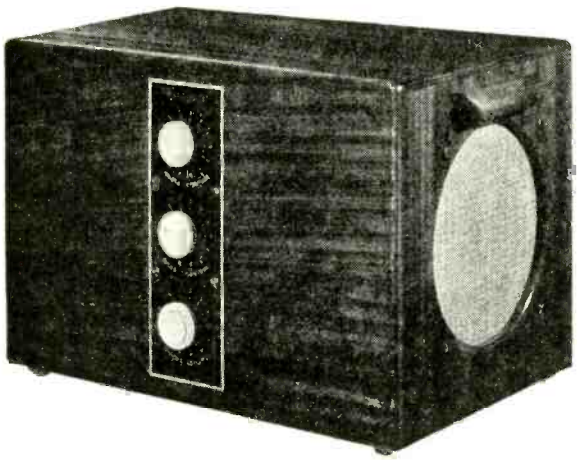
Two new HIGH FIDELITY products by Truchord

Again 'Truchord' pioneer the way to high fidelity at reasonable cost. These two models incorporate the same electronic equipment that in so short a time made the "50 series" premier amongst 'quality' reproducers.

1 HIGH FIDELITY AMPLIFIER/LOUDSPEAKER UNIT *Model 50T*



This unit is also available for combined mains and battery operation: Model 50T/6V and Model 50T/12V for 6v and 12v respectively. Both models incorporate a power pack providing 75 watts, giving adequate power for operating a record player etc. Ideal for "quality" reproduction "in the field." Prices on application.

This new portable unit is designed and built for the connoisseur and provides the means of obtaining the ultimate from record, radio or microphone. It incorporates five B.V.A. valves with phase-splitter, push-pull circuit (8 watts) with negative feed-back, independent bass and treble controls, and a high fidelity audio transformer accurately matched to a high-flux 10in. P.M. Speaker. Provision is made for switched output to extension speaker; the built-in speaker is ideal as a monitor when recording etc. Also incorporated are pick-up and microphone input sockets. The whole is housed in a tasteful walnut cabinet 18in. × 12in. × 12in.

Independent tests taken show the amplifier response to be flat within plus/minus 1½ db. from 20 c/s to 20 Kc/s.

Price 25 Gns *(not subject to P.T.)*

2 HIGH FIDELITY RECORD AND RADIO REPRODUCER *Model 508 R.G.*

Demonstrations of all these models by arrangement.

Here is revolutionary performance from both record and radio. Housed within its handsome acoustically balanced walnut cabinet is the same electronic amplifying equipment as the Model 50T feeding a high-flux 10in. P.M. Speaker; a 'Truchord' high-fidelity Radio Tuner Unit; and a Garrard 75A three-speed auto-changer unit with turnover magnetic pick-up. This matched 'team' produces a performance that brooks no rival, even with instruments costing double.

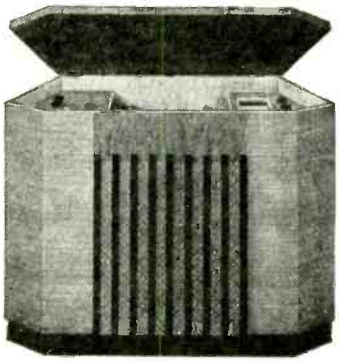
Price 97 Gns *(including P.T.)*

The model 50 R.C. identical with the above, but without Radio Tuner Unit. **PRICE 76 Gns** (including P.T.)

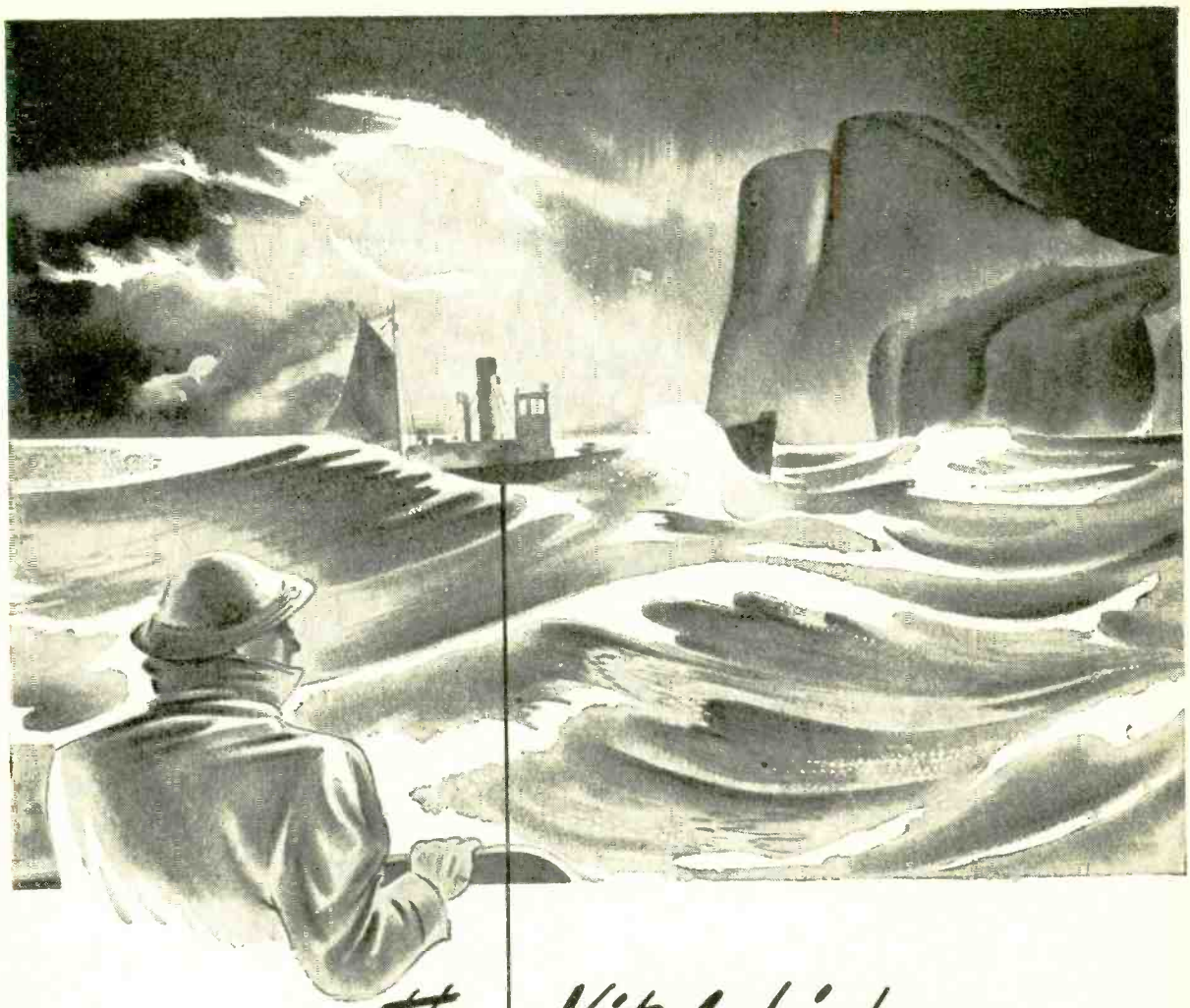
The 'Truchord' Radio Tuner Unit is available separately at **PRICE 14 Gns** (plus **£6/5/10** P.T.)

(Ideal feeder unit for recording, especially recommended by Grundig (Gt. Britain) Ltd. for use with their "Reporter")

'The Radiogram of the future'



REPRODUCERS (ELECTRONIC) LTD., 82 GT. PORTLAND ST., LONDON, W.1. Telephone: MUSeum 7674



The Vital Link . . .

. . . with safety in the hazardous enterprise of the deep sea trawler is its radio and radar equipment upon which safe navigation depends. Thousands of soldered joints contribute to the efficient functioning of this delicate apparatus. One dry or H.R. joint could mean the breakdown of a circuit, the destruction of the vital link, a perilous voyage.

FAULTLESS FLUXING PRESERVES THE VITAL LINK

Dry or H.R. joints are impossible with Superspeed for the flux is always released in exactly the correct proportion. This faultless fluxing action is achieved by the unique STELLATE core which gives six points of rapid solder collapse. At soldering temperature the activated rosin flux is released immediately for effective spreading and wetting. Superspeed is being used more and more in the production of radio and radar equipment where faultless joints are essential.

Superspeed

"WHITE FLASH" ACTIVATED ROSIN-CORED SOLDER

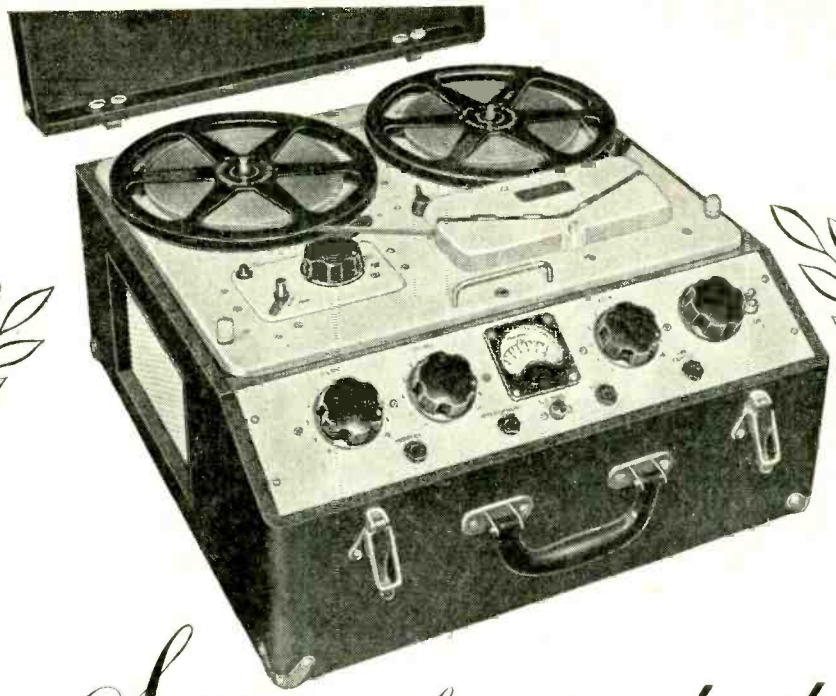
for general electrical, electronic and telecommunication work and all standard uses. A.I.D. and G.P.O. approved. Complies with M.O.S. Specification DTD 599. In all standard tin/lead alloys, 10-22 s.w.g. Also available in a range of coloured cores, indispensable for simple intermediate and final inspection and circuit or operator identification. Samples of Superspeed and the comprehensive Superspeed booklet gladly sent on request. Technical advisers are available for free consultation.

Cored and solid solder rings and solid solder washers supplied to customers' specifications.

MANUFACTURED BY THE ENTHOVEN GROUP

Marketed by Enthoven Solders Limited, Enthoven House, 89, Upper Thames Street, London, E.C.4. Tel. Mansion House 4533

.3415



Setting the standard in Magnetic Recording

ON its introduction four years ago the Ferrograph set a standard in magnetic tape recorders that has remained the target of all subsequent designers. Now re-styled, Model 2A is presented in a physical form worthy of its technical excellence.

Basically the same robust, time-proven and reliable instrument, the new model 2A incorporates many refinements and facilities requested by discriminating Ferrograph owners and users.

No fantastic or exaggerated claims are made for the Ferrograph — indeed none is needed. Its reputation in the United Kingdom and abroad is such that it is justly denominated the standard by which all others are judged.

Synchronous Capstan motor · Improved response and signal-noise ratio · Simplified speed change · Provision for 1,750 reels, i.e. 45 minutes uninterrupted playing time per track at 7½″ per second and 1½ hours per track at 3¾″ · More convenient unit form for portability · Lighter in weight · Provision for Superimposition.

Ferrotape — conforming to Specification WW372/49 — is freely available in four reel sizes, viz.: 200, 600, 1,200 and 1,750 feet.

British Ferrograph Recorder Co. Ltd.

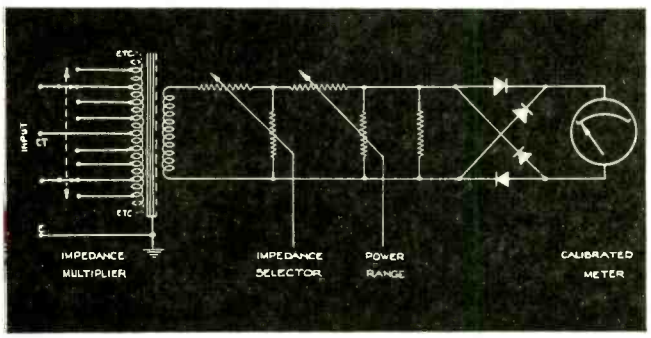
138 SLOANE STREET, LONDON, ENGLAND. SLOane 1510

Exceptional impedance range

With forty-eight impedance steps from 2.5Ω to 20,000Ω for balanced inputs—and a similar number for unbalanced at one-quarter the impedance — the instrument is ideal for optimum load matching. Two important design features play a great part in this meter's excellent performance over so wide a range of impedance. First, the use of a resistance network* to select the significant figures of the input impedance value. Second, decade multiplication of impedance by a transformer with a wound-strip core of anisotropic alloy.

* *Brit. Pat. 648,944*

Audio Frequency Output Power Meter TF893



RANGE

Power:
20μW to 10W in five ranges

Impedance:
0.625Ω to 20,000Ω

Frequency:
Practically flat response over range exceeding 500:1

MARCONI INSTRUMENTS

Signal Generators · Valve Voltmeters · Frequency Standards · Bridges · Wave Meters · Wave Analysers · Beat Frequency Oscillators

MARCONI INSTRUMENTS LIMITED · ST. ALBANS · HERTS · Telephone: St. Albans 6161/7

Midland Office: 19 The Parade, Leamington Spa. **Northern Office:** 30 Albion St., Kingston-upon-Hull. **Export Office:** Marcon House, Strand, London, W.C.2

The new

THE MASTER SOUND SYSTEM

MAGNETIC TAPE RECORDER

Type PMR/3

"from a pedigree line"

And its SPECIFICATION

The Tape Player itself is of unit construction which enables many special requirements and applications to be met without undue modification. The following features can be provided to special order:—

Tape speeds 7½" and 15" per second, or 3¾" and 1⅞" per second.

●

Synchronous drive motor.

●

Remote operation or foot control.

●

Automatic back spacing and reverse drive for dictation purposes.

●

Cassette tape loading.

●

Rack mounted assembly.

TAPE SPEEDS	7½" and 3¾" per second.
TRACKS	¼" wide. Number of tracks 2.
PLAYING TIME PER TRACK	30 minutes at 7½" per second. 60 minutes at 3¾" per second.
SPOOLS	Standard 7" and 5" plastic or metal.
SENSE OF SPOOLING	From left to right with tape coating inwards.
REWIND TIME	One minute for 1,200 ft. of tape (approx.).
HEADS	R.F. erase head. Record/playback head off-set for recording on upper track. Provision on player unit for additional monitoring head for special applications.
TAPE OPERATION	Single control provides:—Record, Playback, Fast Forward, Cueing, Rewind. To ensure additional safety against accidental erase, an additional record / playback switch is provided on the amplifier assembly. Power and brake operation is by means of a relay which will enable remote operation to be provided in special applications.
FREQUENCY RESPONSE	At 7½" per second 60-10,000 C.P.S. plus or minus 3 db. At 3¾" per second 70-7,000 C.P.S. plus or minus 3 db.
DISTORTION	Less than 2½% total harmonic distortion at normal operating level.
SIGNAL/NOISE RATIO	Approximately 50 db. using standard high output tape.
INPUTS	(1) Up to 50 ohms low level —110 db. microphone input. (2) High Z up to 100 K at 1v. unbalanced (radio input).
OUTPUTS	(1) 2½ ohms at 3 watts to internal loudspeaker. (2) 15 ohms at 3 watts for external speaker.
WOW AND FLUTTER	Total wow and flutter content less than ·2%.
MAINS SUPPLY	200/250 v. 50 cycles 230 V.A. Other voltages and frequencies supplied to special order.
DIMENSIONS	16" wide x 11" high x 18" deep approx.
WEIGHT	45 lbs.

M·S·S RECORDING COMPANY LTD

POYLE CLOSE · COLNBROOK · BUCKINGHAMSHIRE · TELEPHONE · COLNBROOK 284

IT'S NEW—IT'S TRUVOX

—it's GOOD whatever you call it!

There has been difficulty in naming ours. Never mind the name—you judge the product!

TRUVOX
???? ????
MARK III

These are the main features :—

1. Three motor drive.
2. "Drop-in" Tape loading.
3. Push-button control, electrically and mechanically interlocked.
4. Separate push-button brake.
5. "Fast-forward" and "fast-rewind" without tape wear.
6. Silent drive eliminating "wow" and "flutter."
7. Half-track working, and two Tape speeds of 7½ inches per second, or 3¾ inches per second.
8. Visual playing-time indicator.
9. With a suitable amplifier, the equipment covers a frequency range from 50–10,000 c.p.s. at 7½ inches per second.

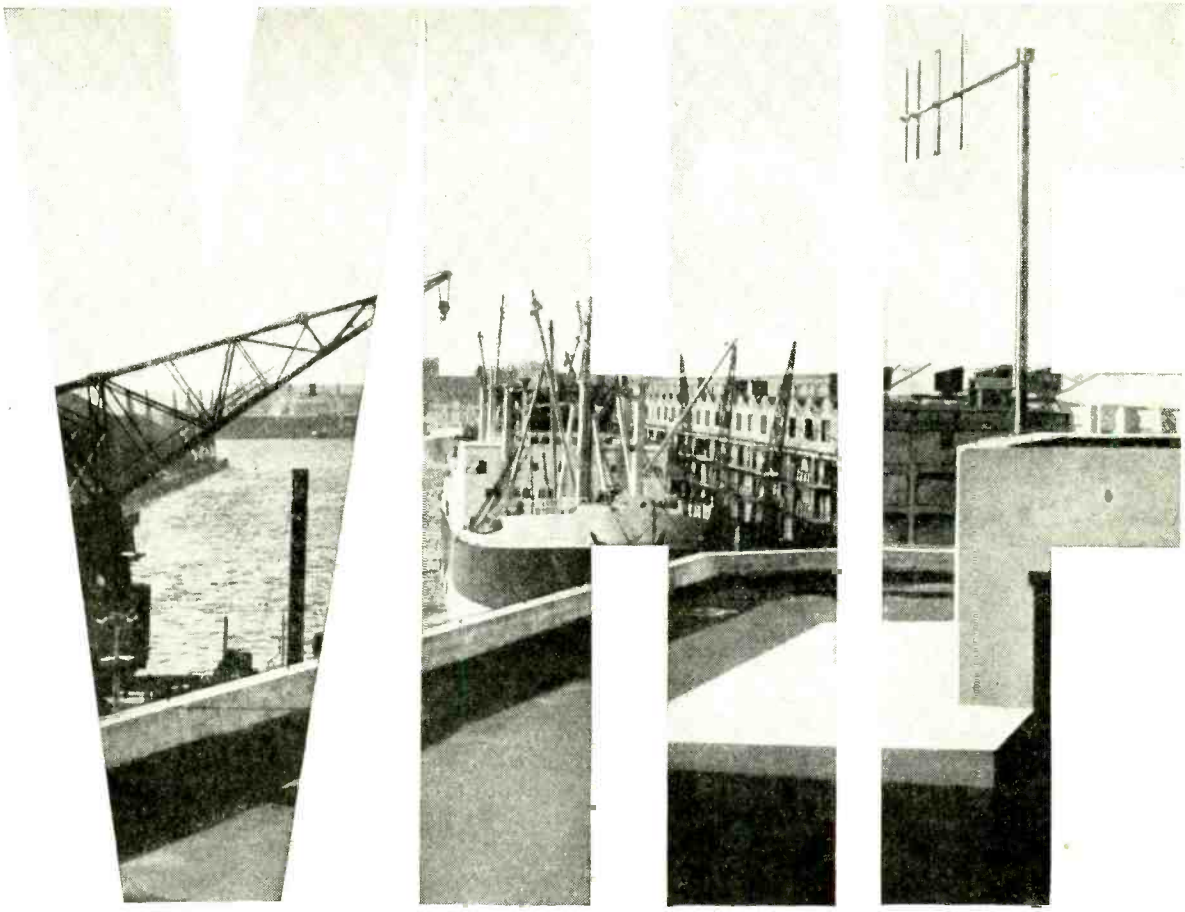
22 Gns
MODEL TR2
200/250 volts
A.C. mains only

TRUVOX LIMITED

EXHIBITION GROUNDS · WEMBLEY · MIDDX

Telephone : Wembley 1212

Sole distributors to the Wholesale Trade for Rola and Celestion Speakers



A V.H.F. system is a valuable aid for dock, harbour and ship canal authorities for it enables them to keep in touch with a vessel from the moment of reaching the harbour mouth until it docks. Docking and berthing arrangements can therefore be made with confidence while the vessel is perhaps some three quarters of an hour steaming distance away. Portable sets are available for pilots to take with them when boarding vessels. They can then immediately give the shore station particulars of draft, speed and anticipated time of arrival. In return they can be given docking information and meteorological and navigational advice if necessary. Equipment of this type is specially designed by Automatic Telephone & Electric Company Limited and is installed at Liverpool and Sunderland. A system for Manchester is in course of completion.

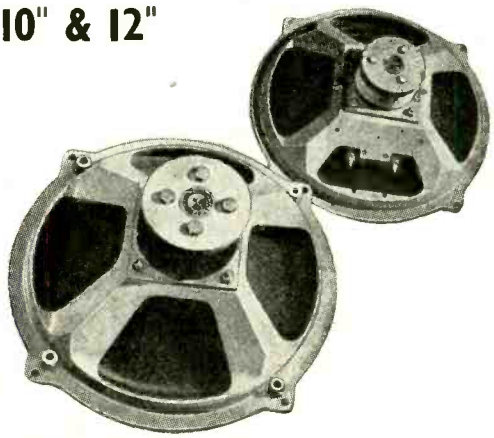
THE PUBLIC ACCLAIM THESE FOUR UNITS

FROM THE *Stentorian* RANGE

These units are deservedly popular — they meet a widespread demand for the highest quality at reasonable cost.

The Tweeter Unit combined with the 10-inch Speaker, Model S1012, provides a very high standard of reproduction. It can be heard, together with the complete range of Speakers, at our London showrooms (109 Kingsway) from 9 a.m. to noon any Saturday, by appointment. Please write, or telephone Holborn 3074.

STANDARD UNITS 10" & 12"



MODEL 1012 (10"). Generally regarded as the most outstanding speaker of its kind. Response: 55 — 11,000 c.p.s. Magnet of 12,000 gauss. Handling capacity 10 watts u.d.o.

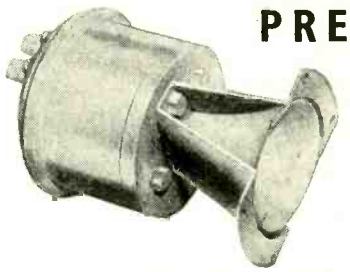
Price (tax paid) minus transformer **£3·14·9**
With universal transformer . . **£5·1·6**

MODEL S.12135 (12"). For large handling capacity with balanced overall response, this unit is quite exceptional. Response: 50 - 11,000 c.p.s. Magnet of 14,000 gauss. Handling capacity 15 watts u.d.o.

Price (tax paid) minus transformer **£13·4·0**
With universal transformer. . . **£14·19·0**

WHITELEY ELECTRICAL RADIO COMPANY LIMITED
MANSFIELD · NOTTS

PRESSURE TYPE TWEETER UNIT

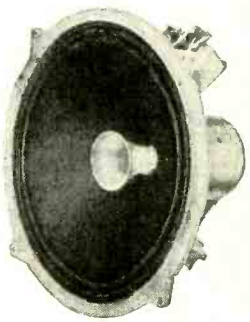


The Unit is of the moving coil pressure type, similar to that in the 10 in. and 12 in. Concentric Duplex Units. Speech coil of aluminium wire, wound on an aluminium former, rigidly fixed to an aluminium diaphragm. Speech coil and diaphragm are at the rear of the magnet; the centre pole is hollowed out to form the commencement of the horn, in the centre of which is the phase equaliser.

Speech coil impedance: 15 or 30 ohms. Flux density: 14,000 gauss. Response: 2,000/14,000 c.p.s. Power handling capacity: 3 watts. **75/6** *Tax Free*

A suitable cross-over network is available at **26/6**

10" CONCENTRIC DUPLEX UNIT



Consistently specified by leading designers where the highest standards of reproduction are desired. The cost is very moderate for its remarkable performance.

