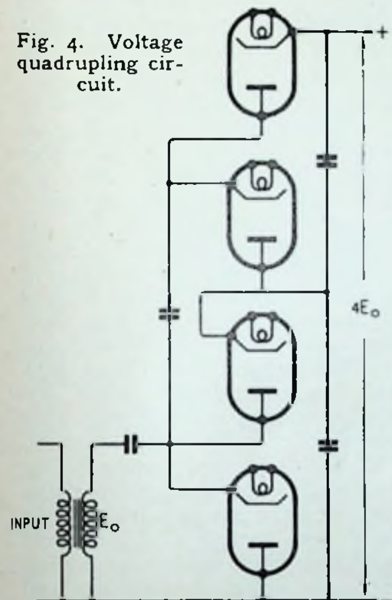
Instead a new circuit was developed by Cockcroft and Walton and is shown in Fig. 3. If E_0 is the peak voltage from the transformer secondary the capacitor C_1 charges to E_0 through V_1 during the negative half cycle. On the positive half cycle the voltage E_0 across C_1 is in series with that across the transformer secondary and therefore C_2 charges through V_2 to a potential $2E_0$. The voltage waveform at A is sinusoidal, oscillating between earth potential and $2E_0$.

Fig. 4. Voltage quadrupling circuit.



The circuit has the advantage that further diodes and capacitors may be put in cascade to obtain voltages greater than $2E_0$. Thus Fig. 4 shows the circuit modified to provide an output voltage of $4E_0$.

With such equipment as this Cockcroft and Walton, in 1932, accelerated protons by allowing them to fall through a potential difference of 600 kV and produced nuclear reactions by allowing the particles to bombard targets made of certain elements. This was the first wholly man-controlled atom-splitting.

Although nuclear energy may be released in such reactions the process is very inefficient, since the energy consumed in accelerating the particles is far greater than that which may be released.

The rectifier-transformer type of accelerator has been largely replaced by other forms of equipment, notably the electrostatic generator devised by Van de Graaff and the cyclotron, developed by Lawrence.

Fig. 5 shows the essentials of an electrostatic generator. A series of corona points, A, usually gramophone needles, are held at a potential of 10 to 50 kV and spray

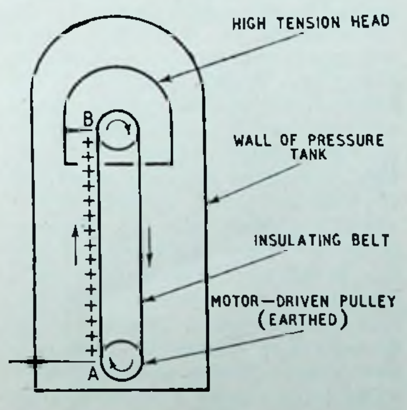


Fig. 5. Simplified diagram of electrostatic high-voltage generator.

positive charge on an insulating, endless belt. The belt, passing over two pulleys, carries the charge up and takes it inside the hollow aluminium spinning which constitutes the high-voltage electrode. Further corona points, B, remove the charge from the belt and transfer it to the high-voltage electrode somewhat like a lightning conductor discharges a thunder cloud. The H.T. head therefore acquires charge and rises in voltage. Equilibrium conditions are attained when the current conveyed to the H.T. head by the belt is exactly equal to that drawn by the ion source and leakage along the insulators (not shown).

Generators such as this operate at voltages between 2 and 5 million and are usually enclosed inside a steel pressure tank. Gas, such as nitrogen, at a pressure of 10 to 20 atmospheres, can then be used as a high-voltage insulating medium.

Higher energies still may be achieved by the use of a cyclotron, a schematic diagram of which is given in Fig. 6. D_1 and D_2 are flat, semi-circular boxes open along their straight sides and called "dees" because of their shape. They are like the two halves of a very short cylinder cut along a diameter. They form part of the capacitance of an R.F. oscillator (about 10 Mc/s) and are mounted on insulating supports within an evacuated circular box. This box lies between the poles of an electromagnet so that the magnetic field is perpendicular to the plane of the dees (i.e., the paper in Fig. 6).

Suppose that the ion source, located centrally between the dees, is producing protons. Then at the instant when D_1 is negative with respect to D_2 (the peak voltage between D_1 and D_2 is between 20 and 50 kV) protons are accelerated forwards and into D_1. Since the dees are metal there is no electric field inside them and, once inside, the proton moves in a circular path under the influence of the magnetic field. If the frequency

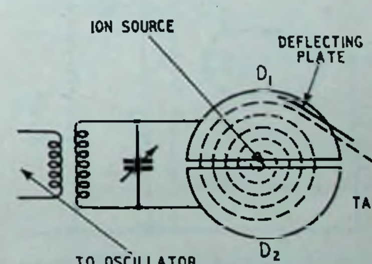


Fig. 6. Schematic diagram of cyclotron showing spiral ion path. In practice the ion path has many more turns than are shown here.

is chosen correctly the proton completes a semi-circle and returns to the accelerating gap between D_1 and D_2 when the field is reversed, i.e., D_2 negative with respect to D_1. The proton is then accelerated again and proceeds to

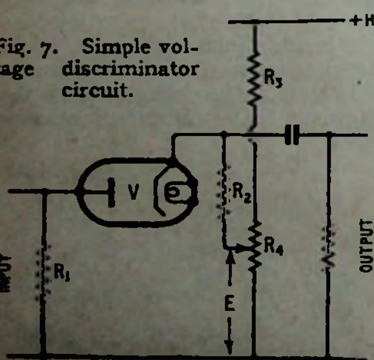
Electronics and Atomic Energy— describe a semi-circle of larger radius inside D_2 returning again for further acceleration in the correct phase. As indicated in Fig. 6 the path is made up of a series of semi-circles of increasing radius until eventually the protons come under the influence of the electric field of the negatively charged deflector plate which pulls them out of the magnetic field and causes them to strike a target.

Cyclotrons giving particles with energies corresponding to 10 million volts are commonplace, and the largest, at Berkeley, California, which has pole-faces 184in in diameter, has produced protons with energy corresponding to an acceleration of 100 million volts.

Professor Oliphant, at Birmingham University, has a special form of accelerator under construction called a proton synchrotron which, it is hoped, will give protons energies corresponding to an acceleration through 1,000 million volts.

The second point at which electronic techniques entered the field was in the detection of the single particles of matter emitted in a nuclear reaction; for example, the protons emitted in Rutherford's original experiment mentioned earlier. A single, energetic, charged particle such as a proton or α-particle entering an ionization chamber (Fig. 1) causes a burst of ionization. If the ions are collected quickly the charge Q collected causes a voltage pulse of amplitude Q/C to be developed across the plates of the chamber whose capacity C may be between 50-100 μμF. The magnitude of the charge is such that a single nuclear particle gives rise to a pulse of the order of 10^{-4} volt. An R.C. coupled linear amplifier with a gain of a million will amplify the pulse to 100 volts at which level it can be presented on a cathode-ray oscillograph screen.

Fig. 7. Simple voltage discriminator circuit.



The output of the amplifier may contain pulses of a variety of sizes, and it is often necessary to reject pulses less than a chosen size. This can be achieved by employing a voltage-discriminator, an example of which is given in Fig. 7. The anode of V is normally at earth potential while its cathode is held at some positive potential E through the resistance R_2 which connects to the potentiometer chain R_3, R_4.

The circuit gives no output pulse except when the amplitude of the input pulse applied across R_1 exceeds E volts. The diode V then conducts and a positive output pulse is developed across R_2.

The rate at which the pulses leave the discriminator can be determined by an integrating counting rate circuit or by an electronic counting circuit, which adds up the pulses it receives and presents the answer as a total on a telephone message register. Originally, counting circuits employed thyratrons in a circuit which would produce only one output pulse for every two input pulses; that is the circuit divided by two. The use of thyratrons imposed a limitation on speed because of the de-ionization time, and to-day hard-valve circuits are preferred. With hard valves, circuits can be designed which will accept pulses at rates up to one or two million per second. The block diagram of the complete equipment for detecting and counting individual nuclear particles is shown in Fig. 8, and is representative of thousands of such pieces of equipment in daily use in laboratories throughout the world.

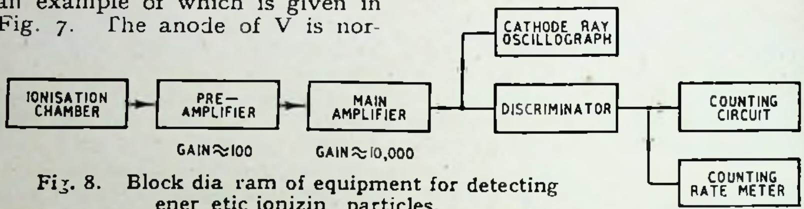


Fig. 8. Block diagram of equipment for detecting energetic ionizing particles.

Two fundamental discoveries led to the large-scale release of atomic energy.

The first, made by an Englishman, Sir James Chadwick, was the discovery of the neutron. The neutron is one of the ultimate units from which atoms are built and, because it has no electrical charge, it does not ionize gases and can travel through great thicknesses of material.

The second discovery was made by two Germans, Hahn and Strassman, and was that a neutron impinging on the heavy uranium atom can be captured and cause the atom to break up into two nearly equal parts—smaller atoms—with the release of a large amount of energy and between one and three further neutrons. This process is called nuclear fission. If, for simplicity, we assume that two neutrons are emitted for fission, then if each of these two neutrons is captured by other uranium atoms further fissions can occur and four neutrons result. It will be seen, as depicted pictorially in Fig. 9, that the neutrons multiply in the system and energy is liberated. This process is called a chain reaction.

These ideas were known before the war and the wartime development was concerned with putting them into practice. The first attempts were made employing slow (low velocity) neutrons and the growth of neutrons in the reaction was arranged to proceed slowly enough to enable control to be effected. Such control is achieved by absorbing the neutrons with some material like cadmium which does not undergo fission and generate further neutrons. The machine which results is called a pile because it is a pattern of uranium rods embedded in a pile of graphite blocks. The graphite is used to slow down the neutrons. The number of neutrons present in the system is constant when the number formed by fission per second is equal to the number lost per second by leakage from the machine and by absorption in the cadmium control rods. By moving the control rods in or out of the pile we can decrease or increase the rate of fission and hence the rate of energy production.

The first pile was completed and went into operation in Chicago, U.S.A., late in 1942. The first pile in England was completed in August, 1947, and can be operated at a power level of 100 kW.

The more spectacular development, the extremely rapid release of atomic energy in a bomb, was achieved in July, 1945, in the U.S.A., employing fast neutrons so that the reaction built up extremely rapidly and was completed in a time of the order of a millionth of a second.

To provide energy on a scale large enough for industrial use it will be necessary to build large piles operating at high temperatures and developing many megawatts of output power. Such developments are in progress in the U.S.A., in England, and in France.

To determine the power level at which a pile is operating it is necessary to measure the number of neutrons present. Since neutrons are uncharged and do not ionize, special methods of detection are necessary.

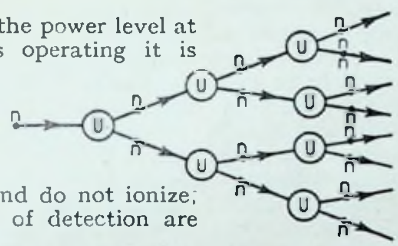


Fig. 9. Diagrammatic representation of a chain reaction illustrating the growth of the neutron n population by the fission of uranium atoms (U) on the assumption that two neutrons are emitted at each fission.

A special boron-coated ionization chamber can be employed. Boron, on capturing a neutron, disintegrates with the emission of an α-particle which ionizes and can can be detected electronically as described earlier. The number of α-particles therefore gives an indication of the number of neutrons crossing the ionization chamber and hence the power level at which the pile is working. If the number of neutrons increases, the number of counts increases and this information can be fed through an electromechanical system (e.g., a selsyn) to lower the control rods into the pile to reduce the reactivity of the system, thereby maintaining the power level constant. The process is analogous to the performance of an electronically regulated power supply.

Electronically operated safety circuits are usually employed to drop special safety control rods into the pile and shut the plant down in the event of failure of the cooling system, instrument breakdown, or the power rising too fast.

The materials used in pile construction—uranium and plutonium—are poisonous and workers fabricating the materials have to be protected. Because both materials emit α-particles it is possible for very minute quantities of material on the hands to be detected by the single particle technique. Automatic equipment for monitoring hands is employed to indicate when the hands are contaminated and need cleasing.

Near an operating pile there is strong neutron and γ-radiation and the strength of these radiations is measured remotely, usually by D.C. amplifier techniques as described earlier.

Within the pile, in addition to a higher intensity of neutrons and γ-rays, the fission products themselves are radioactive. Moreover, slow neutrons are captured and produce artificial radioactivity in many elements. A pile thus produces large quantities of radioactive materials the radiations from which can be harmful to health. Some of these materials are wanted for medical purposes, such as the treatment of cancer, but the majority have to be disposed of safely from time to time.

The circulating gas, water or other medium used to cool the pile becomes radioactive and it is of importance to ensure that it will cause no harm to human beings, animal or plant life if it is to be discharged into the atmosphere in the case of a gas, or a river or the sea in the case of a liquid.

It will be seen from these remarks that the development of instruments which will detect radioactive materials, through the α, β or γ-radiations which they may emit, is of paramount importance. We have already discussed α-particle detection. Fortunately β-particle and γ-ray detection can be done very easily by means of a device known as a Geiger-Muller counter. In one form this device, which can be regarded as a sensitive form of ionization chamber, consists of a wire passing axially down a metallized glass tube as shown in Fig. 10. A very high electric field is maintained between the wire and the cylindrical wall. The cylinder is filled with a gas-vapour mixture at a pressure of a few centimetres of mercury. Entry of a β-particle or absorption of a γ-ray within the counter can precipitate a discharge in the gas (somewhat like a thyratron breakdown) which causes current to flow through the high resistance R. The change of potential across R is of the order of 1 volt and can be amplified and used to drive a counting rate meter or counting circuit. The counters used are usually self-quenching and the discharge extinguishes itself after a de-ionization period of about 100 μ sec.

Large numbers of instruments of this type need to be located about the plant, in laboratories, etc., to protect the health of the workers.

A last sombre thought is that, until we can be certain that there will never be another war, we must always consider the possibility that atomic bombs might be used against us. If that ever happened it would be vital that our Armed Forces and Civil Defence Services be equipped with electronic instruments for detecting radioactive contamination.

Sufficient has been said in this brief review of the subject to indicate that we are at the beginning of an era of technical development

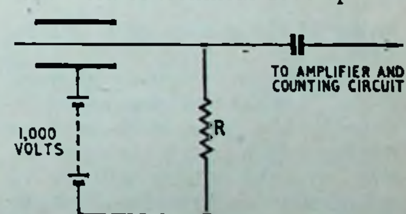


Fig. 10. Schematic representation of a Geiger-Muller counter circuit.

in the field of atomic energy. As we go forward towards industrial applications more and more instrumentation will be required.

The ingenuity of the physicists and electronics engineers has been, and will be, called into play to design the necessary electronic instruments, and increasing numbers of skilled technicians will be required to operate and maintain them.

Ionosphere Review: 1947

Short-wave Propagation Survey, with Forecast for 1948

By
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FOLLOWING the usual practice of *Wireless World* at the end of each year it is intended here to review the course of the present sunspot cycle, with particular reference to the changes which occurred during 1947, and to examine the effects of these upon short-wave propagation during the year. And after that we may attempt to see how conditions may vary during 1948 and after, though, because of the present impossibility of accurately predicting the changes in solar activity a long way ahead, this attempt must necessarily be something in the nature of a conjecture.

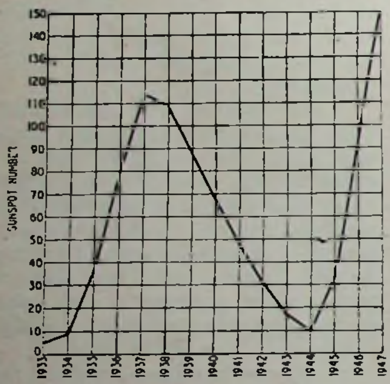


Fig. 1. Annual means of sunspot of relative numbers.

1947 was an extremely interesting year so far as radio-wave propagation is concerned—a year during which much information was acquired which will be of value to several branches of physical science, as well as to the radio engineer. Sunspot maximum apparently ocurred during the year, and was a maximum of very exceptional magnitude. Consequent on this high sunspot activity the regular ionosphere layers became capable of propagating higher radio frequencies than they ever have since radio first began—thus providing for the first time practical information as to their behaviour under such peak conditions of solar activity.

First, for those new to the subject, a few brief words about the nature of the data to be examined. The ionization of the upper atmosphere, which is responsible for the propagation of short radio waves, is brought about, in the main, by the action of the sun's ultra violet radiations, and, since the sun's activity and hence the strength of its radiations varies over a long period which is the sunspot cycle, the state of the ionosphere and hence the conditions for short-wave propagation also varies over the same period. Among other evidence of the variations in the sun's activity are the sunspots which appear upon it, and these are regularly examined at the various astronomical observatories, and the information they obtain is published in the form of "sunspot relative numbers." The observations made at the different observatories are correlated by that at Zurich, and the final "number" published from there. Continuous records of this index of the solar activity go back to 1749—less comprehensive data exist since 28 B.C.—though the final "numbers" for 1947 are not yet available. For this year we have, therefore, used those obtained by the Royal Observatory at Greenwich alone, and these are provisional only.

Measurements of the atmospheric ionization are regularly made at ionosphere observatories in many parts of the world, though, of course, the records of these only go back for a few years. Nevertheless, as will be seen, the correlation between the two sets of phenomena, solar and ionospheric, has been well established. The ionospheric data is usually published in the form of hourly values of the critical frequency of the various layers, and we have mainly used that obtained by the station of the D.S.I.R. at Slough. The critical frequency, it will be remembered, is the highest frequency returned from a given layer when the exploring wave is sent vertically upwards. For communication over a distance the corresponding value is the Maximum Usable Frequency, which is dependent on the critical frequency and the angle of incidence made on the layer in order for the wave to cover the particular distance. As a rough guide we could assume that, at present, the M.U.F. for the maximum distance it is possible to cover in one hop would be about 3.3 times the critical frequency in these latitudes.

Course of the Sunspot Cycle.—In Fig. 1 are plotted the annual means of the sunspot relative numbers for a period covering the whole of the last and present cycles, and from these a rough idea of the characteristics of the present cycle can be gained. It is seen that the solar activity increased exceptionally quickly from the minimum in 1944, reaching, in three years, a far greater value than was reached in the first four years after the preceding minimum in 1933. Sunspot activity during 1947 was thus, generally speaking, at a higher level than at any time in the preceding cycle, and indeed, was higher than it has been during any year since 1778. In fact, during the period of 198 years covered by the continuous records there is only that one year during which the mean sunspot activity was greater than that during 1947—and that 169 years ago. We are thus perhaps fortunate in living at an epoch during which the possibilities for observing the effects of high solar activity upon radio communication—and upon other terrestial phenomena—are such as do not occur very frequently.

However, there are indications that the maximum in the present sunspot cycle has now been reached, and that during 1948 the activity will be decreasing. We cannot, however, be at all certain about this, since there is no reliable way of telling exactly what will happen round about a period of maximum activity like the present. As we shall later see, however, the value of sunspot relative number recorded in May, 1947, has not since been reached, and, during the last few months of the year, there was a more or less steady fall in the activity. Altogether, therefore, we should expect 1948 to be the first year in the "decreasing" phase of the present cycle. Sunspot cycle curves are, however, of the "saw-tooth" variety, indicating a longer period for the "decreasing" than for the "increasing" phase, so that we should not, in any case, expect the activity to fall during 1948 to the same extent that it rose during 1947. 1948, then, may be expected to be a year of high solar activity and consequently of high usable frequencies for long-distance radio communication. During the winter 1948-49, however, these frequencies are likely to be somewhat lower than they are at the present time.

Ionospheric Variations. — In Fig. 2 are plotted (top curve) the monthly means of the sunspot relative numbers for each month of the years 1944-47, and (bottom curve) the monthly means of the noon critical frequencies of the F2 layer for the same period, as measured in England.

The sunspot activity is seen to vary erratically month by month, but to have a generally increasing characteristic towards May, 1947. In May it reached the phenomenally high value of 225 (this is a provisional number, and is, therefore, subject to later correction when the observations of a number of observatories are taken into account). Only twice before within the period covered by continuous records has the monthly mean reached a value exceeding 200, namely, in December, 1836, when it was 206.2, and in May, 1778, when it was 238.9.

The bottom curve of Fig. 2 shows some interesting features, the first of which is the general sweep upwards of the critical frequencies in sympathy with the increasing sunspot activity, due, of course, to the increasing level of ionization of the gases in the F2 layer under the influence of ionizing solar rays of a gradually increasing intensity. It is seen that, as between the epochs of minimum and of maximum activity the increase in noon critical frequency was of the order of 3.0 Mc/s during the summer and 8.0 Mc/s during the winter, implying increases in the M.U.F. for longest-distance transmission of about 9.0 Mc/s and 29.0 Mc/s respectively.

In this curve there are, of course, the seasonal variations in critical frequency superimposed on those due to the sunspot cycle, and these are interesting in themselves. First, as is always the case with the F2 layer in the Northern Hemisphere, the lowest daytime values of critical frequency occur each year during the midsummer period. Then there is, each year, an increase of critical frequency towards the winter, but with the peculiar "mid-winter effect" causing a small fall in the critical frequency at the extreme mid-winter period. This results in the highest daytime critical frequencies of the year occurring, generally speaking, in November and in February.

Thus, in November, 1947, the mean critical frequency for noon was 14.0 Mc/s, implying a mean M.U.F. for longest-distance working in these latitudes of 46 Mc/s. This high value of noon critical frequency will probably not be exceeded in the present cycle, so we may come to regard November, 1947, as being the month of highest frequency radio conditions for the current sunspot cycle, and indeed for many years years past, and possibly for many yet to come. These high critical frequencies were not, of course, unexpected, as will be evident from a quotation from last year's "Ionosphere Review" (*Wireless World*, March, 1947, p. 120): "From Figs. 2 and 3 we might hazard a guess that the highest daytime critical frequencies of the present cycle will occur about October or November of 1947, and that during the latter month the noon mean is likely to be of the order of 14.0 Mc/s."

Correlating Sunspot and Ionospheric Phenomena.—In Fig. 3 are given (full-line curve) the twelve-month running average value of the sunspot number during the present sunspot cycle, and (dashed line curves) the

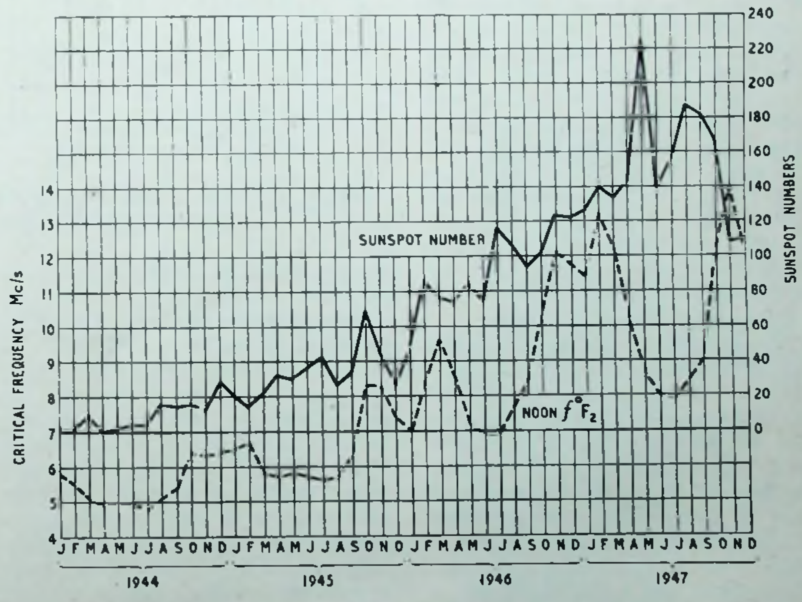


Fig. 2. Monthly means of sunspot relative numbers and noon F_2 critical frequencies for the past four years.

Ionosphere Review: 1947—

twelve-month running average of the noon and midnight critical frequencies as obtained in England. The object of presenting the information in this way is to smooth out the month-by-month fluctuations on the sunspot activity and the seasonal fluctuation in the critical frequency variations, and thus render the long-period effects in both quantities more apparent. It is done by taking for the mean for the epoch at the centre of any month the average of the twelve-monthly means having that month as the centre. Both noon and midnight critical frequencies are seen to respond to the changing sunspot activity relatively faithfully. The greatest degree of critical frequency variation over the cycle occurs in the noon curve—for at noon the sun's effect upon the ionsphere is more direct—and we see that the increase in mean critical frequency over the cycle has been about 5.4 Mc/s. Though over most of the cycle the correlation was very good, during the past few months the increase in critical frequency has lagged behind that in the sunspot numbers, as if some sort of saturation effect in the ionization were occurring. The midnight critical frequency, which is, of course, much lower than that at noon, also follows the increasing sunspot activity faithfully, and does not show the "saturation effect" referred to. Here the increase over the cycle is about 2.8 Mc/s.

The good correlation between the twelve-month running averages of sunspot number and critical frequency applies to all layers and all times of day, the magnitude of the critical frequency change varying with the layer and time of day. Thus the response of the whole ionosphere to variations in the activity of its producing agent, the sun, is, over a period of time, remarkably faithful and well defined.

When we consider this close correlation of the measured critical frequency—and thus, implicitly, of the M.U.F.—with the observed sunspot activity, and when we turn back and examine the sunspot activity during past cycles, we are forced to a rather remarkable yet perfectly logical conclusion—that short-wave propagation conditions during 1947 must have been generally better, and particularly so on the higher frequency bands than they have been during any year since 1778. This will be apparent when it is remembered that the ionization of the *absorbing* layers is not increased by the increasing sunspot activity to the same extent as is the ionization of the refracting layers. Thus, with exceptionally high activity the M.U.F. will be exceptionally high, the L.U.H.F. (lowest useful high frequency) will be only moderately so, and so the band of usable frequencies will be at its widest.

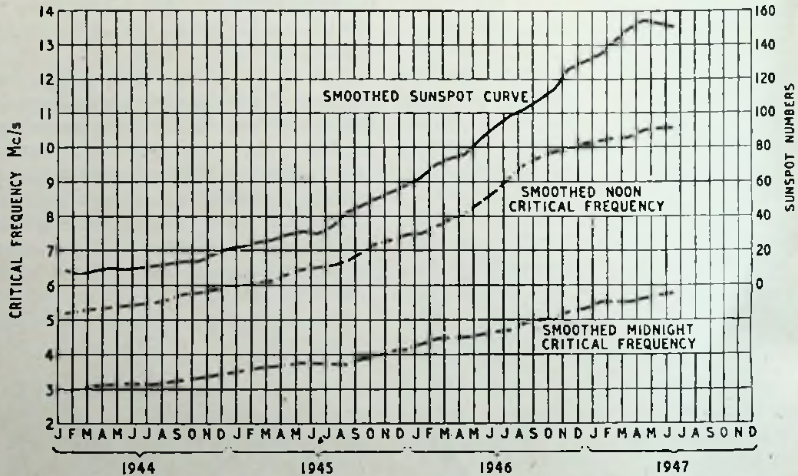


Fig. 3. Twelve-month running averages of sunspot numbers and of noon and midnight F_2 critical frequencies in England.

Practical Results. — The high theoretical values of M.U.F. indicated by the measured critical frequencies during 1947 seem to have been well borne out by the results achieved in actual practice. Higher working frequencies were usable during the autumn and winter in the various communication services than, generally speaking, have ever been regularly usable before. But regular communication services are not usually in a position to experiment in the use of very high frequencies for long-distance work —they have to maintain services on frequencies that are well received on *every* day, although, of course, it is advantageous to work on the highest frequencies on which this object can, at any particular time, be well achieved. But there is considerable up-and-down variation in the ionization of the layers, and hence in the M.U.F.s, from day to day, even under normal conditions, and the most information about long-distance high-frequency propagation will be obtained on frequencies above these regular day-by-day ones. We may briefly examine a few such results to see what they indicate.

We must, of course, confine our attention to propagation over *long* distances—by way of the regular ionospheric layers. For, as is well known, there frequently occur during the summer months cases of propagation over *medium* distances on frequencies up to 100 Mc/s. Such transmissions however, are effected either by way of Sporadic E ionization or by means of refraction within the troposphere, and, since both these phenomena appear not to be affected by the changing sunspot activity, they have no significance in the present case.

Long Ranges on 50 Mc/s.—At the last sunspot maximum (see Fig. 1) there was no authenticated case of long-distance transmission being effected on the amateur 50-Mc/s frequency. During the winter 1946-47, with the sunspot activity approaching that of the last maximum, one such case was recorded between U.S.A. and this country, and one between Holland and South Africa. Since then the sunspot activity has considerably increased, and during the later part of 1947—particularly during November—numerous amateur transmissions on this frequency have been effected between the U.S.A. and Europe, and over many other paths as well. The fact that long-distance transmission on 50 Mc/s has become frequently possible, albeit only during the appropriate season of a year of exceptional sunspot activity like 1947, is certainly interesting information as to the highest frequencies which the regular ionosphere layers are ever likely to become capable of propagating. One is tempted to add that, after the winter of 1948-49, it is unlikely that the amateurs will be able to work their 50-Mc/s contacts again for very many years to come.

Turning to the somewhat lower frequency of 45 Mc/s — upon which the vision channel of the London Television Service operates—it was well known by observations made around the last sunspot maximum that long-distance propagation on this frequency could occur, and on such paths as that between the U.S.A. and this country. The observations indicated that such transmissions would be possible—though not by any means a daily occurrence—during the winters of years when the sunspot number was of the order of 100 or greater, whilst the implication was that they would be possible over southerly transmission paths for longer seasonal periods than in the case of trans-atlantic paths.

This idea seems, in general, to have been well confirmed. Last winter the sound transmissions on 41.5 Mc/s were received in numerous parts of the world, and this autumn and winter the 45-Mc/s signals have also been frequently received. Furthermore, considerable interference has been experienced by viewers in this country from American F.M. stations operating within the vision channel and, in particular, station WEFM in Chicago has frequently been received with such an intensity as to constitute a strong source of interference with the television picture. All these events are of great interest.

Forecast for 1948.—It will be seen from Fig. 3 that the running average sunspot curve has now commenced to fall, and, although the critical frequency curves have not yet begun to do so the indications are that they will soon follow suit. As has been said, attempts to forecast the variations in solar activity a long way ahead have not hitherto been conspicuously successful. And, at a time like the present, when the activity is only just showing signs of a reversal in its trend, prediction is more than usually difficult. However, we may be justified in assuming that during 1948 the activity will, in general, decrease, and, remembering that it usually decreases at a slower rate than that at which it increases, and also that during the first year after the maximum the decrease is often *particularly* slow, estimate that the running average of sunspot number for the middle of 1948 will be about 120. This would imply that the running average of the noon critical frequency should have fallen from its maximum value by about 0.8 Mc/s to about 9.8 Mc/s, and that for midnight by about 0.5 Mc/s to about 5.2 Mc/s.

It is of more practical use, however, to know, not what the running average critical frequency may be at a particular epoch, but what value of monthly mean critical frequency is likely to occur during a particular month. It is not possible to deduce from the twelve-month running average what the monthly mean for any one month is likely to be, owing to the erratic nature of the month-by-month variations in solar activity. But it would appear from a study of Figs. 2 and 3 that by November, 1948, the noon mean critical frequency would only have fallen to about 12.6 Mc/s. This implies that the mean noon M.U.F. for longest-distance working in these latitudes should be of the order of 41.6 Mc/s, as compared with 46 Mc/s in 1947, whilst on certain days it should be quite considerably higher than this.

It is not possible in an article like this to say just how these changes will affect the working frequencies for communication services during 1948, for the detailed specification of such frequencies for all directions and distances is a very complex business. Generally speaking, however, it appears that, so far as the sunspot cycle is concerned, 1948 will be a year of little change. There will, of course, be the alterations in working frequencies necessitated by the seasonal changes, which themselves vary considerably with the geographical location of the transmission paths, but apart from these the alterations made necessary should be of a minor character only. The daytime working frequencies should, it is anticipated, be from 3 to 6 Mc/s lower next November than they are at present, varying according to the different circuits, whilst the decrease in the night-time working frequencies should be of a lower order than this. And the 50-Mc/s amateur band, which was about 10 per cent above the noon mean monthly M.U.F. during November, 1947, should be about 20 per cent above it next November. Nevertheless, since the sun-spot activity will still be high, radio conditions should, in general, be good, and favour the higher frequencies.

Miniature Portable

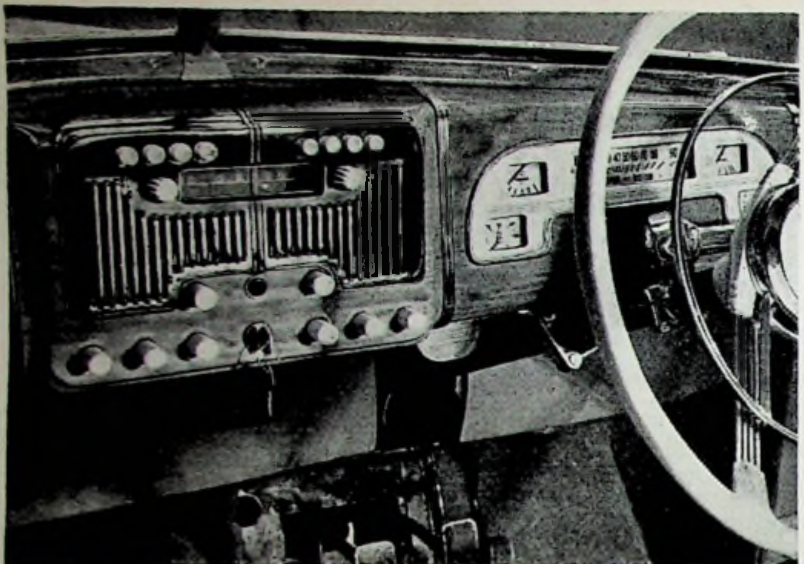
DESIGNED in the form of a book, this self-contained battery superhet measures 8¼in × 6in × 2¾in and weighs 5½lb with batteries. It covers the medium wave band (200-550 metres) and makes use of a sliding metal panel as an aerial. A socket is provided for an additional outside aerial if required. Mullard 1.4 volt miniature range valves are employed and 120 mW of power is delivered to the 3½-in loudspeaker.

Hermes "Radio Tourist" portable. A waterproof carrying case with shoulder sling is available

The set is available in a variety of colours and the price is £13 13s exclusive of purchase tax. The makers are Hermes, Brooke and Co., Poynters, Cobham, Surrey.

TEST REPORT

Push-button Car Set



The Model 100 embodied in the design of the fascia board of a car.

IN this set we see the result of an eminently rational pooling of experience in the diverse fields of radio and car equipment manufacture. The design of the set represents collaboration between the Gramophone Company (H.M.V.) and Smith's Motor Accessories; it is sold, installed and serviced by a subsidiary firm, Radiomobile, Ltd.

The user of a car radio, who is very often the driver, can rarely do more than give the set a cursory glance before switching on, or changing the programme, so that the very simplest form of tuning is most desirable. This fact has been realized by the designers of the Radiomobile set and most of the operations are effected by push buttons. These include programme selection, waveband changing and tone control.

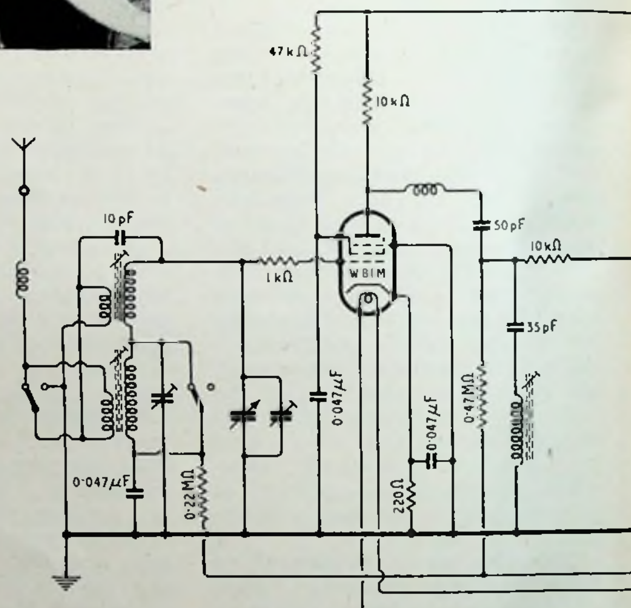
If a passenger wishes to search for a programme not previously set-up on the push buttons he or she can do so merely by pressing in a knob and turning the set in the customary fashion. A wavelength calibrated scale and pointer are included for this purpose.

All the controls of the set are grouped on a small panel measuring $9\frac{1}{8} \times 2\frac{1}{4}$in mounted slightly forward of the receiver unit proper. It has a detachable moulded escutcheon which is available in a range of colours to harmonize with the car instrument panel. The front of the receiver unit has a slight backward tilt and in this inclined face is mounted a 5in loudspeaker.

As the available space for mounting the receiver in some cars may be limited the receiver and power supply units are separate entities, but normally combined. They can be separated when occasion demands and the power unit could then be stowed either in the engine compartment or anywhere else more convenient.

Considerable use is made of miniature components in order to keep the size as small as possible and the weight low. Miniature type valves of the all-glass pattern are used and as a result the overall dimensions, excluding the power unit, are $9\frac{3}{4}$in wide, $4\frac{7}{8}$in high and $9\frac{3}{8}$in deep. The power unit adds another $2\frac{3}{4}$in to the depth. The total weight is $17\frac{1}{4}$lb.

The push buttons for programme selection act directly on the gang condenser and each rotates it a pre-determined amount. The setting-up process is very simple; the desired station is tuned in manually and then one of the push buttons is made to register with this setting of the condenser. This operation is effected by loosening the milled head of the button, allowing the spindle to be drawn in by its spring and register on its condenser stop, then retightening the milled head.

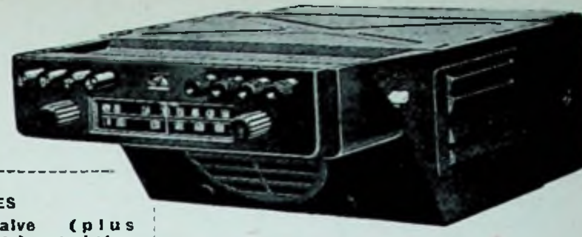


Theoretical circuit of the Model 100 showing the power unit arranged for connection to a 12-volt car installation with a positive earth.

By repeating this procedure, choosing either medium- or long-wave stations, four pre-selected programmes become available by finger-tip control. It is perfectly feasible to make these changes in the selected stations while on the road, the passenger being able to do it while the car is actually in motion as no tools of any kind are required.

The four-programme push buttons are just above and to the right of the scale aperture

Radiomobile Model 100



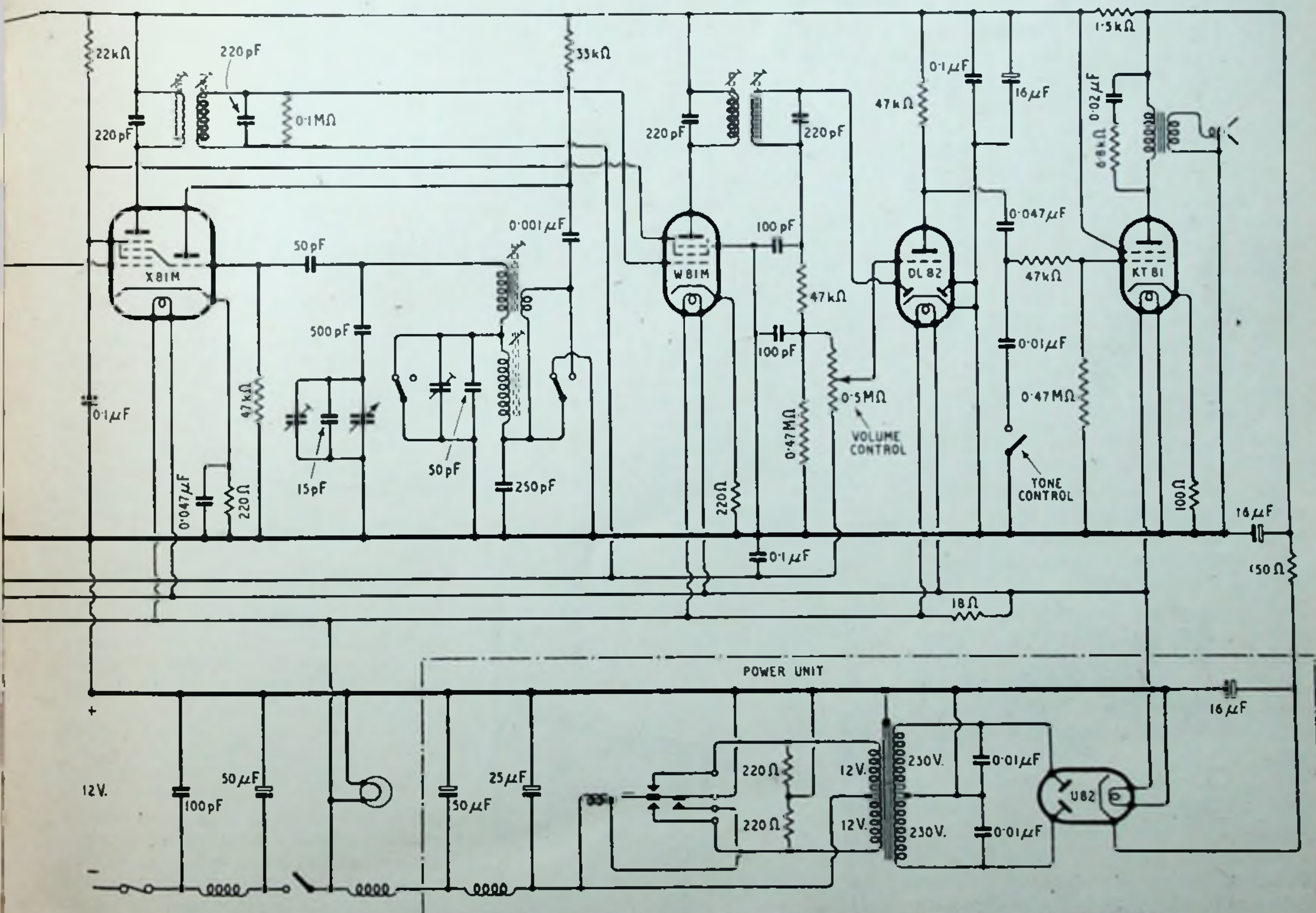
and they are balanced on the left by four more, two for tone and two for waveband switching. Immediately to the right of the scale aperture is the manual tuning control which drives the condenser through bevel gears and arranged so that a spring normally holds the driving bevel out of mesh. This prevents disturbing the tuning by turning the knob accidently. On the left of the scale is another rotary control knob. This is the combined volume control and on-off switch.

The superheterodyne circuit is by no means orthodox. The very short aerial that has to be used necessitates a sensitivity above the average for a broadcast receiver. As the signal pick-up is small, matching the aerial and its screened co-axial cable to the receiver input circuit is of far more importance than usual. But this is embodied in the design of the input circuit and merely results in certain limits being set for the length of the co-axial cable, and the type that can be used. Included in the aerial circuit is a form of anti-interference filter.

The receiver has an R.F. stage with a tuned input circuit with a wide-band coupling linking its anode circuit to the frequency changer. This covers medium and long waves without switching and obviates the need for a third section in the tuning gang condenser. There is included also a further interference rejection network.

FEATURES

Circuit.	Five-valve (plus rectifier) superhet.
Controls.	Push - button or manual tuning. Push-button wave-change. Push-button tone control. Volume combined with on-off switch.
Tuning Range.	195 - 550m; 1,000-2,000m.
Output.	3.5 watts.
Input.	3.25A at 12V (6-V models available).



Radiomobile Model 100—

The frequency changer is a triode-hexode of normal design, and it is followed by one I.F. stage working on 465 kc/s and having a band width of 10 kc/s for 6db attenuation at the limits.

Signal detection, A.G.C., and one stage of A.F. amplification, are provided by a double-diode-triode which in turn is resistance-capacity coupled to an A.F. pentode giving about 3.5 watts output.

A.G.C. is applied in full to the R.F., F.C. and I.F stages, and consequently good control is obtained under all conditions of operation, and they vary very considerably on the road.

High tension at 210 volts and 55 mA is supplied by a vibrator in conjunction with a transformer and valve rectifier. This, and the filaments of the valves, which are 6.3-volt type and arranged in series-parallel, draw 3.25 amps from the car's 12-volt battery. The valves used in the set and in the sequence described here are W81, X81, W81, DL81, KT81 and U82, the last mentioned being the H.T. rectifier.

It is a tribute to the design that with the majority of modern cars only the minimum of engine suppression is needed. Some rearrangement of the plug leads and H.T. wiring may be required, also possibly repositioning of the coil. As for suppressors, one 5-kΩ resistor in the lead from the coil to the distributor and a few 0.5-μF capacitors across some of the L.T. make and break contacting points will generally suffice.

Radiomobile is building up an installation and servicing organization throughout the country. Likely mechanics drawn mainly from garages are given a week's intensive course at the Radiomobile school at Hayes, Middlesex. Here they are coached in the circuit technique, in fault-finding, in installation and the many other aspects of the subject deemed necessary to inspire cofidence in the pupils to tackle any problem arising from the use of this equipment.

A road test was made with a Model 100 fitted in a 1947 family saloon car, the installation having been carried out by the Radiomobile service department in Cricklewood. One suppressor resistor only was fitted in the ignition system and a few changes were made in the run of the leads from the distributor to the plugs. The object of this was to eliminate, so far as possible, loops between the leads and engine casing, thereby minimizing the radiation from these leads. A roof aerial was fitted just above the middle of the windscreen.

With the volume control turned fully up and the set detuned from a station so that maximum sensitivity was obtained, a slight suspicion of ignition noise could be discerned in the background noise of the set. This condition of maximum sensitivity rarely, if ever, is needed for broadcast reception, as in most cases the signal will be strong enough to operate the A.G.C. and so lower the general sensitivity.

As an example of this, the B.B.C. Moorside Edge transmitter was receivable in London at sufficient strength to operate the A.G.C. except in badly screened localities. Several Continental stations were tuned in with ease and provided a signal of real entertainment value. Indeed, on open ground, such as on Wimbledon Common, these stations were of such strength that the volume control had to be backed off, and this was during daylight.

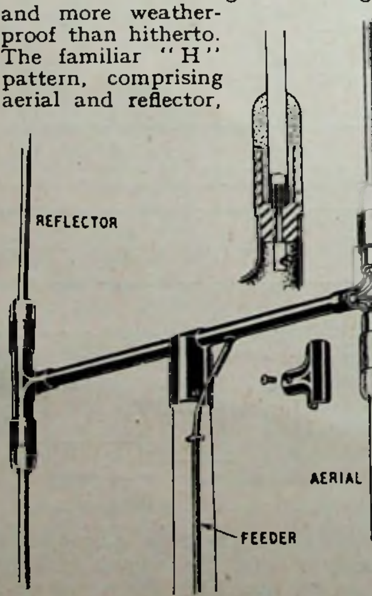
The only interference of any consequence experienced during the tests emanated from passing lorries, motor buses and trolley buses, the former two producing typical ignition noises and the last mentioned the "scratchy" type of interference associated with electrical contacting equipment. The overhead power wires accentuated this, but at no time were these forms of interference really troublesome, due, no doubt, to the filtering action of the built-in noise suppressors.

The set sold by Radiomobile, Ltd., Cricklewood Works, London, N.W.2, costs £27 6s, plus £10 4s 9d purchase tax.

Wolsey Television Aerial

Use of Synthetic Rubber Waterproof Fittings

SEVERAL improvements have been made in the design of Wolsey television aerials and the latest models are lighter, stronger and more weather-proof than hitherto. The familiar "H" pattern, comprising aerial and reflector, weighs only 4lb and consists of a light-weight tubular cross arm with welded-on masthead cap and end junction boxes.



Synthetic rubber waterproof fittings are used at the joints between the aerial rods and junction boxes in the latest Wolsey television aerial.

Aluminium alloy tubes, fitted with synthetic rubber connectors, screw into waterproof sockets on the junction boxes. The aerial junction box has a removable cover giving access to the centre connections for joining up the feeder. The other has a sealed-in straight-through connector.

Either co-axial or twin wire cable can be used. It is brought out through a hole at the masthead cup so that it can be lashed to and brought down the pole.

The "H" pattern aerial, which is listed as model H/M, is a close-spaced array with the reflector 32in, or $\frac{1}{8}\lambda$ approximately at 45Mc/s behind the aerial. The complete aerial, less pole and securing fittings, costs 67s 6d. Wall brackets, chimney stack lashings and feeder are extra. For example, a double set of chimney stack lashings and 8ft pole costs 60s 6d.

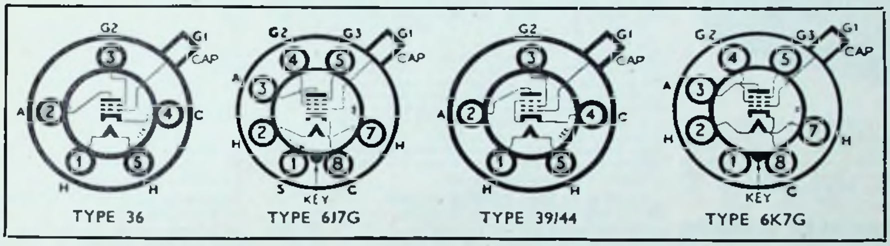
A single dipole without reflector and constructed on the same light-weight and weatherproof lines is also available. It costs 37s 6d.

The makers are Wolsey Television, Ltd., 87, Brixton Hill, London, S.W.2.

BRIMAR — still ★BRIMARIZING!

TYPES 36 and 39/44 were widely used in Philco and other American type receivers dated 1933-1936. Replacement by Brimar types 6J7G and 6K7G respectively, involves a change of sockets and re-alignment of receiver. The substitution of the new valves will give increased gain and it may be necessary to reduce screen voltages or re-arrange wiring to preserve stability.

← PUNCH HOLES HERE →



36
39/44

TYPE	CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
6J7G	U.X. 5 pin.	OCTAL	Pin No. 1 2 3	Pin No. 2 3 4 8 7	Connect Pins 1 & 5 to Pin No. 8. Change top cap connector. Re-align receiver. *See note.*	SLIGHTLY HIGHER GAIN.
6K7G	U.X. 5 pin.	OCTAL	Pin No. 1 2 3 4 5	Pin No. 2 3 4 8 7	Connect Pin 5 to Pin 8. Change top cap connector. Re-align receiver.	SLIGHTLY HIGHER GAIN.

Note: A higher value of screen dropping resistor (to Pin 4 of Type 6J7G) may be necessary to ensure that the screen voltage does not exceed 100 volts.

INSTRUCTIONS: Punch holes where indicated, cut away this portion and file in order of appearance for a quick reference guide.

II

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RADIOGRAM CABINETS. Dignified appearance and good workmanship. Size 31½in. high, 18½in. deep, 33in. wide. French polished, veneered walnut. Price **£28 7s. 3d.** Also available complete with electric motor, auto stop and magnetic pick-up, **£37 6s. 2d.** Ditto with Rothermel Crystal Pick-up, **£38 12s. 7d.** or with 8 record-mixer changer, **£48 18s. 0d.**

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D/C TO A/C CONVERTERS. TYPE 1—Input 18/24 v. D/C. Output 230 v. 50 cycles, 100 watts, **£5.** ; TYPE 2—Input 12 v. D/C. Output 230 v. 50 cycles, 75 watts, **£6**; TYPE 3—Input 100 v. D/C. Output 230 v. 50 cycles, 200 watts, **£8.**

HIGH VOLTAGE BLOCK CONDENSERS. 1 mf. 2,500 v., working size 5in. × 3½in. × 3in., **5/-** ; 1 mf. 5,000 v., working size 8in. × 5in. × 4in., **5/-** ; 4 mf. 1,000 v., working size 5in. × 4in. × 1½in., **5/6** ; 4 mf. 2,000 v., working size 5in. × 5in. × 2½in., **12/6** ; 8 mf. 750 v., working size 4½in. × 4in. × 2½in., **7/6.**

SHORT WAVE CONDENSERS. High-grade; Ceramic insulation. Super Midget type. Single-gangs available in 10, 20, 50, 75, 100 p.f. (75 p.f. has double spindle for ganging). Price **2/6.**

2-GANG, in 4.8, 9.6, 27.1, 50, 75 p.f. Price **5/-.**

SIGNAL GENERATOR TYPE 33. Consists of a battery-driven generator with two separate units for approximately 1 metre and 7 metre operation, include 2 CV6 (VR135) horned triodes and one EA50 diode, also a large quantity of U.H.F. tuning gear. Contained in a teak case, size 18in. × 8in. × 8in. Price **30/-.**

OUTPUT TESTER TYPE 9 consists of a unit incorporating three separate diode detectors and a 3-valve Amplifier, each diode with its separate U.H.F. Tuning System. A retractable 18in. aerial is fitted and three VR130 (HL23) valves, 3 D.I. Diodes and a large quantity of U.H.F. Tuning Gear is included. Contained in a teak case size 18 × 8 × 8in. Price **30/-**, or minus three HL23 valves, **15/-.**

METAL RECTIFIERS.

Output Volts	Current	Type	Price
280	40 m/a.	H.W. or V.D.	5/-
350	75 m/a.	H.W.	5/-
16	1 amp.	Bridge	12/6
48	1½ amp.	Bridge	25/-

TEST UNIT TYPE 73 consists of a special purpose Oscilloscope that requires only rewiring and the addition of a few condensers and resistors to convert into a standard Oscilloscope, input 230 v. 50 c. A 3½in. C.R. tube and 1 SU220A, 1 EB34, 1 5Z4, 3 SP41, 2 EA50, are included. Controls are "Brightness," "Velocity," "X Shift," "Y Shift," Focus Amplifier, "in/out," "Calibrate," "on/off/TX." Price **£8 8s. 0d.** Carriage and packing, 20/-.

TEST UNIT AP53874 consists of a Test Unit for a U.H.F. Tx., incorporates a 230 v. 50 c/s Power Pack, with a smoothed output of 240 v. up to 50 m/a and 6.3 v. 2 a., 2 EF50, 1 EC52, 1 EA50, 1 5Z4G, 1 Y63 Magic Eye, and a large quantity of condensers, resistors and tuning gear. Contained in an attractive steel case. Size 10½ × 9 × 8½in. Price **45/-.** Carriage and packing 5/-.

RELAY UNIT TYPE 9 consists of a 24 v. operated relay unit incorporating 3 KT33C valves, a telephone line (Uniselector) switch with 6 poles, 26 contacts, 5 P.O. type relays, 2 high-speed relays, and a quantity of other material. Contained in an attractive relay rack type metal case 19 × 19 × 9½in. deep. Price **£4 5s.**, or without valves, **30/-.** Carriage and packing 5/-.