SPECIFICATION: Series Gap magnet of Alcomax 3
Flux in LF gap 12,000 gauss on 1" pole.
Flux in HF gap 13,000 gauss on 1" pole.
Power handling capacity, 6 watts. Frequency range 50/14,000 c.p.s. Fundamental bass resonance, 65 c.p.s.

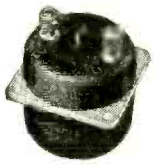
Price: with filter condenser (tax paid) **£10.3.3**
With condenser and matching transformer **£11.13.3**

GOODMANS

P.M. VIBRATION GENERATORS

vibration pick-ups and ancillary equipment

These vibration generators provide vibratory sinusoidal forces of frequency and amplitude by which specific vibratory conditions can be simulated. They provide the means of assessing the effects of sudden accelerotion on materials, structures and components.

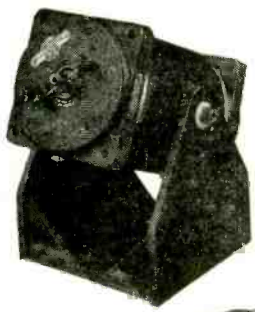


MODEL V47 for the vibration of very light electronic components, optical-cell research, hairspring torque testing etc.

Thrust	Force factor 0.9 lbs. per amp.
Max. Continuous Current Rating (R.M.S.)	1.5 amps: 2.0 amps up to 2 min. duration.
Stroke	0.2 in total excursion.
Impedance	Varies with frequency and load between 3 and 10 ohms.
Frequency Range	Up to 10,000 c/s.
Weight of Moving System	6.5 grams.
Stray Fields	Operating zone less than 25 gauss.
Flux Density	11,000 gauss.
Weight	2 lbs.

MODEL 390A A medium duty model producing an alternating force of approximately ±25 lbs.

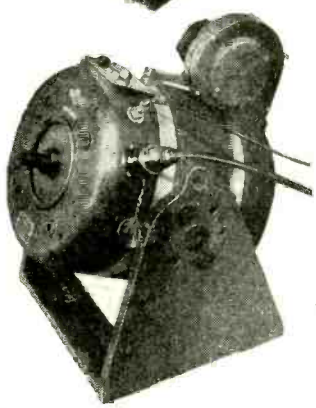
Thrust	Force factor 4.7 lbs. per amp.
Max. Continuous Current Rating (R.M.S.)	2 amps uncooled; 4 amps with air cooling of approx. 5 lbs. per sq. in.
Stroke	0.5 in total excursion.
Impedance	8 ohms matching.
Frequency Range	Up to 10,000 c/s.
Weight of Moving System	0.16 lbs.
Stray Fields	Operating zone less than 100 gauss.
Flux Density	11,000 gauss.
Weight	26 lbs.



MODEL 790 For Vibrating heavy components, and is capable of producing a force of ±50 lbs.

This unit has a force factor of approximately 9.5 amps and a total current capacity, with air cooling, of 4 amps (R.M.S.)

Stroke	0.5 in total excursion.
Impedance	15 ohms matching (approx.)
Frequency Range	Up to 5,000 c/s.
Weight of Moving System	8 ozs. (approx.)
Stray Fields	Operating zone less than 100 gauss.
Flux Density	11,000 gauss.
Total Weight (inc. trunnion)	70 lbs.



MODEL 8/600

For the vibration of heavy loads or complete assemblies. Has a total force of approximately ±250 lbs.

Stroke	1 in. total excursion.
Impedance	to suit driving equipment.
Frequency Range	Up to 3,000 c/s.
Weight of Moving System	6 lb. (approx.)
Stray Fields	Operating zone less than 25 gauss.
Flux Density	10,000 gauss
Total Weight (inc. trunnion)	4 cwt. (approx.)

This unit can be fitted with (a) built in air cooling blower (b) switch to give high or low impedance armature coil and (c) pick-up unit for monitoring wave form and amplitude.

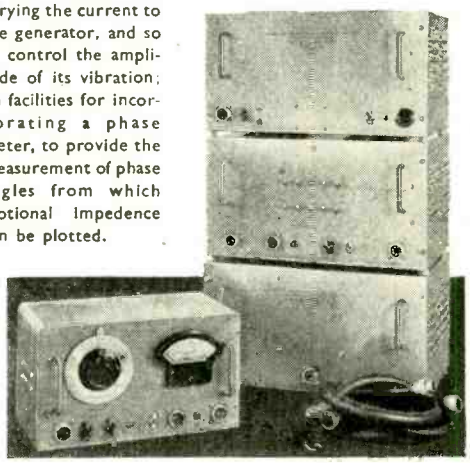
Driving Equipment for Model 390A

(A) **POWER AMPLIFIER TYPE D/120** (120 watts continuous rating) covering a frequency range of 10 c/s to 10,000 c/s and giving full output over the entire range. A specially designed tuning unit increases the current and hence the thrust of the generator with which it is used. This arrangement, in addition to providing a greater current output, also ensures a purer wave-form.

(B) **TRANSFORMER UNIT, TYPE 120** This is provided as a separate unit purely for reasons of physical accommodation.

(C) **STABILISED POWER SUPPLY UNIT, TYPE DS/120** By means of this unit the H.T. supplies for the amplifier are stabilised so that the full power of the amplifier will be maintained even if the mains voltage drops. Subsidiary unstabilised heater and biasing voltages are also derived from this unit.

(D) **OSCILLATOR, TYPE RC/D.1.** This fully covers the range of the amplifier, i.e., 10 c/s to 10,000 c/s. Apart from being a highly efficient oscillator, specifically designed for operation with the Type D.120 amplifier, this is in effect a control unit, and includes (a) a valve volt meter calibrated directly in amperes to indicate the current in the moving coil of the vibrator; (b) a gain control for varying the current to the generator, and so to control the amplitude of its vibration; (c) facilities for incorporating a phase meter, to provide the measurement of phase angles from which motional impedence can be plotted.



Driving equipment also available for Models 790 and 8/600.

Full technical information and Data Sheets are available on request to "Special Products" Division D

GOODMANS INDUSTRIES LTD.

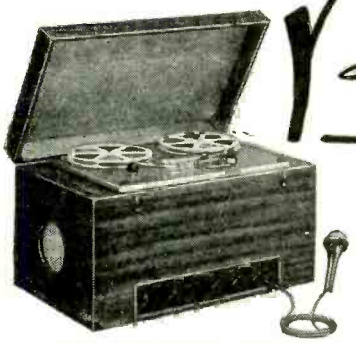
AXIOM WORKS • WEMBLEY • MIDDX. *Telephone: Wembley 1200 (8 lines)*

The Remarkable

Burgoyne

★ Trade Enquiries Invited

32 gns complete



DUAL TRACK TAPE RECORDER

We are proud to offer to-day's greatest value in tape recording—built to professional standards and giving greater reliability and performance. Now being demonstrated at the Radio Centre, where you can see, and hear also, the latest in high fidelity equipment.

★ **64 mins. playing time from a standard 7in. reel—dual tracks.**
★ **Fast forward and reverse rewind through the heads.**
★ **Frequency response 30-9,000 c/s. at 7½in. per second (checked on Decca K1804 Frequency test record).**

Three specially designed recording motors to obviate use of friction drives. Erase and bias frequency 50 Kc/s. Power consumption approx. 80 watts. Output 4 watts. All controls and inputs mounted on front of cabinet on handsome escutcheon plate. Volume control and on/off switch. Bass treble controls for cut and boost operative on both record and playback. Separate radio and microphone inputs.
All accessories by Burgoyne, Lane, Ronette, etc. Available separately as advertised.

★ **Instantaneous braking of tape reels.**
★ **Record/Playback changeover switch with visual indication of position.**
★ **Supplied with Ronette high fidelity crystal microphone.**

Head lift transformer improving signal/amp. noise ratio. Speaker muting switch obviating feed-back between microphone and speaker. High grade P.M. speaker. EXT. speaker sockets. Switching provided for use of amplifier as straight gramophone amplifier for high quality reproduction. Handsome polished walnut cabinet overall dimensions 21in. × 13in. × 13in.
We recommend high coercivity tape by Burgoyne for use in this Recorder 1,200ft. spool 35/- ; 600ft. spool 21/-.

PRICE 32 gns. with crystal microphone or H.P. terms £11.4.0 deposit and 12 monthly payments of 42/9. Carriage and packing 21/-

DON'T take our word for it—come and HEAR this amazing instrument!

THE TYPE A6 AMPLIFIER used in this magnificent recorder is available for **£11/15/-.**
A NEW Tape Table by Lane or Burgoyne is now available at **£17/10/-.**

We stock the most comprehensive range of **TEST EQUIPMENT** in Gt. Britain—for cash or on easy h.p. terms. This is a selection of gear available:

Item	Cash	Deposit	12 monthly payments
AVO			
Heavy Duty Meter ..	£15 0 0	£5 0 0	21/-
Model 7 Meter	£19 10 0	£6 10 0	26/-
Model 40 Meter	£19 10 0	£6 10 0	26/-
Universal Minor	£10 10 0	£3 10 0	15/-
Signal Generator, Mains or Battery	£30 0 0	£10 0 0	39/-
Universal Bridge	£34 0 0	£12 0 0	42/-
Electronic Test Unit	£19 10 0	£6 10 0	26/-
Electronic Test Meter ..	£40 0 0	£13 6 8	50/-
Valve Characteristic Meter	£60 0 0	£20 0 0	75/-
D.C. Minor	£5 5 0	£1 15 0	9/2
Model 8 Meter	£23 10 0	£7 16 8	30/4
Leather cases for 7, 8, 40 and heavy duty meters	£3 0 0	£1 0 0	5/-
ADVANCE			
Audio Generator H1	£25 0 0	£8 6 8	33/-
Signal Generator E2	£28 0 0	£9 6 8	36/6
TAYLOR			
45B Valve Tester	£25 10 0	£8 10 0	32/6
66A Signal Generator ..	£22 10 0	£7 10 0	30/-
70A Universal Meter 1,000 opv.	£12 10 0	£4 10 0	17/-
71A Universal Meter 1,000 opv.	£12 10 0	£4 3 4	17/3
72A Universal Meter 1,000 opv.	£16 0 0	£6 9 8	20/-
75A Universal Meter 20,000 opv.	£15 0 0	£5 0 0	20/6
77A Universal Meter 20,000 opv.	£15 0 0	£5 0 0	20/6
85A/P Universal Meter 20,000 opv.	£19 10 0	£6 10 0	26/-
110C Bridge	£14 10 0	£4 10 0	20/-

UNIVERSAL AVOMETER

Model 8

20,000 ohms per volt plus AUTOMATIC OVERLOAD PROTECTION.

Item	Cash	Deposit	12 monthly payments
TAYLOR (*cont.*)			
120A Universal Meter 20,000 opv.	£9 0 0	£3 0 0	13/4
130A Insulation Circuit Tester	£15 0 0	£5 0 0	20/6
170A Electronic Test Meter	£24 0 0	£8 0 0	31/6
190A Audio Oscillator ..	£22 10 0	£7 10 0	29/-
240A Pattern Generator	£14 0 0	£4 13 4	19/-
260A TV Wobbulator ..	£36 15 0	£12 5 0	46/-
30A Oscilloscope	£35 0 0	£12 10 0	41/9
88A Universal Meter ..	£21 10 0	£7 3 4	27/9
20B Circuit Analyser ..	£15 15 0	£5 5 0	21/6
90A Universal Meter ..	£15 15 0	£4 15 0	22/-
44A Montrose Meter ..	£2 10 0	—	—
RADAR Kilovolter	£3 17 6	£1 6 0	7/6
COSSOR Tele-check ..	£27 0 0	£9 0 0	35/-
COSSOR Double Beam scope 1035	£110 0 0	£20 0 0	£7/17/6
COSSOR Portable Oscillograph 1039	£28 0 0	£9 6 8	36/2
EVERSHED Wee-Megger 250 v. or 500 v. ..	£20 19 9	£6 18 0	26/8
HUNTS Bridge	£18 18 0	£6 6 0	25/-
PULLIN Universal Test meter	£11 11 0	£2 0 0	20/-
PULLIN RC Bridge/Valve Volt-meter	£43 9 0	£14 9 8	53/6
PULLIN S Meter	£3 0 0	£1 0 0	6/-
AMPLION D.C. Test meter	£5 0 0	£1 13 4	8/11
B.P.L. 1 MA 3½in. Meter	£3 10 0	£1 3 4	7/-
B.P.L. Foundation Meter 1 mA. f.s.d. 3, ½in.	£3 10 0	£1 3 4	7/-
PIFCO Radiometer ..	£1 9 6	—	—

M·O·S **MAIL ORDER SUPPLY CO.** *The RADIO CENTRE*

DEPT. W.W. 33, TOTTENHAM COURT ROAD, LONDON, W.1. Phone: MUSeum 5671

EDISWAN

STABILISED POWER SUPPLY UNIT TYPE R1103

Giving 250-400 volts highly stabilised D.C. output at 0-200 mA

BRIEF SPECIFICATION

INPUT 200-250 volts 40-100 c.p.s.

OUTPUT High stability D.C. output 250-400 volts adjustable in three ranges. Maximum load is 200 mA up to 350 volts and 150 mA from 350 volts to 400 volts. In addition two unstabilised 6.3 volt A.C. heater supplies are provided.

STABILITY A 10 volt change in mains input voltage results in an output change of less than 0.15 volts.

A change from zero to full load results in an output change of less than 0.4 volts.

OUTPUT RESISTANCE Less than 4 ohms.

RIPPLE Approximately 5mV R.M.S.

OUTPUT CIRCUITS All circuits isolated from earth. Heater supplies can be operated at up to 500 volts from earth.

MOUNTING The unit is designed for standard rack mounting, or bench use.

This new stabilised power supply unit is the second of a range of such units made by Ediswan giving a highly stabilised supply of D.C. power for laboratories, test benches, etc., in cases where a higher voltage or current than those supplied by the unit type R1095 is needed.

The unit operates on 200-250 volts 40-100 c.p.s. A.C. input and provides a highly stabilised D.C. output of 250-400 volts, adjustable in three stages. In addition two unstabilised 6.3 volts A.C. heater supplies are provided.

Price £57.0.0

Further details of this and Unit Type R1095 available on request.

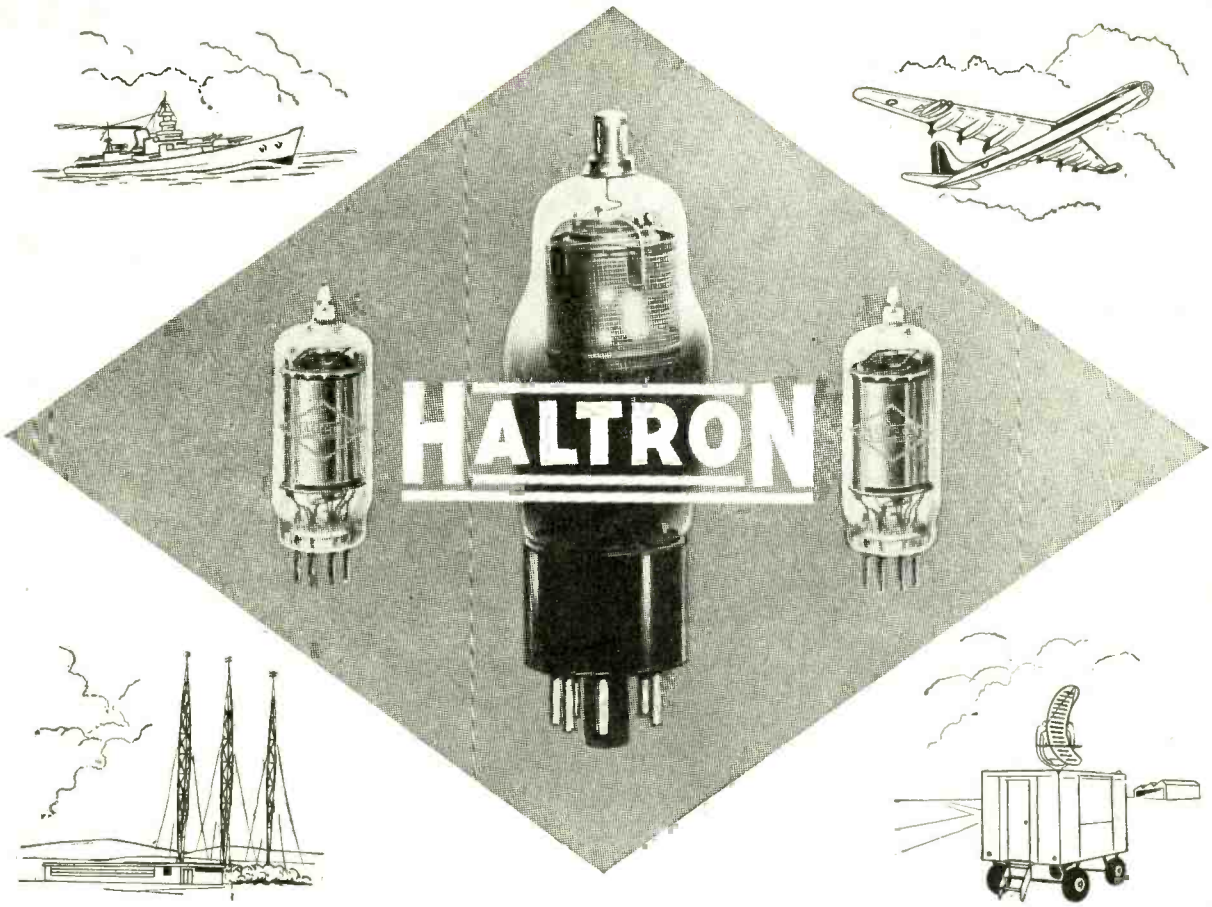
THE EDISON SWAN ELECTRIC COMPANY, LTD.

Radio Division

155 CHARING CROSS ROAD, LONDON, W.C.2

Telephone: Gerrard 8660 *Telegrams: Ediswan Westcent, London.* *Member of the A.E.I. Group of Companies.*

SP91



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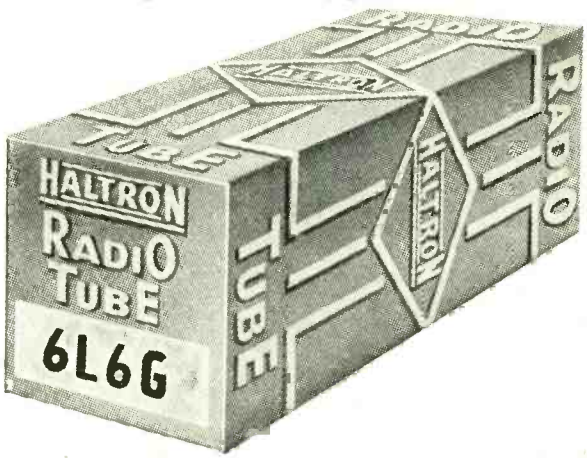

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Tel.: Ambassador 1041 (5 lines) Cables: Hallectric, London

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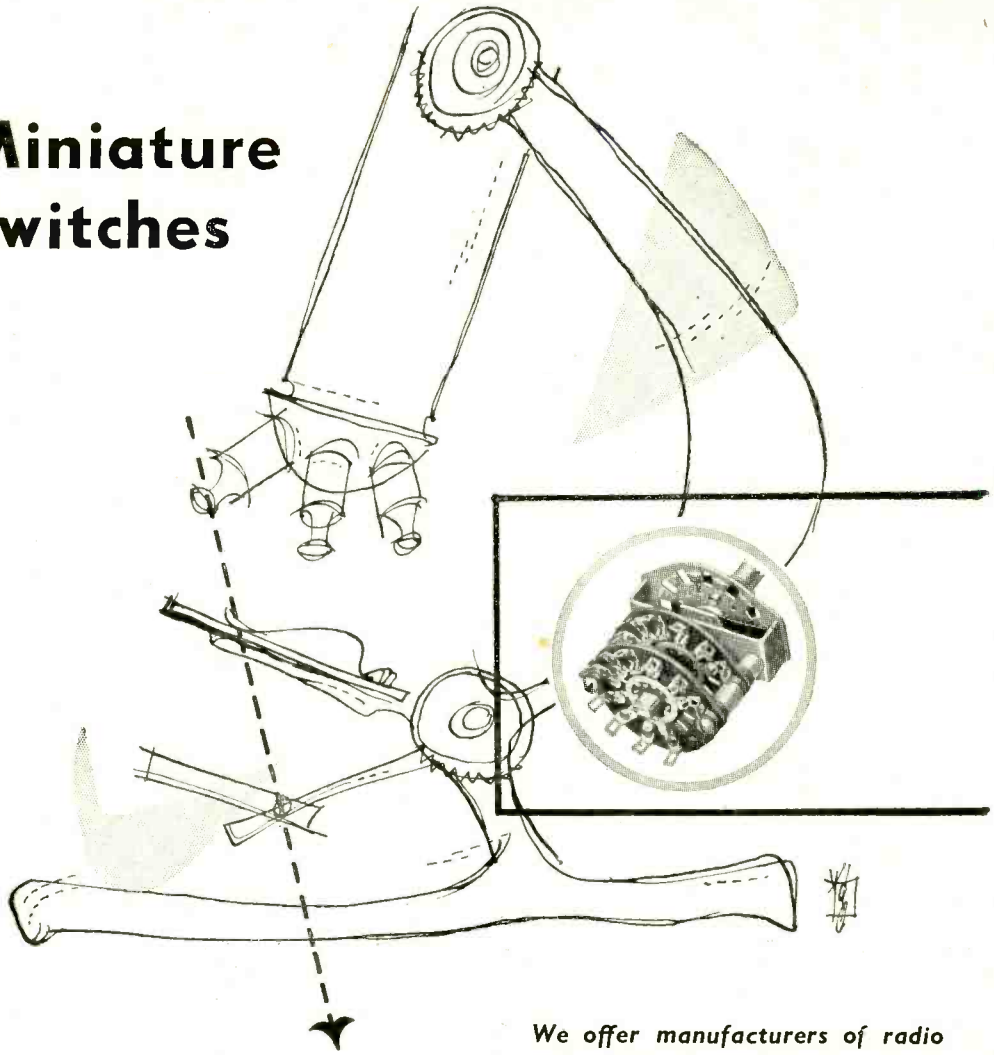

"A chip off the old block"—this refers, of course, to the miniature version of the well-known A.B. "H" Type switch. It combines all the virtues of the Standard "H" Type—yet takes up so much less space. Of sound and robust design it is capable of operating under widely varying conditions.

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BRITISH INSTRUMENT INDUSTRIES EXHIBITION
OLYMPIA-LONDON
JUN.30-JUL.11'53
STAND Nº 2C

Valve Voltmeter Type 712 (illustrated above)

- ★ Frequency range from 30 c/s to 200 Mc/s
- ★ Balanced, unbalanced, and differential inputs
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- ★ Six resistance ranges reading up to 100 megohms
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Millivoltmeter Type 784 (illustrated below)

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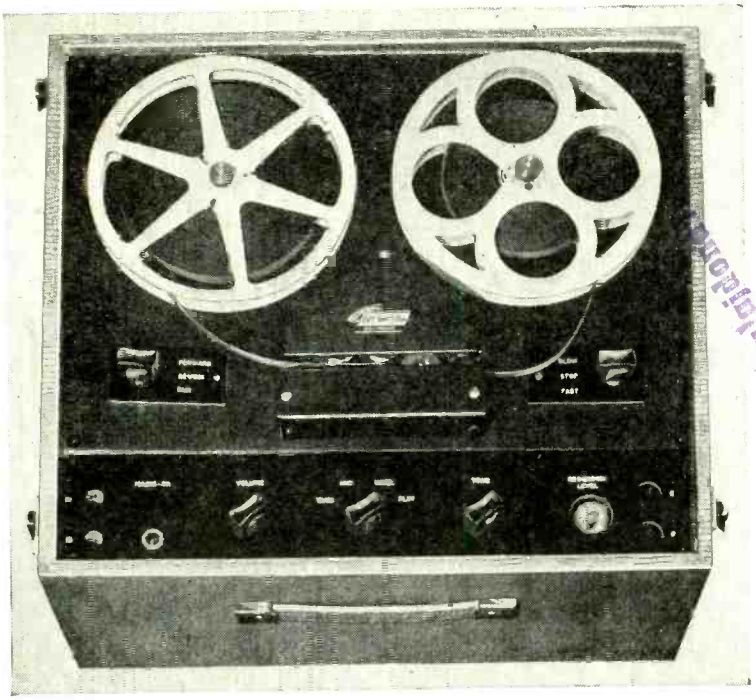
Tel: High Wycombe 2060 *Cables:* Airmec High Wycombe

The MUSIC-MASTER JUNIOR TAPE RECORDER



£35

Carriage forward.
Special transit case, £2.
(Refunded on return.)