R107. ONE OF THE ARMY'S FINEST COMMUNICATIONS RECEIVER. (See "W.W.," Aug., 1945.) 9 Valves, R.F. amp. osc. Frequency Changer, 2 IF's. (465 kc.). 2nd Detector, AVC. Af. amp. AC mains, 100-250 v. or 12 v. accum. Frequency range 17.5 to 7 m/cs., 7.25 m/cs. to 2.9 m/cs., 30 to 1.2 mc/s. Monitor L.S. built in. Complete with output stage. Write for full details. **£16 16s.** complete.

VARIABLE CONDENSERS. Ceramic insulation. 2-gang .0005, **7/6** ; 3-gang .0005, **10/-** ; 4-gang .0005, **10/-** ; 1-gang .0005, **5/-** ; 2-gang .00016, **5/-** ; 3-gang .00016, **10/-** ; 3-gang .0003, **10/-.**

TYPE 103 ROTARY TRANSFORMER. Normal rating is 19 v. D/C input. Output, 300 volts 30 m/a and 6.5 volt 3 a. D/C. By applying between 200 and 250 volts D/C to the H.T. output side, the two low-tension windings may be used to charge accumulators. The 19-volt side will charge a 6-volt accumulator at 2-3 amps. the 6.5 side a 2-volt accumulator at 1-2 a. With a 12-volt input to the 19-volt side, 180 v. at 30 m/a and 4 v. at 3 a. may be obtained. With a 6-volt input to the 6.5 side, 180 v at 30 m/a may be obtained. By extending the spindle which is flush with the frame and applying 200 to 250 v. D/C mains to the 300 v. side, the unit becomes a powerful high-speed electric motor, suitable for small drilling machines, etc. Similarly, it may be used with 6 or 12 v. input to the 6.5 v. or 19 v. side. It employs a powerful ring magnet and is of substantial construction, costing originally over **£5.** A fortunate purchase enables us to offer these fine units at **10/-.**

DENCO C.T.3 COIL TURRET COVERS. .15 to 42 m/s. in six bands. Consists of completely wired coil pack for communication receiver, including trimmers, padders, scales, knobs. Mechanical bandspread, I.F. 1.6 m/cs. R.F. stage, iron cores, polystyrene insulation. Circuits available at **1/6.** Price **£7 0s. 10d.**

LOUDSPEAKERS. 5in. P.M., **15/-**, with trans., **20/-.** 6in. P.M., **17/6**, with trans., **22/6.** 8in. P.M., **20/-**, with trans., **25/-.** 10in. P.M., 15 Ω 6 watt, **47/6.** 12in. P.M. 15 Ω 12 watt, **£5.** 12in. P.M. 15 Ω 12 watt twin-cone high fidelity, **£8 8s.** 12in. P.M. 20 watt, **£7.** 6in. 1,140 Ω Field with trans., **27/6.** 10in. 2,100 Ω Field 3 Ω 6 watt, **30/-.**

BABY ALARM KIT. Consists of a complete kit of parts for a mains-driven amplifier, microphone and Midget speaker, to enable sound of baby's breathing or crying to be heard in any room. Complete with circuit. **55/-**

CRYSTAL RECEIVER KIT. Complete with phones. The ideal gift for the schoolboy, **10/-.**

WEARITE TUNING PACK. A super job. Completely wired with padders and trimmers. Long- medium- and short-waves. Iron core coils, **42/-.**

2-VALVE SHORT-WAVE BATTERY KIT. A complete kit of parts for a 2-valve receiver, covering 15-600 metres, including valves, coils, drilled chassis, H.T. and L.T. dry batteries to last approximately 6 to 12 months. A pair of double headphones and full instructions. Price **£3 16s. 4d.**

STANDARD OUTPUT TRANSFORMERS. Match any push-pull pentodes to 3 or 15 ohms. Handles 8 watts, **17/6.**

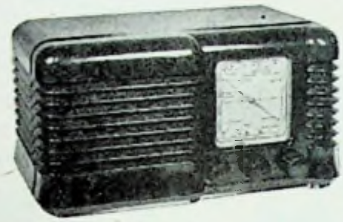
GRAMOPHONE AMPLIFIER KIT. A complete kit of parts to construct a good quality mains-driven 2½-watt gramophone amplifier. May be used with any pick-up. Complete with circuit, **£3 5s.**

SUPER OUTPUT TRANSFORMERS. By means of a series parallel arrangement wherein the maximum winding is used for each ratio extremely high efficiency is obtained. Any valve single or push pull may be matched to any voice Coil (2 to 30ohms) type Mo.15.15 watts, **35/-.**

METERS. A huge purchase of military surplus meters allows us to offer the following bargains. Best makes. Bakelite cases, prices are approx. ¼ original cost.

Range	Ext. Diam.	Basic Movement	Fitting	Type	Price
300 v.	3½"	8 M/A	Flush	M.I.A/C	12/6
500 M/A	3	—	Proj.	M/C D/C ..	12/6
2½ A	2"	—	Flush	Thermo	7/6
4 A	2½"	—	Port	H. Wire	7/6
20 A	2"	25 M/A	Flush	M/C D/C ..	7/6
40 A	2"	12½ M/A	Flush	M/C D/C ..	7/6
25 A	3½"	5 M/A	Flush	M/C D/C ..	7/6
25 A	3½"	25 M/A	Proj.	M/C D/C ..	7/6
½ M/A	2"	½ M/A	Flush	M/C D/C ..	7/6
150 M/A.	2½"	150 M/A	Flush	M/C D/C ..	12/6
200 M/A	3½"	200 M/A	Flush	M/C D/C ..	12/6
1 M/A	3½"	1 M/A	Flush	M/C D/C ..	20/-
5 M/A	2½"	5 M/A	Flush	M/C D/C ..	10/-

MIDGET RADIO KITS



MIDGET RADIO KIT. Build your own midget radio. A complete set of parts, including valves, loudspeaker and instructions. In fact, everything except cabinet necessary to build 4-valve Medium and long Wave T.R.F. radio operating on 200-250 v. mains, A/C or D.C. Wavelengths covered 200-557 and 700-2,000. Size 10 × 6 × 6in. Completely drilled chassis. Price, including tax, **£8 0s. 11d.**

SUPERHET MIDGET RADIO KIT. A complete kit of parts for a 5-valve superhet. Covers 16-50 and 200-557 metres, AC/DC 200-250 v. Size, 10 × 6 × 6in. Completely drilled chassis. Price including tax, **£9.**
An attractive brown bakelite cabinet can be supplied for either kit at a cost of **27/4.**

ELECTROSTATIC VOLT METERS, 0-5K, 3½in. scale, flush mounting, 4½in. dia. **65/-** each.

FERRANTI 0-500 MICROAMP METERS, 3½in. dia., scale 2½in., res. 75 ohms., flush mounting, **25/-.**

AIR-DIELECTRIC TRIMMERS. Super-midget variables ceramic insulation, screw-driver adjustment, 25, 50 or 100 pF. **1/-.**

FERRANTI 1 MILLIAMP METERS. 3½in. external diameter, flush mounting, with self-contained Westinghouse bridge rectifier. Scale marked 0-10 volts with fifty divisions, fitted in well-made wooden box 6 × 5 × 5in., **35/-.**

MAINS TRANSFORMERS. Military surplus. All 230 v. 50 cycles input.

Type No.	Output	Price
3	500-0-500 v. 150 m/a. 4 v. 2½ a. 4 v. 1 a. 4 v. 5 a.	35/-
4	865-0-865 v. 500 m/a. Tapped at 690 v. and 760 v. 4 v. 3 a. 4 v. 4 a.	75/-
5	450-0-450 v. 150 m/a. Tapped 300 v. 4 v. 3-3 a. 4 v. 3-5 a.	30/-
35	300-0-300 v. 250 m/a. 4 v. 3-5 a. 6.3 v. 5-7 a. 6.3 v. 1-2 a.	35/-
30	Output 30 v. 4 a.	20/-
31	Output 40 v. 3 a. and 104 v. 1½ a. (auto-wound)	21/-
32	Output 700-700 v. 150 m/a. 1,000 v. 30 m/a. 4 v. 1 a. 4 v. 4 a.	40/-
33	Output 38 v. at 2 a. tapped at 32, 34, 36 v.	15/-

ALL-WAVE SUPERHET KIT. A Kit of Parts to build a 6-valve (plus rectifier) receiver, covering 16-50 metres. Medium and Long-wave bands. Valve line-up 6K8, 6K7, 6Q7, 6J7, two 25A6 in pushpull. Metal Rectifiers are incorporated for H.T. supply. Output impedance is for 3 and 15 ohms. The latest Wearite Coil Pack incorporating Iron Dust Coils is used, making construction and alignment extremely simple. A pick-up position on the wavechange switch and pickup terminals is provided. A complete kit including valves but without speaker or cabinet. Chassis size 14 × 6in. Overall height, 9in. Price **£11 16s. 3d.**

Suitable loudspeakers are the GOODMANS 10in. 6-watt P.M. at 47/6, or for superlative reproduction, the Goodmans 12in. P.M. at **£6 15s.**

SUPERHET TUNING PACKS. Completely wired and aligned. 13-40, 40-120, 190-570 metres. R.F. stage, 465 k/c.; 9 connections only. Complete with 3-gang condenser, calibrated, engraved Perspex dial, and S/M drive. Litz wound polystyrene insulation, permeability tuned I.F.'s, 7 k/c. bandwidth. Price complete **£3 17s. 6d.**

ELECTRIC GRAMOPHONE MOTORS. A few available. Write for details.

ALUMINIUM CHASSIS. Substantially made of bright aluminium, with four sides.

Size	Price	Size	Price
7 × 3½ × 2in.	4/6	9½ × 4½ × 2in. ..	5/6
10 × 8 × 2½in. ..	7/-	12 × 9 × 2½in. ..	7/9
14 × 9 × 2½in. ..	8/3	16 × 8 × 2½in. ..	8/6
20 × 8 × 2½in. ..	10/6	22 × 10 × 2½in. ..	13/6

Cleaning Switch Contacts

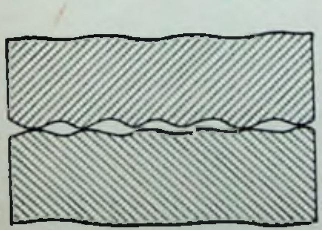
Use of Solvents: Effect of Lubrication

By J. J. PAYNE, Grad. I.E.E.
(Admiralty Signal Establishment)

CARBON tetrachloride is generally accepted as a useful agent for removing the cause of defective or noisy switch contacts and it is widely believed that it functions by removing surface films of grease.

The opinion that grease is often the cause of faulty contact is inaccurate, as will be seen later; it can have little or no direct effect on electrical contact. It will, in fact, be shown that a thin layer of grease is an important feature in the operation of a switch, or any form of moving contact. The real cause of noisy contact is thought to be due to particles of solid matter with insulating characteristics which mechanically lift the surfaces of the contacts apart, and are held by the thin layer of grease.

In order to study the process involved let us consider a switch of the wiping contact type. The two mating surfaces appear smooth, but in fact consist of a series of microscopic undulations. Only the high spots of these two surfaces can be in electrical contact, as shown in the figure. It would appear possible from this figure that the high spots of one contact could enter the valleys of the other. There is little chance of such an occurence, as it is extremely unlikely that all the scratches will be exactly parallel. Thus high spots only will be in contact.



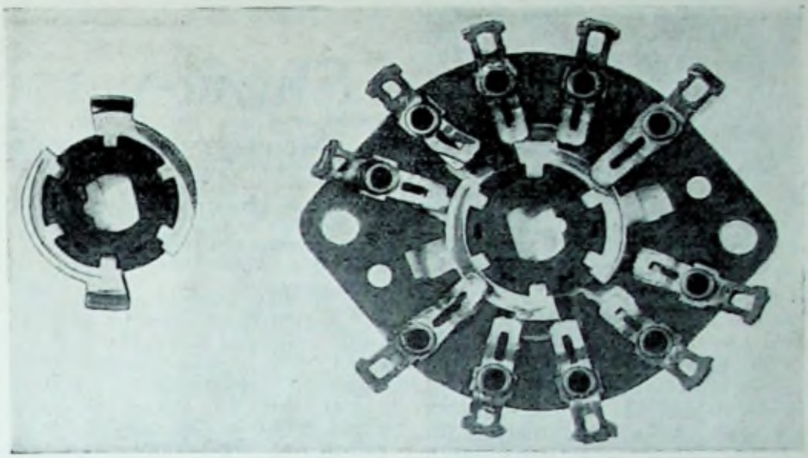
Sketch of contact surfaces.

Consider now a layer of grease applied to these surfaces, of thickness less than the depth of the scratches, and the switch operated a few times. Due to the viscous nature of the grease, the contact pressure will force the high spots through this layer. Thus they will still make electrical contact, and the valleys will now be filled with grease. As it is the high spots which are again in contact the presence of the grease has in no way affected the area of contact, and hence the resistance. When this layer has collected sufficient foreign matter to pile up and separate the contacts, the switch will become noisy and erratic in operation. This is due to random building-up and collapsing of the piles of foreign matter during movement of the switch. When the majority of them are forced into the valleys, electrical contact between the high spots is again possible. This random effect will, therefore, result in large changes of contact resistance, even causing a series of complete makes and breaks, accompanied by the usual symptoms known as noise.

Let us now proceed to cure this fault by applying a quantity of carbon tetrachloride to the contact. As this is a solvent for the grease, the grease will go into solution. Hence the foreign matter is no longer held to the contact faces, and will be washed off, together with the grease. As the cause of the faulty contact has been removed, our switch has now returned to its original noise-free action.

But we are not yet out of the wood. In curing the faulty switch, we have removed the film of grease. As in any mechanical device, the result will be increased friction, and, eventually, excessive wear, even though a switch is not normally operated at high speed.

A series of mechanical life tests were conducted by the author on a batch of new wafer-type switches. Half of this batch were treated with carbon tetrachloride. In every case the untreated switches showed no serious effects, while excessive wear took place on those treated. This in some cases led to the severing of the tongue on the moving contact, and in others the fixed contacts were dragged from their normal position until the moving contact jammed against their edges. The dark patches on the tongue of the switch rotor, illustrated in the accompanying photograph, represent the area denuded of plating, thereby exposing the base metal, which has suffered severely from



Photograph of typical wafer switch, subjected to mechanical life test after cleaning with carbon tetrachloride.

Cleaning Switch Contacts—

the effects of wear. One of the upper contacts clearly shows the distortion due to drag. It was known that a film of grease had been applied to the above switches during manufacture. Thus the increased life of the untreated switches can be attributed to the presence of this film. This was further confirmed by tests on treated samples, which had a new film of grease applied in the manner about to be described. The presence of this grease produced no significant change in contact resistance.

It may be concluded that the ideal switch-cleaning fluid is one which will remove any foreign matter, but will leave a film of grease deposited on the contact surfaces. A suitable method of achieving this result is to use a cleaning fluid with lubricant in solution. Such a solution when applied to a faulty switch would wash out any foreign matter in the manner previously described. Furthermore, on evaporation of the solvent a film of grease would be deposited on the surfaces. A suitable solution was found to be 10 per cent lanolin in white spirit or trichlorethylene.

There is a danger of flooding the switch in an attempt to make sure. This must be avoided, as excess fluid will spread over the insulation, and the thickness of film on the contact will not be increased. The effect of flooding the switch would be to deposit grease on the surface of the switch insulation. As this will also tend to collect foreign matter, trouble may eventually occur due to surface tracking.

The continued use of this method of contact cleaning may eventually lead to insulation troubles as mentioned above, although no cases of this nature have been brought to the author's attention. This difficulty may be overcome, however, by periodically cleaning the entire switch with neat solvent and when dry applying a drop of lanolin solution to the contacts. In cases where low insulation losses are of vital importance this latter method may be adopted every time such a switch is cleaned. A method of controlling the application of this solution, by colouring with an aniline dye, has been suggested to the author. This would give visual indication of the area covered by solution, and would also serve as a warning of large deposits of grease on vital insulators. Conversely the effectiveness of removing this excess grease may be observed.

Short-wave Conditions

December in Retrospect : Forecast for February

By T. W. BENNINGTON

(Engineering Division, B.B.C.)

DURING December maximum usable frequencies for this latitude decreased both by day and night. The daytime decrease—mentioned in this column for December —was due to the "mid-winter effect," while the night-time decrease was the normal one due to the greater length of night in the Northern Hemisphere. Despite the daytime decrease in M.U.F.'s conditions were such that long-distance communication on the higher frequencies was good to most parts of the world, albeit frequencies as high as 50 Mc/s were seldom usable, though they had been during November. Night-time working frequencies, though relatively low, seldom fell below about 9 Mc/s, except over a few high-latitude paths.

There was not much ionosphere disturbance during the month, and those storms which did occur were not of great intensity. The most disturbed period was 4th/13th, and disturbances of a minor kind took place on 15th/16th, 23rd and 29th/31st.

Forecast. — By February the "mid-winter Effect," which, in the Northern Hemisphere, always results in a decrease in the daytime F2 layer ionization round about the winter solstice, should have come to an end, and the daytime M.U.F.'s should therefore increase considerably. There should also be an appreciable increase in the night-time M.U.F.'s, as compared with those for January.

Daytime working frequencies are thus expected again to be very high —of the same order as those which prevailed last November—and long-distance communication on exceptionally high frequencies should be frequently possible in all directions from this country. The 28-Mc/s amateur band should be *regularly* usable for long periods over daylit paths, and long-distance communication on 50 Mc/s may become an occasional possibility. In fact, conditions for the use of this latter frequency are not likely again to be so good during the present sunspot cycle. Night-time working frequencies will be higher than during January, though frequencies as low as 9 Mc/s will still be necessary in order to maintain regular communication in some directions.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during February for long-distance circuits running in different directions from this country. In addition a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers. All time in these reports are in G.M.T.

Montreal :	0000	11 Mc/s		(16 Mc/s)
	0200	9 ,,		(14 ,,)
	0000	11 ,,	or 15 Mc/s	(18 ,,)
	1100	21 ,,		(28 ,,)
	1200	26 ,,		(40 ,,)
	2000	21 ,,	or 17 Mc/s	(34 ,,)
	2200	15 ,,		(22 ,,)
	2300	11 ,,		(18 ,,)
Buenos Aires:	0000	15 Mc/s		(20 Mc/s)
	0400	11 ,,		(19 ,,)
	0700	15 ,,		(20 ,,)
	0800	21 ,,		(30 ,,)
	0000	26 ,,		(41 ,,)
	1000	21 ,,		(34 ,,)
	2100	17 ,,		(29 ,,)
	2300	15 ,,		(23 ,,)
Cape Town :	0000	15 Mc/s		(20 Mc/s)
	0300	11 ,,		(18 ,,)
	0500	15 ,,		(20 ,,)
	0600	21 ,,		(30 ,,)
	0700	26 ,,		(42 ,,)
	1800	21 ,,		(32 ,,)
	2000	17 ,,		(28 ,,)
	2300	15 ,,		(22 ,,)
Chungking :	0000	0 Mc/s		(14 Mcs)
	0400	11 ,,	or 15 Mc/s	(16. ,,)
	0600	21 ,,		(29 ,,)
	0700	26 ,,		(39 ,,)
	1300	21 ,,		(20 ,,)
	1500	17 ,,	or 15 Mc/s	(21 ,,)
	1800	11 ,,		(15 ,,)
	2200	9 ,,		(14 ,,)

February is not usually a particularly bad month for ionosphere storms, though those which do occur are likely to be troublesome over dark transmission paths. At the time of writing it would appear that storms are more likely to occur during the periods 1st/4th, 7th/8th, 15th, 21st/22nd and 25th/29th than on the other days of the month.

WORLD OF WIRELESS

Receiver Production ◆ First Radar Patent ? ◆ New Government Radio Post

B.R.E.M.A.

THE third annual report of the British Radio Equipment Manufacturers' Association, one of the four constituent bodies of the R.I.C., was issued last month.

In the section dealing with the production programme for the year June, 1947, to May, 1948, details are given of the £18,200,000 worth of receivers which the pre-war set manufacturers are licensed by the Ministry of Supply to produce during that period. This is said to be the equivalent of 1,300,000 sets. Special arrangements have been made to meet the needs of newcomers to the industry.

An increase of £70,000 a month over the rate of exports during the peak period of 1946 has to be maintained to the end of 1948 to meet the year's target of £12 million which the Government has set the industry.

It is stated that the Ministry of Supply regards car radio "as a pure luxury at this present time" and in consequence the policy of allowing free production would have to be modified.

Under "Television" the report states that the shortage of C.R. tubes is the main limiting factor to greater output of receivers. The root of the difficulty is said to be the scarcity of skilled glass-blowers and it is therefore unlikely that the supply of tubes would meet future demands unless moulded production becomes economically possible. This, in turn, is dependent on large orders for tubes within a limited range of sizes. The question of standardizing tube sizes as a first step towards mass production is, therefore, being considered.

In reviewing the work of the Association's Technical Committee reference is made to its investigations into F.M. It is pointed out that it is likely that a frequency of around 90 Mc/s will be employed by the B.B.C. for the F.M. transmissions, whereas the original investigation into the increased cost of producing receivers for F.M. was based on the use of 45 Mc/s. The further cost of covering the 90 Mc/s band "would undoubtedly be very considerable."

HISTORIC PATENT

WHAT is believed to be Watson-Watt's first radar specification has just been published by the Patent Office. Originally filed on September 17th, 1935, the complete specification was accepted in May, 1937, but it was withheld from publication until now, when it is issued as No. 593,017.

Watson-Watt's address on the complete specification is given as Bawdsey Research Station, Bawdsey Manor, Woodbridge, Suffolk.

Among the claims enumerated by the patentee is that of "locating the position of aircraft, marine craft or other objects by utilizing re-radiation broadcast from the object when subjected to primary radiation, consisting in radiating from a transmitter pulses of electro-magnetic waves of suitable frequency and polarization separated by intervals of substantially zero radiation, and receiving the electro-magnetic pulses re-radiated from the object in an indicating receiver."

The specification is obtainable from The Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 1s inland or 1s 1d abroad.

OUR COVER. Two processes in the manufacture of C.R. tubes are given on our front cover and above; showing, respectively, annealing the neck to the bulb and sealing-in the electrodes. The photographs were taken at the High Wycombe factory of Electronic Tubes Ltd., a Cossor subsidiary.

TELEVISION FRANCAISE

OUR note in the December issue regarding the reception of French television in this country has brought forth enquiries regarding the present transmissions from the Eiffel Tower. We, therefore, give below one or two relevant details.

The transmitter, used during the war, was installed by the Germans and was dismantled by them during the retreat. The equipment now in use was produced by Cie Française de Television.

The vision transmitter works on 46 Mc/s with a peak power of 30 kW. The scanning rate is 455 lines per frame and 25 frames per second. Sound is transmitted on 42 Mc/s with a power of 5 kW.

Transmission times (G.M.T.) are: Daily (except Sat. and Sun.), 1150-1205. Daily (except Sat. and alternate Sun.), 1600-1730. Tuesday and Friday, 2000-2130.

"SPRAYED-ON" SETS FOR INDIA

IT is understood that a contract is about to be signed between Sargrove Electronics, Walton-on-Thames, and an Indian firm for the supply of 100,000 broadcast receivers. These are to be made by the ECME process (*Wireless World*, April, 1947), in which the principle of high-speed "printed circuit" manufacture is carried to extreme lengths by spraying on circuit elements and wiring in the form of metallic and graphite coatings on insulating panels.

The recently imposed ban on the import of completed receivers into India has been temporarily relaxed in favour of these sets, though ECME plant is ultimately to be installed there for local production.

DR. SMITH-ROSE

THE new post of Director of Radio Research in the Department of Scientific and Industrial Research is to be filled by Dr. R. L. Smith-Rose, who has been superintendent of the Radio Division of the National Physical Laboratory since 1939.

In his new position he will be in charge of the radio research work of the D.S.I.R. for which a new station is to be built. The work at present being carried out in the N.P.L. Radio Division and the D.S.I.R. Radio Station at Slough, together with the work being undertaken for the D.S.I.R. at the Ministry of

World of Wireless—

Supply's Telecommunications Research Establishment, Malvern, will be conducted at the new station.

Dr. Smith-Rose, who is 53, and was recently elected a vice-president

Dr. R. L. Smith-Rose, D.Sc., Ph.D., M.I.E.E., D.I.C., A.R.C.S.

of the American Institute of Radio Engineers, joined the staff of the electrical department of the N.P.L. in 1919 and later was a member of the small band of workers who formed the nucleus of the wireless division of that department. He has been associated with the work of the Radio Research Board since its formation in 1920. He became principal scientific officer on the formation of the Radio Division in 1933.

His researches cover radio direction finding, the propagation of radio waves and the investigation of the electrical constants of the soil and sea water and their influence on propagation.

WHAT IS RADAR?

IN the course of recent correspondence with the Post Office on the vexed question of "What is a Broadcasting Station?" we were given *inter alia* a concise definition of radar. It is defined as "a radiolocation system where transmission and reception are carried out at the same location and which utilizes the reflecting or retransmitting properties of objects in order to determine their position."

This definition was given during the recent Atlantic City Conference.

PICKUP TRACKING ERRORS

THE practice of setting pickup heads at an angle to the arm to minimize tracking errors was one of the topics discussed in a lecture by W. J. Lloyd, B.Sc., A.M.I.E.E., on "Factors in the Reproduction of Gramophone Records" at the British Sound Recording Association meeting on December 19th. It was pointed out that although angular tracking errors were reduced by this method, the frictional force at the stylus point did not act on a line passing through the pickup arm pivot as it does in the case of straight arms. There is a resultant force acting on the needle point towards the centre of the record and in some pickup movements the bias due to this force might give rise to more distortion than that due to the tracking error.

NEWS IN MORSE

IT is some months since we last published details of the transmissions of official news bulletins in morse in the London Press Service radiated daily by the Post Office stations. As there have been a number of changes recently we give the revised schedule below. These transmissions are intended for overseas reception.

The transmission times (G.M.T.) and the stations radiating are:—

0130-0315 GBV, GIJ, GAH, GPN, MIJ, MIK, GIH
0330-0500* MIK, GIH
0445-0545* GAH
0800-0930 GCV
0945-1045* GCV
1100-1200* GBV, GIM, GCV, GCF
1215-1315* GCF, GCV, GIA
1330-1430* GBV, GIM, GDZ, GCF
1445-1545* GCF, GCV, GIA, GAG
1600-1700* GBV, GIH, GBI, GCF
1715-1815* GBO, GCV, GIA
1830-1930* GBV, GDI, GAH, GBO, GPX
1945-2045* GPN, GPF, GAV
2100-2200* GBV, GDI, GAH, GPN
2215-2315* GPN, GBI, GIH
2330-0100* GBV, GIJ, GAH, GPN, MIJ, MIK, GIH
2330-0030† GBV, GIJ, GAH, GPN, MIJ, MIK, GIH

The frequencies (kc/s) on which these stations operate are:—

GBV, 78; GIJ, 6,985; MIJ, 7,447; GDI, 7,780; GAH, 8,065; GPN, 8,827; MIK, 9,725; GIH, 10,650; GPX, 11,645; GBI, 10,865; GIM, 12,975; GBO, 13,065; GDZ, 13,910; GAV, 14,455; GPF, 16,100; GAG, 17,105; GCF, 19,005; GCV, 19,365 and GIA, 19,640.

* Sundays excluded. † Sundays only.

NEW YEAR HONOURS

J. D. Cockcroft, C.B.E., Ph.D., LL.D., M.Sc., F.R.S., director of the Atomic Energy Research Establishment at Didcot; **V. Z. de Ferranti,** M.C., chairman and managing director of Ferranti, Ltd., and **R. Y. Southwell,** F.R.S., rector of the Imperial College of Science and Technology, were created Knights Bachelor in the New Year Honours.