COMPLETE WITH MICROPHONE, TAKE-UP SPOOL and one reel of SCOTCH BOY TAPE

The MUSIC-MASTER Junior TAPE RECORDER is a moderately priced machine of outstanding performance. A Two-SPEED tape mechanism is employed and the reproduction is completely free from all forms of "wow" and "flutter." The major features of the machine are listed below.

1. Two tape speeds.
2. Electrical braking giving complete elimination of wear.
3. Positive spool locks.
4. Completely silent running.
5. Rapid rewind and forward tape spooling without touching tape by hand.
6. Forward and Rewind in 50 seconds.
7. Very high microphone sensitivity.
8. Provision for recording from microphone, gramophone or radio.
9. Headphone monitor circuit for direct listening to material being recorded.
10. Built-in 5-inch monitor speaker.
11. Provision for use with extension speaker.
12. Magic Eye recording level indicator.
13. Provision for playback on headphones.
14. Contacts provided for external stop and start of mechanism, etc.

An illustrated brochure is available giving full details and technical specification of the machine. Please send stamped addressed envelope.

Delivery 2-3 weeks from order. Trade enquires invited.

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Large stocks available, a few of which are enumerated below:—

Full Scale Deflection	Scale Length	External Dimensions in.	Movement	
.5 A	1½	2½×2½	R.F. Thermo	7/6
.25 A	1½	2½ round	R.F. Thermo	7/6
3 A	1½	2½ round	R.F. Thermo	7/6
3.5 A	1½	2½×2½	R.F. Thermo	7/6
4 A	1½	2½×2½	R.F. Thermo	7/6
20 A	1½	2½ round	M/C	8/6
30 A	1½	2½×2½	M/C	8/6
40 A	1½	2½ round	M/C	8/6
1.5 mA.	1½	2½ round		12/6
5 mA	1½	2½×2½	M/C	8/6
6 mA	2	3½ round		16/9
50 mA	1½	2½×2½	M/C	8/6
500 Micro/a.	1½	2½ round	M/C	15/-
20 V	2	2½×2½	M/C	8/6
40 V	1½	2½×2½	M/C	8/6
1 mA	2	3½ round	M/C	25/-

MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA Scale dimension 2½in. Overall dimensions 2½in. dia. 1½in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermo couple, reversing scale and recalibrating the meter, a high grade test instrument with any range above the basic F.S.D. may be built up. Price 4/9

1 mA METER IN PLASTIC CASE

The movement is 1 mA mounted in a case 3½in. square and 3½in. high. The scale is 2½in. long and the dial is 2½in. diameter. There is ample room in the case for a switch and multipliers. Internal Resistance 100 ohms. Price 27/6

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6 v. 11 plate—PREMIER. Height. 6½in.; Length. 7¾in.; Depth, 6½in. Price 60/-

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6 v. 16 amp.—PREMIER. Parking Light Battery. Price 27/6

6 v. 80 amp.—CANADIAN C.E.S. STORAGE BATTERY. 1 teak case. Guaranteed Brand New in original manufacturer's crate. Price 97/6

All prices plus 7/6 carr. and packing.

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200-250 v. A.C. Will charge 6 v. or 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size: 6in. long, 3½in. wide 9½in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 Post and Pkg. **39/6**

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All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.

Cat. No.

2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator ..... £1 . 2 . 6

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Input 230 v. A.C. Output 12 v. at 1 amp. Completely shrouded. Price 9/11.

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Balanced Armature Low Resistance

Type 1. 6/11 pair

High Resistance (S. G. Brown), 4,000 ohms, 10/9 pair.

Standard Type 12/6 pair

Lightweight High Resistance 14/6 pair.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and recording and sound projectors. Price 22/6.

MOVING COIL MICROPHONE

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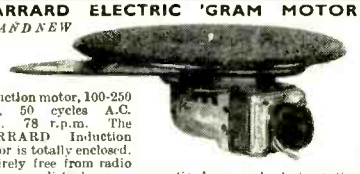
A matching transformer for high impedance can be supplied at 3/6 extra.

MICROPHONE STAND BASE

Heavy Moulded Black Base fitted with Standard thread adaptor. Dimensions: 7¾in. across, 2in. deep. Weight: 1¼lb. post paid 3/11.

GARRARD ELECTRIC 'GRAM MOTOR

BRAND NEW



Induction motor, 100-250 volt, 50 cycles A.C. only. 78 r.p.m. The GARRARD Induction Motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic. Variable speed. With 12in. Turntable. Price £4/19/6. plus packing and carriage 5/-.

GARRARD Type 75. Latest 3-speed Autochange Unit complete with 2 Acos High Fidelity G.P.19 Pick-up Heads. 1 L.P. and 1 standard. **£14.19.6**

GRAMOPHONE UNITS

GARRARD Rim Drive 78 r.p.m., complete with magnetic pick-up and turntable ..... £5 . 19 . 6

COLLARO 3-speed single gram. unit, complete with head for L.P. and Standard recordings ..... £8 . 8 . 0

Packing and carriage on each of the above units 2/6.

THE NEW BSR "MONARCH" AUTO-CHANGER

This is a 3-speed automatic mixed record changer designed to play 12in., 10in., and 7in. records intermixed in any order. Capacity 10 records, operates on 100/125—200/250 volts 50 c/a. A.C.

New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self compensated for the L.P. lower frequencies with the Turnover frequency at the correct point. PRICE £17/17/-. plus 5/- packing, carriage and insurance.

SPECIAL OFFER

THE *FAMOUS* "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP—TYPE GPX *for Standard and Long Playing*

The Chancery Light Weight GP.X Pick-up embodies certain unique features achieving a standard of performance not possible with normal magnetic or crystal pick-ups. The secret of the high standard of performance is in the use of the special microcell crystal cartridge assembly which has an unusually wide frequency response. The sapphire stylus is precision ground and semi-permanent. With two cartridges 1 L.P. and 1 Standard. Price 52/6. *Additional L.P. or Standard Cartridges can be supplied from stock at* £1/11/6 *each.*

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at approx. 50 per cent less than list price. By a famous manufacturer. Low Impedance, twin track. Frequency range 50-10,000 c.p.s. @ Tape speed of 7½in. per sec. Complete with circuit diagram of suggested associated components. Two types available: Record/Playback or Erase. Price 19/6 each.

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ELAC—2½in. dia., Moving Coil, 15 ohms imped 15/-

PLESSEY—3in. dia., Moving Coil, 3 ohms imped. 15/-

ELAC—3½in. dia., Moving Coil, 3 ohms imped. 15/-

ELAC—5in. dia., Moving Coil, 3 ohms imped. 14/6

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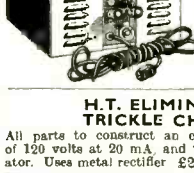
Plus 5/- packing and carriage.

VITAVOX—K12/20 12in. dia., Moving Coil. 15 ohms imped. £11/11

Plus 5/- packing and carriage.

H.T. ELIMINATOR Ex-Govt.

By famous manufacturer



NEW & UNUSED Input 200/250 v. A.C., Output 120—at 30 mA., housed in strong metal box size 10in. long, 7in. wide, 6¾in. deep.

37/6

Plus 2/6 pkg. and carr.

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All parts to construct an eliminator to give an output of 120 volts at 20 mA. and 2 volts to charge an accumulator. Uses metal rectifier £2.

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Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver. 6/-.

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All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a. 4 v. @ 2-3 a. 25/-

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SP301A, 300-0-300, 120 mA., 5 v. @ 2-3 a. 6.3 v @ 3-4 a. 28/-

SP301B, 300-0-300, 120 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3-5 a. 28/-

SP350A, 250-0-350, 100 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 29/-

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Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13:1 to 80:1 all centre-tapped and can be used to match any output valves either single- or push-pull. Class "A" "AB1," "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price. 45/-.

SPECIAL OFFER

DOUBLE WOUND AUTO-TRANSFORMER 250 watts.

Input/Output	Output/Input	
100 volts	110 volts	
110 „	113 „	
200 „	116 „	
210 „	119 „	Price 42/6
220 „	122 „	Plus 2/6 Pkg., Carr.
230 „	134 „	
240 „	146 „	
250 „		

With the two windings connected in series a vast number of voltage tappings are available.

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„ K3/45	3.6 kV.	1 mA.	8/2
„ K3/50	4 kV.	1 mA.	8/8
„ K3/100	8 kV.	1 mA.	14/8
„ K3/160	12 kV.	1 mA.	21/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/6
„ RM2	125 v.	100 mA.	5/-
„ RM3	125 v.	125 mA.	6/-
„ RM4	250 v.	250 mA.	18/-

L.T. Type. G.E.C. Full Wave.

6 v. 1 amp.	4/-
12 v. 1 amp.	8/-

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium, with four sides.

7×5½×2in.	4/-
7×3½×2in.	3/9
9½×4½×2in.	4/3
10×8×2½in.	5/6
12×9×2½in.	7/-
14×9×2½in.	7/6
10×9×3in.	7/-
12×10×3in.	7/9
14×10×3in.	7/11
16×10×3in.	8/3
16×8×2½in.	8/-

ALUMINIUM PANELS 18 s.w.g.

7×6in.	1/3	7×4in.	1/-
9½×6in.	1/8	9½×4in.	1/5
10×9in.	2/2	10×7in.	1/11
12×9in.	2/8	12×7in	2/5
14×9in.	3/2	14×7in.	2/11
16×9in.	3/8	16×7in.	3/5
20×9in.	4/8	20×7in.	4/5
22×9in.	5/2	22×7in.	4/11

Govt. Surplus—Ex. W.D. STEEL AERIALS

Also ideal for fishing rods—*ALL BRAND NEW*

12ft.—3 4ft. sections of copper-plated steel highly flexible tapering ¼in. to ⅛in. Brand new in container. 6/9. Packing and carriage 1/6. Insulated Base, 3/-. Webbing waterproof carrying case with shouldersling, 2/6.

EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.92 valve etc. Brand new, in carton, 5/-.

CLASSIC EXAMPLES of Quality for the Hi-fi Specialist

AMPLIFIERS • R/F UNITS • SPEAKERS • PICK-UPS • MOTORS • T/V • RECORDING EQUIPMENT

★ GUARANTEED MERCHANDISE ★ ALL GOODS IN STOCK AT TIME OF ADVERTISING
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AMPLIFIERS, R.F. AND TONE CONTROL UNITS

Item No.		Cash			£12 p'ments
1.	Leak T12 with Contro Unit	£37	16	0	48/4
2.	Leak Feeder Radio Unit	£37	16	0	48/4
3.	Leak Vari-slope	£12	12	0	17/6
4.	Quad Amplifier	£35	0	0	44/2
5.	Quad Radio Feeder Unit	£26	10	0	33/4
6.	Sound Sales A-Z Amplifier	£32	10	0	33/4
7.	Rogers R.D. Minor	£11	0	0	15/-
8.	Rogers Baby de Luxe Amplifier	£22	10	0	28/6
9.	Decca Type No. P.A.5	£17	10	0	21/8
10.	Goodsell Amplifier 8A.10	£15	15	0	23/4
11.	Goodsell Control Unit U/TC	£8	8	0	12/6
12.	Goodsell Control Unit F/U/IC	£12	12	0	17/6
13.	Goodsell MA15 Amplifier	£19	10	0	33/8
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15.	Goodsell Control Unit P/FA	£22	10	0	28/9
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18.	Garrard RC.72A Unit with Head	£16	16	6	21/8
19.	Garrard RC.75A	£16	17	6	22/6
20.	Garrard RC.80	£19	19	0	25/4
21.	Garrard Transcription Motor 201	£23	13	0	29/2
22.	Garrard Transcription Motor 201/2B	£23	13	0	29/2
23.	Garrard Transcription Motor 201/5B	£24	12	6	29/2
24.	Connoisseur 3-speed	£23	13	0	29/-
25.	Decca GU4 Unit	£9	19	11	14/-
26.	Decca GU4A Acos Heads	£11	17	6	16/8
27.	Decca GU4M Decca Heads	£13	10	0	18/6
28.	B.S.R. MU10 Motors and Turntable	£3	18	7	7/8
29.	B.S.R. MU14 Motors and Turntable	£6	8	6	10/6
30.	B.S.R. GU4 Motors and Turntable	£13	19	0	18/6
31.	Collaro 3-speed Auto 7", 10", 12"	£12	5	0	16/6
32.	Collaro 3-speed Mixer 7", 10", 12"	£14	10	0	20/-
33.	B.S.R. Monarch 7", 10", 12"	£17	17	0	26/6
34.	Trixette A358 3-speed Garrard	£42	0	0	53/4
35.	Decca Decalian 2-speed S/p.	£32	0	0	40/-

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36.	Goodmans Axiom 101 8"	£7	2	9	11/6
37.	Goodmans Audiom 60	£11	12	4	15/6
38.	Goodmans Axiom 150 Mk. II	£14	9	0	20/-
39.	Tannoy Duo Concentric 15"	£33	10	0	38/4
40.	Tannoy Duo Concentric 12"	£38	0	0	48/-
41.	Decca Corner Speaker	£31	0	0	40/-
42.	Wharfedale Super 5/CS/AL	£7	4	4	13/4
43.	Wharfedale Super 8/CS/AL	£7	4	4	13/4
44.	Wharfedale OMMI Direc. 3-unit	£85	10	0	90/9
45.	Wharfedale 10" Golden	£8	6	0	13/4
46.	Wharfedale 10" CSB	£18	10	0	25/6
47.	Wharfedale W/12/CS	£14	1	5	18/-
48.	Wharfedale W12/CS/AL	£23	1	10	28/10
49.	Wharfedale W15/CS	£16	0	0	21/8
50.	WB Stentorian 12" unit	£9	9	0	14/-
51.	Rola G.12 units	£9	9	0	14/-
52.	Classic "Concert" 2-unit	£45	0	0	58/6
53.	Acoustical Corner Ribbon	£95	0	0	120/-
54.	Vitavox "Klipschorne"	£145	0	0	180/-
57.	Classic Hi-Fi Cabinet for Quad/Leak Amp.	£30	0	0	40/-
58.	Voigt unit only	£42	0	0	53/4
59.	Voigt Corner Horn (White)	£48	0	0	60/-

TAPE DESKS AND RECORDERS

Item No.		Cash			£2 p'ments
60.	Wearite Type A Tape Deck	£35	0	0	45/-
61.	Wearite Type B Tape Deck	£40	0	0	50/-
62.	Bradmatic Desk 6RP Heads	£42	0	0	55/-
63.	Sound Mirror Type A	£33	0	0	41/8
64.	Truvox Type A	£23	2	0	30/2
65.	Lane Type I	£16	10	0	22/-
66.	Qualtape Type 1	£16	16	0	22/-
67.	Excel Pro/Tape Desk	£75	0	0	97/1
68.	M8S Type PM R1 Recorder	£150	0	0	191/8
69.	Ferrograph Type A	£79	10	0	100/-
70.	Vortexion Recorder with Wearite Deck	£84	0	0	107/4
70A.	Vortexion with Truvox Desk	£72	2	0	92/-
71.	CJR Portable Recorder	£119	0	0	146/8
72.	Sound Mirror Portable	£79	10	0	100/-
73.	Sound Mirror Table Model	£69	10	0	88/2
74.	Simun Model 2B	£60	0	0	76/8
75.	Simon Model IA	£83	0	0	105/-
76.	Wirek Magnograph	£65	0	0	76/8
77.	Wirek Reporter	£59	0	0	74/-
78.	Bradmatic Amplifiers	£62	0	0	78/7
79.	Scophony Baird Mk. 2	£68	5	0	86/3
80.	Grundig Model A	£78	15	0	100/9

TAPE RECORDING ACCESSORIES AND EQUIPMENT

81.	Bradmatic Circuits		5	0	—
82.	Bradmatic Plate Coil		9	0	—
83.	Bradmatic Oscillator Coil		9	0	—
84.	Bradmatic Bias Rejector Unit		12	6	—
85.	Bradmatic Mumetal Screens		4	6	—
86.	Bradmatic Tape Guides		5	0	—
87.	Bradmatic 5RP Heads	£3	5	0	—
88.	Bradmatic 6RP Heads	£3	15	0	—
89.	Bradmatic 5E Erase Heads	£3	5	0	—
90.	Sound Mirror Tape, per reel	£1	5	0	—
91.	G.E.C. Tape, per reel	£1	10	0	—
92.	E.M.I. Tape, per reel	£1	10	0	—
93.	Scotch Boy Tape, per reel	£1	15	0	—
94.	Collaro Tape/Rec. Motors*	£1	18	0	—
95.	Spare Spools		6	6	—
96.	Acos Microphone	£6	6	0	—
97.	Rothermel Mike	£3	0	0	—
98.	Reslo Ribbon Mike	£9	9	0	—
99.	Reslo Table Stand	£2	12	0	—
100.	Reslo Moving Coil Mike	£5	5	0	—
101.	B.S.R. FP.10, 1,400 r.p.m.	£1	18	0	—
102.	B.S.R. SR.1, 2,750 r.p.m.	£1	12	0	—
103.	B.S.R. SR.2, 2,750 r.p.m.	£1	5	0	—

*Left and right drive.

PICKUPS AND PICKUP HEADS AND CROSS-OVER UNITS

(H.P. Available over £10)

104.	Decca XMS with two Heads	£7	0	0	—
105.	Decca Hi-Fi Mag. Pickup Head	£2	19	6	—
106.	Connoisseur Pickup	£6	9	0	—
107.	Connoisseur Pickup Head	£3	11	8	—
108.	Connoisseur Pick-up Transformer		15	0	—
109.	Leak Ruby Standard or L.P.	£12	12	0	17/6
110.	Leak Diamond Std. or L.P.	£19	2	6	33/4
111.	Leak Pickup Transformer	£2	15	0	—
112.	Acos G.P.19	£3	11	5	—
113.	Acos G.P.20	£3	11	5	—
114.	Acos L.P. and Std. Heads	£2	3	4	—
115.	Acos Pickup Arm	£1	7	6	—
116.	Decca Pickup Arm	£1	7	6	—
117.	Collaro Pickup Arm	£1	5	6	—
118.	Chancery Crystal Pickup	£2	12	0	—
119.	Decca Crystal Pickup	£2	12	6	—

LARGE SCREEN T/V. Decca Projection T/V for sale or for hire for Coronation. Details on request. Also other makes, tubes, components for wide angle viewing, etc.

H.P. DEPOSITS *All goods value £10 or more available on H.P. Terms. Minimum deposit—one-third of cash price in all cases. Longer terms on goods over £100 by arrangement.*

SERVICE Merchandise is thoroughly tested before despatch and guaranteed. Every effort is made at all stages of business to ensure your personal satisfaction. Enquiries are invited for any items not listed here. New showrooms for tape-recorders, large-scale T/V and gramo. equipment now open.

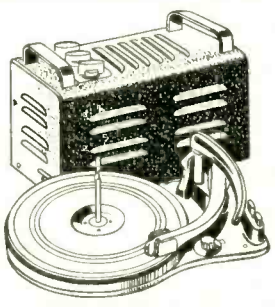
FULL LISTS ON REQUEST

THIS MONTH'S SPECIAL OFFER

Decca P.A.6 Amplifier in case. Plessey 3-speed Autochange for 7", 10" and 12" records and Goodmans Axiom 101 8" Speaker. All famous equipment, brand new and tested. Usual price of complete outfit £52/5/9. Our special price

£36 cash

or £12 deposit and 12 monthly payments of 46/-



FOR QUALITY FIRST

THE CLASSIC ELECTRICAL CO., LTD. 352/364, LOWER ADDISCOMBE ROAD, CROYDON, SURREY. Telephone: ADDiscombe 6061-6062.

Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

Managing Editor : HUGH S. POCOCK, M.I.E.E.
Editor : H. F. SMITH

MAY 1953

In This Issue

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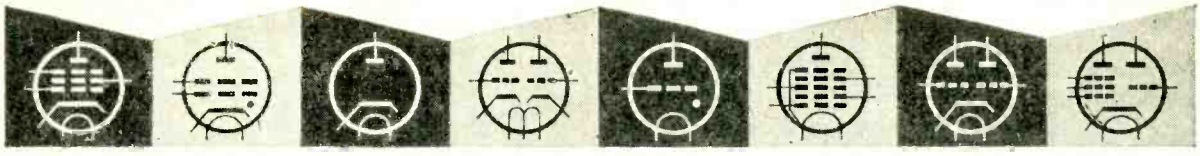


VALVES, TUBES & CIRCUITS

5. DM 70 — SUBMINIATURE TUNING INDICATOR FOR BATTERY OR MAINS RECEIVERS

An entirely new form of cathode ray tuning indicator, the Mullard DM70 is characterised by a compact subminiature bulb, a simple triode structure, a linear form of indication and a 1.4-volt 25mA directly-heated filament.

Whilst having electrical characteristics similar to a triode, the grid and anode together produce a visual indication of the voltage applied to the grid. These two electrodes consist of flat plates, the grid having an aperture shaped like an exclamation mark and the anode being coated with luminescent material on the face nearer the grid. The filament is located on the side of the grid remote from the anode and is parallel to the axis of the aperture. On viewing the anode through the grid aperture, a luminescent column is observed, the length of which is a maximum when approximately zero bias is present on the grid. Its length decreases from the " waist " of the aperture upwards as the bias becomes more negative. The valve is so constructed that the " dot " remains illuminated until the column has almost disappeared. The DM70 can be controlled by an undelayed a.g.c. voltage or by the demodulator circuit of a receiver to give maximum length of column when no signal is being received. On " tuning-in " to a carrier the length of column decreases, the minimum length indicating accurate setting of the tuning control.

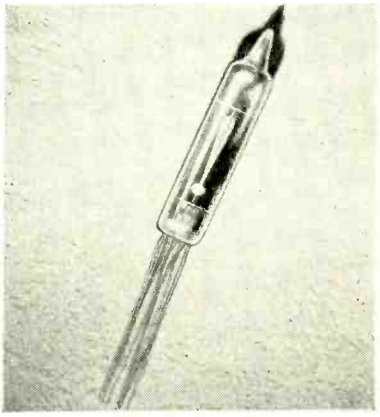


Fig. 1.—DM70, showing grid aperture.

In a particular receiver the h.t. voltage and the a.g.c. or demodulator voltage for maximum received signal are usually predetermined. Under these conditions control over the operating conditions of the DM70 may be obtained by correct choice of the filament voltage polarity. In the data given, the best method of filament connection has been indicated for each application, the " earthed " pin being at the same potential as the earthed side of the a.g.c. circuit. This is normally connected to the chassis of the receiver.

The small bulb (10mm. diameter), solder-in leads and linear form of indication permit the valve to be mounted in several unconventional ways such as part of the moving cursor in the tuning dial. It then serves as an illuminated pointer, the " dot " assisting in this function and also acting as a pilot light in battery receivers.

In a subsequent advertisement it is hoped to deal with the application of this valve in both mains and battery receivers.

PRELIMINARY DATA

OPERATING CONDITIONS

Battery-operated receivers

	Pin 4 earthed	Pin 5 earthed	
V_b	90	67.5	V
V_a	85	60	V
V_g	0	0	V
I_a	170	105	μA
*Length	11	10	mm
V_g (for complete extinction)	−10	−7	V

Mains-operated receivers (Pin 5 earthed)

V_b	110	170	250	V
R_a	0.47	1.0	1.8	MΩ
V_g	0	0	0	V
I_a	105	110	105	μA
*Length	10	10	10	mm
V_g (for complete extinction)	−15	−23	−34	V

FILAMENT

V_f	1.4	V
I_f	25	mA

LIMITING VALUES

$V_{b\,(o)}$ max.	450	V
V_b max.	300	V
**V_a max.	90	V
V_a min.	45	V
†p_a max. ($V_a \leq 90$ V)	25	mW
†p_a max. ($V_a = 200$ V)	10	mW
I_k max.	300	μA
R_{g-f} max.	10	MΩ

BASE B8D

*Length of fluorescent column observed, measured from the top of the aperture. The maximum value is approximately 14 mm.

**In circuits without anode series resistor.

†Values of p_a max. for intermediate values of V_a may be determined by linear interpolation.

Reprints of this advertisement together with additional data may be obtained free of charge from the address below.

MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2

MVM 228

Wireless World

MAY 1953 VOL. LIX No. 5

V.H.F. in Suspense

MANY hundreds of thousands of words have been spoken in both Houses of Parliament on the general topic of broadcasting since the Government issued a White Paper setting forth its intentions nearly a year ago. We have patiently read every relevant word in *Hansard*, but still admit to complete ignorance as to what are the Government's real intentions on the future of v.h.f. broadcasting.

The White Paper could hardly be more categorical (in para. 11) in saying that the completion of the B.B.C.'s plans, including the introduction of v.h.f., "must have first claim when labour and materials become available." That statement has not been unequivocally withdrawn by the Postmaster-General or Asst. P.M.G., though there are strong indications that the Government's support for v.h.f. has weakened.

As to the urgency of the matter there can be no doubt. Our correspondence columns—and a large number of unpublished letters from readers—bear witness to the growing inadequacy of medium-wave broadcasting. It is not defeatist to say that neither the B.B.C. nor anyone else can find any technical means of overcoming these troubles, and, for a radical improvement in the sound broadcasting service, we must turn to the higher frequencies.

Emergency Service

"IT can't happen here" is what the amateur radio transmitters have hitherto been told when they have offered to organize themselves to help against natural disasters like flood and tempest. But it *did* happen here, and amateurs, on their own initiative, took over the service of a Post Office coastal station which had been put out of action by the tidal inundations at the beginning of the year. Since then, the Radio Society of Great Britain has invited members willing to take part in an emergency scheme to register their names; we understand the response has been considerable.

In a country like this, of short distances and highly developed communications, it would be carrying caution too far to set up the complex kind of amateur organization that has worked so well in America. But it might be at least worth while to have the nucleus of a scheme, with a register of those willing to help.

New-style Patronage

IN the good old days the writer of fiction sometimes enjoyed the patronage of a nobleman of literary inclinations. The scientific writer, too, has long benefited from a kind of indirect subsidy on publication of his ideas through gifts made to his learned societies. But, till quite recently, the unassuming technical writer has had none of these benefits.

Things are changing. As we recorded in our pages a few months ago, a severely technical book may now command sales that arouse the envy of authors of best-selling "thrillers." The writing of technical books and articles is on the way towards being recognized as a job in its own right; there is already a flourishing Discussion Group concerned with the subject as well as a lecturership at University College, London. This is as it should be; in an increasingly mechanized and technical world there is a growing demand for the ever-wider dissemination of information on the widely diverse range of techniques in use. And the time is past when publication can be directed solely towards the kind of specialist who understands nearly as much of the subject as the author. Material has now to be presented more skilfully, and with sympathy towards those who may be working on the fringe of the specialized field concerned.

Just as the work of the technical writer is being accorded fuller recognition, so, in our particular sphere at least, he is beginning to enjoy the fruits of what we may call an up-to-date version of the old-style patronage of the arts. The Radio Industry Council, assuming the role of patron, recently presented six generous premiums and *ex-gratia* awards to writers of articles in published journals.

Components for Transistors

By G. W. A. DUMMER,* M.B.E., M.I.E.E.

Low Operating Voltages and Currents Make Extreme Miniaturization Possible

IT is already becoming apparent both in the U.S.A. and in the U.K. that a new range of components comparable in size to the transistor must be developed. A modern junction transistor is of the order of $\frac{3}{16}$ in square and the opportunity given for miniaturization is nullified if components of normal size, or even miniature ones, are used with transistors.

The normal valve and its associated components are comparable in size and a sub-miniature valve compares favourably with sub-miniature components, but there are at the moment few components comparable in size to the transistor.

The low voltage and low current needed to operate the transistor make possible almost wattless resistors and very thin dielectric capacitors, and the capacitors need withstand breakdown voltages of, say, 10-50 volts only instead of the normal 150-750 volts. Another factor which will aid the development of tiny components is that negligible heat is dissipated in the transistor itself, whereas the normal valve with its relatively large heater dissipation requires adequate ventilation.

Although transistor development is still in an early stage, and very few transistors (particularly junction types) are available for experimental use, it is not too early to consider the development of these new components which are entirely different from those in use to-day. The illustration (Fig. 1) shows some of the components which are being developed, compared in size with normal and miniature types. Some of these experimental components are described below:—

Fixed Resistors (*Grade* 2).—In designing a resistor to operate at, say, 20 volts and carrying a few microamps of current, wattage dissipation can be almost ignored and the component can be made extremely small. Experimental resistors have been constructed consisting of a 0.001-in diameter glass fibre, such as used in glass wool, coated with a carbon mix to form resistors of one megohm in a length of approximately one inch. These resistors are just barely discernible to the naked eye.

Fixed Resistors (*Grade* 1).—Experiments on a similar 0.001-in diameter glass fibre have shown that it is possible to coat the fibre with a platinum/gold solution which has a resistive value of 2,000 ohms per inch length. This is approximately 40 times the value obtained with nichrome or other high-resistance wire of equivalent diameter. The resistor produced by this method is extremely stable and has a noise value of the order of 0.02 microvolts per volt and a temperature coefficient of 0.025 per cent per degree C. The metallized glass-fibre resistor may be wound round a glass rod, or folded where high resistances are required. In actual fact and because of the low operating voltages, most resistors in transistor circuits are of the order of thousands or tens of thousands of ohms.

Resistors have also been made on flat glass plates by depositing a platinum/gold mixture on one surface and then firing in an oven at about 400 deg C, when the metal compounds are reduced to metal. Whilst in this stage, a meander or zig-zag pattern is scribed through the metal to produce a long resistance path. The plate is then fired at about 600 to 700 deg C (depending on the glass) to form a firmly bonded resistance coating. Resistors of several hundred thousand ohms have been produced at $\frac{1}{10}$th watt in a size $\frac{1}{8}$ in by $\frac{1}{8}$ in; end connections can be soldered directly. The stability of these resistors after one year's life is better than 1 per cent and they will withstand climatic cycling with less than 2 per cent change in resistance.

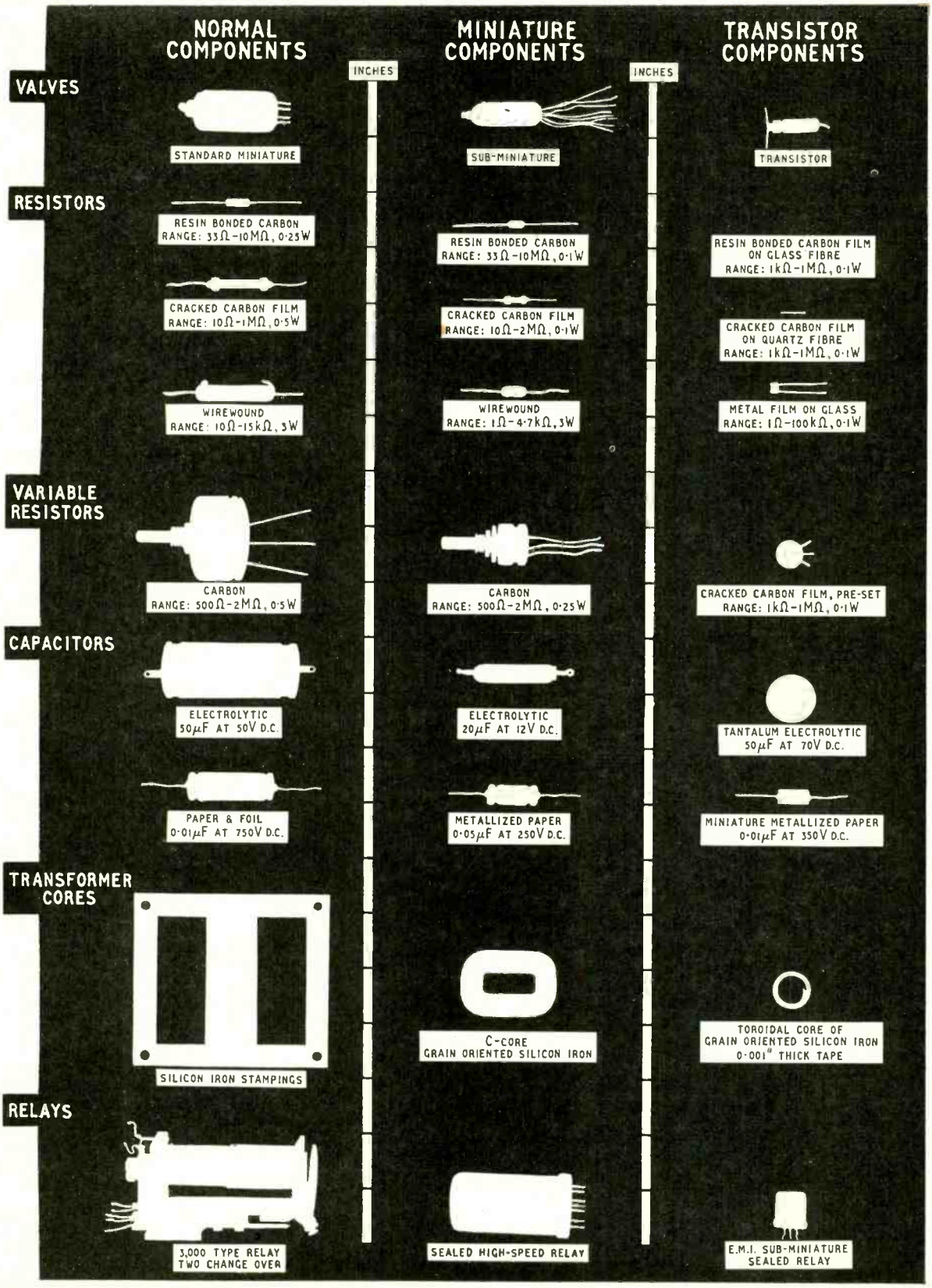
Pyrolytic carbon, or cracked carbon, resistors (high stability) have been manufactured experimentally by a leading resistor manufacturer in which the carbon film is deposited on a quartz fibre approximately 0.01 in in diameter instead of on the normal ceramic rod. These resistors have all the usual characteristics of the cracked carbon resistor and can be used for transistor applications. For values up to one megohm the length of (0.01-in dia) quartz fibre is about one half-inch. Carbon has been successfully cracked on quartz fibres varying in diameter from 0.003 in to 0.025 in.

Potentiometers. — Sub-miniature carbon-track potentiometers have already been designed for electronic equipment used in telemetering and guided missiles, and these are comparable in size to the new range of transistor components. The potentiometer has a cracked-carbon track deposited on a ceramic ring and made in values up to 10,000 ohms, above this value sprayed carbon tracks are used. This is intended to be used as a pre-set potentiometer requiring good stability once set. The size is $\frac{3}{8}$ in diameter by $\frac{1}{4}$ in deep.

Capacitors.—The low voltage operation of the transistor means that capacitors need not be designed

* Telecommunications Research Establishment.

See opposite page: *Fig. 1 Normal sized, miniature and transistor components are shown here on the same scale. The glass-fibre resistor is too thin to be visible on this reduction.*



to withstand the normal high breakdown voltages and therefore the thickness of the dielectric can be reduced to the extreme minimum. If a capacitor has to be designed to withstand, say, 20 volts only, both dielectric and metal electrode can be almost as thin as it is humanly possible to make them.

Experimental plastic films approximately 0.0001 in thick have been made by the following process: A metal film approximately 0.00005 in thick is evaporated on to a glass plate, then an extremely thin film of plastic, about 0.0001 in, is spun on to the metal and cured. Spinning ensures that there are no pin holes and that the coating is even. The metal-coated foil is then floated off the glass plate in an inert solvent and the capacitor foils thus produced rolled up in the usual manner.[1]

The advantages of the electrolytic capacitor are realized when used in transistor applications, as the maximum capacitance per unit area is obtained with the electrolytic capacitor if the operating voltages are low. This is due to the extremely thin dielectric (a few millionths of an inch). At a working voltage of 10 or 20 a capacitance of many microfarads can be encompassed within a very small space. The use of porous-foil electrolytic capacitors is being investigated and so also is the use of the tantalum electrolytic capacitors, as has been described previously.[2]

Transformers.—In the design of transformers in which the windings carry negligible current and the voltages are of the order of 10, it becomes possible to use extremely fine wire and the main limitation in the size of such transformers is principally the primary winding, especially in this country where 230 V is standard. In the U.S.A. small mains transformers have been designed for operation at 116 V, 60 c/s, a primary current of 0.014 A and a secondary of 8 V 50μA. Including a half-wave rectifier, smoothing capacitors and smoothing resistor, the overall size is $1\frac{1}{4}$ in cube only. The core material used is "Hipersil" which permits a very high flux density and therefore aids miniaturization. Transformers designed for these low output voltages and currents are inefficient at normal mains frequencies and emphasize the need for further development of miniature batteries.

Audio Transformers.—Here again, transformers have been designed in the U.S.A. to carry 10 mW of audio power with a superimposed direct current of 0.1 mA (transistor collector current) and contained in a cube of $\frac{3}{8}$-in sides. "Ferrite" cores have many advantages for transistor components and will undoubtedly be used a great deal in transformers, particularly for carrier frequencies.

Batteries.—The development of miniature batteries capable of delivering the small powers required for long periods is probably the next stage in the operation of transistor circuits. Little work has been done on transistor batteries in the United Kingdom, but batteries have already been made in the United States which can last for reasonable periods and are comparable in size to the range of components described here.

Miscellaneous Components.—The development of new types of relays, switches, etc, may follow, but it is too early yet to decide detailed requirements. A miniature sealed relay is being developed by E.M.I. with a single-pole change-over contact, in size $\frac{1}{2}$-in cube only, which may prove a useful transistor component. Possibly some of the sub-miniature items developed for hearing aids may also find applications in this field.

Assembly Techniques.—It is not possible to assemble these tiny components in the usual way with chassis and panel fixings and one solution is to use

[1] See British Patent App. No. 13452/51 (R. J. Heritage, 2/50 in Canada Sep. No. 631,572, 1952, and U.S.A. Sep. No. 290,083, 1952).
[2] *Wireless World*, December, 1951, p. 510, "Electrolytic Capacitors," by G. W. A. Dummer.

Fig. 2 On the left is shown a multi-vibrator using sub-miniature valves and components while on the right is a similar circuit using transistors and special components.

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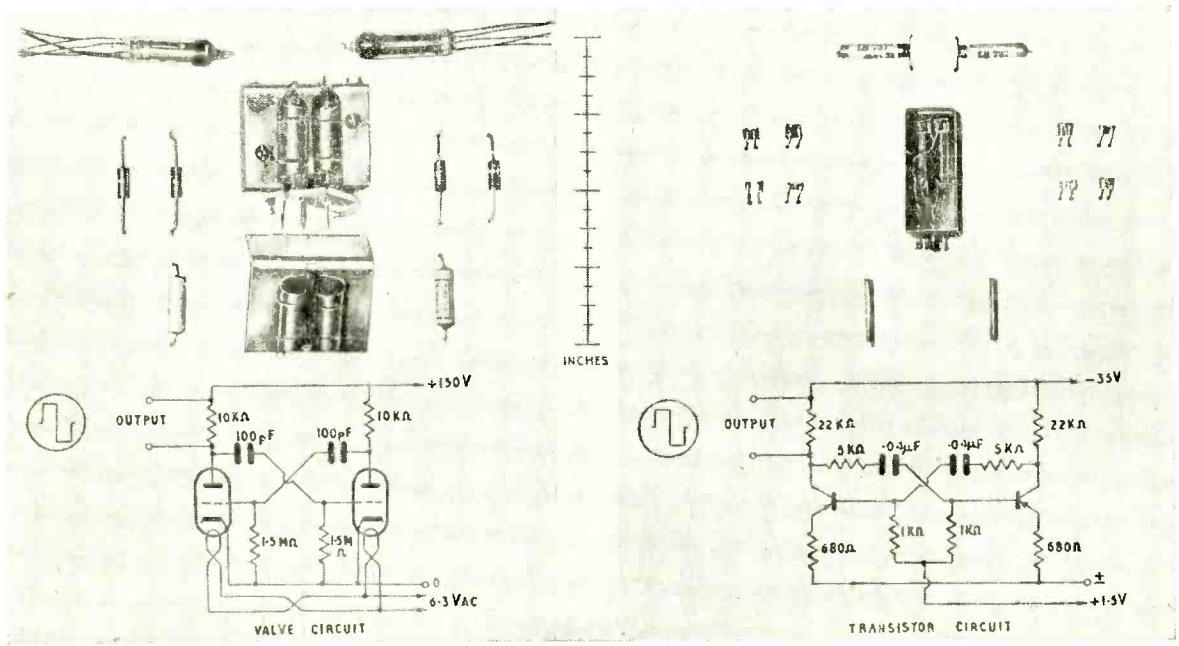


the potted techniques and casting resins of the polyester or ethozyline types. The method of assembly is to fit the components and the transistors in a jig using stout wires as supports. The assembly is tested whilst in this frame. A potting solution is then prepared, usually by mixing 1 part catalyst, 1 part accelerator and 100 parts polyester resin (with 25 parts powdered mica filler to prevent cracking of the casting at low temperatures). The assembly is then placed in a suitable mould coated with mould release agent and the casting resin poured in. There is usually an exothermic reaction which raises the temperature of the resin and the embedded components, but the use of the 1 part accelerator and 1 part catalyst results in a comparatively long gelling time (about five hours) and the exothermic reaction temperature is then cut down to about 10/20 deg C. After this period the casting may be removed from the mould and although it will continue to polymerise for some weeks, it is ready for use.

Conclusion.—There is a new field of development in this range of sub-miniature components, but there are many problems to be solved; handling and mechanical tolerances will be particularly difficult. The close mechanical tolerances required in the manufacture of these precision devices will present a tremendous problem, particularly in production. In addition, there will be such difficulties as preventing the corrosion of fine wires in transformers, relays, etc, and the compatibility of the component materials with the potting resins.

There seems little doubt however, the work of this type must be done if components for transistors are to be developed and made in the United Kingdom and this article described some of the research and development effort which has already been carried out. An example of the work now being done is exemplified by the transistor multi-vibrator unit with its component parts and circuit compared to a similar circuit using valves and normal miniature components and shown in Fig. 2. The transistor assembly is an example, also of the potted technique.

Research on Insulating Materials

Items of Interest from the Recent I.E.E. Symposium

OF the many groups of materials essential to radio and electronic technology, few are as important or require to be as versatile as insulants. Not only must they be non-conductors, to keep currents in their allotted paths, but in radio-frequency applications must show low losses in alternating fields. They may be called upon to provide high or low permittivity (dielectric constant), to show stable electrical characteristics over a wide range of temperatures, and, in this age of nuclear fission, to withstand irradiation by gamma rays or bombardment by high-energy particles !

Not so long ago the electrical or radio engineer was content to tabulate the qualities of the available dielectric materials and to select the appropriate grade for any given occasion, as one might select a cheese or wine. Nowadays a recondite literature of basic physical theory is available on the subject, and the time may not be far distant when it will be possible to predict the dielectric performance of materials with some confidence, or even to synthesize new materials to a specification.

Some insight into the breadth and depth of this subject was provided by the specialist papers in the Symposium on Insulating Materials, held last March at the Institute of Electrical Engineers, and attended by representatives of 10 countries.

Typical of the modern approach to dielectrics was the paper by L. Hartshorn, J. V. L. Parry and E. Rushton. "Dielectric Losses in Some Representative Insulating Materials," which describes the exploration of the properties of silicones, hydrocarbon plastics, and phenol- and aniline-formaldehyde resins over a frequency range from 10 c/s to 2,400 Mc/s, and gives a physical picture of the origin of irregularities in the $\tan\delta$ and loss curve in terms of the characteristic relaxation times of various elements of the molecular structure. Over the frequency range 1 kc/s-10 Mc/s, the power factor of silicones of widely different viscosities and molecular chain length is sensibly zero, certainly less than 0.0001, but at frequencies below 100 c/s it rises steeply and there is a peak above 100 Mc/s. As this is independent of chain length over a range of 24 to 356 intermediate Si-O links it seems likely that the higher resonance is a phenomenon associated with the time-constant of the silicon-oxygen link, and that the low-frequency rise is due to the ends of the chain which carry three CH_3 groups.

The hydrocarbon dielectrics polystyrene and polyethylene, and polytetrafluorethylene (p.t.f.e.), in which the fluorine atoms do not destroy the electrical symmetry of the molecule, have been investigated in detail and show low but measurable power factors which do not vary greatly, or in any characteristic way, with frequency. Such variations as are observed are thought to be due to traces of impurity, and the figures obtained in commercial samples do not necessarily represent the ultimate intrinsic performance of these substances.

Water Absorption

The performance of phenolic resins, which are much used in electrical engineering, is dominated by water absorption. In phenol-formaldehyde the loss increases and the permittivity falls steadily with frequency. Moisture content increases the loss without affecting the shape of the curve plotted against frequency, and the form of the curve is retained with a vacuum-dried specimen. From this it is concluded that OH groups in the resin are responsible for a loss similar to that of the absorbed water, and that one added water molecule is equivalent to about two

original OH groups. Aniline-formaldehyde, on the other hand, shows a broad peak of power factor at room temperature centred at about 200 kc/s, which corresponds to a relaxation time equivalent to that of ice at -5°C. It seems probable, therefore, that the effect of water is determined by the nature of the bond with the insulating material, and that it may vary over a whole range of conditions from liquid water to the equivalent of ice.

Investigations on "Kel F"—a modified form of p.t.f.e., in which chlorine atoms are substituted for some fluorine atoms in the molecular chain, giving improved mechanical working properties—has provided experimental support for Fröhlich's* model of polarization in solid dielectrics, and gives good agreement with the calculated shape of the power factor/frequency curve, at least for the main peak. Equally striking is the correlation between calculated and measured loss curves for some benzene derivatives described in a paper by A. Turner.

Several speakers underlined the need for exploration of the region below centimetre wavelengths—the present limit with cavity-resonator and transmission-line techniques—in order to verify the existence, at higher frequencies, of changes in permittivity and loss predicted by theory. One possible method of investigating permittivity in the millimetre band is to use a free-field spectrometer in which electromagnetic horns with lenses take the place of the optical collimator and telescope. The technique is complicated by diffraction effects arising from the fact that apertures are of necessity comparable with the wavelength, but these can be allowed for and, by the methods described by W. Culshaw in the paper on "A Spectrograph for Millimetre Wavelengths," measurements of permittivity accurate to within ± 0.5 per cent can be obtained.

An interesting survey of ceramic dielectrics was given by P. Popper in a paper "Ceramic Dielectrics and their Application to Capacitors for Use in Electronic Equipment." The physical basis for the high permittivities obtained in crystalline ceramic aggregates are surveyed and an outline is given of the methods which have been used to modify the original characteristics obtained with titanium oxide. Nearly twenty useful materials are now available to the condenser manufacturer for meeting various requirements as regards permittivity, power factor temperature coefficient and electric strength. In general, ceramic dielectrics can be divided into two groups, those which do or do not develop a hysteresis loop on the application of an alternating field. It is not always realized that the electrostrictive properties of the former group of "ferro-electrics," which can be usefully exploited in pickups and microphones, is an embarrassment when such materials are used for their high permittivity in capacitors, and suitable precautions must be taken to avoid mechanical resonance. The paper described low-loss, high-stability capacitors for use in tuned r.f. circuits, and the manner in which the temperature coefficient of capacitance can be adjusted to offset the temperature coefficient of inductance of the associated coils. It also underlines the advantages of small size to be gained by the use of ferro-electric ceramics of high permittivity in bypass condensers, where losses and temperature effects are less critical. Due to the small physical size, the inductance of leads can be kept below 0.01μH.

The symposium also covered the range of insulating materials used at supply frequencies and discussed many of the newer laminated plastics. Subsequently, the papers will be published in a special issue of the *Proceedings I.E.E.*, Part IIa, No. 3.

* "Theory of Dielectrics" by H. Fröhlich (Clarendon Press, 1949).

Audio Shows

THIS year's "P.A." exhibition organized by the Association of Public Address Engineers will be held at the Horseshoe Hotel, Tottenham Court Road, London, W.1, for two days (May 5th and 6th) instead of one as in the past. At this fourth annual A.P.A.E. show, which will be open on both days from 10.0 to 6.0, there will be the following 18 exhibitors: Cosmocord, G.E.C., Goodmans, Grampian, Grundig, Leak, Lowther, Lustraphone, M.S.S., Magneta, Pamphonic, Reosound, Reslosound, Rola, Trix, Truvox, Vitavox and Whiteley.

Throughout each day there will be 20-minute demonstrations of public address equipment. Admission to the show is by ticket, available from the honorary secretary, Alex J. Walker, 394, Northolt Road, South Harrow, Middx, or by trade card. Production of this issue of *Wireless World* will also permit admission.

During the week-end of May 16th-17th, the fifth annual exhibition of sound recording and reproducing equipment, organized by the British Sound Recording Association, will be held at the Waldorf Hotel, Aldwych, London, W.C.2, from 10.30 to 6.0. Non-members are admitted by purchasing a 1s 6d catalogue.