Among those appointed Officers of the Order of the British Empire (O.B.E.) in the New Year Honours were: **C. G. Phillips,** for services as assistant director of telecommunications at the Ministry of Civil Aviation, and **F. J. Toone,** managing director of Parmeko, Ltd.

A. E. Adams, chief designer of Scophony, Ltd.; **L. I. Farren,** technical assistant in the G.E.C. Research Laboratory, Wembley; **S. B. Gwynn,** divisional engineer (wireless), Burma, and **H. Wolfson,** senior research chemist in the Valve Research Laboratory of Standard Telephones and Cables, were appointed M.B.E.s.

H. Widbourne, lately foreman of workshops at T.R.E., has been awarded the British Empire Medal.

PERSONALITIES

Air Cdre. C. P. Brown, C.B., C.B.E., D.F.C., is relinquishing his Air Ministry post of Director of Operational Requirements (E) to become Chief Signals Officer, R.A.F. Mediterranean and Middle East Command. He was Director of Radar at the Air Ministry from 1942 to 1946.

R. G. Clark, M.I.E.E., who as been manager of the engineering department of the Ferguson Radio Corporation since July, 1946, has been appointed a director. He was formerly head of the research and development department of Philips Lamps.

W. H. Date, B.Sc., A.M.I.E.E., has been appointed head of the Electrical Engineering Department of the Polytechnic, Regent Street, London, W.1, on the retirement of Philip Kemp. He was formerly senior assistant in the department.

J. V. Holman, managing director of Philco, has been elected a deputy chairman of the Joint Air Transport Committee of the London Chamber of Commerce.

C. L. G. Fairfield, M.A., A.M.I.E.E., who has joined the Mullard Wireless Service Co., will act as assistant to the directors in a technical capacity. He will be concerned with the applications of Mullard research and development work to industrial problems.

E. S. McCallister has been appointed to the electro-medical department of Philips Electrical, Ltd. He was previously in the instrument section of Mullards.

A. McVie, director of Kolster-Brandes and Standard Telephones and Cables, has retired from the chairmanship of the British Radio Equipment Manufacturers' Association.

O. S. Puckle, formerly chief engineer of Sobell Industries, has joined E.M.I. Developments.

Vincent de Ferranti, M.C., who is created a Knight Bachelor.

Andrew Reid, who handled the Press arrangements for the 1947 National Radio Exhibition at Olympia, has been appointed Press Officer to the Radio Industry Council. He will work from his own office at 11, Garrick

Street, London, W.C.2 (Tel.: Temple Bar 3901/2).

D. Robinson has been appointed sales manager of the Amplifier Department of Philips. He was the first chairman of the Institute of Public Address Engineers and was, before the war, joint managing director of Grampian Reproducers, Ltd.

WHAT THEY SAY

Pre-eminence of Radio.—"I believe that radio equipment is already more continuously available and serviceable than the celestial bodies which are so readily obscured by haze, mist or cloud and of which the sun alone is conveniently available, if at all, for daylight observation. Consequently I believe that the radio aids as a group are no longer secondary to classical celestial navigation, and that they are now the primary aids, a first eleven with celestial methods relegated to the second and reserve teams."—Sir Robert Watson-Watt broadcasting on "Twentieth-Century Aids to Navigation."

IN BRIEF

A.S.E. now A.S.R.E.—The Admiralty Signal Establishment, which, with branches at Haslemere and Whitley, is the largest of the Admiralty research organizations, has changed its name to the Admiralty Signal and Radar Establishment. The work of the establishment now touches upon all aspects of Naval warfare, including communications, naval aviation and modern weapons of diverse types.

Television Licences.—In the six months ended in November the number of television licences issued in this country had risen by 12,515, which is an increase of 66.8 per cent on the May figure of 18,735. The latest figure is 31,250. The number of broadcast receiving licences (including television) in force in Great Britain and Northern Ireland at the end of November was approximately 10,992,200.

Physical Society's Exhibition.—The 32nd annual exhibition of scientific instruments and apparatus, organized by the Physical Society, will be held in the Physics and Chemistry Departments of Imperial College, South Kensington, London, S.W.7, from April 6th-9th. Admission will be by ticket obtainable from the Society. On the opening day the hours of admission will be from 2.0 to 9.0 and on subsequent days from 10.0 to 1.0 and from 2.0 to 8.0.

Mullard's Educational Service, which is at the disposal of technical colleges, training centres, radio societies, etc., was featured by the company in its exhibit at the Science Masters' Exhibition held recently in Sheffield. The service is especially intended for users of film-strip projectors and includes a series of lectures under the general title "The Radio Valve." The Unicorn Head Film Strip Library, British Industrial Films, Chenil Galleries, 183, King's Road, Chelsea, London, S.W.3, distributes the lectures which, with the film strip of approximately 50 illustrations, cost 10s each.

Empire Radio School.—A liaison team from the R.A.F. Empire Radio School at Debden, Essex, is to visit Australasia in a Lincoln aircraft, "Mercury II," fitted with the latest types of radio equipment for demonstration to units of the Australian and New Zealand Air Forces. Among the gear with which the aircraft is equipped is the G.E.C. radio compass, Rebecca Mk IV—a miniaturized version of Mk II, which is also carried, Gee, Loran, H2S and V.H.F. communication sets TR1143A and TR5043.

Continental Television.—The Dutch secretariat of the Continental Television Society, the object of which is the promotion of television in Belgium, France, Luxembourg and Holland, is appealing for technical literature. The address of the Society is Kerksingel 69, Overschie, Rotterdam, Holland.

German Production.—The manufacture of civilian broadcast receivers has been resumed by a number of old-established firms in Germany. Most of the receivers are of comparatively simple type and vary in price from 235 to 540 marks. Among the well-known pre-war names appearing on the new sets are Telefunken, Loewe, Blue Spot, and Lorenz.

R.S.G.B. Membership.—The annual report of the R.S.G.B. records that during the year 2,997 new members joined the society. Of the total membership of 13,870 at the end of September, 546 corporate members resided overseas.

Television Film.—Special film recording equipment was developed and manufactured by Pamphonic Reproducers for making the B.B.C. film of the Royal Wedding. The film was made by photographing the image on a television screen at Alexandra Palace. The equipment, comprising apparatus for camera control and sound recording with automatic volume compression was developed within three weeks.

Electrical Trades Union.—The Radio Technical Advisory Committee of the E.T.U. has arranged a series of meetings in London for the radio workers it numbers among its members. Details of the first two meetings are given in the meetings section on page 56. The meetings are not confined to members of the Union. The full list of fixtures is obtainable from the Area Office, 324, Gray's Inn Road, London, W.C.1.

French Components Exhibition.—The French Radio Industry Council announces that its annual exhibition of components, accessories and measuring instruments will be held from February 2nd to 7th at the Parc des Expositions de la Porte de Versailles, Paris, 15^e. The full title and address of the French R.I.C. is Syndicat National des Industries Radioélectriques, 25, Rue de la Pépinière, Paris, 8^e.

A Valuable Index.—The annual index to Abstracts and References published in our sister journal *Wireless Engineer* during 1947 will be available after February 9th, from our Publisher. It includes an author index and a classified subject index. As supplies are limited early application for copies is advised. The price is 2s 6d (by post 2s 8d).

INDUSTRIAL NEWS

E.M.I. has purchased from Radio and Television Trust, Ltd., its Perivale factory, which is some three miles from the main factory of the E.M.I. group at Hayes, Middlesex. These two factories, together with that at Treorchy, South Wales, will be operated largely to increase the company's exports.

Philco and Airmec.—The factory referred to above has been disposed of by Radio and Television Trust, Ltd., owing to the need for reducing the company's manufacturing organization on account of the drastic cuts in the quota of receivers for the home market. Airmec, Ltd., is the manufacturing side of the company and produces Philco sets for the home market, which are sold through Philco Radio and Television Corp. of Great Britain, and Airmec sets for export through Airmec International Sales, Ltd.

Philips Electrical Industries, Ltd., is the name of a private company formed to acquire and hold certain shares of the Philips group of companies in this country. This internal reorganization of the company "has no external implications."

Radio Equipment, Ltd., has been formed as a Holding Company to acquire ninety per cent of the shares in the Mullard Wireless Service Co.

Components Exhibition.—The Radio Component Manufacturers' Federation, which is organizing the fifth annual private exhibition of British radio, television and electronic components and test gear, announces that stands have been allotted to 100 exhibitors. The exhibition, which will be held at Grosvenor House, Park Lane, London, W.1, from March 2nd-4th, will be open from 10.0 a.m. to 6.0 p.m. to holders of invitation tickets. It will not be open to the general public.

Belling-Lee.—The twenty-fifth anniversary of the founding of Belling and Lee, Ltd., was celebrated with a dinner in London on December 22nd to which friends and supporters of the company were invited.

R.S. Amplifiers, Ltd., of Reynolds Road, Acton Lane, London, W.4, has been acquired by Henri Selmer and Co., Ltd., of 114-116, Charing Cross Road, London, W.C.2 (Tel.: Temple Bar 0444), to whom all enquiries regarding R.S. equipment should now be sent.

Mullard has opened another "feeder" factory at Hove, Sussex. It is for the assembly of sub-miniature valves, including those used in the Government-sponsored "Medresco" hearing aid.

Rola-Celestion.—The Board of British Rola has been enlarged to include W. H. Page and S. J. Tyrrell, directors of Celestion. At the same time C. R. Nortcliffe, sales director of Rola, joins the Board of Celestion. Mr. Tyrrell will co-ordinate the research and technical development of the two companies.

Marconi's announce that the £300,000 order placed by the Chinese Government twelve months ago is now ready for shipment. The contract included sixteen telegraph/telephone transmit-

World of Wireless—

ters, thirty triple diversity receiving equipments and 150 commercial receivers.

Radio Industries Ball.—The success of the Ball held at the Royal Albert Hall on October 3rd has prompted the Radio Industries Club to decide to make it an annual event.

O. Greenlick, Ltd., of 34, Bancroft Road, Cambridge Heath Road, London, E.1, has moved to 265, Whitechapel Road, E.1.

S. G. Brown, Ltd., of Victoria Road, North Acton, London, W.3, ask us to say that the price of the moving-coil headphones advertised in the December issue was incorrect and should have been £5 5s.

CLUBS

Birmingham.—High-frequency heating will be discussed and demonstrated at the meeting of the Slade Radio Society on February 6th by W. D. Wilkinson, B.Sc., of the G.E.C. Development Laboratory. Meetings are held at 8.0 on alternate Fridays at the Parochial Hall, Broomfield Road, Slade Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23, Warwick.

Bovingdon.—An Amateur Radio Section of the Bovingdon Airport Club has been formed but is not confined to members of the airport staff. It therefore serves the Bovingdon, Chesham, Hemel Hempstead, and Berkhamsted areas of Hertfordshire. Meetings are held on Wednesdays at 7.30 in Building 161. B. N. MacLarty deputy engineer-in-chief of Marconi's, who until recently was head of the B.B.C. Design and Installation Dept., will talk on high-powered B.B.C. transmitters at the meeting on February 4th. Sec.: J. D. Lord, Police Station, Bovingdon, Hemel Hempstead, Herts.

Brighton.—Dr. D. G. Tucker will lecture on the Synchrodyne receiver at the meeting of the Brighton and Hove Group of the R.S.G.B. at the Golden Cross Hotel, Western Road, Brighton, at 7.30 on February 23rd.

Ilford.—Demonstrations of the Goodmans' infinite baffle speaker and the G.E.C. tape recorder will be given to members of the Ilford and District Radio Society on January 29th and February 19th respectively. Meetings are held on Thursdays at 8.0 at St. Alban's Church Room, Albert Road, Ilford. Sec.: C. E. Largen, 44, Trelawney Road, Barkingside, Essex.

Oxford.—The Oxford and District Amateur Radio Society has been reformed and now meets on the first and third Wednesdays of the month at 7.30 at the Club Room, "Magdalen Arms," Iffley Road, Oxford. Sec.: H. Worsfold, 143, Iffley Road, Oxford.

Worthing.—The February meeting of the Worthing and District Group of the R.S.G.B. will be held on the fifth at Oliver's Café, Southfarm Road, Worthing, at 7.30. The Ministry of Supply film "R.D.F. to Radar" and some R.S.G.B. films, including that of the Atlantic City Conference, will be shown. Sec.: G. W. Morton, 42, Southfarm Road, Worthing, Sussex.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"The Application of Frequency Modulation to V.H.F. Multi-Channel Radiotelephony," by J. H. H. Merriman, M.Sc., and R. W. White, B.Sc., on February 4th.

"Maintenance of Television Receivers in the Home," discussion, opener G. H. Watson, on February 10th

Both these meetings will be held at Savoy Place, London, W.C.2, at 5.30.

Faraday Lecture.—"Electricity and Everyman," by Dr. P. Dunsheath, C.B.E., M.A., on February 27th, at 6.30, at the Central Hall, Westminster. This is a public meeting.

East Midland Centre. — "Speech Communication under Conditions of Deafness or Loud Noise," by Dr. W. G. Radley, C.B.E., on February 10th, at 6.30, at the Gas Department Lecture Theatre, Nottingham. Sec.: G. Smith, Loughborough College, Loughborough.

Cambridge Radio Group. — "The Cavity Magnetron," by Drs. H. A. H. Boot and J. T. Randall, F.R.S., on February 3rd, at 8.15, at the Cavendish Laboratory.

Mersey and North Wales Centre.— "The Design of High-Fidelity Disc Recording Equipment," by H. Davies, M.Eng., on February 16th, at 6.30, at the Royal Institution, Colquitt Street, Liverpool. Sec.: A. V. Milton, 12, Bevington Hill, Liverpool.

North-Eastern Centre. — Dr. Dunsheath's Faraday Lecture (see above), on February 18th, at 6.15, in the Lecture Theatre, Literary and Philosophical Society, Newcastle-on-Tyne. Sec.: E. C. Rippon, c/o C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-on-Tyne, 6.

North-Eastern Radio Group. — Dr. Radley's paper (see East Midland Centre) on February 16th, at 6.15, at King's College, Newcastle-on-Tyne.

North Western Radio Group.— "Some Wartime Developments in Electronic Circuit Technique," by Prof. F. C. Williams, O.B.E., D.Sc., D.Phil., on February 25th, at 6.30, at the Engineers' Club, Albert Square, Manchester.

Western Centre.—Dr. Dunsheath's Faraday Lecture (see above) on February 10th, at 6.0, at the Reardon-Smith Lecture Theatre, Cardiff. Sec.: L. Burdes, B.Sc. (Eng.), Electricity Dept., Dorset House, The Promenade, Clifton, Bristol, 8.

Irish Branch.—"Propagation Problems in connection with Short-Wave Broadcasting," by W. Jones, M.Sc., on February 19th, at 6.0, at Trinity College, Dublin. Sec.: R. N. Eaton, 1, Foster Place, Dublin.

Mersey and North Wales Students' Section.—"The Engineering Aspects of Gramophone Record Reproduction," by R. G. Whitehead, B.Sc. (Hons.), H. K. Barker, B.Sc., and H. P. Caldecott, B.Sc., on February 7th, at 2.30 at the Royal Institution, Colquitt Street, Liverpool.

British Institution of Radio Engineers

London Section.—"A Multi-Carrier V.H.F. Police Radio Scheme," by J. R. Brinkley, on February 12th, at 6.0, at the London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1.

Midlands Section.—"Some Aspects of Moderate Precision Temperature Control in Communication Engineering," by M. P. Johnson, B.A.Sc., on January 30th, at 6.30, at the Technical College, The Butts, Coventry. Sec.: C. Stokes, B.Sc., 6, Esterton Close, Coventry, Warwick.

Merseyside Section.—"Link-Coupled I.F. Circuits Applied to Car Radio Receivers," by R. D. Trigg, on February 18th, at 6.45, at the Lecture Room, Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, 2. Sec.: J. Gledhill, B.Sc., 123, Portelet Road, Liverpool, 13.

North-Eastern Section. — Questions Evening on February 11th, at 6.0, at Neville Hall, Westgate Road, Newcastle-on-Tyne. Sec.: M. A. Boardman, 20, Princes Avenue, Gosforth.

North-Western Section.—"A New All-Stage Valve," by J. A. Sargrove, on February 12th, at 6.45, at the College of Technology (Reynolds Hall), Sackville Street, Manchester. Sec.: B. E. P. Ritson, 38, Parswood Court, East Didsbury, Manchester, 20.

Scottish Section. — "Supervisory Control," by L. G. Brough, on Feb. 18th, at 6.45, at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.

Institution of Electronics

"Electronic Organs," by L. E. A. Bourn, on January 26th at 7.0 in the rooms of the Royal Society of Arts, John Adam Street, London, W.C.2. Sec.: A. H. Hayes, 24, Buckingham Street, London, W.C.2.

North-West Branch.—"The High-Vacuum Technique," by Dr. R. Witty, on February 6th, at 6.30, at the Reynolds Hall, College of Technology, Manchester. Sec.: L. F. Berry, 105, Birch Avenue, Chadderton, Lancs.

British Sound Recording Association

"Recent Developments in Magnetic Recording," by P. T. Hobson, on February 27th at 7.0, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

Institution of Mechanical Engineers

"Radio Valve Manufacture," by J. W. Davies, H. W. B. Gardiner, B.Sc.(Eng.), and W. H. C. Gomm, B.Sc.(Eng.), on January 30th at 5.30, at The Institution, Storey's Gate, St. James's Park, London, S.W.1.

British Kinematograph Society

Newcastle-on-Tyne Section. — "The Film in Relation to Television," by Marcus F. Cooper, on February 3rd, at 10.30 a.m., in the Neville Hall, Neville Street, Newcastle. Sec.: Edward Turner, 30, Ettrick Grove, Sunderland, Co. Durham.

Radio Society of Great Britain

"Interference—its Cause, Effects and Cure," by W. Hartley, G8UY, on February 13th at 6.30, at the I.E.E., Savoy Place, London, W.C.2.

Electrical Trades Union

"Definitions and Standards of Skill in the Radio Trade," open discussion on January 26th at 7.0 at the Alliance Hall, Caxton Street, London, S.W.1.

"Pre-detector Amplifying Systems," open discussion on February 24th at 7.0 at the Caxton Hall, Victoria Street, London, S.W.1.

The names and addresses of secretaries are included where they have not been given previously in this volume.

Slot Aerials

Vertical Polarization from a Horizontal Radiator

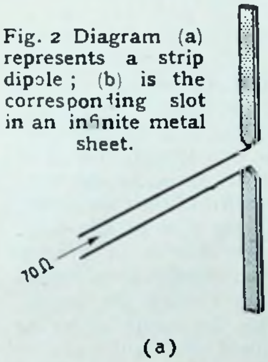
By D. A. BELL, M.A., B.Sc.

A LOT of the optimistic talk about the benefits to broadcasting and television of radar technique has been unjustified, but the "slot" aerial may prove to be a new line of development which, having started in wave-guide technique for radar, will grow upwards from centimetre wavelength to V.H.F. broadcasting, if not lower. As an example, it is reported that the B.B.C. are considering the use of slot aerials for their 90-Mc/s F.M. transmissions.

At centimetre wavelengths, energy is transmitted more efficiently as bounded electromagnetic waves in a waveguide than as currents in a conductor. When we want to radiate the energy which is being carried by a waveguide, we need not put the energy back into current form and then radiate from an aerial, but instead we can radiate electromagnetic wave energy directly, for example, through a horn.

Now the directivity of any radiator, whether aerial array or horn, is proportional to the dimension (in wavelengths) of the radiator *at right angles* to the plane in which the directivity is measured. So if we want a beam which is narrow in the horizontal plane but covers a wide vertical angle, for example, in a ship which is liable to roll, we must use an aerial such as a one-tier broadside array of radiators (all fed in suitable phase) which is broad but not high.

The connection of a large number of dipoles to a common feeder with correct phasing and impedance matching would be a difficult problem at centimetre wavelengths. But if we punch a row of spaced holes in the side of a waveguide, each hole will radiate some of the energy passing down the guide; and uniform phasing of the radiation from the holes is effected by spacing them correctly along the length of the guide, remembering that the wavelength inside the guide will be greater than the wavelength in free space. (Fig. 1.)



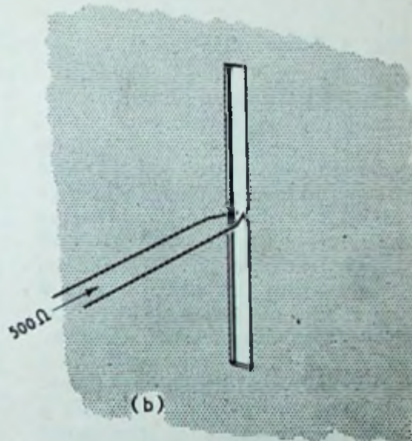


Fig. 2 Diagram (a) represents a strip dipole; (b) is the corresponding slot in an infinite metal sheet.

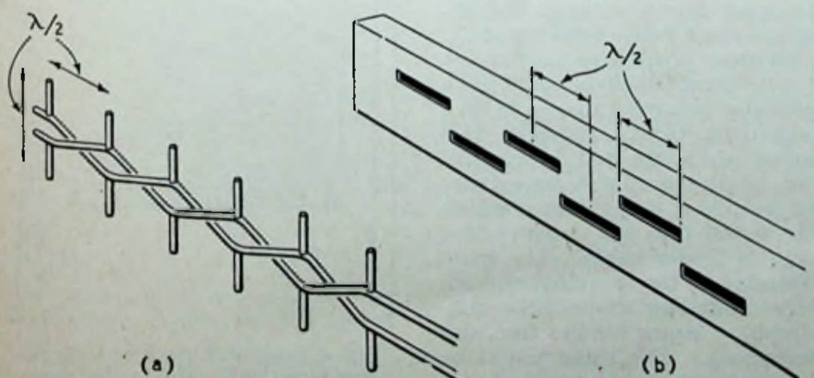


Fig. 1 An array of dipoles (a) becomes difficult to construct and feed at centimetre wavelengths; but a slotted wave guide (b) gives an equivalent radiation pattern.

Investigation of the optimum type of radiating "hole" in the waveguide led to the use of a slot of length about half a wavelength and of much smaller width, and from here on we find that study of the radiating properties of the resonant slot leads to results of much wider interest. First of all, a slot in an infinite sheet is closely equivalent to a flat strip dipole in free space if we consider the shapes of conductor and dielectric to be interchanged, (Fig. 2), except that the slot behaves as a "magnetic dipole." The polar diagram of a slot radiator in an infinite sheet is very similar to that of a dipole in free space, but whereas the electric field is parallel to the length of the dipole, it is the magnetic field that is parallel to the length of the slot. In practice, of course, the conductor in which the slot is situated is rarely even an approximation to an infinite sheet, and the resulting edge effects may be regarded as a diffraction phenomenon which can slightly improve the polar diagram in favourable cases. If we enclose one side of the slot, preferably with a chamber at least a quarter-wavelength in diameter, the radiation can emerge from one side only; but unless the sheet is of very large extent, there will still be some backward radiation due to diffraction round the edges of the sheet.

The feed to a dipole is normally inserted in series with the mid-point, and for the resonant length the input impedance is purely re-

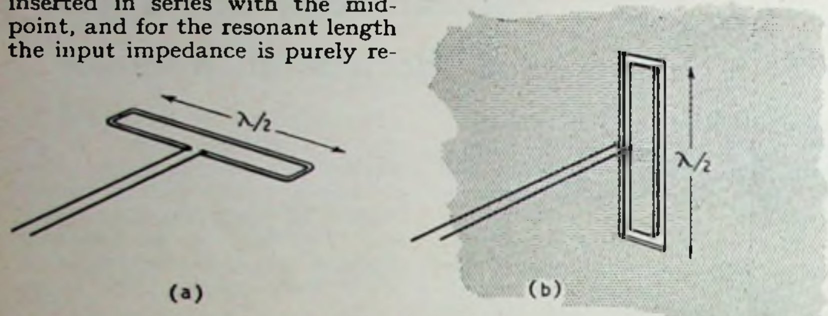


Fig. 3. Folded dipole diagram (a) with the corresponding folded slot (b)

sistive and about 70 ohms in magnitude for a fairly thin conductor; similarly, the input to a slot is fed across the centre (Fig. 1*b*) and the input resistance at resonance is about 500 ohms.[1, 2, 3] Increasing the diameter of the conductors of a dipole reduces the impedance, but increasing the width of a slot reduces the admittance; i.e., increases the impedance. Again, just as the input impedance of a dipole can be multiplied by a factor of the order of 4 by using a folded construction, so the input impedance of a slot can be *reduced* roughly four-fold by folding it.

The two practical advantages of a slot aerial are, first, that it can be incorporated in a conducting structure and, secondly, that its polarization is at right-angles to that of a dipole. For the first factor, Booker[1] has suggested that slots might be cut in the skin of an aircraft and plugged with dielectric, thus avoiding the use of projecting-rod aerials for the V.H.F. band. Similarly, marker and landing beacons on aerodromes could radiate from horizontal slots let into the surface of the ground, even in the surface of a runway if necessary. The low-frequency limit to this type of application is set by the need for a cavity about a quarter-wavelength deep below the slot.

Although the question of horizontal *versus* vertical polarization for television broadcasting is complicated, there are one or two advantages of horizontal dipoles that are not available with vertical dipoles. One is that a horizontal dipole has zero pick-up in the end-on direction, while a single vertical dipole receives uniformly from all directions in the horizontal plane. By replacing the vertical dipole by a horizontal slot, we can receive a vertically polarized signal and yet have little response in the end-on directions. (At first sight one might hope to get perfect suppression of back radiation by enclosing one side of the slot; but unless the slot is in a very large sheet, the diffraction round the edges may reduce the front/back ratio to the same order as that of a dipole with reflector or director in the optimum position; it will also cause some end-on pick-up.) In future, perhaps, blocks of flats will have provision for a television slot aerial to be incorporated in the window frames on the side of the building facing the transmitter, thus providing a good built-in aerial for those on the upper floors, without disturbing the clean lines of the building.

Another possibility is the use of a vertical stack of slots as a vertically polarized analogue of a stack of horizontal dipoles. If 6 narrow slots are fed in parallel (Fig. 4) the resultant impedance will be about 80-90 ohms, which will match into the conventional types of feeder cable. The main difficulty is the requirement for the surrounding sheet to be considerably larger than the slot dimensions. The sheet might be of wire mesh, and stretched between two masts.

The technique has now been carried a stage further by eliminating the sheet surrounding the slot and leaving only a narrow loop of conductor corresponding to the edge of the slot.[4]

The examples which have been quoted should be sufficient to show that there are many possibilities of interesting applications.

References

1 "Slot Aerials and Their Relation to Complementary Wire Aerials (Babinet's Principle)," H. G. Booker, *J.I.E.E.*, Vol. 93, Part IIIA, p. 620.

2 "Slot Feeders and Slot Aerials," C. E. G. Bailey, *ibidem*, p. 615.

3 "Resonant Slots," W. H. Watson, *ibidem*, p. 747.

4 *F.M. and Television*, July, 1947; p. 38.

Appendix

Driving-point Impedance of a Slot.