The following 24 firms are exhibiting at the B.S.R.A. show, and many of them will be demonstrating loudspeakers and disc, tape and wire recording and reproducing gear: Acoustical Manufacturing, British Ferrograph, C.J.R. Electrical, C. T. Chapman, Cosmocord, E.M.I., Garrard, Goodmans, Grundig, Leak, Leevers-Rich, London Office Machines, Lowther, M.S.S., Minnesota Mining, Reproducers (Electronic), Reslosound, Rogers Developments, Simon, Sugden, Thermionic Products, Vitavox, Wharfedale and *Wireless World* and *Wireless Engineer*.

SCHOOL BROADCASTING

SIXTY broadcast receivers and twenty loudspeakers which have been tested and approved as suitable for use in schools are detailed in a list recently issued by the School Broadcasting Council for the United Kingdom.

The receivers, all of which have been tested under school conditions, are grouped in two sections; the first includes 40 sets "whose design is specially suitable for schools," while the second gives receivers, which, although designed primarily for domestic use, are approved for school use.

All the receivers are stated to be generally suitable for use in classrooms, and those sets capable of providing the output necessary for schools where reception is required in an assembly hall or where a number of loudspeakers are to be used simultaneously are marked. The manufacturers listed as making equipment "specially suitable" for schools (and, in brackets, the number of approved types available) are: Audix B.B., Ltd. (5), Clarke & Smith Manufacturing Co. (7), Communications Systems, Ltd. (2), F. W. Coomber & Son (5), Dictograph Telephones, Ltd. (2), E. K. Cole, Ltd. (3), Gramophone Co., Ltd. (2), Grampian Reproducers, Ltd. (1), Hadley Sound Equipments (1), Magneta Time Co. (5), A. F. Merriot, Ltd. (1), Sound Sales, Ltd. (1), Tannoy Products (1), Trix Electrical Co. (3), Ultra Electric, Ltd. (1).

The loudspeakers given in Part III of the list have been approved for use as extension speakers.

Copies of the list, together with further information on school broadcasting equipment, can be obtained free from the Secretary, the School Broadcasting Council for the United Kingdom, 55, Portland Place, London, W.1.

Portable P.A.

Negative Feedback Amplifier with Alternative Input Arrangements

By E. GRIFFITHS, Grad.I.E.E.

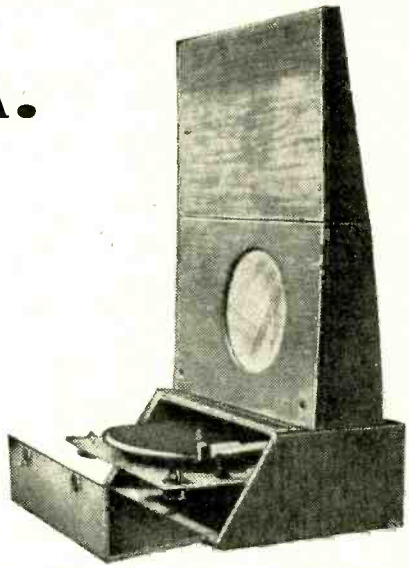


Fig. 1. The portable P.A. units opened and assembled for use.

THE equipment described in this article was designed to give an output of 8 watts with less than 1% distortion and it is intended principally for use in small halls. A major requirement was lightness with reliability and the circuit design is such that a reasonable output can be obtained in the event of a valve failing.

Commercial gramophone equipment appears to fall into two classes, the record player and amplifier in one heavy box giving an output of about 3 watts into a small loudspeaker and large equipment consisting of several separate units. Both are equally inconvenient for carrying about on buses and it has been found more convenient to have two boxes of more or less the same size and weight. The equipment described here consists of one box measuring 15in × 13½in × 6½in containing the turntable motor and pick-up and the other measuring 18in × 12in × 6½in housing the power pack, amplifier and a 10-in loudspeaker. Fig. 1 shows the playing arrangement and it will be seen that the loudspeaker box sits on the playing desk, the front of which pulls open drawing the turntable assembly forward for easy access. The back of the loudspeaker box hinges up to give an extended baffle and thus prevents the bass boom which would occur in a small cabinet of these dimensions if the back were closed. The loudspeaker is also mounted non-centrally so that the front to back length is different in each direction. Fig. 2 shows a rear view of the loudspeaker unit, the power pack being on the right and the amplifier on the left. The mains cable and connectors are wound on the two hooks above the loudspeaker and the space between the two units is utilized for carrying various adaptors. There is also sufficient clearance for a few records to be carried in the lid of the box.

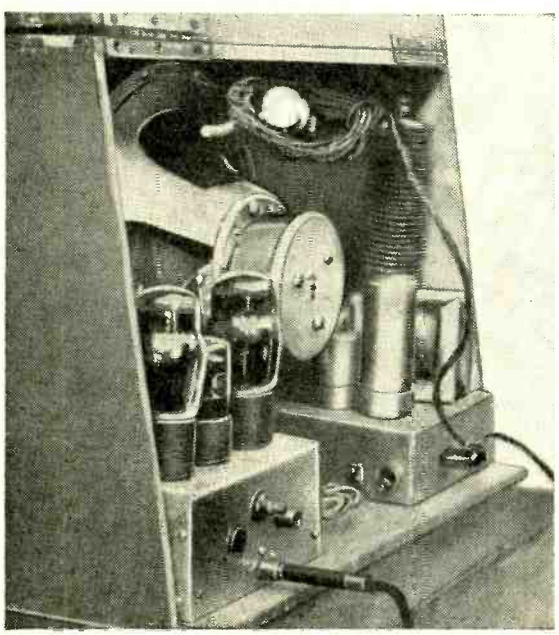


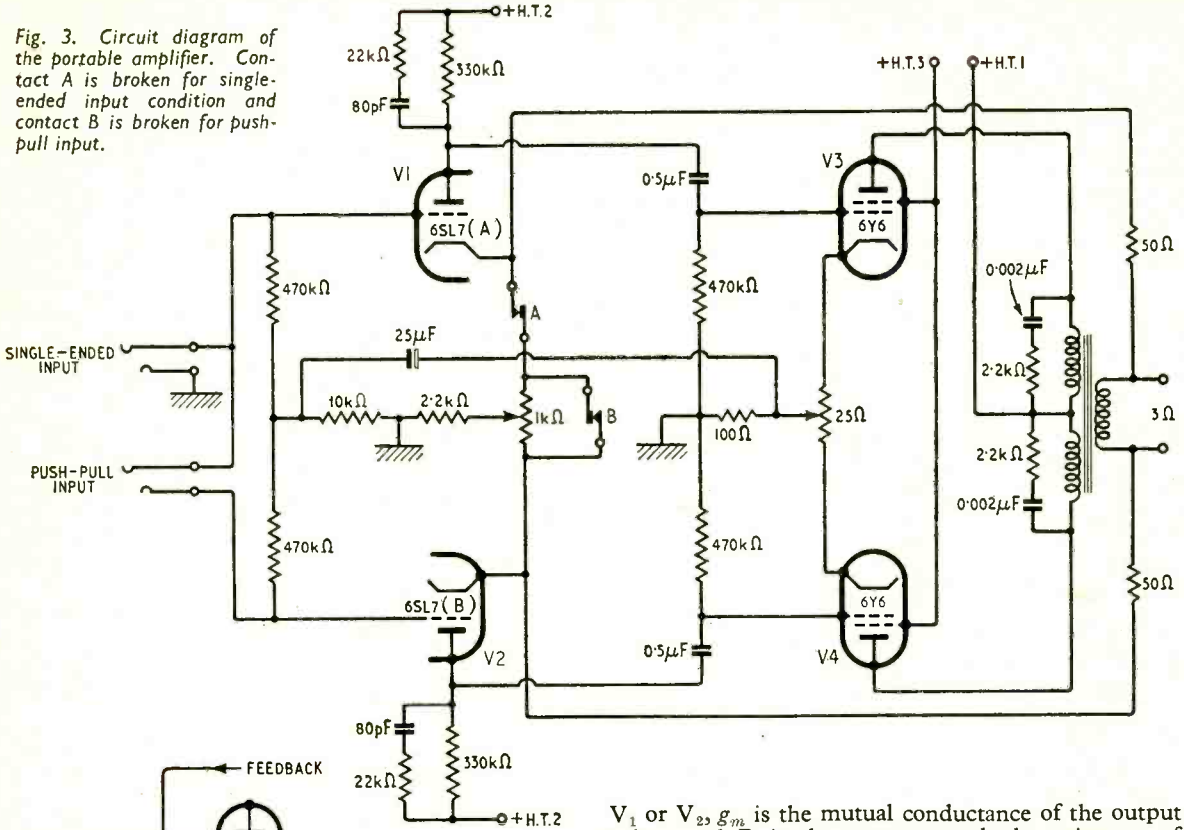
Fig. 2. Rear view of the amplifier unit showing the power pack on the right.

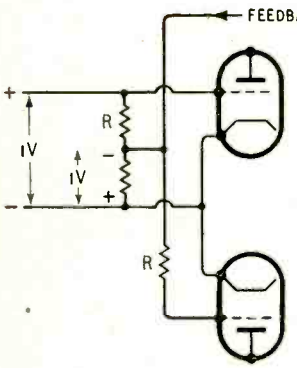
Amplifier.—The circuit diagram of the amplifier is shown in Fig. 3 and it will be noticed that both single-ended and push-pull inputs are provided. The former may be used with a radio tuning unit or pre-amplifier, but the latter was found more suitable for the crystal pick-up used with this equipment. Auxiliary contacts on the input jacks are used to switch the feedback connections so that the feedback is suitably arranged for the particular input in use.

The phase reversal for single-ended connection is obtained by a method which is novel as far as the author is aware and has the advantage of giving phase splitting with negligible loss of gain. Fig. 4 illustrates the principle adopted to obtain voltages of equal and opposite polarity.

In the example shown an input of 1 volt is assumed with the polarity indicated. To obtain parallel-connected feedback[1] a voltage must be applied in series with the grid resistor. If in addition, this self-balancing feedback voltage can be arranged to equal the input voltage, then this feedback voltage may also be used to drive the grid of V_2. With the simple basic circuit shown, the input resistance has an effective value of R/2 and this point may have to be

[1] "Negative Feedback" by E. Griffiths, *Wireless World*, March 1950.





Left: Fig. 4. The phase-splitter used in the amplifier for push-pull operation.

Fig. 3. Circuit diagram of the portable amplifier. Contact A is broken for single-ended input condition and contact B is broken for push-pull input.

allowed for. The obvious way of deriving this feedback voltage is to use a tap on the following grid resistor. This is however not a good arrangement since any push-pull amplifier should be designed in such a way that the grid voltages are compensated against gain variations so that a balanced output voltage is obtained.

It is well known that a common cathode resistor in a push-pull stage has a compensating voltage developed across it and if the common cathode resistance is made sufficiently large this can be used for providing phase reversal; unfortunately when only a limited h.t. voltage is available the d.c. voltage drop across this resistance cannot be spared. If however, a smaller resistance is used, the voltage across this may be fed back to a previous stage and the amplification of the latter stage used to provide the phase reversed voltage. This is, in effect, what is done in the circuit described here. If reference is made to Fig. 3 it will be seen that the a.c. voltage across the common cathode resistance of the output valves is parallel-connected back to the grid circuit of the driven valve. An analysis of this circuit (Appendix I) shows that when A is the gain of V_1 or V_2, g_m is the mutual conductance of the output valves and R is the common cathode resistance of V_3 and V_4, the ratio of the grid voltages applied to the input valves is given by :—

$$\frac{e_2}{e_1} = \frac{g_m RA}{1 + g_m R(A + 1)}$$

Hence if $g_m R = 1$ (a typical value) and $A = 40$, $e_2/e_1 = 40/42$, i.e. an unbalance of about 5 %. The ratio of the driving voltages of the output valves is given by :—

$$\frac{e_3}{e_4} = 1 + \frac{1}{g_m R(A + 1)} = 1 + \frac{1}{41}$$

or an unbalance of just over 2 % for the values given above.

An inspection of the original equations will show that the amplifier is inherently self balancing, the output unbalance being affected mainly by the gains of V_2 and V_4. When the push-pull input connection is used the phase reversal arrangement will not be operative if perfect balance is obtained in the amplifier, this is however unlikely and the circuit then provides a balancing voltage to the input which corrects for amplifier unbalance.

Overall negative feedback is obtained from the secondary winding of the output transformer and is fed back across the cathodes of the input valves when the push-pull input is in use and in series with the cathode of the driven valve when the single-ended input is used. The changeover is done by auxiliary contacts on the input jacks, but there is no reason why a single input connection with a changeover switch should not be employed. The basic circuits are shown in Fig. 5(a) and (b). The re-arrangement of the negative feedback connection is desirable because if this is not done when changing to single-ended

input, the balancing resistor must cancel the feedback voltage in addition to providing the grid voltage for V_g. This will require an unbalance voltage of about 2.5 volts across the common cathode resistance of the output valves and this is rather too much to expect.

The effective grid-cathode capacitance is reduced by applying negative feedback across the cathodes of the input valves and this allows high value grid resistors to be used with high-*mu* triodes without loss of top. The 6SL7 is operated with a very low anode current so that negligible current flows from the cathodes through the loudspeaker coil when the feedback is applied in series with the cathode resistor.

The gain of the amplifier with full feedback is 1, and hence an input level of approximately 5 V is necessary to obtain an output power of 8 watts. The gain without feedback is 21.5 db and hence a gain variation of 20 db could be obtained by reduction of the amount of feedback. This has not been done in this design since 5 V is readily available from a radio tuning unit and ample gramophone volume is available from a crystal pick-up.

Two variable controls are provided, one for balancing the feeds of the output valves and the other for adjusting the relative proportion of feedback between the two sides of the amplifier. The latter control is adjusted so that no a.c. voltage appears across the common cathode resistor of the output valves when tone is applied to the push-pull input. If distortion measuring equipment is available an alternative method is to adjust this control for minimum distortion at an output level of 8 watts.

The output transformer construction is described in Appendix II, and it will be seen that a 3-ohm load is used with the secondary windings connected in parallel or a 12-ohm load with the windings in series. With the latter arrangement the feedback factor has to be reduced and a loss pad must be inserted between the secondary of the output transformer and the switching circuit as shown in Fig. 6. The anode load on each output valve is about 80 % of that recommended for single-ended working. This enables the same output power to be obtained for a smaller voltage swing on the primary and hence reduces the amount of third harmonic distortion generated. The transformer primaries are shunted with a CR combination which helps to preserve a constant load impedance at high frequencies.

With full feedback the amplifier response was only 0.2 db down at 30 c/s and 16 kc/s, the output impedance being less than 1 ohm measured at the secondary of the output transformer.

Power Pack.—The heaviest section of most amplifier equipment is the power pack and weight has been saved in this unit by eliminating the usual mains transformer and heavy-duty smoothing choke. A filament transformer is used however to avoid the need for series connection of the heaters.

The power supply unit shown in Fig. 7 delivers 210 V. from 210-V. mains and it is reasonable to suppose that this arrangement used on 230-V. mains would allow an output power of 10 watts from the amplifier with less than 1% distortion. To save the weight of a large smoothing choke the anodes of the output valves are fed from across the reservoir capacitor. It will be recalled that the common cathode voltage of the output valves is used as feedback to the input circuit (for phase inverting) and hence any hum current in the output valves will produce a hum voltage in the output if the two halves of the 6SL7 are unbalanced. The 6Y6 has a relatively low anode resistance and hence the hum voltage at the anodes must be kept as small as possible, for this reason a 64-μF reservoir capacitor is used. With this arrangement the amplifier hum level is approximately 1 micro-

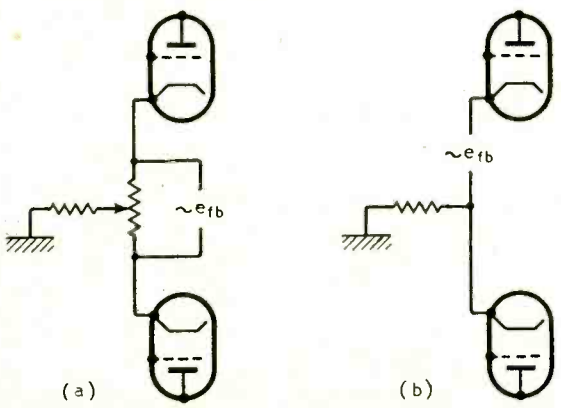


Fig. 5. Method of applying negative feedback (a) for push-pull operation (b) for single-ended input.

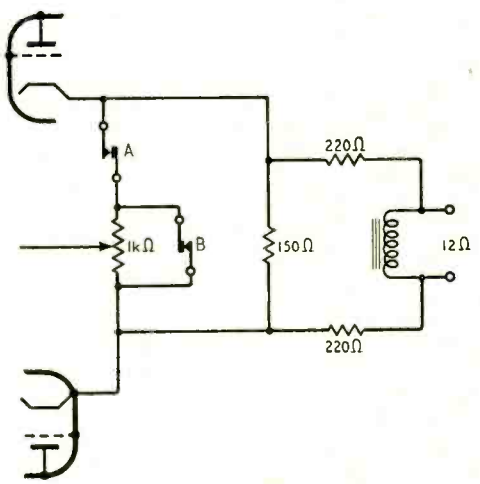


Fig. 6. Modification to negative feedback circuit for 12-ohm output.

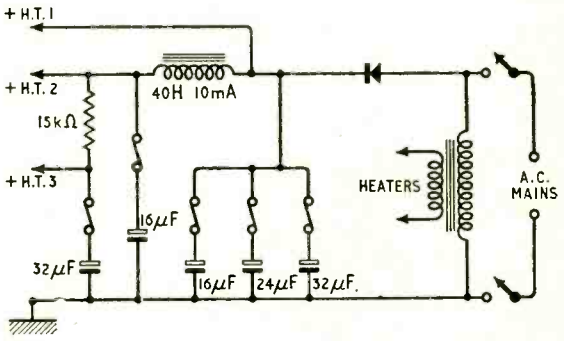


Fig. 7. Details of the power supply unit. An S.T.C. metal rectifier Type RM4 can be used.

watt. The smoothing choke passes the anode current for the 6SL7 and the screen current for the output valves, a total of 5 mA, hence a small and light choke can be employed. All capacitors in the power pack are separately fused so that failure of a capacitor will have no serious effect on the operation of the amplifier.

Cases.—The cases are made from a resin-bonded material faced with mahogany, the total thickness being approximately $\frac{3}{8}$ in. All joints are dovetailed, pinned and glued with the exception of the front surfaces which are pinned and glued. The underside of the playing desk is screwed to the sides for easy access to the motor for oiling and adjustment. Small ball-catches are used to hold the lid of the loudspeaker section in position when closed. Experience with the equipment has shown that it has met all that has been required of it so far and it has stood up well to being carried about on buses several times weekly for two years.

APPENDIX I

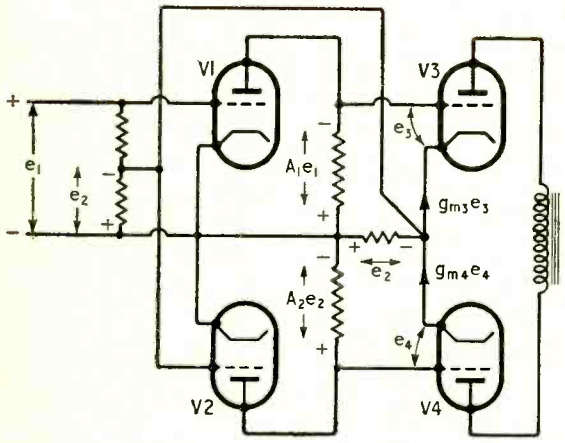
Fig. 8 shows a simplified circuit of the amplifier with the voltages in various parts of the circuit marked on the diagram. The symbols used are:

A_1 Gain of V_1
A_2 Gain of V_2
g_{m3} Mutual conductance of V_3
g_{m4} Mutual conductance of V_4
e_1 Grid-cathode voltage of V_1
e_2, e_3, e_4 Grid-cathode voltage of V_2, V_3, V_4 respectively

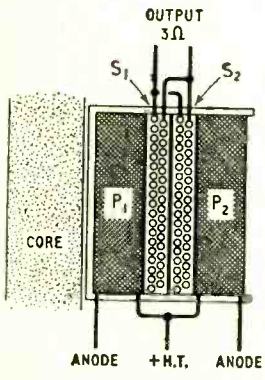
$$e_2 = g_{m3}e_3R - g_{m4}e_4R \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$e_3 = A_1e_1 - e_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$e_4 = A_2e_2 + e_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$



Above: Fig. 8. Magnitude of the voltages in different parts of the circuit.



Left: Fig. 9. Disposition of the windings on the output transformer.

Substituting from equations (2) and (3) in (1) and rearranging terms the ratio of the grid voltages on the input stage are given by:—

$$\frac{e_2}{e_1} = \frac{g_{m3}A_1R}{1 + g_{m3}R + g_{m4}(A_2 + 1)R} \quad \ldots\ldots\ldots\ldots \quad (4)$$

Substituting from equation (4) in (2) and doing a little mathematical juggling:—

$$e_3 = \frac{A_1[1 + g_{m4}(A_2 + 1)R]}{1 + g_{m3}R + g_{m4}(A_2 + 1)R}e_1 \quad \ldots\ldots\ldots \quad (5)$$

$$e_4 = \frac{g_{m3}(A_2 + 1)A_1R}{1 + g_{m3}R + g_{m4}(A_2 + 1)R}e_1 \quad \ldots\ldots\ldots \quad (6)$$

whence

$$\frac{e_3}{e_4} = \frac{1 + g_{m4}(A_2 + 1)R}{g_{m3}(A_2 + 1)R} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

Equation (5) shows the negligible loss of gain that occurs with this method of phase splitting. The fact that equation (7) is independent of A_1 does not of course mean that A_1 can be any value, since from equations (5) and (6) the actual magnitude of the grid driving voltages is dependent on A_1. It does however mean that the ratio of the grid driving voltages is independent of the phase angle of A_1. In addition since $(A_2 + 1)$ appears in both the numerator and denominator of equation (7) the effect of the phase angle of A_2 is very much reduced so that phase shift in the coupling circuit between V_2 and V_4 has little effect on the phase balance of the output grid voltages. The ratio of the currents in each half of the output transformer is given by:

$$\frac{g_{m3}e_3}{g_{m4}e_4} = 1 + \frac{1}{g_{m4}R(A_2 + 1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

And hence the output unbalance is independent of A_1 and g_{m3}, which determine the magnitude of the output voltage only. A low unbalance thus requires a high value for A_2 or/and $g_{m4}R$. Again since A_2 appears as a small fraction of the unbalance factor in equation (8) the effect of the phase angle of A_2 is small.

APPENDIX II

Output Transformer

Core:—1-in stack of Silcor III—M.E.A. No. 29 laminations 0.020-in thick. E's and I's inserted from opposite directions in the bobbin alternately.

Windings (see Fig. 9):—P1, No. 34 s.w.g. enam 1,200 turns total, layer-wound with 0.002-in transformer paper between layers, 120 turns per layer.

S1, Two layers of No. 20 s.w.g., 33 turns per layer with 0.002-in transformer paper between layers.

S2, As S1.

P2, As P1.

All layers should occupy full width of bobbin.

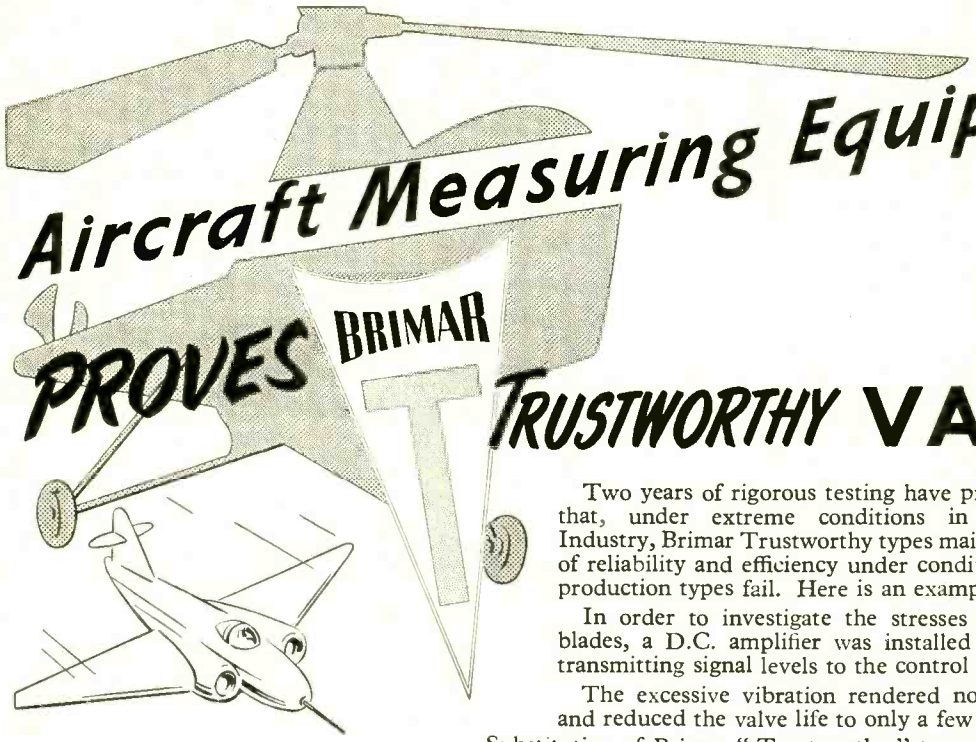
Two layers of 0.005-in Empire Cloth to be inserted between all sections.

A transformer to this specification was wound for the author by the Cabot Radio Co. Ltd., 28 Bedminster Parade, Bristol, 3.

BOOKS RECEIVED

B.S. 1928: 1953 Lateral-cut Gramophone Records and Direct Recordings. Dimensions of grooves, centre holes, etc., and recommendations for labelling commercial pressings; dimensions, flatness, and thickness of lacquer in blanks for direct recording. Pp. 12, British Standards Institution, 24, Victoria Street, London, S.W.1. Price 2s 6d.

Rundfunk-Fernsch-Jahrbuch 1953.—Survey of German broadcasting and television activities with details of u.h.f. stations, wavelengths and powers. Also contains a German edition of "World Radio Handbook for Listeners." Pp. 208, illustrated. Kultur-Verlag GmbH, Passauer Strasse, 4, Berlin, W.30. Price DM7.



Aircraft Measuring Equipment

PROVES BRIMAR TRUSTWORTHY VALVES

Two years of rigorous testing have proved beyond doubt, that, under extreme conditions in the Services and Industry, Brimar Trustworthy types maintain a high standard of reliability and efficiency under conditions where ordinary production types fail. Here is an example :

In order to investigate the stresses of helicopter motor blades, a D.C. amplifier was installed in the motor head, transmitting signal levels to the control cabin below.

The excessive vibration rendered normal valves useless, and reduced the valve life to only a few minutes.

Substitution of Brimar " Trustworthy " type 6067 freed the D.C. Signals of all noise, and measurements were able to proceed.

In another case, an Aircraft Company required instrumentation to measure stresses on jet aircraft when approaching the speed of sound. This equipment consisted of sensitive amplifiers located in the aircraft. Normal valves were too noisy under these conditions to give reliable results, but modification, to employ Trustworthy valves, has since solved the problem. Further, the equipment has stood up for a considerable number of hours service under these arduous conditions.

These are but two of many examples which prove that extra-rugged, extra-reliable Trustworthy valves are so often the perfect solution to an otherwise insoluble problem.

3 TRUSTWORTHY types are immediately available for commercial use

6064 the Trustworthy version of CV138 (6AM6/8D3)
6065 „ „ „ „ CV131 (9D6)
6058 „ „ „ „ CV140 (6AL5)

BRIMAR

for TRUSTWORTHY

BRITISH MADE

BRIMAR VALVES

Standard Telephones and Cables Limited **FOOTSCRAY, SIDCUP, KENT**

Tracking 2000g at 10 grammes maximum stylus pressure

acos REG'D Hi-g SERIES
PICK-UPS & CARTRIDGES

The listening public is inclined to take technical achievements for granted —to assume, for instance, that the increasingly exacting requirements of microgroove records can automatically be met by pick-up manufacturers. This is not the case. There is nothing automatic about it. The technical progress made by record manufacturers is, in effect, a challenge to pick-up manufacturers—a challenge which Cosmocord, whose slogan "Always well ahead" really does mean something, are always ready to take up. Sometimes the record manufacturers set us a problem, to which the solution is "impossible" and therefore takes quite a time to provide.

Such a problem is involved with regard to pick-up tracing capabilities which now have to be of a substantially higher order than those for 78 r.p.m. records, and are likely to become even more critical.

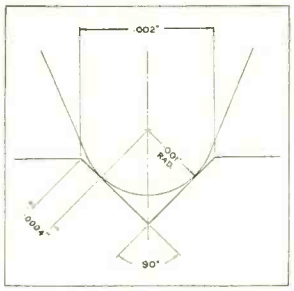


Fig. 1

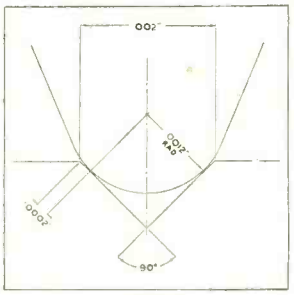


Fig. 2

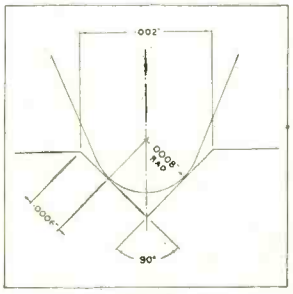


Fig. 3

Cosmocord, with the very helpful co-operation of the Decca Record Company, have recently made a detailed examination into the optimum tracking requirements that *could* arise in modern types of microgroove records. This was done in order to establish a basis for the design of pick-ups that would not only satisfy the requirements of all records at present available to the public, but if possible anticipate future developments within the limits as set out in the recently published British Standard Specification (B.S.1928 : 1953).

THREE FACTORS

The three important factors that had to be considered by Cosmocord in designing such a pick-up were minimum groove width, maximum lateral displacement and maximum stylus tip acceleration.

The minimum groove width as laid down by the British Standard Specification is .002in. The conditions existing in a record giving up to 30 minutes playing time per 12in. side are well demonstrated in the accompanying scale drawings. For simplicity's sake, the groove angle has been shown as 90° and the radius at the bottom of the groove has been left out, as at .0003in. maximum it has no effect. Three pick-up stylus radii are shown, the nominal .001in. radius (Fig. 1) and its upper and lower limits of .0012in. and .0008in. (Figs. 2 and 3 respectively) according to British Standard Specification. It can be seen that the .001in. radius has .0004in. wall above its point of contact, whilst the .0012in. radius has no more than .0002in. This does not take into account the pinch effect which can reduce the margin by .0002in. at 5,000 c/s.

PRACTICAL CONSIDERATIONS

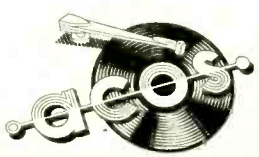
In order to arrive at maximum possible displacement, some assumptions have to be made that are dictated by practical considerations. Working on the basis of 200 grooves per inch the maximum possible displacement (d) is .003in. At a frequency of 40 c/s. this displacement corresponds approximately to a maximum velocity of 2 cm/sec. ($v = 2\pi fd$).

Accepting the recording characteristics of the Decca Long Playing test record No. LXT 2695 as typical for commercially produced long playing records, the maximum velocity and corresponding acceleration at 10,000 c/s. can be calculated. According to the record specification the recording pre-emphasis at 10,000 c/s. relative to 40 c/s. is + 24.4 dbs. and this gives a velocity of 31.6 cm/sec. and a corresponding displacement of .0002in. $\left(e = \frac{v}{2\pi f}\right)$. It further follows that expressed in gravitational units the acceleration at 10,000 c/s. may be as high as 2000g $\left(g = \frac{ef^2}{10}\right)$, where e = displacement = .0002in. and f = 10,000 c/s.).

WHAT OF THE FUTURE?

The examination, as can be seen even from this simplified statement, has brought to light conditions that appear to be incredible at first sight. They are, however, far from being purely hypothetical and it may be only a question of time before they appear on commercially produced records. Even now there are a few odd records on the market which come very close to these limiting conditions.

It can be seen that the problem set by the record manufacturers in this matter was a formidable one. Cosmocord have answered it so completely with their Acos "Hi-g" series of pick-up cartridges that they already meet, here and now, any likely future development of gramophone records within the B.S. 1928 : 1953 specification.



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Acos Crystal Devices are Protected by Patents and Patent Applications in Gt. Britain and Other Countries.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

TRANSISTORS

4—Introduction to the Junction Transistor

By THOMAS RODDAM

IN the first article of this series the *n-p-n* junction transistor was mentioned very briefly. The time has now come to study the properties of the junction transistor in more detail. Most of the discussion will be based on the Bell Telephone Laboratories' *n-p-n* transistor, Type M 1752, but some of the discussion and the method of expressing the characteristics apply to the RCA *p-n-p* junction transistor.

The constitution and appearance of the *n-p-n* transistor were shown in Figs 7 and 8, page 73, of the issue of this journal February 1953. It consists, as was seen, of a sort of railway sandwich, with a very thin layer of *p*-germanium between two bits of *n*-germanium bread. The actual method of preparation of the Bell units is a secret, just like a railway sandwich, but there are two methods known to be possible for making junction transistors. At a guess, the first is the one used by Bell, though I repeat it is just a guess.

The first way of producing a junction transistor is to grow a single crystal according to a special programme. It sounds really very easy : you take a pot of molten germanium, dip a crystal of germanium into it and then slowly pull the crystal upwards. The temperatures are controlled so that the liquid germanium solidifies where it is lifted upwards by surface tension, and if all goes well you have a single crystal growing. If the bath is filled with *n*-germanium the crystal will be *n*-germanium. After growing some *n*-germanium you shift the crystal end to a *p*-germanium bath, and deposit a layer, still in the same single crystal, of *p*-germanium. Then back to *n*-germanium again. Cut into neat slices and serve, with appropriate contacts. The only trouble is that the process of getting a single crystal, even without changing mixtures, is remarkably difficult, and needs very complicated control equipment.

The other way of making junction transistors has been described for *p-n-p* transistors. It depends on the fact that certain impurities, in very small quantities, convert *n*-germanium into *p*-germanium. The impurity used is indium. A small block of *n*-germanium is provided with a gold-plated area on each side, to make the indium wet the wanted area uniformly. Indium is then applied to the gold-plated areas and the material is heated until the indium melts and covers the gold-plated contact area. The indium now begins to diffuse into the germanium, producing two *p*-layers, one on each side, which move towards each other inside the block. After the right length of time at the right temperature, a good *p-n-p* junction transistor is obtained.

As you can see, these processes are the sort which may be at their best in large-scale production, when elaborate control devices can be used. But just how far that work has gone, no one seems willing to say, although quite a number of American companies are building new factories for transistor production.

What will they get for their money when they start making really large numbers of junction transistors ? The *n-p-n* properties can be easily summarized. It is relatively quiet, and at 1,000 c/s has a noise level only 10-20 db above ordinary Johnson noise. This is about 30 db better than the current point transistors, although these have been improved by 15 db since the old Type A. The junction transistor is inherently stable, because the current amplification factor is slightly less than unity. This quantity α is equal to $(r_m+r_b)/(r_c+r_b)$ and for the ordinary

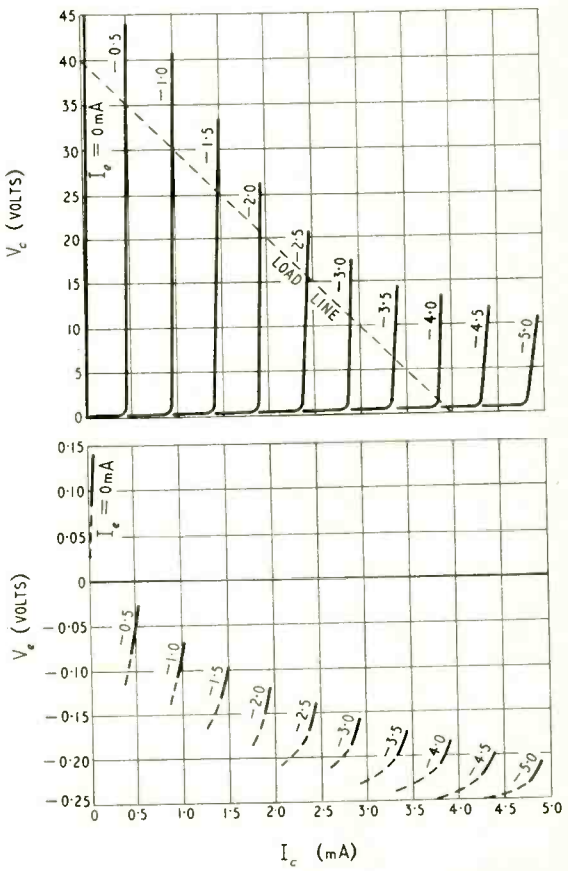


Fig. 1. Static characteristics of an n-p-n type junction transistor.

Type M1752 is about 0.95. Both r_m and r_c are so much bigger than r_b that we can take $\alpha = r_m/r_c$ with $r_m < r_c$. Substituting this inequality in the various equations of the earlier articles will show that there is no possible negative resistance condition, so that amplifiers are a lot easier to design.

The junction transistor is very efficient, having almost ideal static characteristics. We shall come back to this. It is rugged and non-microphonic, gives a high gain, although the frequency response may be limited. In this way it is rather like a pentode, which will give a very large gain if matched, but which has such a high impedance that a matched load is seriously shunted by the self-capacitance of the valve.

The characteristics of an *n-p-n* transistor are shown in Fig. 1. Notice first that the collector voltage is positive, not negative. This is because the centre region is of *p*-germanium, whereas in the point transistor (Fig. 4, p. 71, February 1953 issue) the centre region is of *n*-germanium. Similarly the emitter is held slightly negative. I am not going to say that this is more convenient, because although it means we can use supplies originally intended for ordinary valves, it also means that the curve tracer we designed for point-type transistors must be modified for *n-p-n* junction transistors.

The most striking feature of the characteristics is the steep linear slope. It is possible to swing, without distortion, over almost the whole length of the load line. The actual load line shown is for a resistance of 10,000 ohms, and a good working point on this load line would be 20 volts, 2mA, a total power from the supply of 40mW. It is possible to drive the transistor down to $V_c = 0.1$ volt and up to zero emitter current, where $V_c = 39.5$ volts. Moving the working point slightly, to $V_c = 19.8$ volts the available power output corresponds to a peak swing of 19.7 volts, or an output power of 19.4mW. For Class A working the maximum possible output for a 40mW input is 20mW. To get 19.4mW is well within 5 per cent of the theoretical limit.

The current in the base circuit of a transistor is the difference between the collector current and the emitter current. For the junction-type transistor this base current is very small. As a result the current gain from base to collector is very high, of the order of 20-50 times. The base input circuit, with earthed emitter, becomes of particular importance, especially as there is no longer a stability problem, as there was with the point transistor. It appears that a rather different physical picture is useful to the designer, too. When the transistor is connected as an amplifier, the circuit, in its barest bones, will be that shown in Fig. 2(a). In Fig. 2(b), the potential energy distribution for electrons in the absence of a signal is shown. The positive bias on the collector

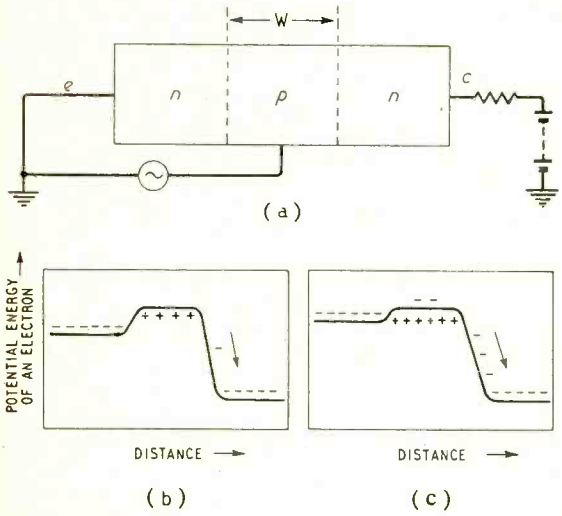
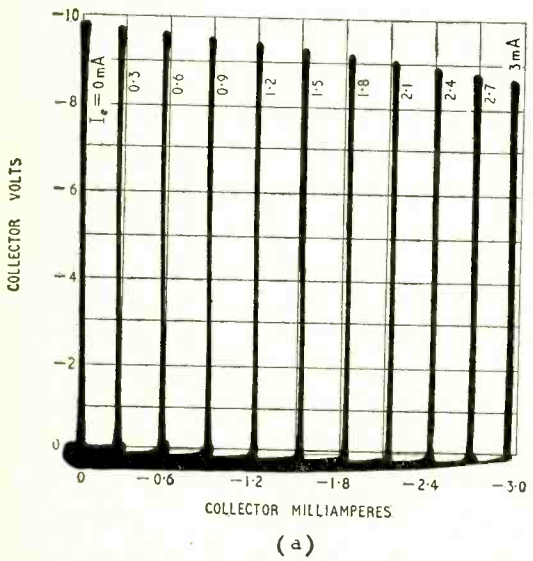


Fig. 2. (a) Earthed-emitter n-p-n junction transistor biased as an amplifier. (b) Potential energy distribution of electrons with no signal and (c) with the base made positive.

Fig. 3. Characteristics of a p-n-p junction, taken on an automatic curve tracer. (a) With emitter current and (b) base voltage as a parameter.



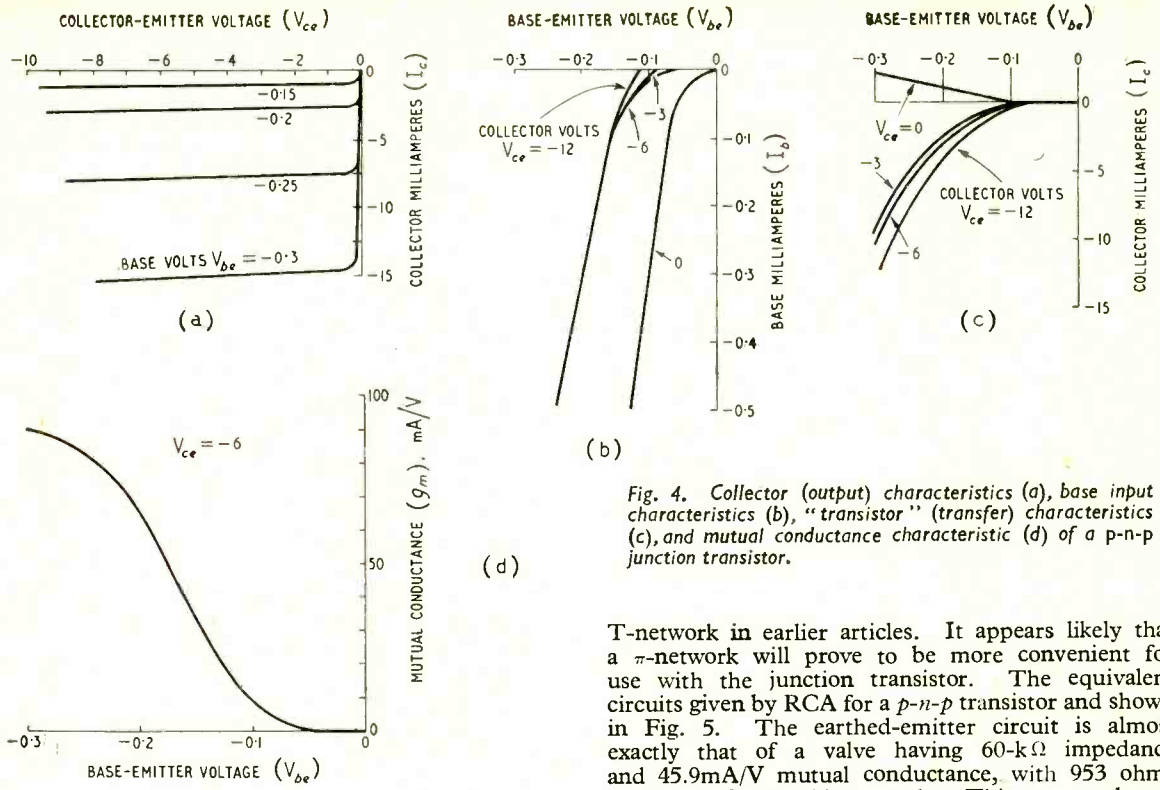


Fig. 4. Collector (output) characteristics (a), base input characteristics (b), "transistor" (transfer) characteristics (c), and mutual conductance characteristic (d) of a p-n-p junction transistor.

produces a reverse bias across the *p-n* base-collector junction. If the base is made to move positive the diagram is changed to the form shown in Fig. 2(c), and more electrons diffuse across from the emitter into the base, just as in a pentode more electrons move into the space between grid and screen when the grid is driven positive. If the base is thin, that is W is small compared with the diffusion length of the electrons, they can cross the base to the collector junction and rush downhill to the collector. The collector current is thus controlled by the height of the emitter-base step. It seems very reasonable, therefore, to use an ordinary valve approach to the earthed emitter junction transistor, and to determine a mutual conductance in the form of *d* (collector current) /*d* (base voltage). A typical value is 50mA/volt, which looks very high in valve terms.

It is interesting to compare the characteristics shown by the two methods. Fig. 3 shows the collector characteristics of a *p-n-p* junction transistor (reversed polarity) plotted on an automatic curve tracer with emitter current as parameter and with base voltage as parameter. The same transistor was used for both sets of characteristics, but in the base-voltage set the curvatures are much more easily observed. Another set of characteristics is shown in Fig. 4, and apart from the fact that they are upside-down they can be seen to resemble the ordinary pentode characteristic quite closely, except that the base impedance is not infinite. The mutual conductance curve, showing the dependence on bias, is unpleasantly curved, but as you can see, values as high as 90mA/volt are obtained. This represents a g_m/I_e ratio of 22 at a standard working point, compared with the corresponding g_m/I_k ratio for a 6AG5 pentode of 0.55.

For circuit design work we have used an equivalent T-network in earlier articles. It appears likely that a π-network will prove to be more convenient for use with the junction transistor. The equivalent circuits given by RCA for a *p-n-p* transistor and shown in Fig. 5. The earthed-emitter circuit is almost exactly that of a valve having 60-kΩ impedance and 45.9mA/V mutual conductance, with 953 ohms connected from grid to earth. This means that if we match this transistor to a 60-kΩ load the voltage gain from base to loaded collector will be $45.9\times60/2=1380$. To find the gain in decibels we must make an allowance for the change of impedance: the simplest way of calculating this is to include the effect of a suitable step-down transformer. As one input impedance is 950 ohms, this transformer will be 60,000: 950 (impedance ratio). The gain of the circuit in decibels is then 20 log 1380 $(950/60{,}000)^{\frac{1}{2}}=20$ log 174. This gain, just under 45db, is reduced by the feedback between collector and base, and the maximum power gain is given as 40db, while the input and output impedances are also reduced to about one-half their values when r_{bc} is neglected. The gain quoted for *n-p-n* transistors by Bell is 50db.

If we make use of the results from the previous articles, we can insert in the T-network the values given by Wallace and Pietenpol (*Bell System Technical Journal and Proc. I.R.E.*, July 1951):

$r_c+r_b=266$ ohms
$r_e=25.9$ ohms
$r_e-r_m=-13.1\times10^6$ ohms
$r_e+r_c-r_m=0.288\times10^6$ ohms

The input impedance, as shown in the last article, is

$$r_e+r_b+\frac{r_e(r_m-r_e)}{r_c+r_c-r_m+R_L}$$

Putting $R_L=0$ and $r_m/r_c=\alpha$ this is approximately

$$r_b+r_e\cdot\frac{1}{1-\alpha}$$

Now α is very nearly unity: Fig. 6 shows a typical distribution for α over a batch of 118 *p-n-p* transistors. The highest value of α I have seen in published data is 0.9965, for which $1/(1-\alpha)$ is about 300. In

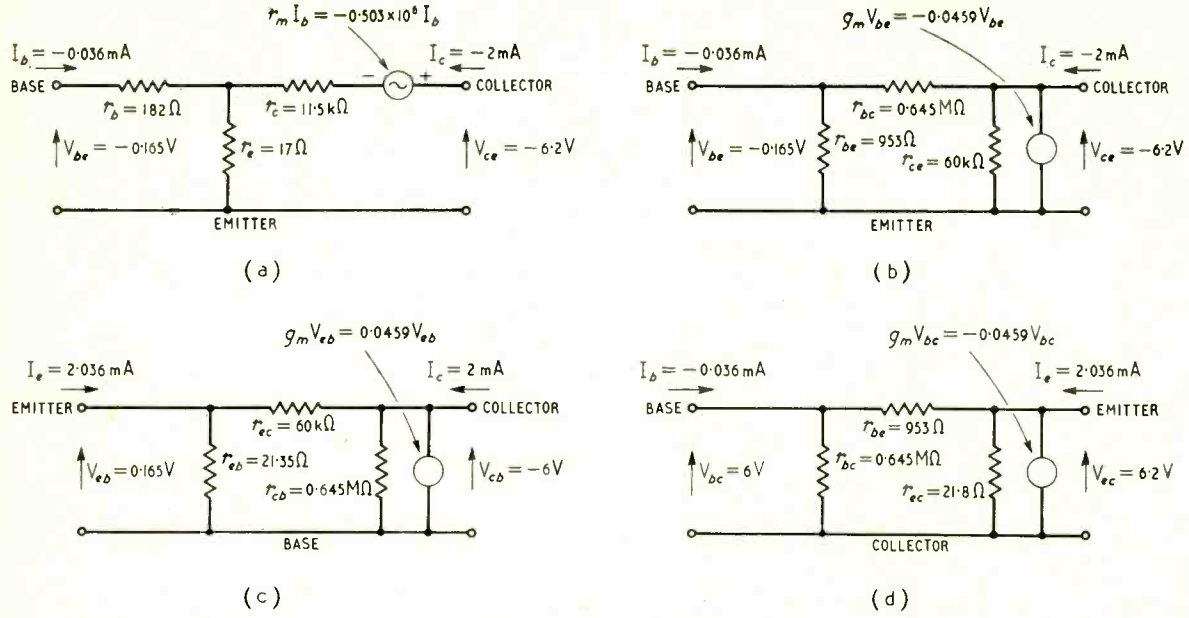


Fig. 5. Equivalent circuits for a p-n-p (RCA) transistor: (a) T-network, (b) π-network, (c) common base circuit, (d) common collector circuit.

these circumstances you will see that the input impedance is a rather delicate matter.