In reference [1] above, Booker has shown that if Z_1 is the impedance of a dipole, and Z_2 the impedance of a corresponding slot, then

$$Z_1 Z_2 = \tfrac{1}{4} Z^2$$

where Z is the "characteristic impedance of free space" and is equal to 120 ohms (377 ohms). Hence if the impedance of any type

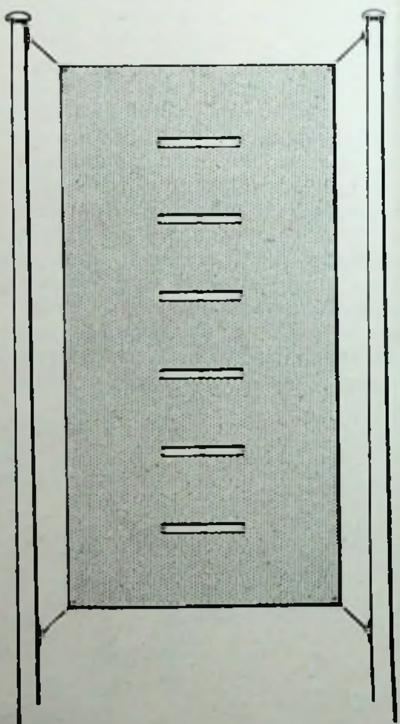


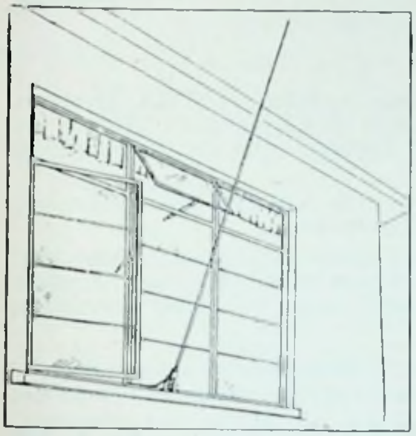
Fig. 4. Suggested stack of slots to give directional gain in the vertical plane with vertically polarized radiation.

of dipole system is already known, the impedance of the corresponding slot system is immediately obtainable from the relation

$$Z_2 = \tfrac{1}{4} Z^2 / Z_1.$$

THE "BELLING-LEE PAGE"

Providing technical information, service and advice in relation to our products and the suppression of electrical interference



Window Mounting Aerials

We have been examining some official statistics showing that of all complaints of interference reported by the public to the Post Office Engineering Department, a very large proportion can be attributed to the set user trying to do without any aerial, or at least a wire round the room.

Readers of this journal know that a good outside aerial is necessary in order to obtain a reasonable signal to noise ratio. They also know that their advice is often ignored owing to expense, trouble and difficulty of erection. All these objections can be met by the recommendation of a "Winrod"*1 window mounting aerial. The cost is low, under a pound and deliveries are ex-stock. We all know it cannot be said to take the place of a normal aerial such as we would like to see erected, but it is an out-door aerial that can be fitted at window-sill level, and as such, the signal to noise ratio must be many times better (very often 20 db.). Its more general use would add greatly to the enjoyment of radio reception and would have the effect of giving new life to an old set.

Where there is really serious interference then a full blooded anti-interference aerial such as the "Eliminoise"*2 and "Skyrod"*3 would have to be considered.

Suppression of Interference

Although regular readers of the "Wireless World" do not require to be reminded of the fact, the general public should remember that no aerial suppresses interference; it may, if correctly chosen and erected with skill, enable the listener to pick up programmes without interference, but the interference has not been suppressed.

With a "Winrod" or other aerials, mains borne-interference may be present. This can be dealt with by the use of a "Belling-Lee" set lead suppressor L.300/3*4 which is normally fitted at the plug point supplying the receiver, and ensures that the mains lead going to the receiver is free of interference. This is important as at no other time do the mains come so close to the set. An alternative arrangement is to fit a "Belling-Lee" L.1118/CT*5 to the incoming mains of the house, but this may be rendered ineffective in a terraced house or flats by re-radiation through the walls, of interference from neighbouring wiring. It would also be ineffective if the interference is caused by faulty switches or wiring inside the house.

Midland Television Service

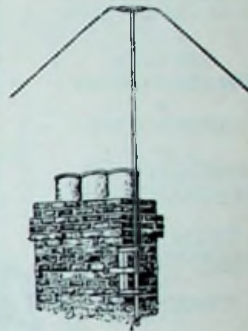
At the time of writing it occurs to us that information of the vision and sound frequencies of the Birmingham television station (Sutton Coldfield) may be released before this goes to press. Experience in the London area has shown that there would be a rush by members of the public to have aerials erected, and certainly wide-awake dealers will be anxious to announce to passers-by that they are in fact television minded. We have put ourselves in the position that within a few days of the release of the vital information, Belling & Lee Ltd. will be able to despatch aerials. We have in fact many orders already on our books.

If rumours are to be believed, the service area will be very great and the potential market enormous.

Belling-Lee Service

Most wireless dealers will be glad to give service on Belling-Lee products. To assist both the dealer and the public, we are issuing window cards to dealers so that it is clear to prospective customers that willing and knowledgeable service is available within. Every dealer cannot know all the answers, but they are supported by an efficient specialist service department who are here to give prompt attention to their queries.

If this comes to the notice of any dealer who has not yet had a card, and who is interested, will he please get in touch with us giving the name of his preferred wholesaler.



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*3 **"SKYROD"** (Regd. trade mark) vertical aerial in 3 sections for chimney mounting.

L518 Collector only. Price **£4 4s. 0d.**

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Coil-pack Modification

Two-station Switch Selection with Variable Short-wave Tuning

By L. MILLER

THE need occasionally arises for designing a "compromise" broadcast receiver; that is, a set with switch tuning for the local stations, plus a good normal performance for short-wave reception.

By a simple modification of the present-day widely used "tuning pack," these requirements are easily satisfied, the method used and described here by the writer having the advantage that no additional switching is necessary.

The experiments carried out were on a standard "Weymouth" two-circuit coil pack, and the values given apply specifically to that company's product, but the principle can easily be adapted, with a little experimentation in capacitor values, for other makes of tuning packs.

Modification Details. — The medium-wave band is fixed-tuned to the Home Service on 877 kc/s, which, in the case of the Weymouth pack, requires a total capacity of some 220 pF, the inductance of the medium-wave coil being 153 microhenrys. Allowing for 20 pF due to stray capacities, a fixed capacitor of 150 pF is wired across the medium-wave trimmer, which tunes from 15 to 65 pF. When the wave-change switch is set at the medium-wave position, therefore, the Home Service is peaked with the trimmer nearly fully screwed home. A further 150-pF fixed capacitor is, of course, wired across the medium-wave oscillator coil trimmer.

The Light Programme is picked up on the long-wave band, and a total capacity of 320 pF is required to peak the 2,000-microhenry long-wave coil to 200 kc/s. Still assuming 20 pF for strays, fixed capacitors of 250 pF are wired across the long-wave

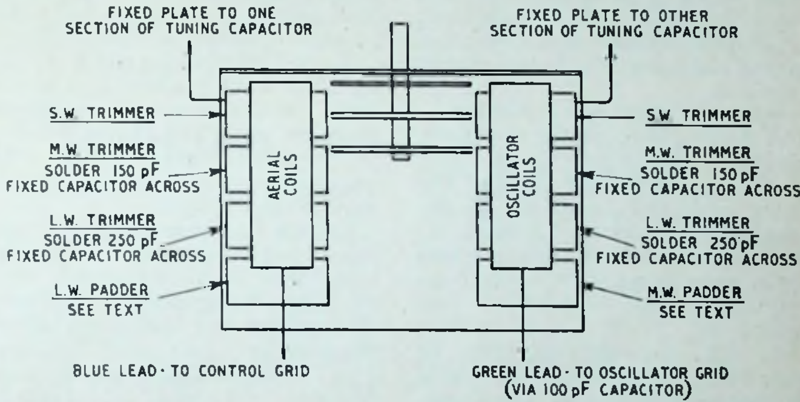

Fig. 2. Modification of the tuning assembly, as seen from wiring side.

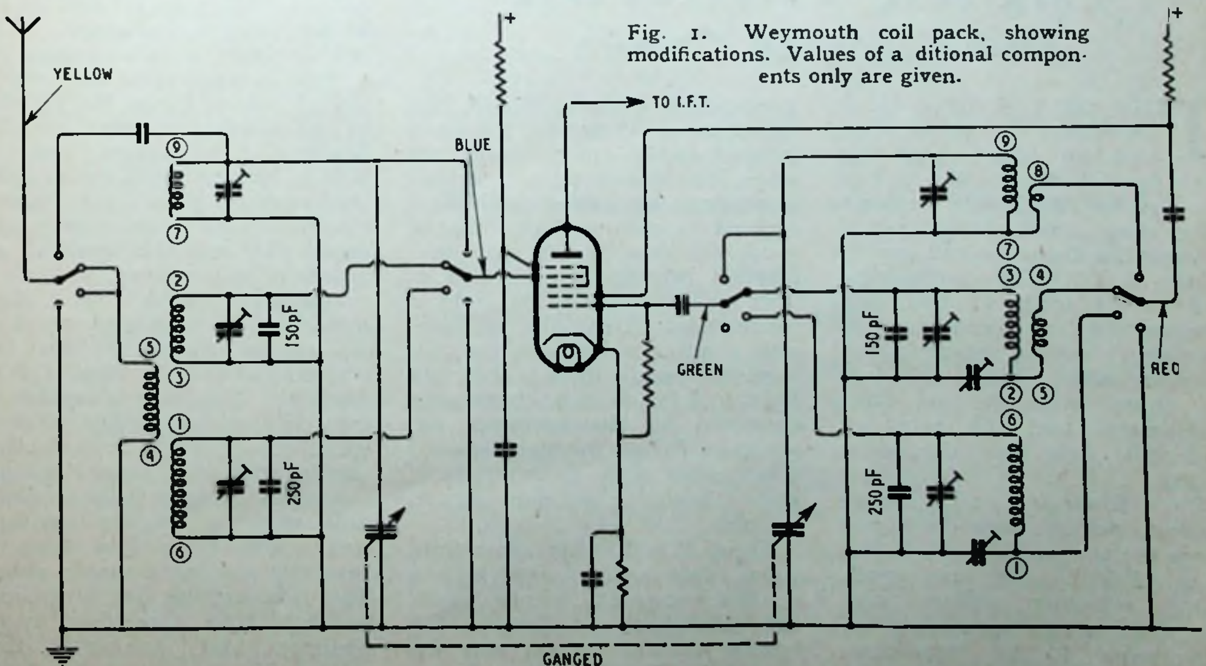

Fig. 1. Weymouth coil pack, showing modifications. Values of a ditional components only are given.

The new camera in use.

to such an extent that great depth of focus can be obtained in the picture. Since shading signals are entirely absent the camera can be turned from one scene to another without the picture being upset by these troublesome effects, which can be very irritating even when the equipment is under expert control.

The C.P.S. Emitron will enable a great saving in the electric power required to illuminate indoor scenes as well as improving the comfort of the actors, and outdoor broadcasts will be possible until dusk. Indeed, the camera will go on producing a satisfactory picture until failing light stops play in most games.

Manufacturers' Products

Checking Electricity Consumption

AN electronic kilo-volt-ampere meter, designed to give large industrial consumers a warning when the rate of consumption of electricity exceeds a predetermined amount has been introduced by Everett, Edgcumbe & Co., Ltd., Colindale Works, Hendon, London, N.W.9.

It operates on the basis of comparing the time taken to charge a capacitor through a resistance, in one case from a voltage generated by the total factory load and in another by a voltage generated in the instrument and which is the "reference."

The instrument integrates the relative time taken to charge the condensers over periods of about five minutes and if the load circuit exceeds the rate of charge of the reference it actuates a relay which can be wired into a local alarm circuit or repeated to any distant part of the factory.

Aerial Connector

THE Burgoyne aerial connector provides means for making a watertight connection between a co-axial or low-impedance balanced pair, feeder and an aerial of the dipole or other resonant type, for which wire or cage elements are employed.

It consists of a massive aluminium casting, the two halves of which are held together by 16 nuts and bolts and weatherproofed by applying a sealing compound to the joints.

Large eye-bolts fitted with ceramic bushes serve as anchorages for the aerial on the outside and the feeder on the inside, soldering tags being included to give good electrical connections. Rubber and fibre washers make watertight seatings for these bushes.

With co-axial feeders and the centre conductor and sheath joined direct to the two parts of the aerial an unbalanced system results, but this is often used quite successfully for both transmission and reception on the short waves.

The connector appears a little heavy for the purpose, weighing as it does 14½oz without the feeder. In the case of a 40-metre doublet it would probably be suspended in the centre of a 66-foot stretch of wire. However, there is a ¼in hole in the top rib for an anchorage wire if facilities allow.

The Burgoyne connector is distributed by Mail Order Supply Co., 24, New Road, London, E.1, and the price is 24/6 complete with sealing compound and full assembly instructions.

Television Pre-amplifier

AT the limit of the television service area greater amplification than that provided in the average receiver is sometimes needed and is conveniently obtained from a pre-amplifier. The type TAB, produced by Clive Courtenay & Co., of 5, Horsham Road, Dorking, Surrey, has two R.F. stages using SP41 valves. It is designed for 80-Ω input and output impedances and gives a gain of 30 db for a bandwidth of 7 Mc/s (41-48 Mc/s) so that it covers both sound and vision channels.

Designed for use with coaxial feeders it is easily connected between the aerial feeder and the receiver. It has its own internal power supply unit and is in a steel case measuring 7¼in by 5¼in by 2⅝in. There is a gain control operating by grid bias, compensated for input capacitance changes, on the first R.F. stage. The two valves are coupled by a band-pass filter and there are input and output transformers matching the valves to 80 Ω

A padder unit designed for use in conjunction with the pre-amplifier is also available. This is a resistance network of 80-Ω input impedance providing three outputs each at 80 Ω. There is a loss of some 16 db between the input and each output, so that with the pre-amplifier the overall gain to each output becomes about 14 db. It measures 1½in by 5¼in by 1½in and enables three receivers to be used on a common aerial without interaction.

Push-pull Input Circuits

Part 2.—Cathode-follower Phase-splitter

By W. T. COCKING, M.I.E.E.

ONE of the most widely used phase-splitters has the form of a cathode-follower, but with a coupling resistance in the anode as well as in the cathode circuit. It is by no means new and it preceded the cathode-follower as such, probably in time, and certainly in popularity. The earliest reference[1] to it which the writer has been able to trace is October 1935.

In basic form the circuit is the same as that of Fig. 7 (Part I), but with the input voltage applied between grid and earth instead of between grid and cathode. It is shown in Fig. 9 in its commonest form. It has the very desirable feature that the input and both output voltages all have one common earth terminal, so that it can readily beused after a circuit which has one of its output terminals earthy. The input voltage is E_{AB} and the outputs are E_{3}, and E_{12}.

If the bias resistor R_b in Fig. 9 (a) is considered as short-circuited to alternating currents it is obvious that the input voltage E_{AB} must be equal to the sum of the grid-cathode voltage e_{gc} and the cathode output voltage E_{3}. With resistive circuit elements it is also obvious that all these voltages are in the same phase. Therefore, E_3 must always be less than the input voltage by the amount of the grid-cathode voltage. The "amplification" $A_c = E_3/E_{AB}$ is thus always less than unity.

With the unearthed input circuit of Fig. 7 an amplification of 10-20 times is possible, but when one input terminal is earthed the amplification drops to less than unity. This is the price which must be paid for the convenience of the earthy input circuit. There is, however, also a considerable gain in linearity, through the negative feedback provided by R_c.

It is obvious that the circuit of Fig. 9 suffers from the same defect as that of Fig. 7 at low frequencies, which is that the output at the anode tends to increase relative to the output at the cathode because of the rising impedance of C_d, the decoupling capacitor. By analogy with Fig. 7 one would expect to obtain equality of the outputs at other frequencies when $R_a = R_c$ and this is actually the relation usually adopted in practice.

However, strictly speaking, this does not equalize the outputs, for the anode current of the valve is not the only current through R_a and R_c. There is a current through the grid leak R_g which flows through R_c and increases the cathode output. At high frequencies there are also currents through the grid-cathode and grid-anode capacitances C_{gc} and C_{ga}. These currents are not in phase with the anode current and they have the effect of making the anode and cathode output voltages unequal in amplitude and of giving them a phase difference which is not equal to the ideal 180°.

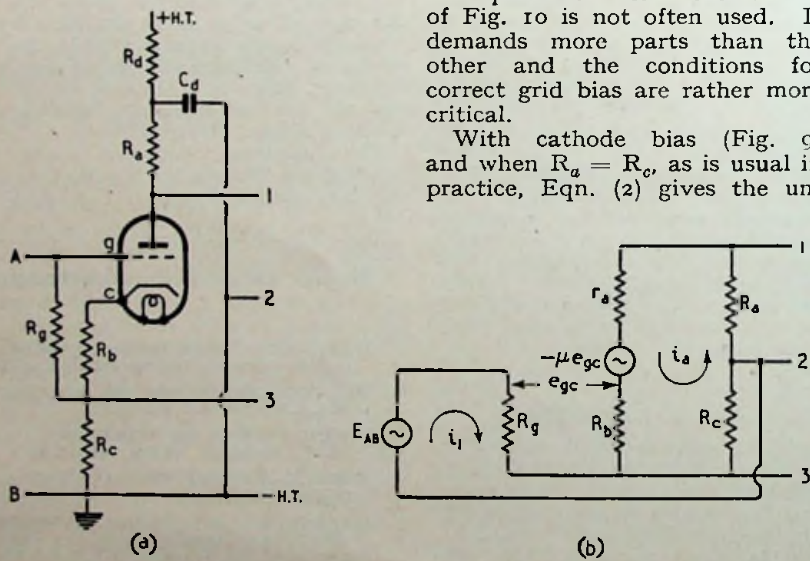

Fig. 9. The usual circuit of a cathode-follower type phase-splitter is shown at (a) and the equivalent circuit for low and medium frequencies at (b).

Over the middle range of frequencies, where the capacitances all have a negligible effect, the equivalent circuit has the form of Fig. 9 (b). The usual expression for the amplification is given by Eqn. (1) in Appendix II and it shows the cathode and anode outputs as being equal when $R_a = R_c$. It is accurate only when the frequency is such that the capacitances exercise a negligible effect and when R_g is infinitely large. This last condition is approached very closely in practice if R_g is returned to a potential divider across the H.T. supply instead of to the cathode circuit. This is shown in Fig. 10 and in using Eqn. (1) for this circuit we write $R_b = 0$, since there is no point in providing a bias resistor when the bias is otherwise obtained.

Although it is the better from this point of view the circuit of Fig. 10 is not often used. It demands more parts than the other and the conditions for correct grid bias are rather more critical.

With cathode bias (Fig. 9) and when $R_a = R_c$, as is usual in practice, Eqn. (2) gives the unbalance in the two outputs; that is, the value of this equation is the fraction by which the cathode exceeds the anode output. It is at once obvious that a pentode is likely to be better than a triode, for the numerator will be smaller owing to the higher A.C. resistance of the valve, and the denominator may well be somewhat larger.

However, the pentode is inconvenient in this circuit because of the screen supply which *must* be decoupled to cathode if the valve is not to become effectively a triode. This introduces further possibilities of error at extremes of frequency. A triode is, therefore, almost invariably used.

It is usual to make R_a and R_c equal and about equal to r_a, while R_b is rarely more than one-tenth of R_a. Under these conditions the unbalance is of the order of

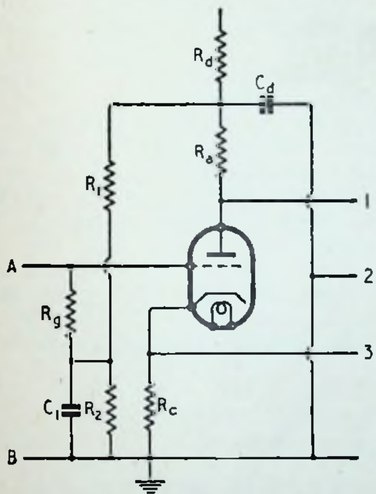

Fig. 10. A modified form of bias circuit is shown here.

$5/g_m R_g$. Now R_g can be as high as 2MΩ in most cases and g_m will rarely be less than 2 mA/V. Under these conditions the unbalance will be 0.125 per cent. In no practical case is the unbalance from this cause likely greatly to exceed this figure, so that it can nearly always be ignored. It is likely to reach practical importance only when R_g is below about 100 kΩ.

At high frequencies the equivalent circuit has the form shown in Fig. 11, ignoring the anode-cathode capacitance of the valve. If the current i_1 through R_g can also be ignored, and it has been indicated above that this usually is permissible, the unbalance is given by Eqn. (4) of Appendix II. The expression is in two parts one with and one without the operator j attached to it. The part without j indicates a difference of amplitude between the anode and cathode outputs, the voltages so compared being correctly in opposite phase. Such an error can be corrected by a subsequent balance adjustment except in so far as its frequency-dependent term is concerned.

The part prefixed by j indicates the fractional amplitude of a component of one output in phase quadrature with the main output. It cannot readily be corrected in any subsequent circuit.

In a typical practical case we may well have g_m = 2mA/V, $R_a = R_c = r_a$ = 20k Ω, and R_b = 2k Ω. If C_c = 100 pF and it is unlikely to be higher, and C_{gc} = 5 pF, the phase unbalance at 10 kc/s is 0.02 per cent. The inphase unbalance is some 0.2 per cent.

These figures are so small that they are without much practical significance. In spite of the fact that the cathode-follower phase-splitter is inherently unbalanced, the magnitude of the unbalance is so small that for all ordinary purposes in A.F. amplifiers it is quite negligible. Practically speaking, it is necessary only to make R_a and R_c equal, and also the shunt capacitances C_a and C_c, and to keep the grid leak of as high a value as possible. The capacitances C_a and C_c are usually composed mainly of the input capacitances of the two halves of the following push-pull amplifier, and so normally tend to be approximately equal. It is usually unnecessary to equalize them artificially.

As already mentioned the low-frequency unbalance is the same as with an earlier circuit and is given by Eqns. (7) and (8) Part I. It is almost entirely a phase unbalance and can be made negligible by the use of a large enough value for the decoupling capacitance C_d. Under normal conditions it should have a minimum value of 8 μF.

The input impedance of the stage is high. It is defined as the ratio of the input voltage E_{AB} to the total current flowing from the input voltage source into the input lead. Referring to Fig. 11, $Z_{in} = E_{AB}/(i_1 + i_2 + i_3)$. At low and medium frequencies i_2 and i_3 are negligibly small, and it has already been shown that $i_1 = e_{gc}/R_g$; therefore, $Z_{in} = R_g E_{AB}/e_{gc} = R_g E_{AB}/(E_{AB} - E_3) = R_g/(1 - A_c)$. By inserting typical values into Eqn. (1) it is found that A_c usually lies

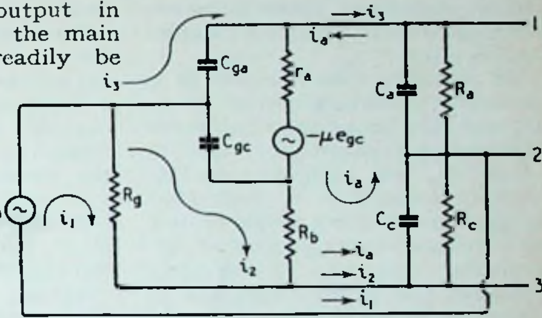

Fig. 11. The circuit equivalent at high frequencies to that of Fig. 9 (a) is given here. The anode-cathode capacitance of the valve can usually be ignored without serious error.

between 0.85 and 0.95. If it is 0.9, Z_{in} = 10 R_g, and with the usual 2 MΩ for R_g, the input impedance becomes 20 MΩ.

A similar effect occurs at high frequencies with C_{gc} as long as E_{AB} and E_{32} are nearly in phase. As A_c approaches unity, the cathode-earth voltage approaches the grid-earth voltage in value, and the difference between them, which is the grid-cathode voltage, is small, so that the current is small and the effective input capacitance from the element becomes very small and tends to zero.

The effect of the grid-anode capacitance is increased, however. In the limiting case when $A_a = 1$, if E_{AB} and E_{21} are in phase, the voltage acting to drive the current i_3 through C_{ga} is $E_{AB} + E_{21} = 2E_{AB}$, and then the effective input capacitance is $2C_{ga}$.

With normal values of components and over the audio-frequency range it is sufficiently accurate for most ordinary purposes to take the input impedance as comprising a resistance 10 R_g shunted by a capacitance $2C_{ga}$. The inequalities of, and phase errors between, the two outputs are negligible, and the amplification A_c [given by Eqn. (1)] is of the order of 0.9.

No mention has so far been made of the output impedance of the stage. That at the cathode tends

Push-pull Input Circuits—

towards that of a cathode follower whereas that at the anode conforms to the output impedance of a stage with negative current feedback. The cathode output impedance is much lower than r_a whereas the anode output impedance is much higher than r_a. In normal applications of the circuit, however, these facts are without much practical significance.

In choosing circuit values it is generally satisfactory to make R_a and R_c about one to two times the working value of r_a and to make R_g as high as possible without making it so high that reverse grid current in the valve, or surface leakages on components, become troublesome. Because the input resistance is about 10 times R_g, the value of the input coupling capacitance

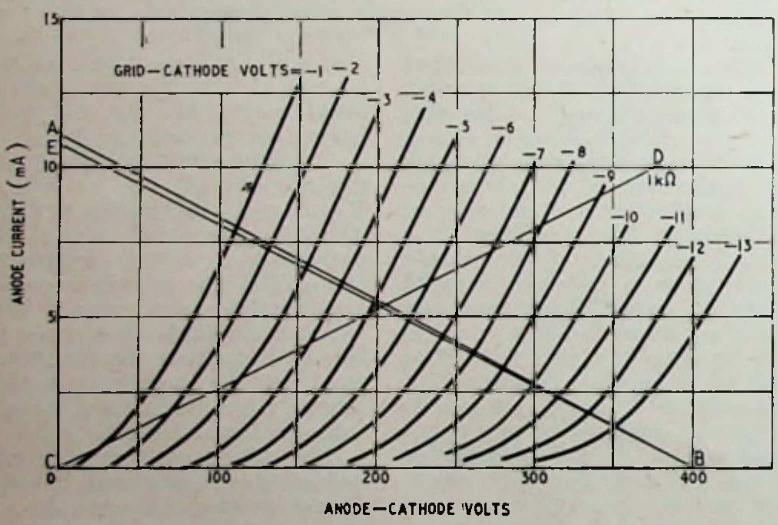

Fig. 12. **Characteristics of the EF37 valve as a triode with load lines AB (36kΩ), and EB (37kΩ) and a bias line CD (1kΩ).**

can be about one-tenth of that appropriate to the value of R_g alone.

The decoupling resistor R_d should be as high as possible consistent with obtaining the requisite output from the stage, and C_d should be large, say 8-16 μF. The bias resistor R_b must be chosen to suit the valve and its operating conditions, but is usually 1-2 kΩ.

Turning now to the output available, this is of the same order as that given by the same valve working as a normal amplifier with a coupling resistor of $2R_a$, the same decoupling resistor R_d and bias resistor R_b, and the same H.T. supply voltage, but the linearity will be better because of the negative feedback provided by R_c. The output referred to above is the total output, $E_{32} + E_{21}$.

The exact conditions can readily be calculated by the usual graphical method. The D.C. load line for a resistance $R_a + R_b + R_c + R_d$ is drawn from the H.T. supply voltage on the anode-volts/anode-current valve curves and the desired operating point is selected; the mean anode current I_a and anode-cathode voltage V_{ac} are then known. The A.C. load line for $R_a + R_b + R_c$ is then drawn through the point.

It is convenient to tabulate the anode currents and grid-cathode voltages corresponding to the intersections of the line with the valve curves and to convert them to changes of current and voltage about the mean values by deducting these mean values from them. The cathode-earth voltage is then the product of the current changes and $R_b + R_c$ while the cathode output voltage is the product with R_c. The sum of the grid-cathode voltage changes and the cathode-earth voltage changes give the grid-earth voltage changes, — the input. The dynamic characteristic is the plot of cathode output against input voltages and is the actual working characteristic taking feedback into account.

This procedure, while easy, takes some little time to carry out and it is helpful, therefore, to have a quick means of roughly estimating the output. With a triode the anode-cathode voltage cannot usually be swung below $25 + V_c/6$ volts (where V_c is the voltage across C_d) without driving the valve into grid current.