We can revert to these detailed calculations at some later date. For the present let us look at one of the most striking features of the junction transistor. The curves in Fig. 7 show the characteristics of the *n-p-n* transistor at extremely low levels. A rather nice working point would seem to be $V_c = 0.16$ volts, $I_e = 60\mu A$, $I_e = 50\mu A$ and $V_e = 0$. The dissipation is then $10\mu W$ and the output power will probably be of the order of $3\mu W$. This is a level of about −26db referred to 1mW, not a very low level by many standards, but an oscillator producing this level will operate from a battery consisting of two coins and a piece of wet blotting paper. I have not yet had time to construct an oscillator using an *n-p-n* transistor and operating at this low level, but with the relatively clumsy point transistor an oscillator, which I shall describe later, giving about 10mW has been run for some 200 hours from an ordinary 4.5-V flat torch battery.

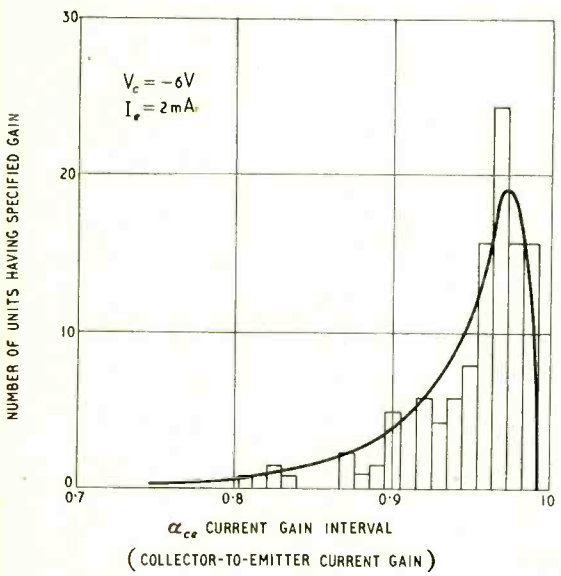


Fig. 6. Distribution of collector-to-emitter current gain for a batch of 118 p-n-p transistors.

These very low level characteristics of the junction transistor do not have very great immediate application, because at the moment most of us are trying to fit transistors into existing patterns of equipment. For example, we may be replacing one valve unit by a transistor unit, keeping to the same supplies and the same performance.

We shall begin to make enormous advances as soon as we can design a system completely for transistors. All our problems will be passed back to the system engineers for reconsideration. Let us glance at a typical case : we now assume that it is best to concentrate the gain in a broadcasting network at the transmitter, and bang out hundreds of kilowatts to save a valve in each of myriads of receivers. Now, however, we can provide an extra 20 decibels of gain in each receiver by using a transistor consuming $10\mu W$, instead of a valve consuming 2W. Even a million receivers will only use 10 watts, so from the power efficiency viewpoint we should complicate the receiver, not the transmitter. This is not the last word on this question, of course : in fact it is hardly the first word, but it serves as a very simple example of the new thinking the systems engineers will be doing.

To round off this rapid survey of the junction transistor, let us look at some of the typical amplifier arrangements we can use. The earthed-emitter circuit appears to be the most generally useful form

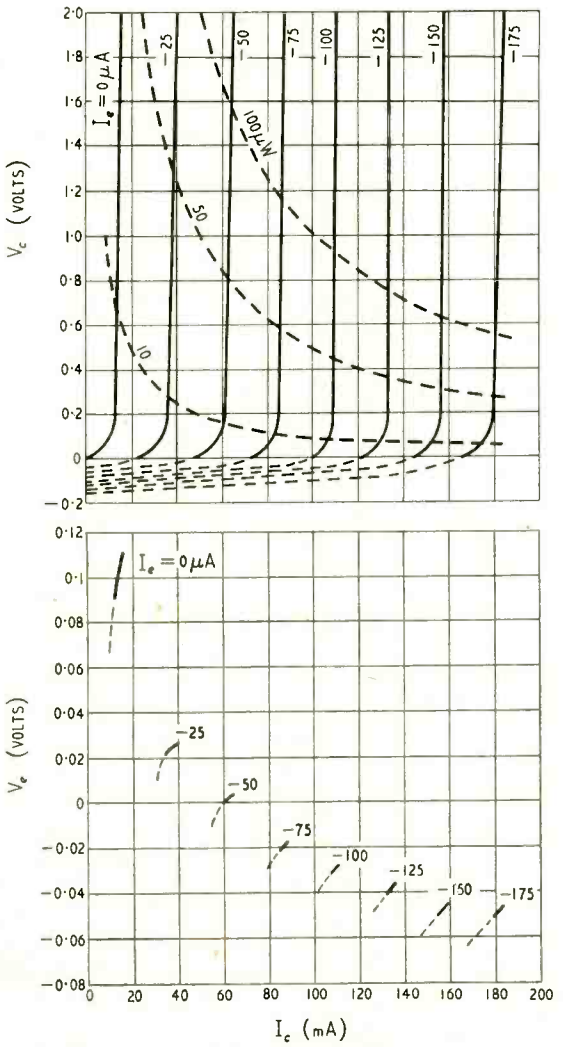
for simple amplifiers. We shall start off by taking the circuit shown in Fig. 8. The base is floating, and the collector current and emitter current are exactly equal. Now when the emitter current is zero, the collector current has a value I_{co}, a very important quantity in junction transistor circuit design. As I_e is increased, I_c increases, with $dI_c/dI_e=\alpha$. Assuming a linear characteristic, the value of I_c is $I_{co}+\alpha I_e$. We know, however, that $I_e=I_c$ so that $I_e=I_c=I_{co}+\alpha I_e$ and $I_c=I_{co}/(1-\alpha)$

From Fig. 7, I_{co} is rather less than 20μA and α is about 0.96, so that I_c will be about 500μA, which at a collector voltage of 20V gives quite a reasonable working point on Fig. 1. The main difficulty here is that a small change in α will give such a large change in working point. I shall discuss this question in more detail later.

Following on from this basic idea we can move the working point by two expedients. These are shown in Fig. 9. In the first circuit we allow some of the base self-bias to leak away through the base resistor. The base is thus less positive, and the collector current is reduced. In the second circuit a small extra positive bias is applied to the base by the current pulse through R and the emitter. As a result the collector current is increased.

Additional bias can be provided by reducing the base resistance to zero and adding resistance in the emitter lead. This makes the base slightly negative with respect to the emitter. In appearance and in behaviour this resistance in the emitter-earth lead behaves like the conventional cathode bias resistance in a valve circuit. The gain of a junction transistor in the earthed-emitter circuit is inversely proportional to r_e so that an external addition to the emitter resistance produces a gain reduction, due, of course, to negative current feedback.

For reasons which will be made clearer in a later article, we usually have to combine these various types of biasing in order to get a reasonably stable working point for different specimens of transistors. The circuit of Fig. 10 shows a typical arrangement of a simple *n-p-n* transistor amplifier. Across the transistor itself the voltage drop is 25 volts, at a current of 2mA. The resistance R_1 is chosen to use up all the available battery voltage. Using a 60-volt battery and allowing 1,000 ohms for the transformer we should use $R_1=16.5k\Omega$. This puts the emitter at +33 volts



Left : Fig. 7. Static characteristics of n-p-n junction at very low levels.

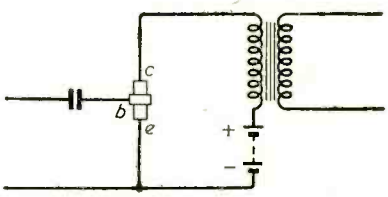


Fig. 8. Practical arrangement of earthed-emitter amplifier.

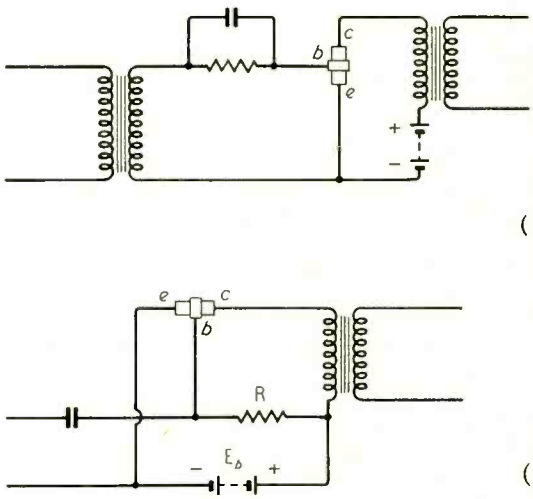


Fig. 9. Modifications to the circuit of Fig. 8 to obtain (a) lower collector current by introducing a capacitor and leak to reduce the base self-bias and (b) higher collector current by adding R to increase the positive base bias.

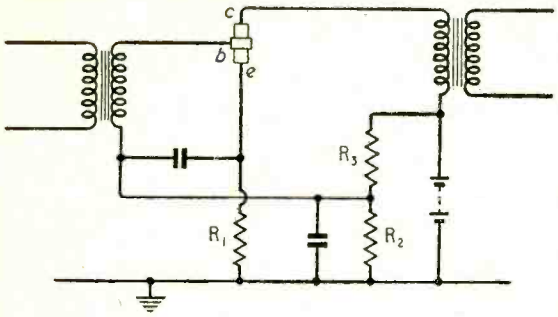


Fig. 10. Simple n-p-n junction transistor amplifier, showing biasing arrangements for stable operation.

above earth, so we now choose R_2 and R_3 to bring the base to about +33 volts, too. To save arithmetic, take R_2=33kΩ and R_3=27kΩ. All these feeding resistors are decoupled, so that although the negative feedback effect is very large, when it is a question of fixing the working point, there is no loss of gain. A reasonable collector load is about 10-15kΩ and this defines the output transformer. The input transformer . . . well, all you can do at present is to let the circuit warm up for half an hour, measure the impedance and design to suit. In general, I have found that it is necessary to assume an input impedance of about 1,000 ohms, and tolerate the increase which takes place with warming-up. This is expensive in gain. An alternative is to step up to about 10kΩ at the input, when a gain of about 25-30db can be obtained.

Apart from the differences in α and I_{co} which have been mentioned above, in some of the *n-p-n* transistors I have tested that elegant straight line characteristic has bent over at somewhere between 5 and 25 volts. This puts a rather low limit on the maximum output power.

This scamper over the junction transistor story will have left the reader thinking in terms of milliwatts and microwatts. To conclude, therefore, we may notice that a power transistor has been described showing characteristic curves up to 10 amps emitter current and 3 amps collector current. Nearly 100 watts of Class A power can be obtained from this unit, with 10-20db gain. The area is one square centimetre.

References and acknowledgements. Figs. 1, 7, 8 and 9 are based on Figs. 4, 5, 17, 18 and 19 of " Some Circuit Properties and Applications of *n-p-n* Transistors " by R. L. Wallace, Jr., and W. J. Pietenpol," *B.S.T.J.* July, 1951 and *Proc. I.R.E.* July 1951. Fig. 2 is based on Fig. 22 of " Transistor Electronics " by W. Shockley, *Proc. I.R.E.*, Nov. 1952 ; Figs. 3 and 6 on Figs. 4 (b), (d) and Fig. 12 of " A Developmental Germanium *p-n-p* Junction Transistor " by R. R. Law, C. W. Mueller, J. I. Pankove and L. D. Armstrong, *Proc. I.R.E.*, Nov. 1952 ; Figs. 4 and 5 on Figs. 2 (b), 3 (a), (b), 4, 5 and 6 of " Junction Transistor Equivalent Circuits and Vacuum-tube Analogy " by L. J. Giacoletto, *Proc. I.R.E.*, Nov. 1952.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Broadcast Transmitter Distortion

I AM indebted to Ian Leslie's letter (your April issue) for a solution to a problem with which I have been troubled for some time.

Numerous enquiries amongst other associates who, like myself, have gone to considerable expense in purchasing first-class equipment, have revealed similar defects in B.B.C. transmissions.

My equipment includes two expensive high-fidelity speakers, a well-designed tuner and a " quality " amplifier, all of which are beyond reproach. Notwithstanding this, the speakers rattle at times like old tin cans.

We have tolerated bad quality and unnecessary interference of all descriptions long enough and it is about time some tangible solution was found. Experiments carried out for years at Wrotham will, apparently, go on indefinitely before anyone institutes a better broadcasting system.

I have a feeling that we have slipped up badly in allowing the B.B.C. to make increased use of recorded programmes; we rarely get " live " transmissions, but are forced to listen for the majority of the time to inferior recordings.

Land-line transmissions, particularly in the north, leave much to be desired. The lines are often noisy and quality in the upper register is frequently poor.

In an effort to effect some improvement may I suggest:

1. That listeners should insist on the number of recorded transmissions being reduced to a minimum and never resorted to when it is possible to use a "live" broadcast.

2. That the B.B.C. discontinue using compression and find a more satisfactory remedy for cutting out interference from adjacent transmitters.

3. That more supervision be exercised over land-line transmissions.

4. That television transmitters, covering as they now do some 80 per cent of the listening public, be employed to transmit sound when not required for television.

Although receivers, amplifiers and loudspeakers have been considerably improved in recent years, it is deplorable that the quality from B.B.C. transmitters, except on rare occasions, by no means approaches the standard achieved 20 years ago.

Skipton, Yorks. A. YATES.

Flashing Beacons

I WOULD like to refer to the letter from John Baggs in the April issue of *Wireless World* on the subject of interference with radio and television reception from flashers used to control the lighting of zebra beacons.

My company considers that it should be known that the flashers manufactured by us comply with BSS800, and have been fully approved by the General Post Office for effective suppression. Tests have shown that no interference will be experienced from these flashers even after

a year or so's wear when, as Mr. Baggs states, the contacts may become pitted.

It may also be of interest that every flasher is being individually tested before despatch on G.P.O.-approved radiation interference test equipment, to ensure that no Venner flasher will be guilty of spoiling radio or television programmes.

Venner, Ltd., J. H. RAWLINGS.
New Malden, Surrey.

Lamp Interference

A NEIGHBOUR of mine who owns a television receiver has complained of chronic interference on vision and sound for a considerable time. On seeing the picture I immediately exclaimed "Oh! valve diathermy apparatus, of course!" There was a single hum bar with the characteristic herringbone pattern above and below it towards the top of the picture. I was even more confirmed in my diagnosis when I realized that we were only a stone's throw from a hospital.

The G.P.O.'s aid was enlisted, and the engineer insisted that it was nothing to do with the hospital (which fact we ourselves confirmed with the authorities). He discounted the possibility of diathermy altogether and said he believed the radiation to be coming from an ordinary domestic vacuum lamp in the neighbourhood. He always found it extremely difficult to trace such interference when hundreds of lamps were on in the vicinity.

If such heavy interference is possible from these lamps, how is the herringbone pattern, which I should imagine would require a wide band of frequencies, actually produced?

Weymouth, Dorset. K. ROBINSON.

"Vision A.G.C."

HAVING an interest in television a.g.c. systems, I would like to raise one or two points about the article in your April issue. First, you state that the video output is maintained constant against variations of ±20db. That may be correct, but you do not state that the contrast control is the only means of adjusting the mean level in order to achieve this. This, to my way of thinking, is important, for two reasons:

(a) If the contrast control is set too low, the signal increase produced by "aeroplane flutter" will be most manifest by an overload effect at the grid of the first i.f. stage. This in turn results in a decrease of picture contrast. (This effect occurs when sensitivity is increased in an attempt to offset loss of signal at low contrast setting.) The result of this mode of setting up is a reverse flutter effect of a somewhat abrupt nature and at its best is quite disturbing.

(b) When contrast is used as a major control, i.e., where signal strength is low and sensitivity is at maximum setting, the amount of black level stabilization that actually takes place is dependent on the contrast setting, being least at maximum contrast and greatest at a point equivalent to about two-fifths contrast. Actual measurement shows that the range of anti-flutter gets progressively poorer as inputs fall below 120μV peak white.

The article states quite correctly that the system will be of most value in fringe areas, where fading is more troublesome. Unfortunately any a.g.c. system, especially a gated system, suffers from having to rely on the "reserve" sensitivity of the receiver plus the sensitivity of the a.g.c. gating, etc., and if contrast is controlled by a variation of either characteristic a loss of a.g.c. is suffered except at one critical setting of the contrast control. This setting is not only difficult to adjust, but also varies with input signal strength.

The article also states that the system is sufficiently fast to counteract flutter up to 50 c/s, above which the eye "couldn't care less," so to speak. It is true that the eye will not respond to a change in 0.02sec, but I must insist that the a.g.c. does not respond either. The system's rate of operation is limited by the circuit values used, and on test the a.g.c. action gets noticeably worse above 15 c/s, subject to the "gain" of the pulse amplifier—again depending on contrast control setting. Furthermore, above 10 c/s low-frequency beats are produced, and these cannot be attenuated by the a.g.c. unless the a.g.c. can first remove the "parent" flutter frequency. Therefore, unless all flutter above 10 c/s is removed, the resultant beats are present.

However, generally the article is of great interest and I look forward to seeing something more on a.g.c. in the near future.

Southend-on-Sea, Essex. HENRI T. PICHAL.

Cathodic Protection

I HAVE noted with interest the reference to cathodic protection by "Diallist" in your February issue, and since I specialize in this subject, you will perhaps permit me to make the following brief observations:—

(1) Under-water corrosion, even in the Persian Gulf, is not due to direct chemical attack, as your columnist suggests, but is electro-chemical in character.

(2) The galvanic anodes used to form the primary cell do not consist of aluminium but are made of a special magnesium alloy.

(3) In addition to the galvanic system utilizing reactive anodes, there is a further system in use in the Persian Gulf. This system makes use of relatively inert anodes through which externally generated current is applied.

(4) Cathodic protection by means of the two systems referred to has been adopted not only for protecting jetties in the Gulf but British design and British equipment is employed in many countries for the protection of such widely diverse structures as the hulls of ships, tanks, and underground pipelines. In this country alone there are several hundred installations.

(5) The reference to the effect on fish seems to be very greatly exaggerated. W. GODFREY WAITE,
F. A. Hughes and Company, London, W.1.

V.H.F. for Voyagers

TRAVELLING from Holland to England with a colleague during the recent storm period, I had the following experience of ship-to-shore communication in the North Sea.

At the Hook of Holland, due to the storm we were unable to leave the ship, and the ship was unable to leave the port for a period of twenty-four hours. The natural reaction of all passengers under such circumstances is to send a message to their destination to relieve anxiety. However, at the Hook, as in so many ports of the world, ships are barred from using their medium-frequency radio equipment within three miles of the land. The ship on which I was travelling, in common with all ships on the Harwich-Hook of Holland run, is not fitted with v.h.f. radio-telephony.

After some time, and after much shouting through the gale to the shore, we were able to organize ship-to-shore communications by means of a 30ft bamboo pole with a bag on the end of it. Written messages were placed in this bag by passengers and transferred to the shore for despatch by telegraph to England.

During the crossing to Harwich on the following day, it was still impossible for passengers to send telegrams via the ship's wireless installation. This was due to congestion of available medium-wave channels, priority being accorded to safety-of-life messages on these channels. Attempts to use the radio-telephone channels were only slightly more fruitful, in this case one or two of the passengers' calls were successful after about two hours' delay.

Is it not time that v.h.f. ship-to-shore communication was established on all Channel and North Sea routes in the interests of passengers' convenience and safety?

Cambridge. A. G. CLARKE.

WORLD OF WIRELESS

More Television Stations ◆ New Navigational Aids ◆ Personalities ◆ News in Brief

B.B.C. Television Plans

SIR IAN JACOB, director-general of the B.B.C., stated recently that the Corporation hopes to erect 10 low-power television stations when the present scheme for five medium-power stations is completed. These are, of course, provided for in the Stockholm v.h.f. frequency plans which allow for two more television stations in the present band and 28 in the 174-216 Mc/s band. It should, however, be pointed out that since it has not yet been decided how the v.h.f. broadcasting bands will be utilized in this country, the British delegation to the conference entered a reservation in signing the agreement, which makes the signature effective only so far as the 41-68 Mc/s band is concerned.

The proposed chain of 20 stations will bring television to 98 per cent of the population. Although these projected stations will be of low power, they will not be "boosters" in that that they will not rely on their direct reception of the signal radiated by the nearest high-power transmitter.

On the question of colour, Sir Ian stated that it may come in two or three years, but it would have to be a compatible system using no more than the present bandwidth. It would probably be introduced by equipping one studio and one O.B. unit for colour, which will be used only on occasions when colour would be an advantage.

It is understood that arrangements have been completed for the B.B.C. to acquire a site at the Crystal Palace for the erection of the high-power transmitter which will replace the Alexandra Palace station when the lease of the building expires in 1956.

Radar Plotter

OBSERVATION of a radar screen is not sufficient to determine if another ship is steering a collision course with respect to the vessel on which the observations are made. It is constantly being stressed that it is essential to keep a good radar plot, and hitherto it has been necessary to do this on a chart or plotting sheet. Decca have now produced a screen which enables direct plotting on the radar display without the serious parallax error which was previously caused by the normal screen being some distance from the actual tube face.

A half-silvered mirror is placed between the tube and the Perspex plotting surface. The curvature of this surface is opposite to that of the p.p.i., so that the reflection of any mark made on the plotter will coincide with the radar echo on the tube when viewed from any angle. The plotting screen is edge-illuminated so that wax pencil marks show up clearly on the radar screen, but when the light is switched off the marks are not visible on the p.p.i.

The "Deccaplot," as it is called, fits over the face of the standard Decca 12in display unit.

Mobile Decca Chains

AN OBVIOUS, yet little publicized, use of the Decca Navigator system is described in the March issue of *Decca Navigator News*. To cover a desired area of a few thousand square miles in a part of the world not served by one of the existing permanent chains, transportable low-power transmitters are set up. Their principal use so far has been for hydrographic surveys, but the transportable chains have also been employed successfully on oil exploration in the Persian Gulf.

PERSONALITIES

Professor Willis Jackson, D.Sc., D.Phil., M.I.E.E., who in July will be assuming the directorship of research and education with the Metropolitan-Vickers Electrical Co., has been elected a Fellow of the Royal Society. The citation refers to his "studies of the electrical behaviour of dielectrics and of the performance of transmission lines and wave-guides." Professor Jackson at present occupies the Chair of Electrical Engineering at the Imperial College of Science and Technology, London, where he has been since 1946.

G. T. Clack has resigned, because of pressure of work, the honorary lecture secretaryship of the Television Society, which he has held for the past four years. Prior to his appointment he was for some time responsible for the lectures for the Society's engineering group. Mr. Clack is a senior laboratory engineer at the Bush Research Laboratory, which he joined in 1938, and is at present primarily engaged on technical liaison work.

(*Left*) P. D. CANNING

(*Right*) W. A. ROBERTS

P. D. Canning, the new chairman of the Radio and Electronic Component Manufacturers' Federation, has been with the Plessey Company since 1933, and was for some years responsible for development and production of transmitting equipment and for radio installation work. Since 1948 he has been acting as liaison between the company and trade associations. He is also serving his second term of office as chairman of the R.I.C. Technical Direction Board.

W. F. Randall, B.Sc., M.I.E.E., the new vice-chairman of the R.E.C.M.F., has been a director of the Telegraph Construction and Maintenance Co. since 1945. He joined the company in 1922 to undertake research work on cable and loading materials and from this research emerged mumetal. When the h.f. plant was set up for the production of mumetal he was put in charge.