The maximum anode-cathode voltage is usually about the same amount less than the mean voltage across C_d; i.e., $V_c - 25 - V_c/6$ volts. The total swing is thus $\frac{2}{3} V_c - 50$, and the peak outputs at anode and cathode are each $(\frac{2}{3} V_c - 50)/4$. This is a very rough figure, but is useful for an initial estimation of the possibilities. If $V_c = 200$ V, for instance, an output at anode and cathode of the order of 20 V peak each can be expected. With 300 V the output will be about 37.5 V peak.

The mean anode-cathode voltage is about $V_c/2$ and the mean anode current about $V_c/2(2R_a + R_b)$. The mean cathode-earth voltage is about $\frac{V_c}{2} \cdot \frac{R_a + R_b}{2R_a + R_b} \approx \frac{V_c}{4}$. This is important, for with many valves there is a maximum permissible heater-cathode voltage and it is usually desirable to earth the heater. In the case of the EF37 valve, for instance, the rating is 100 V. There is also for this valve a maximum figure of 20 kΩ quoted by the makers for the resistance between heater and cathode, so that $R_a + R_b$ must not exceed 20 kΩ.

With such a valve therefore, V_c is limited to about 400 V and the outputs to about 55 V peak, and the mean anode current will be of the order of 5 mA. This is within the maximum rating of 6 mA.

As an example of the determination of operating conditions and to illustrate the degree of accuracy of this rough method, the dynamic characteristic will now be deduced by the accurate method given earlier. We shall take an EF37 valve strapped as a triode. Since $R_b + R_c \leqslant 20$ kΩ, we shall take $R_a = R_c =$

18 kΩ, since this is the nearest preferred value in the 5 per cent and 10 per cent tolerance ranges. The valve data places a limit of

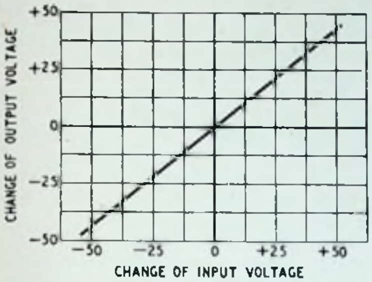

Fig. 13. Dynamic characteristics of the phase-splitter.

3 MΩ on R_g, and we can with confidence settle this at once at the standard value of 2.2 MΩ. We shall take V_c as 400 V.

The valve curves are shown in Fig. 12. As we do not know R_b at this stage we cannot draw the final load line, and we start off by drawing AB for 36 kΩ. It is obvious that the bias should be about − 6 V. With an input of 5 V peak, the grid-cathode voltage would swing from − 1 V to − 11 V and grid current should just be avoided. The anode-cathode voltage would swing from 105 V to 308 V with a mean value of 220 V. The outputs would be − 115 V and + 88 V so that there is considerable distortion. The cathode-earth voltage would be (400—220)/2 = 90 V and the anode current 5 mA, so that the valve would operate within its rating.

A slightly lower bias would be better, but it cannot be much lower without the rating of the valve being exceeded. It is convenient to use a standard resistor for R_b, so let us try 1 kΩ. We draw the bias resistor line[2] by joining the intersections of the current ordinates with the grid-volts curves corresponding to the product of the current and the resistance. This is the line CD in Fig. 12. The new load line is now for 37 kΩ and is BE, and the no-signal operating point is the intersection of CD and BE at a current of 5.3 mA. The heater-cathode voltage is 5.3 × 19 = 100 V. It is just on the rating of the valve and it would be desirable to reduce it somewhat by reducing the H.T. voltage. The grid bias is 5.3 V.

The next step is to tabulate the grid voltages and the corresponding anode currents as in columns 1 and 2 of the table. Then prepare columns 3 and 4 for the changes of voltage and current, by deducting the no-signal values from columns 1 and 2, and produce column 5 by multiplying the figures of column 4 by the total cathode resistance $R_b + R_c$ = 19 kΩ; this gives the change of cathode voltage. The sum of columns 3 and 5, in 6, gives the change of input voltage. Finally, column 7 is prepared by multiplying the figures of column 4 by the resistance R_c across which the output voltage is developed, in this case by 18 kΩ. The output at the anode is the same but with the signs reversed.

The relation between input and output voltages is shown by the curve of Fig. 13 and it will be seen that this is a straight line within the limits of accuracy imposed by rather small-scale graphical calculations. The maximum input is set by the onset of grid current, and is at a grid-cathode voltage of −1, corresponding to a grid-earth potential of + 51.8 V, the corresponding output being + 45 V. The amplification is 45/51 8 = 0.87 times.

The output of 45 V peak is somewhat below the figure of giving a preliminary indication of the output. In this case the output is limited by grid current and this indicates that a somewhat higher value of bias resistor would be better. There are, however, signs in Fig. 13 that the curve is starting to bend beyond − 50 V input and but little increase in bias resistance would be practicable.

A stage such as this will just feed a pair of push-pull PX4 valves directly but in view of the high value of H.T. supply needed there is nothing to spare for decoupling. Fortunately in this case decoupling is usually unnecessary.

The heater-cathode voltage with no signal is some 100 V, the maker's maximum rating. On full output it rises to 145 V peak. It is not clear from the published figures whether this is permissible or not. Since a large heater-cathode voltage is normally used only with a superimposed signal it has probably been taken into account.

It will be seen from this that the conditions are rather tight when the phase-splitter is called on to feed a triode output stage directly and because of this the writer usually prefers to use an intermediate push-pull stage with an amplification of the order of 10 times. The phase splitter is then called on to provide an output of 4.5 volts or so only,

TABLE

1 Grid-cathode volts	2 Anode current (mA)	3 Change of grid-cathode volts	4 Change of Anode current (mA)	5 Change of cathode volts	6 Change of input voltage	7 Change of output voltage
−1	7.8	+4.3	+2.5	+47.5	+51.8	+45
−2	7.2	+3.3	+1.9	+36.1	+39.4	+34.2
−3	6.6	+2.3	+1.3	+24.7	+27.0	+23.4
−4	5.95	+1.3	+0.65	+12.15	+13.45	+11.65
−5	5.45	+0.3	+0.15	+2.85	+3.15	+2.7
−5.3	5.3	0	0	0	0	0
−6	4.8	−0.7	−0.5	−9.5	−10.2	−9.0
−7	4.3	−1.7	−1.0	−19.0	−20.7	−18.0
−8	3.75	−2.7	−1.55	−29.5	−32.2	−27.9
−9	3.2	−3.7	−2.1	−40.0	−43.7	−37.8
−10	2.65	−4.7	−2.65	−50.4	−55.1	−47.7
−11	2.3	−5.7	−3.0	−57.0	−62.7	−54.0
−12	1.8	−6.7	−3.2	−61.0	−67.7	−57.5

55 V estimated earlier, but the agreement is reasonable since the method of estimation is a very rough one intended only for and the valve can very easily be operated well within its limits.

In conclusion, it must be pointed out that condition of R_a and R_c

Push-pull Input Circuits—
being equal, which has been assumed in all the foregoing, is one which must be closely observed in practice. It is usually desirable to employ resistors matched within about 2 per cent, but the usual tolerance of $\pm$ 20 per cent on actual value is quite satisfactory.

APPENDIX II

Referring to the circuit of Fig. 9(*b*), under the conditions that the reactance of C_d is negligibly small, that $R_g = \infty$ and that $R_a = R_c$,

$$A_c = \frac{E_{32}}{E_{AB}} = A_a = -\frac{E_{12}}{E_{AB}} = \frac{g_m R_c}{1 + \frac{R_b + 2R_c}{r_a} + g_m(R_b + R_c)} \quad (1)$$

where $g_m = \mu/r_a$ = mutual conductance.

When R_g is not infinite and $R_a = R_c$, the unbalance is

$$U = \frac{E_{32} - E_{21}}{E_{21}} = \frac{i_1}{i_a} \approx \frac{1 + \frac{R_b + 2R_c}{r_a} + g_m R_b}{g_m R_g} \quad \ldots \quad (2)$$

provided that $i_1 \ll i_a$

At high frequencies the circuit has the form of Fig. 11. Assuming that C_{ac} and R_g have a negligible effect, the unbalance is

$$U \approx \frac{i_2 + i_3}{i_a} \approx \frac{(r_a + R_b + 2Z_c)(1 + Z_{gc}/Z_{ga}) + 2\mu Z_c Z_{gc}/Z_{ga}}{\mu Z_{gc}} \quad \ldots \quad \ldots \quad (3)$$

When $Z_{gc} = Z_{ga} = 1/j\omega C_{gc}$ and $Z_a = Z_c = R_c/(1 + j\omega C_c R_c)$ this becomes:

$$U \approx \frac{2\omega C_{gc}}{g_m}\left[1 + \frac{R_b}{r_a} + \left(g_m + \frac{2}{r_a}\right)\frac{R_c}{1 + \omega^2 C_c^2 R_c^2}\right] + j\frac{2\omega C_{gc}}{g_m} \cdot \frac{\omega C_c R_c}{1 + \omega^2 C_c^2 R_c^2}\left(g_m R_c + \frac{2R_c}{r_a}\right) \quad \ldots \quad \ldots \quad (4)$$

References

[1] " Resistance Coupling for Push-Pull Amplification," by Walther Richter, *Electronics*, October 1935, Vol. 8, p. 382.

[2] " Self-Bias and the Valve Load Diagram," by W. T. Cocking, *Wireless Engineer*, December 1934, Vol. 11, p. 655.

Book Review

Klystron Tubes. By A. E. Harrison. Pp. 271 + *x*; 155 figures and charts. McGraw-Hill Publishing Company, Aldwych House, Aldwych, London, W.C.2. Price 17s 6d.

THE word "Klystron" is taken from the Greek, and is derived from the "breaking of waves in the sea," as they do whenever the wind and shallow ground force them to move along bodily. The higher portions on the crest of the wave are then moving faster than the lower portions in the troughs, with the result that the higher portions catch up with the lower ones. This produces a progressively steeper slope of the front of the wave, until finally the wave topples over, disintegrating into foam and spray.

A stream of electrons moving along in one particular direction can be made to behave in a fashion not unlike the above described wave if we superimpose a rapidly alternating velocity on the common uniform velocity of the electrons. Then slower moving groups will be immediately followed by faster moving groups, with the result that the faster ones catch up with the slower ones, eventually, and form what is called a "bunch." The rapidly alternating velocity is impressed on the stream of electrons by an electrode consisting of a pair of grids connected to and surrounded by an external circuit; this is called the "buncher." It will now be clear why a device based on a process as just described has been called a "Klystron." To complete this rough description; when the beam has been "bunched," that is to say, once there is a strong alternating component of current density in the beam, it is passed through an electrode similar to the "buncher" in every respect, but called the "catcher." There the alternating component of beam current gives rise to an alternating voltage across the grids, which can and should be larger than the voltage across the grids of the "buncher," which originally gave rise to the alternating velocity component in the electron beam.

The Klystron tube, or valve, was first described in papers by the brothers Varian and W.W. Hansen working in the Physics Department of Stanford University, California, not long before the outbreak of World War II. Later on development of the Klystron was carried on by the Sperry Gyroscope Company, a firm very much concerned with aids to navigation and blind flying and blind landing systems. Dr. Harrison, now Assistant Professor of Electrical Engineering at Princeton University, was formerly Klystron Applications Engineer at Sperry's. He is thus very well qualified to write a monograph on the Klystron, to the practical and theoretical progress of which he has himself contributed so much.

This is a book mainly addressed to the user and to the designer of Klystron tubes. By user here is meant somebody who conceives, engineers and develops, for instance, communication systems using Klystrons, or radar systems involving Klystrons — not somebody who merely takes a new Klystron out of a box and plugs it in place when the old one has failed. The book should also be of interest to those who teach modern radio engineering and who wish to have a solid and authoritative account of the principles and the theory of the Klystron on which to base their teaching. The mathematics employed in the book is of a standard implying familiarity with the elements of differential and integral calculus, and is marshalled with great care and with a view to clarity and simplicity. Though Bessel functions are employed, this should not dismay anyone who has realized that they are merely the cylindrical analogue of the familiar circular functions, to which they are indeed asymptotic in most cases.

The Klystron in all its ramifications is treated in great detail and many diagrams are given both of theoretical and practical results. A special chapter on power supplies will be very welcome to users who are new to the field, similarly a chapter on microwave measurement techniques. Design charts, a glossary of terms and symbols and a very comprehensive bibliography round off the book which should form a valuable addition to many technical libraries.

R. K.

Books Received

The World Radio and Television Annual.—Edited by Gale Pedrick. Although primarily concerned with programme matter, this annual contains a number of interesting contributions on the broadcasting organizations of various countries. Pp. 192, with many illustrations. Sampson Low, Marston and Co., 43, Ludgate Hill, London, E.C.4. Price 12s 6d.

These You Can Hear.—By W. Norman Stevens. Most of the pages in this booklet are devoted to descriptions of overseas broadcasting stations. It also includes a wavelength-frequency conversion chart. Pp. 32, illustrated. Amalgamated Short-Wave Press, Ltd., 57, Maida Vale, Paddington, London, W.9. Price 2s.

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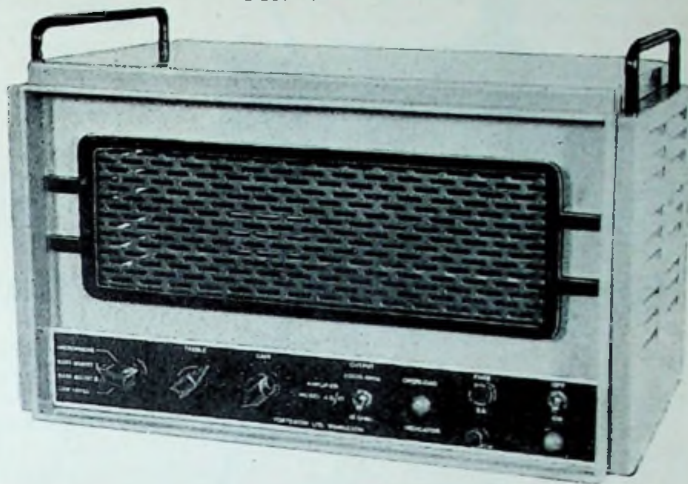

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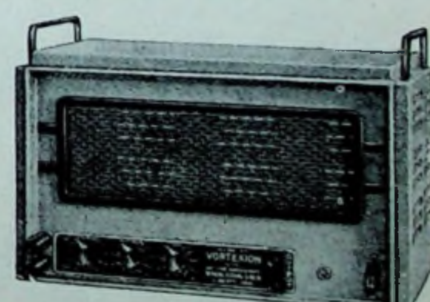

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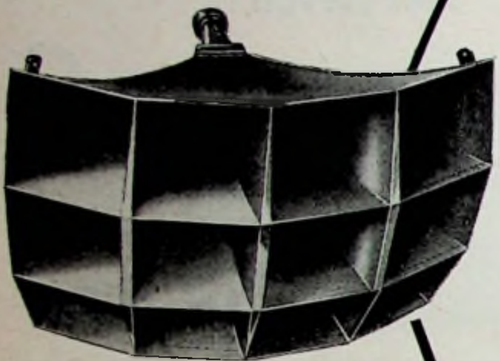

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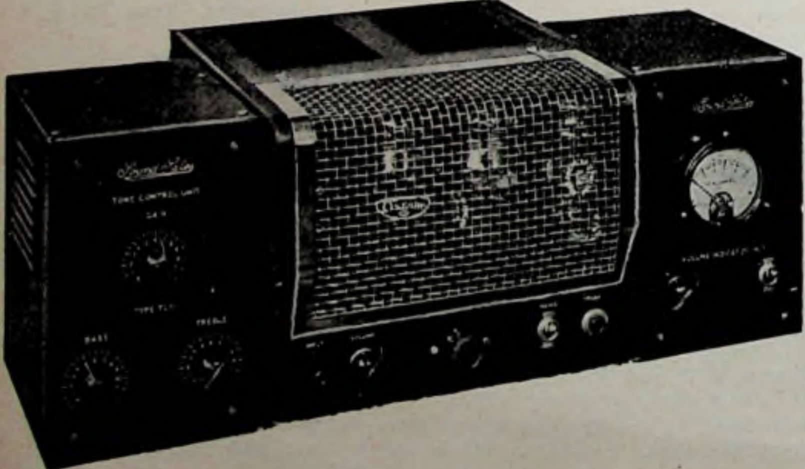

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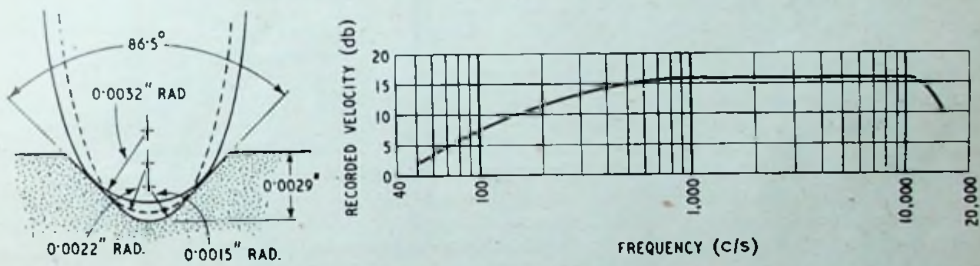
Commercial Disc Recording

Informal Lecture and Discussion at the I.E.E.

At a meeting of the Radio Section of The Institution of Electrical Engineers on 9th December, 1947, an informal lecture on "Commercial Disc Recording and Processing" was given by B. E. G. Mittell, M.I.E.E. Mr. Mittell stated that at present commercial conditions appeared to confine the disc record to the speed, diameters and groove spacing which were in common usage.

Commercial records were, perhaps, too tied to their traditional paths, and it was necessary to consider what steps could be taken to adopt improved techniques, consistent with maintaining the continuity requisite to avoid adverse reaction from the buying public. Mr. Mittell then put forward proposals for the standardization of groove and stylus shape and recording characteristics.



Proposals for standardization of groove, reproducing stylus and recording characteristic put forward by Mr. Mittell.

Discussion was particularly invited towards a measure of agreement in this country, and an exchange of views elsewhere.

With the aid of lantern slides and exhibits the manufacture of commercial disc records was described, starting with the studio and ending with the finished record.

Demonstrations were given of recorded quality and surface noise successively in the original recording, the metal "mother" and the "pressing." Recording up to 20 kc/s was also demonstrated.

The discussion which followed indicated that there was no fundamental disagreement with the proposals for standardization of groove, stylus and recording characteristics put forward by the opener. It was thought that a preliminary committee on which the principal British record producers were represented would have no difficulty in reaching tentative agreement, and that their findings could then form the basis of a British Standard.

Attention was given mainly to recording at 78 r.p.m. and it was pointed out that the proposed recording characteristic put forward by the N.A.B. of America was essentially a $33\frac{1}{3}$ r.p.m. standard; it could not be said to have met so far with universal acceptance even in the United States. Most speakers thought that some degree of pre-emphasis of high frequencies was desirable with present recording materials, but that the amount proposed by the N.A.B. was excessive and would lead to tracing distortion at the modulation levels usually recorded on commercial discs. A rise of 3 db from 3,000 c/s to 6,000 c/s and a further 3 db from 6,000 c/s to 12,000 c/s was suggested as a suitable compromise.

There was general agreement that an extended high-frequency response was worth while, provided that distortion components in both recording and reproducing systems could be reduced to a satisfactory low level. Even when the response of the reproducer, or of the ear of the listener, was restricted, the subtle improvement resulting from the recording of high, even ultrasonic, frequencies could be detected. It was thought that this might be explained on the basis of improved transient response.

The only justification for a rising characteristic, with subsequent correction in the reproducer, was the relative reduction of surface noise. Many speakers thought that the proper approach would be to reduce noise at its source by research into alternative materials for the record.

Vinyl plastics had been given extensive trials as an alternative to standard shellac mixes and had shown considerable promise. They were, however, more expensive, and preliminary market research in America seemed to indicate that the public did not yet regard the improvement as worth the extra cost. The absence of abrasive meant that more care would have to be taken to ensure a correctly shaped needle point, and specially designed pick-up movements might be needed, owing to the reduced elasticity of the groove wall. It was pointed out that the recording characteristic was intimately bound up with the properties of the record material and that a statement of mechanical impedance limits at the reproducing point should be included in any standardization of frequency characteristic.

Groove wear during playing was discussed and it was stated that sapphire points did not necessarily damage the groove walls. A record which had been played 1,000 times by a commercial pick-up with 38-gm vertical weight on the sapphire point was demonstrated by way of proof.

Opinions differed on the expectations of life of sapphire points. Some thought that wear could be detected after 50 playings, others that 2,000 playings could be obtained with a 30-gm pick-up before the width of the flat reached 0.002in. In the absence of the grinding-in process the shape of sapphire and diamond styli was of paramount importance in controlling surface noise.

The development of lightweight pickups and the demand for automatic record changers meant that "permanent" points were essential. Fears of trouble through breakage were largely unfounded. With a cantilever-sprung mounting, giving vertical compliance, sapphire points could be dropped several inches on to a disc without risk of fracture.

"j" What It Is, and How To Use It

By "CATHODE RAY"

I HAVE been asked to do something to clear up the great mystery of the small j—for those to whom it is a mystery. Apart from any mystery that may be considered to attach to mathematics in general, j seems to be surrounded by an aura of special mystery, akin to occultism and spooks. The idea is that $j = \sqrt{-1}$, which is obviously incomprehensible, seeing that no number when squared equals -1. $\sqrt{-1}$ is openly referred to in sober mathematical works as an "imaginary number"; and when the bewildered student seeks light on this it is explained to him that imaginary quantities (i.e., those in which $\sqrt{-1}$ appears as a factor) extend into some other dimension, which does exist but cannot be visualized by the human mind. Here we recall the stories of people who have suddenly and mysteriously disappeared, and the explanation that somehow they have slipped into a fourth dimension which is outside normal human experience or comprehension. At that point the student is tempted to give up.

Well, there is something in all this, but there is no need to let it hinder one from using j for solving A.C. calculations. If it worries you, you can ignore all the $\sqrt{-1}$ business. Actually, however, even its unimaginableness may be a help to those, like myself, who are unhappy about any mathematical operations that they cannot visualize.

First let me say that I am not going to attempt a complete treatise on j. There is at least one whole book devoted to it, and extensive parts of many other books; and the Editor has better use for his precious paper supply than republishing at length what can be found elsewhere. Anybody who wants to be able to handle A.C. calculations intelligently and effectively ought to get down to it and study j until its use is quite natural and familiar. There is no other way. I suggest Colebrook's "Basic Mathematics for Radio Students"; and there are some concise practical notes (Colebrook-inspired) in Hague's fine book "Alternating Current Bridge Methods." All I hope to do is to show that j is worth knowing and can be understood by anybody who can cope with elementary algebra and geometry.

What use is j, then? Students of electricity in general, and of radio in particular, start with D.C., and (unless hopelessly dim) soon find their way about D.C. circuits quite confidently. It is when they tackle A.C. that the trouble begins. It is like trying to see exactly in what order a trotting horse puts down its feet; they never keep still long enough. Even when one has become accustomed to using fixed numbers for reckoning the strength of something that is rapidly varying all the time, and has grasped the idea of two new sorts of circuit element to add to resistance, there is the difficulty that these new sorts (inductive and capacitive reactances), although reckoned in ohms, cannot just be added to resistive ohms in a straightforward sensible manner.

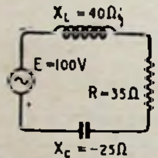


Fig. 1. Simple A.C. circuit to illustrate the meaning of j.

Take an example of the simplest possible circuit that contains all three (Fig. 1). I assume you know all about how to work out the reactances ($X_L = 2\pi f L = \omega L$; $X_C = 1/2\pi f C = 1/\omega C$). What one generally wants to know in this sort of situation is (*a*) the strength of current that will flow, and (*b*) the phase of the current relative to the voltage. If one could just add up all the ohms, $40 + 35 + 25 = 100$, apply Ohm's Law, and say the current is 1 amp, everything would be nice and easy, but unfortunately there would be no such thing as radio.

What we are told to do is first to *subtract* X_c from X_L to get the total reactance (because the two reactances are opposite, whatever that may mean), and then work out the circuit impedance, Z, from the formula

$$Z = \sqrt{R^2 + X^2}$$

In this case $X = 15\,\Omega$, so $Z = 38.1\,\Omega$ if I have done my arithmetic correctly, and the current is 2.625A. The angle of lag, ϕ—the proportion of a complete 360° cycle by which the current lags behind the generator voltage—can be calculated from

$$\tan\phi = X/R$$

or alternatively (if we have worked out Z), $\cos\phi = R/Z$ or $\sin\phi = X/Z$. They all come to the same. Here X/R is 0.4285; so, looking up a table of tangents, $\phi = 23.2°$.

Even in such a very simple example, the $\sqrt{R^2 + X^2}$ sort of thing is rather a nuisance, because one cannot do it all on a slide-rule. The squaring and the square-rooting are all right, but they have to be interrupted in the middle to do the addition. If calculations of this sort have to be done only occasionally, perhaps one can put up with that. But it is very time-wasting when there are strings of them, as there may be in working out experimental results or in designing. And this is only the simplest possible case. When it comes to working out complicated circuits, either for particular values as in Fig. 1, or generally, by means

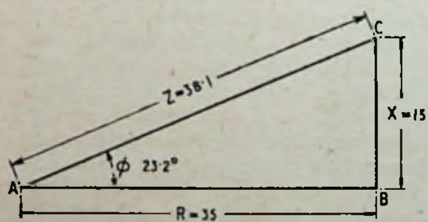


Fig. 2. The graphical method of calculating the impedance of the circuit, Fig. 1.

of algebra, and expressions of the $\sqrt{R^2 + X^2}$ kind have to be multiplied and divided and otherwise manipulated, it decidedly becomes what the R.A.F. describes as a bind. And anyway, what lies behind this awkward $\sqrt{R^2 + X^2}$?

In the days of our youth I suppose we were all confronted with the celebrated Theorem of Pythagoras, according to which, in a right-angled triangle, the length of the hypotenuse (word the Greeks had for the longest side) is related to the lengths of the other two sides in exactly the same way as the magnitude of the impedance in Fig. 1 is related to the reactances. So an alternative method of arriving at Z and ϕ is to draw a right-angled triangle with the lengths of its shorter sides representing R and X to any convenient scale (Fig. 2). Then the length of the third side to the same scale gives Z; while ϕ can be measured with a protractor. I usually measure R and X along a corner of whatever paper I am using (provided I can depend on its having been cut at right angles).

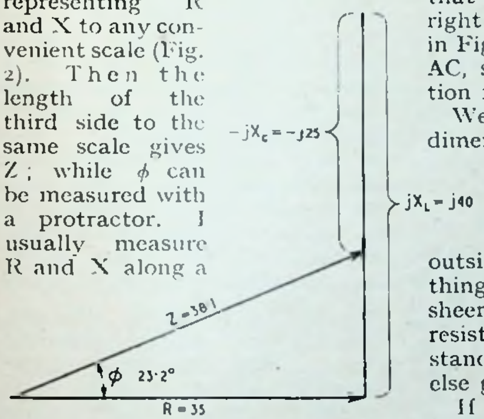


Fig. 3. Fully graphical solution to Fig. 1.

Although that is probably the quickest and most mistake-proof method for approximate results with this simple circuit, it is not quite so convenient for complicated circuits, and breaks down entirely when general forms have to be worked out.

If, then, we are likely to have more to do with A.C. circuits than occasionally computing the simplest forms, it is worth while adopting a better method.

The process of adding a number of things of the same kind (such as resistances in a D.C. circuit) can helpfully be represented by distances moved along a straight line. The usual convention is to measure the distances from left to right along a horizontal line; negative quantities are then represented by movements from right to left. The plus and minus signs are the instructions to add or subtract (in the graphical representation, to move to right or left), and the number indicates the quantity or distance. The only stipulation is that they must all be the same sort of quantity—all ohms resistance, or all volts, or all potatoes, etc.

Resistance and reactance, although both measured in ohms so that they can both be represented to the same scale in a diagram, just don't add in this way. It is a fact of nature, which can't be changed. They do combine in a certain way to make impedance; and, as we know, that certain way happens to be the same way as that by which two journeys at right angles, such as AB and BC in Fig. 2, are equal to one journey, AC, so far as distance and direction from the start are concerned.

We live in and can visualize three dimensions; but suppose there were single-dimension or D.C. creatures that lived in a straight line and were incapable of going outside or even imagining anything else. To them it would be sheer nonsense to say that 35 Ω resistance (which they could understand) added to 15 Ω of something else gave 38.1 Ω.

If we just said + 35 + 15, the carrying out of this operation would be a total movement of 50 units to the right. So it is necessary to have some other symbol of command, or *operator*, to mean that the 15 units must be in a different direction, i.e., at right angles. A very convenient operative symbol is j. So the instructions for calculating the combined impedance of 35 Ω resistance and 15 Ω reactance are written very concisely as $35 + j15$. Expressing this generally :—

$$\mathbf{Z} = R + jX$$

In Fig. 1 there are two kinds of reactance which are mutually cancelling, so can be expressed as + and —. So the more detailed formula is :—

$$\mathbf{Z} = R + j(X_L - X_c)$$

and if the whole thing were done in a diagram it would be as in Fig. 3.

You may have noticed that the **Z** was printed in special type. That is the conventional way of showing that it is not just the ordinary algebraical symbol " Z " representing *how much* there is of

"j," What It Is, and How to Use It—

a certain quantity (to wit, impedance). It is what is called a vector operator, involving direction as well as magnitude. So when you see "$\mathbf{Z}_1 + \mathbf{Z}_2 = \mathbf{Z}_3$" it does not mean that if $\mathbf{Z}_1$ and $\mathbf{Z}_2$ were 100 Ω and 150 Ω respectively, then $\mathbf{Z}_3$ would necessarily be 250 Ω. They have to be worked out fully in the $R + jX$ form.

Now as j is simply an instruction to change direction through one right angle anti-clockwise, two such instructions in succession

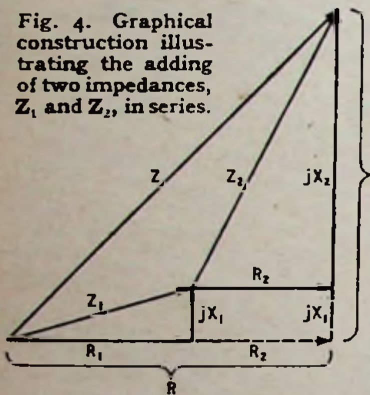


Fig. 4. Graphical construction illustrating the adding of two impedances, $\mathbf{Z}_1$ and $\mathbf{Z}_2$, in series.

must change it through two right angles, which has precisely the same ultimate result as a minus. The obvious shorthand for jj is j^2; so the operator j^2 is equivalent to $-$, and $j^2 1 = -1$; j is *not* an algebraical quantity like x or y, but the result of treating it as if it were is $\sqrt{j^2} = j = \sqrt{-1}$ is unimaginable, and therefore quite appropriate as a factor to apply to quantities which lie outside the universe of the one-dimensional D.C. people. What is more, treating j as an algebraical quantity does get the sums right. Although quantities with j in them must always be kept strictly separate from those without, the algebra often results in two j quantities being multiplied together, giving a j^2. When that happens, it is quite allowable—and very convenient—to substitute -1 for j^2, and so bring the quantity concerned over on to the ordinary rational side of the iron curtain.

I shall give an example of this shortly; but in the meantime it would be as well to be quite clear that all j or up-and-down quantities can be combined together by the usual laws of algebra or arithmetic (so long as the label "j" is not allowed to come off until it is squared), and of course the same for the non-j quantities. So the impedance of any circuit, however complicated, can be expressed in the general form

$$\mathbf{Z} = R + jX$$

in which "R" and "X" may stand for more or less elaborate expressions.

The simplest possible case, after Fig. 1, is a circuit in which there are two impedances in series. Call them $\mathbf{Z}_1$ and $\mathbf{Z}_2$, and their component parts R_1, X_1, R_2 and X_2. (X_1 and X_2 may of course themselves be combinations of positive and negative reactances.) Then the impedance of the whole lot, $\mathbf{Z}$, is

$$\mathbf{Z} = \mathbf{Z}_1 + \mathbf{Z}_2 = (R_1 + jX_1) + (R_2 + jX_2)$$

Sorting these out,

$$\mathbf{Z} = (R_1 + R_2) + j(X_1 + X_2)$$

which can be renamed

$$R + jX$$

where $R = R_1 + R_2$ and
$X = X_1 + X_2$

This ought to be almost painfully obvious, but in case it isn't, the whole thing should be quite clear if it is done graphically as in Fig. 4. Here it is all the same whether the whole impedance, $\mathbf{Z}$, is arrived at by adding the two separate impedances $\mathbf{Z}_1$ and $\mathbf{Z}_2$, either as wholes, or in steps (R_1 to the right, jX_1 up, R_2 to the right, jX_2 up) or after classification (R_1 to the right, R_2 to the right, jX_1 up, jX_2 up).

"So what?" you say. Well, provided that it was obvious to you all along that when adding two—or any number—of impedances in series the resistances and reactances could be separately added to reduce the circuit to only two elements—one omnibus resistance and one omnibus reactance—then the above does not carry you any further, except perhaps to emphasize the basic principle of combining impedances in the j manner. Once you have got the whole impedance into the form

$$\mathbf{Z} = R + jX$$

then the *magnitude* of $\mathbf{Z}$, which is denoted by Z, can be calculated in the usual way from

$$Z = \sqrt{R^2 + X^2}$$

and the phase angle from

$$\tan \phi = X/R$$

Actually, however, one often doesn't bother to do so. To specify any impedance completely, *two* things are necessary. They can be the magnitude and phase angle, $Z/\underline{\phi}$; for example 38.1 Ω/23.2° in Fig. 1. But seeing how convenient it is to work with j (if you don't see yet, I hope you soon will), it is often better to adopt the alternative method, $R + jX$, and to say that the impedance in Fig. 1 is $35 + j15$. This is the form in which some types of impedance-measuring instrument read. There are still other forms, such as the sin-and-cos form; but that is another story. The choice is purely a matter of ease and convenience, just as the settling of a debt may take the alternative forms of a bar of gold, a cheque, a shipment of coal, or an entry in a book. Similarly, there are standard methods of converting from one form to another. For impedances, the $R + jX$ form is becoming increasingly popular.

As you are no doubt bursting to point out, using j does nothing to simplify the Fig. 1 calculation if you have to find the impedance in the $Z/\underline{\phi}$ form. It only provides an alternative form that cuts out the $\sqrt{R^2 + X^2}$ work. But try a slightly less simple example—Fig. 5. Here there are two impedances in parallel. Now the beauty of the j method is that by substituting $\mathbf{Z}$'s for R's the ordinary D.C. circuit principles—Ohm's Law and all that—can be used for

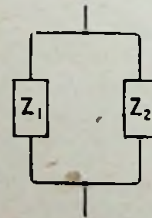


Fig. 5. General case of two impedances in parallel.

A.C. circuits. The rule for resistances in parallel is

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

which easily reduces to

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

In the same way

$$\mathbf{Z} = \frac{\mathbf{Z}_1 \mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2}$$

To work this out for completely general $\mathbf{Z}_1$ and $\mathbf{Z}_2$—that is to say, each being any possible combination of R and X—is admittedly quite a lengthy job by this means, and the final formula is complicated. For the sake of clearness, take the special case of it shown in Fig. 6, where the circuit is supposed to be tuned to series resonance by making $X_1 = -X_2 =$ (say) X. R_2 is zero; so call R_1 just R.

Then $\mathbf{Z}_1 = R + jX$

$\mathbf{Z}_2 = -jX$

So $$\mathbf{Z} = \frac{\mathbf{Z}_1\mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2} = \frac{(R + jX)(-jX)}{R + jX - jX} = \frac{X^2 - jXR}{R} = \frac{X^2}{R} - jX$$

This means that although in the loop circuit, in which all three elements are in series, the two reactances cancel out leaving only R, as a parallel or rejector circuit **Z** is *not* a pure resistance. It is, in effect, a pure resistance, in magnitude X^2/R, *in series with* a capacitive reactance which is the same as X_2. Generally in radio circuits R is very small compared with X, so X_2/R (the so-called dynamic resistance) is very large compared with X, and the $-jX$ can almost be neglected.

Compare the above very easy working with the old $\sqrt{R^2 + X^2}$ way. First it would be necessary to transform X_1 and R_1 into their parallel equivalents; then combine the resultant reactance with

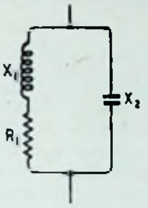


Fig. 6. Special example of impedances in parallel, in which X_1 is made equal to $-X_2$. The j method gives a quick solution.

X_2; and then transform the resulting X and R into series equivalents.

That is not to say the j method is always the best. Experience shows which method to choose. But even apart from its usefulness for such calculations as the above, it is worth while as a link between algebraical and graphical work, and generally for making things more intelligible. And I have kept to only one part of j-work—impedances. One really ought to start with currents and voltages, and do the thing properly under the heading of "Vectors." But, as I said, my function is not to duplicate what the books say; only (this time) to try to show that j is useful and not unreasonably hard to understand.

Valve Symbols

THE British Standards Institution (28, Victoria Street, London, S.W.1) has recently issued a pamphlet (B.S.1409: 1947) giving standardized letter symbols for reference to electrodes and quantities relating to valves. All symbols for elements or quantities inside a valve are small letters, while those referring to externals are capitals; thus, r_a refers to the internal A.C. resistance while R_a is used for external resistance. Similarly, c_{ag} is the internal anode-grid capacitance but C_{ag} any external capacitance across the same points. Double subscripts are used, as above, to indicate the points between which the element is effective.

The valve electrodes are indicated by small initial letters of their names, as "*a*" for anode, with the exception of the cathode which is designated by "*k*." This is Continental usage and is strange to British eyes; it is doubtless necessitated by the use of "*c*" for capacitance.

The sections of multiple valves are labelled by letter subscripts, as "a_d" for diode anode, while the halves of double valves are indicated by single and double "ticks" as, k', g', a', k'', g'', a'', for a double triode. The various grids of multi-electrode valves are indicated by number subscripts in order outwards from the cathode. B.S.1409 costs 2s.

"High-quality Amplifier Design"

A Correction

In Fig. 3 of this article in last month's issue, the anode load of V_2 should be 47 kΩ, and not 4.7 kΩ as shown.

The author recommends the addition of a 47-pF capacitor across each of the 0.47-MΩ resistors feeding the grid of V_2, especially if a screened lead is used to feed this grid. The addition recommended makes for better balancing of the circuit at high frequencies, with slight reduction of distortion and slightly less phase-shift.

Unbiased

By FREE GRID

Is Spookology Spurious?

I DARE say that some of you may have heard of the famous rectory at Borley, in Suffolk. It is hard by the ancient town of Sudbury where Mr. Pickwick laid down the principles which he deemed it expedient to follow whenever he found himself in the midst of an excited election crowd, as he did when he and his followers were in that famous old borough.

It is not with any desire to adopt his advice of shouting with the crowd that I raise the subject of Borley rectory. If recent reports are to be believed, it is still known as the most haunted house in England, as it was when I recollect it in its heyday some thirty or more years ago; and this, mark you, even though it has since been destroyed by fire and razed to the ground. What surprises me is that although it has been visited by Professor Joad and by sundry B.B.C. officials, nobody seems as yet to have had the gumption to adopt modern scientific research methods, such as radar, to elucidate the mystery.

A paranormal entity.

They have been content to rely for their observations on the human senses to detect the presence or otherwise of what I see are now described as paranormal entities—these being the same things as you and I in our vulgar unscientific way used to call ghosts.

It has already been pointed out in *Wireless World* (page 174, May, 1946) that American observers have shown that these so-called paranormal entities are opaque to radio waves of certain length and, therefore, give an indication of their presence on the radar screen. This new application of science is known as radio-psycheuresis, and the specially designed radar apparatus which it employs is called a radio-psycheurlator.

It looks, therefore, as if the duty of being the first to use this new radio aid to ghost detection will devolve on me. Quite frankly I don't intend to go alone, not because I am afeared of paranormal manifestations but simply because my unsupported testimony might be received with incredulity in scientific circles. In any case, I shall want somebody to attend to the diesel-driven generator for supplying power to the radar apparatus. Any reader who is prepared to share my damp and dismal vigil should, therefore, get in touch with the Editor.

Rationalized Radio

IT is astonishing how difficult it is to argue with some men. If you are not very careful they will, when a discussion threatens to go against them, adopt the tactics of a woman or a cross-examining counsel and browbeat and confuse you to such an extent that you will find yourself using your own arguments to contradict yourself. You finally end up by not knowing whether you are for or against the thing you are arguing about. I well recollect this happening to me some years ago when giving expert evidence for the Crown in a well-known murder trial which ended in the jury stopping the case and the acquitted prisoner giving me the inside story of the crime as a token of his gratitude.

The reason that I mention this now is that I have recently had a very heated argument with a man who wants to adopt what I call totalitarian methods in broadcast listening although he terms it the rationalization of radio. He points out, quite rightly, that the function of a radio receiver is fundamentally the same as that of a transmitter. Both are reproducers, their function being to give out a faithful rendering of what is put into them, be it good, bad or indifferent from a musician's point of view. My friend further states that this goal of perfection is not, and cannot be, attained with our present knowledge. Various deliberate distortions, such as contrast contraction, have to be introduced in the transmitter and

Expert evidence.

these ought to be carefully ironed out and counterbalanced in the receiver.

All this seems obvious, but where I fail to agree with him is in his methods of carrying out his ideal. He suggests stopping the sale of ordinary radio sets and having special receivers issued by the B.B.C. These would be designed by their engineers to meet the characteristics of the corporation's transmitters. The sets would be serviced and controlled by the B.B.C. in much the same manner as our telephones are supplied and looked after by the G.P.O.

This is, of course, sheer radio totalitarianism and, as I pointed out to my idealistic friend, if we submitted to it we might just as well abandon the radio link altogether and get the B.B.C. to supply us with carrier-current programmes over the lighting mains. Instantly he agreed with me and, before I knew where I was, I found myself being congratulated on being a convert to the carrier-current system. It is, of course, this sort of technique in argument which is so dangerous and so strongly akin to political platform methods where both sides speak with such a mixture of sincerity, conviction and low cunning that you end up by not knowing what to believe and caring less.

LETTERS TO THE EDITOR

Is H.F. Broadcasting Worth While? ✦ F.M., A.M., and Interference ✦ Impregnation of Windings ✦ Awkward Components

Short-wave Broadcasting

THOMAS RODDAM'S article, "Short Waves for Pleasure," in your October issue, together with the statement of Brigadier-General Stoner, Chief Communications Engineer, United Nations, that of the 300,000,000 people throughout the world who daily listen to some form of broadcasting less than 3 per cent hear any form of direct short-wave broadcast, prompts me to write about the appalling waste of frequency channels, not to mention public money, that is being expended on short-wave broadcasting throughout the world.

Under present chaotic conditions the reception of a short-wave station is a grimly serious business for which the ordinary broadcast listener with his single (16-50 metres) short-wave band receiver is, to put it mildly, hopelessly ill-equipped, and when a station *has* been tuned in the programme value is nil unless the wanted station happens to be the strongest signal in the band at that geographical point.

Not satisfied with the truly appalling chaos that exists, the broadcasting authorities of nearly every country in the world whose treasury can squeeze the necessary funds from the taxpayers are striving to increase their transmissions in every language and dialect with which mankind is afflicted. Most of the peoples speaking these languages, incidentally, are too poor to eat, let alone afford the doubtful luxury of a radio receiver capable of receiving these transmissions.

Could anything be more insane? The magic of the word "propaganda" has so allured all the ruling powers-that-be in the world that this senseless waste of public money, labour, and communication channels must go on. National prestige would suffer otherwise, forsooth! But so long as the B.B.C., for instance, can produce its odd letter or so of enthusiastic appreciation from an eccentric Kaffir on the African veldt, I suppose the end will justify the means.

Surely it is time for a general stocktaking of the whole field of short-wave broadcasting, to assess its value to the community in terms of the enormous expenditure of money, time and valuable technical and other labour. In this it is the duty of radio technicians to take the lead in arousing governments to a sense of responsibility in this matter.

The technical press and the radio engineering profession can discharge its duty to the people at large by ceaselessly "plugging" the present mutually unsatisfactory state of affairs. Some day the truth will penetrate the deep recesses of Portland Place, Whitehall, and (who knows?) even beyond the Oder and the Statue of Liberty.

F. W. T. ATKIN.

London, W.9.

"F.M. and Monopoly"

A LETTER under this heading in your January issue contains the statement: "Only long overdue legislation (already existing in certain European countries) prevents a *selfish minority* from being obliged to keep offending apparatus in good order and fit suppressors—the cost of which would be quite small."

This frequent complaint about "selfish minorities" and the like incites me to ask if your correspondents can tell us, more precisely, what they mean by these expressions. And do they really believe that the fitting of suppressors to a limited range of apparatus—amenable to measurement and control—will, alone, suffice to eliminate the more prevalent types of interference.

As to the existence of legislation in other countries; can anyone name a country in Europe (or elsewhere) where the listener, intent on good reception, has, on

Letters to the Editor—
average, better opportunities and service than is available in these islands?

Lastly: whilst the fitting of suppressors and the elimination of interference is most desirable, it may be that the cost, if applied to all *potentially* offending apparatus would press too hard on our national economy to be sanctioned at the present time. This, I must add, is personal opinion, and it may be wrong, but, at least, it seems a reasonable assumption, having regard to the many other cuts and restrictions in national expenditure.

Rugby. T. H. KINMAN.

THE focal point of W. H. Cazaly's letter on F.M. appears to be a rash presumption that "the great majority of the listening public do not like, or want, super-high-fidelity reproduction."

As we have never had the chance of hearing such reproduction it is astonishing that Mr. Cazaly can glibly state that we don't like it. If he pauses to think for a moment, he will, no doubt, admit that our receivers invariably employ circuits designed, in the interests of selectivity, to remove most of the high, and all the very high audio frequencies. Many and various attempts have been made, usually by the use of electrical and mechanical resonances, to replace, in the amplifier and speaker, what has been carefully eliminated in the tuned circuits. This does not give fidelity, any more than do gramophone records reproduced through "level" amplifiers.

It is true that there is very little to choose between wide-band A.M. and F.M. so far as the re-creation of studio sound is concerned. It is in the matter of interference that F.M. scores so heavily, for, to make A.M. as silent a service, all electrical apparatus, including lighting switches, would have to be fitted with suppressors. This is impracticable. In addition, F.M. can deal effectively with thunderstorms and atmospherics, while A.M. and legislation most certainly can not.

During the last few weeks I have been listening to the B.B.C. experimental F.M. transmissions from Alexandra Palace on an unpretentious but carefully home-made receiver. The quality is astonishing, and the silent background quite uncanny. Before I am accused of living in Alexandra Park let me say that I am using an indoor dipole 25 miles from the transmitter, which, I believe, achieves a mere half-kilowatt in its aerial.

It is really rather frivolous to suggest that one will be forced to listen to the National F.M. service exclusively. There is no unduly difficult or expensive problem involved in incorporating F.M. in an all-wave receiver, although, to cover foreign listening, an additional short-wave band would probably suffice. Incidentally, it is cheaper to install a F.M. transmitter than to provide an equivalent A.M. coverage.

Obviously, the development of such a service will be delayed by present economic difficulties, but I sincerely hope that this country will proceed, as rapidly as possible, with a system which seems to offer the nearest approach to perfect quality in broadcast reception currently available.

S. C. BARRELL.

Ashstead, Surrey.

Television Standards

IN his references to television in his article "Broadcasting Jubilee," in your December issue, P. P. Eckersley has surely overlooked the fact that television is essentially an entertainment for the home.

Criticism of television by non-technical viewers, is not on account of the definition or the size of screen, but rather on account of the lack of colour. So many items in television broadcasts need colour; ballet, opera, exhibitions of pictures for example. For home reception a 600- or 700-line picture in colour would I think be entirely satisfactory.

The "electronic distribution of films" or cinema television, is an entirely separate subject. Possibly 1,500 lines would be required for this, but the problem is one for the cinema industry.

To lay down standards for home television one must take into account the sort of programmes transmitted and I would say that the B.B.C. has certainly sketched the general pattern of the television art.

The cinema is not a yardstick for the measurement of the "goodness" of a television picture. Even the Government Committee made this error.

G. H. L. THOMAS.

Herne Bay, Kent.

Impregnated Windings

IN a letter to the Editor of *Plastics* (Dec., 1947, issue), C. R. Pye expressed concern at the attitude of British radio manufacturers towards the impregnation of windings. There are some statements and criticisms in this letter which cannot be allowed to pass unchallenged.

Mr. Pye states, correctly, that few of the transformers and chokes exhibited at Radiolympia were impregnated. He infers, incorrectly, that the same is true of the production models. The omission of impregnation for exhibition purposes improves appearance, and enables the standard of workmanship to be seen more clearly. No other reasons need be sought.

Mr. Pye "made enquiries at a technical level," and was told that "manufacturers were not convinced of the benefits of impregnation." In view of Mr. Pye's remarks on p. 625 of the same journal, this is understandable. Nevertheless, he proceeds to accuse the industry of sabotaging the export drive by this attitude, with many details of the perils which beset "dry" windings.

He is apparently unaware of the policy of designing special export models, speaking of "exportable commodities [which] are unsound technically." He states with more courage than wisdom: "if components can be kept free from permeation of moisture they will function satisfactorily." One would wish this were true. Personal experience of tropical conditions has shown that this is a comparatively minor point. Mr. Pye refrains from stating the effect of impregnation on fungoid growth and insects. He does not mention that there is no impermeable impregnant, thus removing all reason for using the process.

The truth is that impregnation is used by all reputable manufacturers, the main advantage being increased mechanical rigidity. It is very doubtful if it would ever be used for moisture protection alone. There are many more efficient methods of achieving this, such as immersion in bitumen. Examples of this were shown at Radiolympia, but were not readily recognizable as transformers and chokes by those unfamiliar with such gear. R.F. coils are generally waxed, for similar reasons. The resulting "tropicalization" is of an adequate standard.

Mr. Pye is a varnish chemist. We may therefore forgive electrical inaccuracies. We cannot forgive unjustified criticism based on such inaccuracies. If Mr. Pye can produce an impregnant that will not react with enamel insulation, while retaining a low permeability, its adoption will follow without any encouragement.

D. W. THOMASSON.
Electronic Applications
Research Laboratory, Exeter.

Components for Amateurs

MAY I ventilate in your columns a grievance amateurs hold against manufacturers of certain larger components—notably paper smoothing capacitors, chokes, transformers, etc.—who, with few exceptions, insist on building these units upside-down. The designs, with their fixing flanges at the bottom and terminals perched at the top, are obviously relics of the old "breadboard hookup" days.

Even the not-so-modern amateur uses a metal chassis as the basis of his set and likes to keep his wiring ship-shape underneath. Valve manufacturers realized this many years ago but the fact seems to have escaped designers of other components with a result that wiring keeps popping in and out of the chassis and trailing up and down components like a creeper on a trellis.

Perversely, these unshrouded terminals held magnificently aloft are invariably high potential spots which make running adjustments to pre-sets quite unnecessarily precarious.

With components made the right way up; i.e., with terminals protruding into the chassis at the flanged or fixing end, there is no reason why anything on the upper deck should be dangerously live and the improvement in appearance and efficiency is, surely, obvious.

S. JOHNSON.
Twyford, Berks.

Television and Thunderstorms

IN connection with Mr. Hill's experiences (your Sept. issue) some observations which I made at radar stations in Denmark may be relevant. The frequency mainly used there was 600 Mc/s, and the greatest distance from which echos normally could be received was about 30 miles. Under certain weather conditions this range increased for a short time to 150 miles and more.

The reason for this increase was obviously layers of different temperature in the atmosphere ("inversions of temperature"), which refracted the waves back to the ground, so that they followed the curvature of the earth over a long distance. Similar conditions in the atmosphere may also account for the extremely good reception of television outside the local zone just before a thunderstorm.

OTFRID REIGER.
Vienna.

MANUFACTURERS' LITERATURE

ILLUSTRATED leaflet describing complete equipment for visual alignment of R.F. and I.F. circuits from Erskine Laboratories, Scalby, Scarborough, Yorks.

"Mullard Valves for Industry and Communications," Part 1, including valves up to 25 watts dissipation supplied for electronic and telecommunication equipment, from Technical Publications Dept., Mullard Wireless Service Co., Century House, Shaftesbury Avenue, W.C.2. Circulation restricted to professional equipment designers.

Catalogue of photoelectric cells from Radio-Electronics, St. George's Works, Merton Road, Norwood Junction, London, S.E.25

Illustrated leaflet describing Export Model 127 car radio receiver for short, medium, and long waves from Romac Radio Corporation, The Hyde, Hendon, London, N.W.9.

Technical details of transformer turns-ratio bridge (Type 307B) and oscillator detector units (Types 403A and 404A) from Dawe Instruments, Harlequin Avenue, Great West Road, Brentford, Middlesex.

"Cossor Gee Mark III," Part 1, General Description, from Cossor Radar, Wren Mill, Chadderton, Lancs. Available to air operating companies, service organizations, etc.

RANDOM RADIATIONS

By "DIALLIST"

Interference

ONE comes across some queer faults! Here's one that gave me a spot of bother. For some time it had been noticed that wireless receivers working in the house had occasional fits of noisiness. Neighbours were mentally anathematized for using radiating apparatus; I felt quite sure that nothing in my house could be to blame. One evening a fuse blew. Obviously it "didn't orter," for it was a 5-amp fuse and the circuits served by it never carried more than 1 amp; still, fuses do "go" sometimes owing to old age and corrosion and as there was no further trouble when it was replaced nothing more was thought of it. A few evenings later the noisiness of the receivers increased and remained incessant. I decided to investigate next morning, just to make certain that nothing was amiss with lighting or power circuits, all of which, by the way, are of lead-covered cable, with a sheath-to-earth resistance well under the regulation ohm. Fate was kind to me in three different ways when I switched off at the mains. First of all, the old-fashioned distribution box, put in before my time, has separate switches in the phase and neutral legs of the main lighting leads; secondly, I chanced to switch off the neutral first; thirdly the lamp near the box happened to be alight. You can imagine that when it *stayed* alight with the neutral lead broken I did a bit of quick thinking. Clearly, a dead short from neutral to earth. But where? There are thirty-eight outlets in the house and, as you'll gather, no small length of wiring.

Sleuthing

It was a fault that might have taken ages to locate but for the fortunate fact that soon after I came into the house I'd reorganized the out-of-date fusing system, arranging matters so that groups of three, four or at the most five lighting outlets were served by separate sub-circuits, each with 5-amp fuses in both legs. By removing these fuses, one pair at a time, with only the phase lead switched on at the mains one should be able either to track it down to an individual sub-circuit, or to exonerate the lighting crcuits altogether. Recalling the blown fuse of some days before, the first bridge I removed was that which had held it. The lights on both sides of it went out. To verify, I replaced it and tried the other fuses pair by pair. Lights on the mains side of all of them remained glowing. The power circuits also gave negative results. The faulty sub-circuit served five outlets. A careful inspection of the visible parts of them disclosed nothing wrong, so with a sigh of resignation I rolled back the carpet, found the required floorboard by the tell-tale marks of the "electricians' chisel" and got it up. With its six pairs of leads, the junction box was quite a little Clapham. Better have a look inside. I pulled off the cover before switching off and as I did so the lights went out.

Cause and Effect

Have you guessed yet what was causing the trouble? Let me tell you before you have your final shot that all the "Scruits" were in place, with their skirts well over the insulation in every case. Switching off, I verified every connection and there were certainly no uncovered bits of the bared ends. I knelt, thinking it over and twiddling the metal cover in my hands. Suddenly I let fly a naughty word and transferred a cut and bleeding finger to my mouth. What had bitten me was the jagged edge of a small hole which someone had for some unknown reason made in the cover—I remembered then that the box was an old one which I had transferred from another place when wiring up those circuits. Careful examination showed a cut that the jag had made into the insulation of a neutral lead. Now, why was it over five years before the insulation was cut right through? That time had passed between the installation of the box and the first signs of the fault. Why, again, was the fault intermittent? It obviously was, for radio sets were only occasionally noisy until the final evening. And not long before that a Megger test had given highly satisfactory readings. I believe the reason is this. The junction box was fixed to a joist, which probably moved slightly not only when people walked over the floor, but also as the wood expanded and contracted under the influence of weather conditions. The little jagged piece eventually *sawed* its way through the rubber and cotton. When it had done that, movements of the joist sometimes made and sometimes broke the short that had caused the trouble. A neutral-to-earth short is a fault that may easily occur in a house and remain unsuspected, particularly if the wiring is old It might not be dangerous, unless a phase-to-neutral fault occurred at the generating station. But it is certainly a most undesirable state of affairs and it may be the cause of mysterious fuse-blowings and of noisy radio reception, if of nothing worse. Hence, should such symptoms occur and other expedients fail, tests on the lines described may be profitable.

□ □ □

The Steel Bars

MANY thanks to the numerous readers who sent in answers to my very easy magnet problem (December issue): how can you produce a pair of steel bars of exactly the same size and appearance, one of which is magnetized and the other not, such that the magnet cannot be detected at once by placing them in T-formation. The solution is, of course, to magnetize one so that there are similar poles at either end and an area of opposite polarity in the middle. There is then marked attraction between the two, no matter which is the cross-piece and which the stalk of the T. Special thanks to one reader who points out an unpardonable piece of loose wording on my part. I wrote that if the bar magnetized so as to have its opposite poles at either end were used as the cross-piece and the non-magnet as the stalk, there would be no attraction between the two. I should, of course, have written "minimum attraction," for it is only at a *point* that the force is zero, the end of the other bar covers an area.

□ □ □

Teleciné Pictures

REFERRING to my suggestion last month that "Teleciné Review" might include films transported by air from distant places a third correspondent writes: "Why not transmit the images to this country, frame by frame, by ordinary still-picture radio methods, reassemble them into a film and televise that? The time-lag would then be greatly reduced." There may be something in the idea if a means of speeding up still picture transmissions is evolved; but I hardly think it could be worked with present systems. So far as I remember from my last visit to Cable & Wireless, the time needed for transmitting a 5in × 4in picture is eight minutes. Suppose that prints of 12 consecutive ciné pictures are pasted up into a rectangle of about that size, we could send and receive them in eight minutes. The definition would, of course, be rather poor, since each individual frame would be made up of only 1/12th of the total number of picture points. Still, people might not be over-critical about pictures of distant events, televised a few hours after their occurrence. To make things easy let us suppose that 25 individual pictures could be transmitted and received in 16 minutes. Then the time required for transmitting the 25 × 15 images needed for a 15-second news flash would be 15 × 16 minutes = 4 hours, assuming that there were no delays or interruptions of any kind. As many of the radio picture services are already working at their maximum capacity it might be a matter of some difficulty to secure a 4-hours' run just when you wanted it. It would also be pretty costly.

□ □ □

Television Forges Ahead

FOR some time now television receivers have been selling in the London area (and even in places surprisingly far outside it) just about as fast as manufacturers can turn them out in the factories. The number of television licences has increased by 50 per cent since the end of May and all the signs are that the rate of increase now is governed only by the rate of supply of televisors, the latter being in its turn governed to a great extent by the rate of supply of the right kind of cathode-ray tubes. The man in the street appears to have become reconciled to the 7½in by 6in picture, realising that, small though it may seem, it is amply large for the average living-room of to-day. Certainly, the best-sellers amongst television receivers are those using 9-inch tubes. Those who have bought them seem to be perfectly satisfied with the results and I don't often hear people regretting that the picture isn't a bit bigger. With a set that is interlacing as it should and which handles frequencies up to 2.5 Mc/s adequately, the definition is so good that one soon ceases to think about picture size.

Remarkable Achievement

An outstanding achievement in television was the O.B. of the pantomime from the Regal Theatre at Edmonton. It was announced before the programme started that nothing but the ordinary stage lighting would be used. One expected, perhaps, rather muzzy images and was prepared to make allowances. Actually, the broadcast was first-rate—a great credit to the engineers responsible, for even with the newest type of C.P.S. camera there must have been some pretty problems.

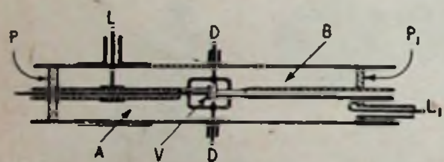
RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

TRANSMISSION LINE AMPLIFIER

THE control grid of a triode valve V with plane electrodes, designed for use as a coaxial line amplifier of centimetre waves, is formed with and carried by an external copper disc D, which is sealed through the glass of the bulb, and is earthed, so far as radio-frequency currents are concerned, by capacity coupling to the walls of the cathode and anode resonators A, B. Input energy is applied to the cathode resonator A from a coaxial feeder L, which can be moved axially to adjust the coupling. The cathode is heated through the centre core of that resonator. The amplified output is drawn off from the resonator B by a coaxial line L_1, which makes a push-fit, so that the usual coupling loop can be rotated.

The earthing of the grid prevents any positive feedback between the anode and grid. In addition, since the anode current also flows through the input impedance, this provides sufficient negative feedback to ensure complete stability.



Coaxial line amplifier.

Standard Telephones & Cables, Ltd., and S. G. Tomlin. Application date May 10th, 1941. No. 585447.

TELEVISION RECEIVERS

THE present television service may eventually be replaced by one using up to 600 or 800 scanning lines per frame. The higher definition will naturally increase the cost of the receiver, putting an undue strain on those who have little fault to find with the standard of reproduction now available.

The inventors have devised a relatively inexpensive type of set which is capable of receiving, say, an 800-line transmission and of reproducing a 400-line picture from it.

The received synchronizing impulses are applied, through an integrating circuit, to a gas-filled relay which responds only to every second impulse. The saw-toothed time-base voltage initiated by the first pulse overlaps the succeeding pulse, which is therefore ineffective. This avoids the circuit complications required to follow an ultra-fast "flyback," and so saves cost.

The General Electric Co., Ltd., and D. C. Espley. Application date October 6th, 1943. No. 587772.

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.

NAVIGATIONAL SYSTEMS

TO increase the sharpness of the "off-course" indication given by an approach beacon of the overlapping beam type, the carrier wave is radiated separately from the signal sideband energy. By suitably adjusting the phasing of the currents fed to the aerials, the maximum of the sideband radiation pattern is made to coincide substantially with the minimum of the carrier pattern, though the carrier amplitude is always kept higher than the maximum sideband amplitude. Both patterns are then simultaneously alternated about the desired line of approach.

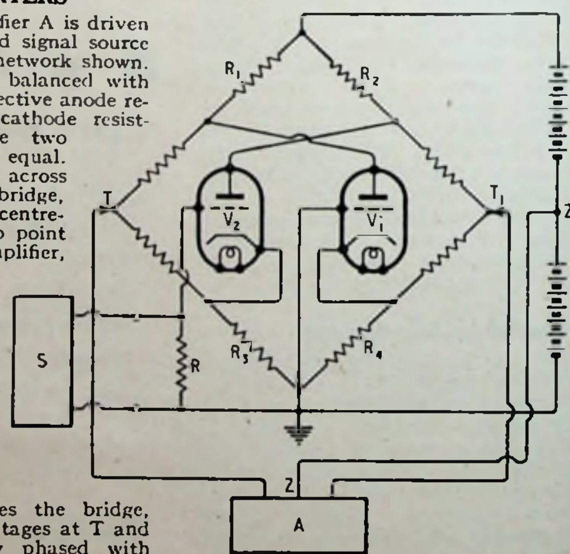
The aircraft receiver is provided with automatic volume control, so that its gain is always regulated by the prevailing level of carrier wave energy, being greatest when the sideband level is lowest, and vice versa. This provides a clear-cut indicator response of the order of one decibel per degree of deviation.

Standard Telephones & Cables, Ltd. (assignees of W. D. McGuignan). Convention date (U.S.A.) November 15th, 1943. No. 586814.

PHASE INVERTERS

A PUSH-PULL amplifier A is driven from an unbalanced signal source S through the phasing network shown. The bridge is normally balanced with no signal input, the respective anode resistances R_1, R_2 and cathode resistances R_3, R_4 of the two valves V_1, V_2 all being equal. High tension is applied across one diagonal of the bridge, the H.T. source being centre-tapped at Z to the zero point of the push-pull amplifier, which is connected across the opposite diagonal.

With this arrangement, an input signal applied to the grid of the valve V_2, across a resistance R, unbalances the bridge, and develops output voltages at T and T_1 that are oppositely phased with respect to the point Z. Fluctuations in the supply voltages are automatically balanced out in the bridge, and any difference in the operating characteristics of the valves V_1, V_2 can be offset by adjusting the output terminals T, T_1 along the resistance arms

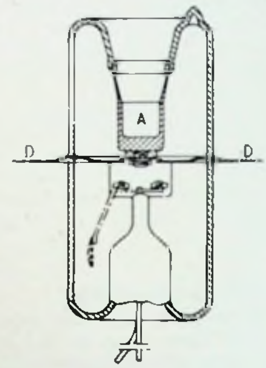


Bridge-type phase splitter.

Marconi's Wireless Telegraph Co., Ltd. (assignees of H. W. Berry). Convention date (U.S.A.) July 27th, 1943 No. 584191.

SHORT-WAVE VALVES

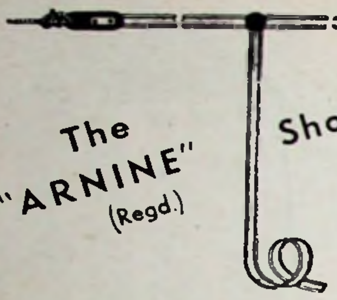
THE valve shown is designed to be directly coupled to a coaxial transmission line carrying centimetre waves. The bulb is divided by a metallic disc D, which is sealed in through the glass and is connected to the control grid, which is located in an aperture at its centre. The cathode is mounted just below the grid, the leads being sealed through the lower pinch. The anode A is thimble-shaped, to take the centre core of a coaxial line, and is sealed to the upper part of the bulb. The inter-electrode spacing is very close.



Grounded-grid triode.

In operation, the valve is used as an "inverted" or grounded-grid amplifier, the grid disc D being earthed either directly or by close capacity coupling, to the walls of the transmission line. The disc then screens the input from the output circuit, and otherwise serves to stabilize the valve and give it a high amplification factor.

Standard Telephones & Cables, Ltd., and J. Foster. Application date, June 13th, 1941. No. 585448.



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2-3 range universal meter with cabinet and V.V.M. kits by Maclachlan, new; 15gns. or nearest.—162, Dudley Rd., Grantham. [8942

AVO 7 meter, £18; mains oscillator, £12; valve tester, £15; all new; offer for lot.—155, Chipstead Valley Rd., Coulsdon. [9006

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2IN thermocouple moving coil milliammeters, 0-350m/a, new ex-Gov.; a bargain at 5/6 each, £3 per doz., post free.—J. McMillan, 5, Oakfield Road, Bristol 8. [8767

FOR sale, Marconi B.F.O. (0-40 kc/s) Muirhead valve voltmeter (0-50 volts), Marconi variable attenuator (0-minus 105 db.), Marconi Ekco distortion meter.—Box 4965. [9020

1000—0 to 5 m/amps.—Moving coil ammeters, 2in flush mounting, packed sep., 5/- ea. (min. 1 doz).—Stanwell & Leatherbarrow, Ltd., 6, Stanley St., Liverpool, 1. [0050

FREQUENCY meter BC.221.—Crystal control 126 kc/s to 20 mc/s; accuracy better than 0.01%; new £45; 45-page manuals giving circuit and full details 7/6.—V.E.S., 46, Windmill Hill, Ruislip Manor, Middlesex.

MICRO amperes.—Model 505, D.C., Turner Electrical Instruments, F.S.D., 100-0-100, moving coil, zero set screw, dead beat, 2⅛in dial, 3¼in diameter, moulded bakelite case, Govt. surplus, new, in original cartons, 1st grade; 30/-.—Below.

AMMETERS.—Range 0-100, moving coil with leads and shunt, by Victoria Instrument Co., 3½in flush fitting, bakelite case, zero set screw, dead beat, Govt surplus, new, in original cartons 1st grade: 25/-.—Below.

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SERVICOMETER model 1212, a new precision instrument employing five valves meter indication designed for speedy location of faults, measurement of tuning coil inductance, measurement capacitance, checking efficiency, aerial earth installations, frequency measurement 100kcs to 20mcs, 12 months guarantee; price £14/17/6.—Radio Development Co., Moretonhampstead, Devon. [8876

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GOODMANS infinite baffle, perfect, £12; R.K. Senior, 1,000Ω field, perfect, £4.—Marshall, 5, Isis Court, Chiswick, W.4. [9010

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COIL pickup, Wilkins & Wright; £5, unused.—9, Whitehall Gdns., Chingford, E.4. [8937

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CORRECTION. — Radio Unlimited, 16, Carnarvon Rd., Leyton, advertised price of Goodmans 12in speakers should have read Model T2/1205/15, £6/15; Axiom Twelve, £8/8; we wish to apologise for any inconvenience caused by the mistake. [9016

PROFESSIONAL recording equipment; to the trade, recording machines, blank discs, cutters, trailer needles, etc., from stock; recording amplifiers, matching transformers, ribbon and m.c. microphones; full trade terms.—Sound Discs (Supplies), Ltd., 83a, Bold St., Liverpool.

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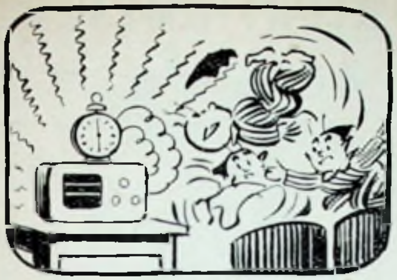

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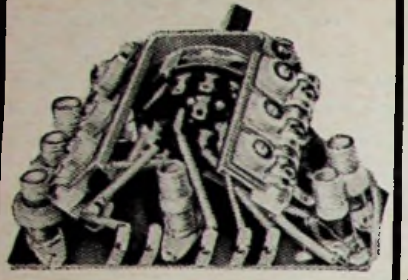

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DEVELOPMENT engineer required for test gear and measuring instrument design; some previous experience and suitable technical qualifications essential.—Send full particulars to Taylor Electrical Instruments, Ltd., 419, Montrose Ave., Slough. [9140

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SERVICE engineers and assistants for shipborn centimetric radar equipment required; applicant should be prepared to live in a port and travel as work requires; preference will be given ex-Naval men.—Box PP.1912, W. H. Smith & Son, Manchester, 3.

TECHNICAL sales representatives required by electro-medical specialists; sales experience essential, also technical knowledge of valve circuits; salary, commission and expenses; areas: London, S.E. England, North Midlands; car owners preferred.—Details Box 5110. [9162

SENIOR draughtsman required for company manufacturing radio and electrical equipment, good salary, prospects and 5-day week.—Write, giving full details of experience and salary required, to Taylor Electrical Instruments, Ltd., Montrose Ave., Slough, Bucks. [9139

AN opportunity is now open for an engineer with first-class experience in designing radio and electrical equipment to join company as chief engineer; excellent prospects for a man with the right experience, initiative and organising ability.—Write to Box 5084. [9141

REQUIRED for radio factory in South Wales, near Aberdare, small parts mechanical designer, preferably experienced in radio and television production.—Write, stating age, qualifications, experience and salary required, to Box R. F. E., Smith's Library, Aberdare. [9092

1948

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Skilful engineering, latest technique with new versatile mountings and ease of connections. Robust, silent working, accurate ratings, ensure long and satisfactory service.

A Transformer for the quality amplifiers or the smallest midget receiver, we make it.

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Example AC/10 PLUS for home gramo, with two inputs, impedance filters for any pick-up, bass boost couplings, etc., £10.

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YOUNG engineer required as representative of leading electronic instrument manufacturers, London area; C. & G. Grade III or equivalent Service qualifications; state age, experience and salary required.—Box 4966. [9021

ASSISTANT engineer required for our laboratory engaged on the design of radio broadcast receivers; applicant must have held similar position for three or more years.—Write in first instance stating full particulars and salary required to the Personnel Manager, McMichael Radio, Ltd., Wexham Rd., Slough.

TECHNICAL Assistant wanted for technical control of all processes in experimental valve manufacture; experience in this type of work essential; some knowledge of high vacuum technique and glassworking practice desirable; West London area.—Applications including academic qualifications, age, experience, and salary required, to be addressed to Box 4975.

TECHNICAL assistant required by well-known company situated West London district for investigation of improved processes in cathode ray tube manufacture; degree in chemistry or an equivalent qualification desirable; industrial experience on similar work an asset.—Applications, which should include full details of training, experience, age and salary expected, to be addressed Box 4962.

ENGINEER required for laboratory investigation and measurements in conjunction with radio and electronic devices; experience in electron optics desirable, with ability for original design; applicants should have reached accepted standard of education and carry adequate production-design experience; West Middlesex area.—Apply giving age, full details of education and experience to Box 4770.

TECHNICAL assistant required by large electrical manufacturer; applicants should have had practical experience in the servicing of radio receivers, and be familiar with the design and operation of dealer test gear; selected candidate would be required to submit reports and compile instruction books on test gear and give practical demonstrations.—Write, giving full details of age, experience and salary required, to Box 4501. [8908

ST. DUNSTAN'S requires an assistant for research work in connection with sound recording and other electronic aids for blind people. Applicants should have an Honours Degree in Physics and/or communications engineering, preferably with practical experience in this branch of electronics. Initial salary according to qualifications in the region of £450-£550 with superannuation under F.S.S.U.—Apply to St. Dunstan's Research Dept., 8, Hinde St., Manchester Square, W.1.

PUBLICITY department of large electrical engineering firm requires assistant to take charge of publication of sales promotion literature; work comprises sub-editoring of material and direction of presentation and printing; essential qualifications, good education and personality, B.Sc. (electrical engineering), age 27 to 45; leadership and administrative ability, originality and good artistic appreciation, knowledge of type and of reproduction processes; previous experience of similar duties.—Write, giving full particulars of experience, and state salary required, to Box N5377, A.K. Advg., 212a, Shaftesbury Av., W.C.2.

E.M.I. ENGINEERING DEVELOPMENT, Ltd., have vacancies in their design drawing office for the following:—(a) Senior electro-mechanical designer-draughtsmen. (b) Senior mechanical designer-draughtsmen. (c) Senior electrical designer-draughtsmen. The above are required on electronic, tele-communication, and electro-mechanical engineering; only 1st class designer draughtsmen need apply. Vacancies offer excellent prospects on high-class work of paramount national importance.—Apply, stating age, fullest details of experience, together with salary required, to Personnel Department, E.M.I., Ltd., Blyth Rd., Hayes, Middlesex. [9118

B.B.C. invites applications for the post of engineer in the audio frequency section of the research department, based in London. Candidates must possess a university degree, or equivalent qualifications, in physics or electrical engineering and must have taken telecommunication as part of their training. A knowledge of electrical measurements, measuring instruments and experience in microphone and loudspeaker technique is essential. The work includes research into microphones and loudspeakers and embraces all other aspects of audio frequency research and development. Preference will be given to a candidate with the ability to guide development work in drawing office and workshops. Musical ability is an advantage. The salary is on a grade rising by annual increments of £40 to a maximum of £890 per annum. Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 14 days of the appearance of this advertisement

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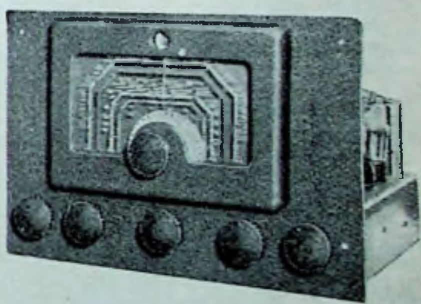

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Those who visited our stand at Radiolympia were quick to appreciate that this chassis, with its workmanlike design and generous specification, provides the enthusiast with something out of the ordinary at a reasonable price.

Among its principal features are:—

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- 10 valves (including magic eye).
- RF amplifier.
- 2 IF stages.
- 4 wave bands.
- 10 Watts push-pull output.
- Tropicalised components.

Communications enthusiasts should write for details of our 1546 Chassis.

PEERLESS RADIO LIMITED
374, Kensington High St., LONDON, W.14
Phone: WEStern 1221

B.B.C. invites applications to fill a vacancy in the research department of the engineering division; the work involves theoretical and practical investigations on aerials, transmitters, and systems of modulation; practical experience of such work is desirable, but not essential; applicants must possess recognised academic qualification, including a knowledge of the theory of wave propagation, and an aptitude for original investigation; the salary is on a grade rising by annual increments of £25 to a maximum of £580 per annum; good promotion prospects; the successful candidate will be based at Oxford, but will later be transferred to a permanent base near London.—Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 14 days of the appearance of this advertisement. [8990

B.B.C. invites applications for a number of posts for senior and junior engineers in the designs department in London. Applicants should have a university degree in engineering or an equivalent qualification, preferably in communication subjects. The work of the department covers design of testing equipment and transmission equipment for music and for 405-line television, the design of transmission apparatus for teleprinter and telephone carrier transmission, and for the various systems of disc and magnetic recording and reproducing equipments used in broadcasting. Specialist knowledge and experience in design work in any of the above is essential in the higher grades and will be an advantage in all cases. Starting salaries dependent on qualifications and experience; appointments will be in grades ranging from £580 per annum maximum for junior designers, to £995 per annum maximum for senior designers. Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 14 days of the appearance of this advertisement.

B.B.C. invites applications for two posts of engineer in the field strength section of the research department based at Oxford. Candidates should possess a university degree, or a recognised diploma, and should have taken telecommunication as part of their training. They must be capable of conscientiously carrying out experiments involving radio frequency measurements in any part of the British Isles and should have an interest in field strength measurement work and allied problems of propagation applicable to broadcasting. Experience of transmitter and aerial work and the use of receiving equipment is desirable. The successful candidates will be based at Oxford in the first instance, but will be required to spend a large proportion of their time away from base, and at a later date the base will be transferred to the London Area. The salary is on a grade rising by annual increments of £30 to a maximum of £680 per annum. Applications, stating age, qualifications and experience should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 14 days of the appearance of this advertisement. [8999

THE MULLARD ELECTRONIC RESEARCH LABORATORY invites applications for the following posts: (1) A senior scientist to lead a group working on ultra high radio frequency circuits in close association with valve laboratory and on centimeter wave projects; he should have a good honours degree in physics or electrical engineering or mathematics, at least four years experience in the UHF field and be capable of both experimental and theoretical treatment of problems in this field. It is expected that the age of the successful candidate will be between 27 and 35 years and his salary between £650 and £1,000 a year according to experience and ability. (2) Scientists for both the group mentioned above and other groups working on supersonics, electronic measurement and control, television and radio component design. They should have similar academic qualifications to the senior man and preferably some experience of research work. It is expected that the successful candidates will be between 20 and 30 years and their salaries between £350 and £700 a year according to qualifications. Applications should be made to the Manager, Mullard Research Laboratories, Salfords, Nr. Redhill, Surrey. [9017

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EX-R.A.F. Cpl. Radar Fitter, 21, ambitious energetic educated to H.S.C. standard, seeks interesting post with plenty of scope.—Box 5045. [9099

SALES engineer (32) seeks post based West London area; final City and Guilds, 7 yrs. with large manufacturer, wide representative experience; specialist communication and industrial instrumentation, medical equipment.—Box 4953. [9011

YOUNG man, 23, good theoretical knowledge radio circuits and fault-finding seeks practical experience, remuneration of less importance than need for experience.—Box 4768.

ENGINEER, middle 30s, C and G Finals in radio communication and technical electricity, seeks change; experienced production testing and test gear and receiver development; some television knowledge.—Box 5103. [9151

GRADUATE engineer of mechanical faculty, with wide experience, managing director of big tele-radio communication factory abroad, specialist in mass production, time and motion study, tools and machine fixtures designing, thorough knowledge of limits and precision fittings for engineering, etc., now seeks appointment in London.—Box 5078. 9120

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WANTED, active interest in sound radio, electric, P.A. or relay concern; £1,500 to £2,000.—Box 5022. [9078

EXPANDING company offers active partnership to experienced engineer with good working knowledge of aerials, amplifiers and test instruments; excellent possibilities for keen, hard-working man; capital £500 to £1,000.—Box 4961 [9013

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THE Technological Institute of Great Britain, 82, Temple Bar House, London, E.C.4. [4918

POSTAL courses of instruction for amateur radio transmitting licence, P.M.G. Certificates in wireless telegraphy, Ministry of Civil Aviation Certificate, radio engineering and television; also instruction at school.—Apply, British School of Telegraphy, Ltd., 179, Clapham Rd., London, S.W.9 (Estd. 40 years).

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CONTACTS desired with overseas radio importers.—Box 5047. [9104

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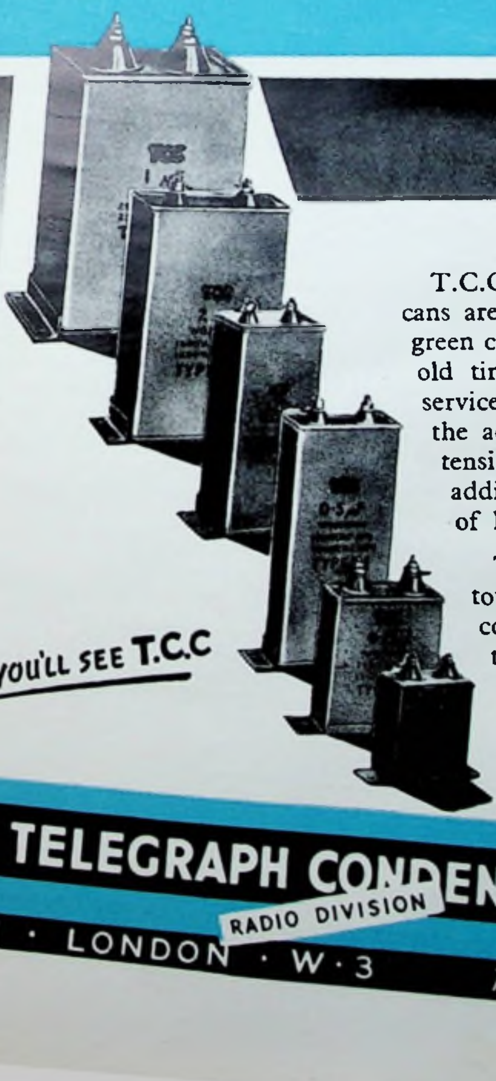

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They are mechanically and electrically tough, and will withstand the most severe conditions, including continuous operation at 71° C (see pages 17 to 21 of List 132/RD/47).

Details of higher working voltages may be had on application.

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