Appointments of engineers-in-charge of the two low-power television stations at Pontop Pike (Newcastle) and Glencairn (Belfast), both of which are to be equipped temporarily with mobile stations, are announced by the B.B.C. **J. P. Brett,** who is appointed to Pontop Pike, has been with the Corporation since 1944 and for the past two years has been at Holme Moss, latterly as a senior maintenance engineer. **C. Duddington,** who also holds a similar position at Holme Moss and was previously at Alexandra Palace and Sutton Coldfield, is appointed to the Belfast station. He joined the B.B.C. in 1946 at the Lisnagarvey, Northern Ireland, transmitting station.

W. A. Roberts, A.M.I.E.E., a senior member of the B.B.C. Engineering Division, who was a member of the Broadcasting Commission which visited the Gold Coast recently to advise on

the setting up of a statutory broadcasting corporation, has been appointed to the Colonial Office to advise on the further technical development of broadcasting in the Colonial territories. He was at one time assistant to the B.B.C. chief engineer. Mr. Roberts will make a series of tours to the Mediterranean and East Africa, Central Africa, the West Indies, South-East Asia, the South Pacific, and West Africa.

J. H. Williams, who has been in the radio industry since 1922, first with Marconiphone and then with Cossor's, has become joint managing director, with William Harries, of Regentone Radio and Television Ltd., and the Radio Gramophone Development Co., Ltd. On leaving E.M.I., Ltd. (which took over Marconiphone), he joined Cossor's in 1939 and became joint managing director in 1943. He resigned from Cossor's in 1947 and has since been acting as a consultant in the industry.

Richard R. C. Rankin, O.B.E., A.M.I.E.E., who, as announced in our March issue, has succeeded Dr. C. F. Bareford as a director of Telcon Telecommunications, Ltd., was erroneously stated to be a director of Mullard Ltd. He is technical manager of Mullard Equipment, Ltd. (of which he is also a director), and of the Equipment Division of the parent company, Mullard, Ltd.

OUR AUTHORS

G. W. A. Dummer, who writes in this issue on components for use with transistors, joined the Telecommunications Research Establishment in 1939, and, with E. Franklin, designed the first p.p.i. to be used in radar. During the war he was in charge of a group designing synthetic radar trainers. Mr. Dummer subsequently became responsible for component development and panclimatic testing. He is at present in charge of a Component Development Division, an Engineering Research Division and a Testing Division at T.R.E. He is doing fundamental work, on printed and potted circuit techniques, and, with D. L. Johnston, read a paper on this subject before the I.E.E. in January this year.

R. F. Hansford, joint author of the article on radar repeaters in this issue, studied communication engineering at the Portsmouth Municipal College and during the war was at the Admiralty Signal and Radar Establishment, developing navigational radar gear. After the war he was in the Research Department of the Sperry Gyroscope Co. until 1952, when he joined Decca Radar, Ltd., to take charge of its newly formed Radar Applications Division. He is a founder member of the Institute of Navigation and was for a number of years its technical secretary.

G. J. Dixon, who, with R. F. Hansford, contributes the article on p. 218, was a wireless mechanic in the R.A.F. prior to joining the Decca organization in 1946. He is now a member of the staff of the Decca Radar Research Laboratories and is at present in charge of a radar link development project.

H. E. Styles, author of the article in this issue on a sensitive two-valve receiver, is superintendent of laboratories in London Transport Executive. A chemist by profession, he gained a 1st class honours B.Sc. (Chemistry Special) degree at London University.

Charles A. Marshall, author of the article on the design of a television converter, graduated from Manchester University in electrical engineering in 1944. The following year he joined the Philips group of companies as a technical assistant at Mitcham Works, Ltd. In 1948 he transferred to the Mullard Research Laboratories as a development engineer in the television laboratory where he has been mainly concerned with the design of r.f., i.f. and video sections of both 405- and 625-line receivers. He is at present working on the problems involved in the application of valves in television tuner units for multi-channel working in the 174-216 Mc/s band.

OBITUARY

It is with regret that the death is announced of **Frank Powell Best**, M.Sc. (Cantab), B.Eng., B.Sc., technical manager of the Marconi International Marine Communication Co. and the Marconi Sounding Device Co., on March 26th at the age of 52. In 1924 he joined the Radio Communication Co., which four years later was amalgamated with the Marconi Marine Co. He became deputy technical manager, but in 1934 transferred to Marconi's W.T. Co. to assist in the development of equipment for marine use. In 1939 Mr. Best returned to the Marconi Marine Company as technical manager, and a year later was also appointed technical manager of the Marconi Sounding Device Co. He was chairman of the technical committee of the International Maritime Radio Committee (C.I.R.M.).

It is with regret that we record the death of **H. L. Bowen**, a technical executive of Mullard's Valve Division, soon after his arrival in the U.S.A. He had been chairman of the technical committee of the British Radio Valve Manufacturers' Association since 1949 and during his stay in America he was to represent the Association at the Joint Electron Tube Engineering Council Conference held in Atlantic City in March. Mr. Bowen recently celebrated his 25th year with the Mullard organization. He was a member of various committees of the British Standards Institution and was also a member of the Valve Standardization Committee of the International Electro-technical Commission (C.E.I.).

IN BRIEF

Receiving Licences. — During February the number of television licences increased by 69,531, bringing the total to 2,072,980. At the end of the month 10,794,918 "sound" receiving licences—including 180,375 for car sets—were current in the British Isles bringing the total to 12,867,898.

Four-day Components Show?—If the R.E.C.M.F. is guided by the consensus of opinion at the annual general meeting of the Federation and by the success of this year's show, the 1954 components exhibition will be extended to four days instead of the present three.

French Audio Journal.—A monthly journal *Revue de Son* made its debut with the April issue and will cover all aspects of sound reproduction. The publishers are Editions Chiron, 40, Rue de Seine, Paris 6, and the price is 180 francs per copy.

R.E.C.M.F. Council.—As a result of the ballot at the annual meeting of the Radio and Electronic Component Manufacturers' Federation, the following firms were elected to the council (the representative's name is in brackets):—Automatic Coil Winder (R. E. Hill), British Moulded Plastics (J. H. Bridge), Garrard (Hector V. Slade), Hunt (S. H. Brewell), Multicore (R. Arbib), Painton (C. M. Benham), Plessey (P. D. Canning), Reliance Electrical Wire (C. H. Davis), Telegraph Construction (W. F. Randall) and Telephone Manufacturing (W. A. Jackson). At the first meeting of the council, P. D. Canning and W. F. Randall were elected chairman and vice-chairman respectively. In addition to the re-election of A. F. Bulgin, E. M. Lee and L. H. Peter as vice-presidents, S. Wilding Cole and Hector V. Slade were also elected vice-presidents.

Radio-controlled Models.—The annual international contests for radio-controlled model boats and aircraft, organized by the International Radio Controlled Models Society, will be held at Southend-on-Sea, Essex, on July 25th (boats) and 26th (aircraft). Further details and entry forms are obtainable from R. Ing, 36, Sunny Gardens Road, Hendon, London, N.W.4.

Electron Optics.—A science meeting of the Physical Society on "Recent Research in Electron Optics," arranged by Dr. O. Klemperer of Imperial College, will be held at the College, Imperial Institute Road, London, S.W.7, on May 15th and 16th. It will be divided into the following sections: electron lenses, correction of aberrations, electron guns, focusing in electron accelerators, electron optics in television tubes and valves, and electron spectrometry. Application forms to attend the meeting are available from the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7. Closing date for applications is May 7th.

Gramophiles.—A National Gramophone Conference is being organized by the National Federation of Gramophone Societies at High Leigh, Hoddesdon, Herts, for the weekend of May 29th to June 1st. During the conference high-fidelity recording and reproducing equipment will be demonstrated. Full details may be obtained from G. E. Palmer, 106, Streatfield Road, Kenton, Harrow, Middx.

Pye-U.S. Agreement.—"Joint research and development in the field of industrial and broadcast television cameras and studio equipment" is provided for in an agreement recently signed by Pye, Ltd., and General Precision Laboratory, Inc. (New York), who have been associated for the past three years in the development of studio equipment. Each company will manufacture and market its own equipment, but the "combined engineering knowledge of the two firms will be pooled." Pye and G.P.L. are also stated to be co-operating on theatre television.

British Plastics.—Among the 20 or more papers to be read at the convention which runs concurrently with the British Plastics Exhibition at Olympia, London, from June 8th to 18th, are a number of interest to the radio and allied industries. Of particular interest is "Plastics in the Telecommunications Field" by R. C. Mildner, H. F. Wilson

and E. I. Cooke, of the Telegraph Construction and Maintenance Co. It will be read on June 17th. There will be 80 or more exhibitors at the show, which is sponsored by *British Plastics*. Admission to the exhibition, which is open from 10-6 is price 2/6. Further information and free tickets for the convention can be obtained from *British Plastics*, Dorset House, Stamford Street, London, S.E.1.

Radar Exports.—Decca's annual report records that during the past year, over £1M worth of the company's marine radar equipment was exported. The report adds that Decca radar is believed to be "more extensively fitted than any other marine radar equipment in the world."

Dover Harbour R/T.—The port of Dover is to be equipped by Rees Mace Marine, Ltd., with Pye v.h.f. radiotelephones for harbour control. The central station will be installed in the signal tower on the eastern arm of the harbour. Tugs operated by the harbour board will be equipped with multichannel v.h.f. sets to enable them to communicate either with the signal tower or with other ships.

Cintel large-screen (24 × 24ft) television equipment is being installed in the Festival Hall to enable a paying audience of 3,000 to see the B.B.C. broadcast of the Coronation procession and service in Westminster Abbey.

Glass Exhibition.—The proposed Glass Industries Exhibition planned to be held in London this month, and to which we drew readers' attention in our February issue, has been postponed indefinitely by the organizers, B. & C. D. Trade Exhibitions, Ltd.

New Relay Company.—British Relay Wireless and Television, Ltd., is the name of the company recently formed to integrate the sound and vision relay services operated by the British Relay Wireless Group and Link Sound & Vision Services, Ltd. The latter company was formed jointly by Pye, Ltd., and Murphy Radio, Ltd., who will be shareholders in the new company.

R.G.D.—The Radio Gramophone Development Co. which was taken over by W. Harries, chairman and managing director of Regentone Radio & Television, Ltd., last year, has moved from Hampton Court to Eastern Avenue, Romford, Essex (Tel.: Romford 5991).

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Recent Work in France on New Types of Valves for the Highest Radio Frequencies" by Dr. R. Warnecke and P. Guenard at 5.30 on May 13th at Savoy Place, London, W.C.2.

North Lancashire Sub-Centre.—Annual General Meeting, followed by an informal lecture on "The Nervous System as a Communication Network" by J. A. V. Bates, M.A., M.B., B.Chir., at 7.0 on May 6th at the Harris Institute, Corporation Street, Preston.

Television Society

London.—"A Delayed Trigger Oscillograph" by R. Anderson and J. R. Smith (Plessey) on May 7th.

"A Directly-driven Line Scan Circuit" by Emlyn Jones and K. Martin (Mullard) on May 29th.

Both meetings will be held at 7.0 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Recent Advances in the Application of Electronics to Chemical Instrumentation" by G. I. Hitchcox at 6.30 on May 6th at the London School of Hygiene & Tropical Medicine, Keppel Street, London, W.C.1.

Merseyside Section.—Annual General Meeting followed by "The Development of the Radio and Electronics Industry in India" by G. D. Clifford at 6.45 on May 7th at the Electricity Service Centre, Whitechapel, Liverpool.

Royal Society of Arts

"Training for Science and Technology" by Sir Richard Southwell, M.A., LL.D., D.Sc., F.R.S., at 2.30 on May 13th at John Adam Street, London, W.C.2.

British Sound Recording Association

London.—Annual Coventon on May 15th at the Waldorf Hotel, Aldwych, London, W.C.2. Discussion with demonstrations of high quality and stereophonic (sound) reproduction, to be opened by three leading authorities on the subject.

Institution of Production Engineers

Shrewsbury Section.—"Electronics as an Aid to Productivity" by R. McKennell at 7.30 on May 27th at the Shrewsbury Technical College.

MARITIME FREQUENCY CHANGES

AS already announced, the marine radio-telephone distress and calling frequency for small craft will be changed from 1650 kc/s to 2182 kc/s on May 1st. This change is in conformity with the plans for the maritime mobile frequency band 1605-2850 kc/s drawn up by the Extraordinary Administrative Radio Conference at Geneva in 1951. The implementation of the plans also necessitates changes in the working frequencies of the U.K. coast stations and we give below their radio-telephony (R/T) frequencies and also the frequencies they will employ for telegraphy (W/T).

Under the new frequency arrangements, British ships will be divided into two categories, (a) fishing vessels, and (b) coasters and deep-sea ships. Both classes will use the new R/T distress and calling frequency and for communication with coast stations they will adopt one or more working frequencies from the following numbered channels:—coasters and deep-sea ships, (1) 2009, (2) 2016, (5) 2527 and (6) 2534 kc/s; fishing vessels, (3) 2104, (4) 2111, (7) 2548, and (8) 2555 kc/s. A ninth channel (3373 kc/s) is reserved for fishing vessels working Wick Radio.

		R/T Service (kc/s)	M.F. W/T Service (kc/s)
Wick	(GKR)	1827, 2705, 3617	432, 1615, 2842*
Stonehaven	(GND)	1855, 2691	458, 1618
Cullercoats	(GCC)	1841, 2719	484
Humber	(GKZ)	1869, 2628, 2684	441, 1618
N. Foreland	(GNF)	1848, 2698, 2733	418
Niton	(GNI)	1834, 2628	464
Jersey	(GUD)	1657.5	516
Land's End	(GLD)	1841, 2719	438, 522
Burnham	(GRL)	1855, 2670	476
Seaforth	(GLV)	1715, 2754	447
Portpatrick	(GPK)	1883, 2607	472
Oban	(GNE)	1848, 2740	1622
Malin Head	(EJM)	1841, 2593	421, 1618
Valentia	(EJK)	1827, 2614	429, 1612
Parkeston Quay	(GUQ)	—	429
Folkestone	(GUR)	1827	—
Newhaven	(GUV)	1855	—
Cork Harbour	(EJC)	—	516
Guernsey	(GUC)	1642.5	—

* Fishing vessels only.

The following three frequencies are reserved for the use of deep-sea ships for R/T communication with coast stations:—2090, 2097 and 2146 kc/s.

For inter-ship radio-telephony communications, the frequencies 2226, 2231 and 2306 kc/s are reserved for fishing vessels; 2241, 2246 and 2301 kc/s for coasters and deep-sea ships and 2421 kc/s for deep-sea vessels in the Atlantic and Mediterranean.

"Fishing vessel" frequencies are reserved exclusively for use by these craft, but the category "coaster and deep-sea ships" will include tugs, pilot vessels, cross-channel passenger boats, yachts and miscellaneous craft.

Ship frequencies for ship-shore telegraphy (A1 and A2) for fishing vessels are 1623, 2042 and 2496 kc/s. The inter-ship W/T calling and traffic frequencies are 1606 and 1609 kc/s.

The telegraphy distress frequency is still 500 kc/s and all coast stations, with the exception of Oban, keep a continuous watch on this frequency.

Correction

Fig. 4(b) in "D.C. Restoration in Television," in the March issue shows the waveform sloping the wrong way during the narrow pulses. In parts such as DF it is shown as sloping upwards to the right whereas it should, of course, slope downwards.

THE "BELLING-LEE" PAGE

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

Three Moot Points.

There are a lot of "Doubting Thomases" in the world, but we suppose that must be, so long as it is good law to "let the buyer beware."

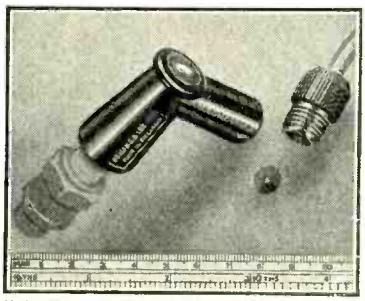
This month we have three good cases for discussion.

(1) Statements that ignition suppressors are harmful to cars.
(2) Multi-array television aerials are no good.
(3) No necessity to protect centre insulators of a dipole.

Let us take these one at a time.

(1) Within the last few months the editor of a widely read paper writes that the fitting of ignition suppressors is detrimental to the starting of motor cars.

Without going into details as to what car or cars, or of what vintage, we can only say that we cannot find evidence to support this. During the past year or so, two important papers on the subject have been read to learned societies—April 1952 to The British Institution of Radio Engineers, "Current Radio Interference Problems," by E. M. Lee, B.Sc., and February 1953 to a joint meeting of The Institution of Mechanical Engineers and The Institution of Electrical Engineers, "Ignition Interference with Television Reception," by A. H. Ball, A.M.I.E.E. and W. Nethercott, B.A., B.Sc.



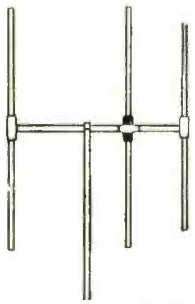
"Belling-Lee" "Sparkmaster" Sparking Plug Suppressor L.762.

The authors of those papers, and the discussion that followed, made it clear that in general there was no detrimental result. Mr. A. H. Ball is a Research Engineer with Messrs. Joseph Lucas Ltd., and would not recommend anything that would reflect badly on their electrical equipment. Mr. Nethercott is head of the department dealing with electrical equipment at the Electrical Research Association.

Nor would the A.A. and R.A.C. give this thing their blessing if their members were going to be in trouble through following their recommendations.

This Company has sold many thousands of pounds worth of these suppressors and will not be able to help itself from selling them probably in millions. We appreciate that there may be a little trouble with a very small percentage of decrepit cars, but in general, for one to decry ignition interference suppression is equivalent to Canute trying to keep back the tide.

(2) We read that a multi-array television aerial has no advantage over an "H." Let us say here and now, that very often better results would be obtained by raising an "H" on a really high mast, but generally it is easier to erect a 3 or 4-element array. Now, leaving out the claims of various manufacturers, the text books on the subject tell those interested just what can be expected, i.e. a practically constructed "H" has a gain of over 5 db over a dipole, and a 3-element array over 8 db. One correspondent stated that all the gain in a multi-array was lost in matching. In fact the insertion loss of a matching transformer in any soundly designed aerial is of the order of 0.1 db.



"Belling-Lee" "Junior Multirod."

(3) Elsewhere we read that there is no necessity to protect the centre insulator of a dipole. The very first television aerials manufactured for sale in this country were made by "Belling-Lee." The centre of the dipole then was open to the elements. We well remember holding a wet sponge over the centre termination without noticeable results; a snowball was also frozen on, and still all was well. Many thousands were sold like that before the war. Many stood up all through the war and some may still be in service. In certain sheltered locations however, where there are heavy deposits of soot, a semi-conductive film tends to "short" the terminals. Sometimes heavy rain will wash away the deposit. We agree that clean water is not harmful, but a leaky centre insulator may be, if it allows an accumulation of semi-conductive sludge.

Horizontal Polarisation.

Readers of this page would surely be horrified to see a friend of theirs with an aerial looking like figure 1. In the first place, we do not believe in knocking the chimney about, property owners may rightly object. Secondly, when we can drop the pole clear away down at right angles from the crossarm, let us do it. Fig. 2 shows an ideal arrangement.

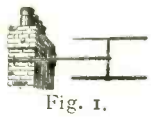


Fig. 1.

Fig. 2.

Are You?

This attractive little windscreen transfer, shown here full size, light blue above and black below, is given free with every "Sparkmaster." The resistor that reduces plug burning; eases starting from cold; reduces pinking and suppresses interference with television.

Written 28th March 1953

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MODERNIZING THE

Wireless World Television Receiver

Part 1—General

IT is now some years since the *Wireless World* Television Receiver was described. Since then there has been considerable technical development and a definite change in the requirements of viewers. Larger and brighter pictures are now demanded. The 9-in tube operating at 5 kV no longer meets the needs of most people; a 12-in tube at 8–10 kV is nearer the mark.

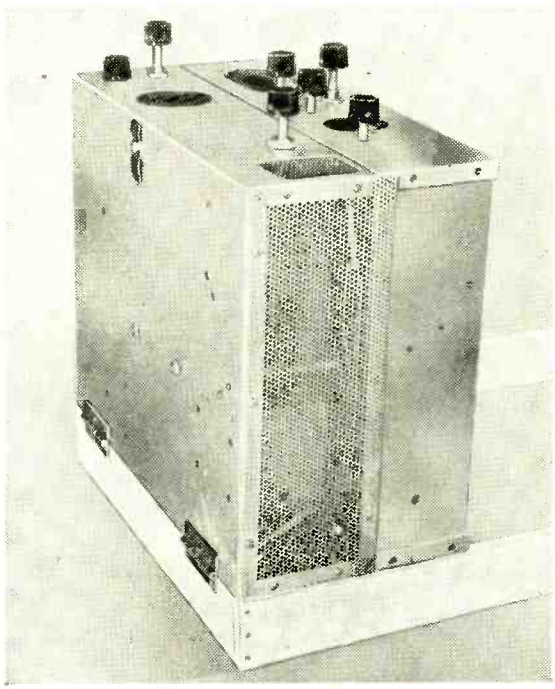
The general tendency of development is towards still larger pictures using 14–16-in tubes working at up to 14 kV. In order to keep the cabinet dimensions reasonably small the deflection angles of the latest c.r tubes have been increased since this permits the use of a larger screen without a corresponding increase in the cabinet depth. These two factors, the increase of operating voltage and the increase of deflection angle, have enormously increased the volt-amperes needed for deflection. As a result a great deal of the technical development of recent years has been concentrated on the time-bases and it is probably only here that major advances have been made.

It is interesting to review critically the performance of the *Wireless World* Television Receiver and judge it by to-day's standards, rather than those of 1947 when it was described. Its only major defect of performance is in giving a somewhat smaller and less bright picture than fashion now dictates. In the receiver proper, by which is meant the circuits from aerial to tube which handle the picture signal, the performance can hardly be improved even to-day.

Two alternative receiver units were described; one, a straight set for double-sideband reception of London only, the other, a superheterodyne for vestigial-sideband reception of any British television station. The straight set falls below a modern standard of performance in only one particular; its sound-channel rejection is rather low. The superheterodyne is free from this and on performance will stand comparison with more recent designs. The only thing that could be brought against it is the fact that its intermediate frequency is rather close to one of the amateur bands, but this seems to be more a theoretical criticism than a practical one for very few cases of interference have been encountered.

The scope for improvement in this superheterodyne is thus rather limited and a new design would aim at obtaining the same performance in a simpler way rather than at improving the performance itself. The main fault of this superheterodyne is, in fact, its rather complex mechanical form. The aim in any redesign would be to simplify the construction and to make the unit smaller by taking advantage of the smaller valves and components now available.

On the time-base side, the greatest fault of the original design was a tendency to poor linearity in the frame scan. This was later put right by a simple corrector circuit. The greatest difficulty experienced by constructors, however, was undoubtedly with the line time-base. The factor of safety in the design was very small and variations in components and valves made it difficult to scan the full picture width in all cases. It made it difficult because it necessitated extremely critical adjustment of inter-dependent controls.



The time-base units closed in their normal position.

In all other respects the design proved an exceedingly good one. Synchronizing held over long periods without adjustment and even interlacing proved remarkably rigid. The fly-back e.h.t. system using a voltage-doubler with metal rectifiers turned out to be completely free from trouble.

Basically, therefore, one would not wish to make any major change in the design save to fit a larger tube operating at a higher anode voltage and to make the line time-base less critical of adjustment. However, this does actually entail a complete redesign of both line and frame time-bases and of the deflector coils!

Before going into this in detail it may be remarked that the redesign, which it is the purpose of these articles to describe, has been carried out for a c.r. tube of medium deflection angle of around 53°. *It is not*

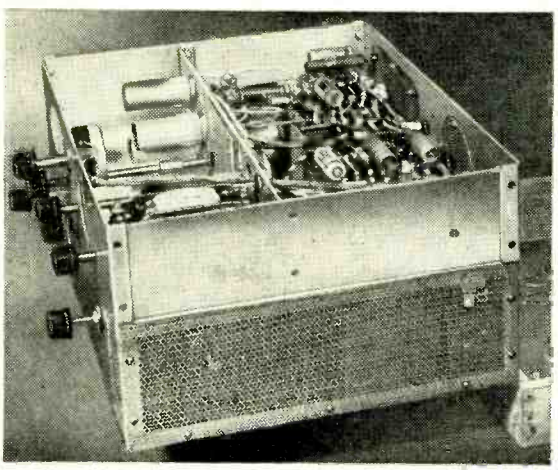
suitable for tubes of 70° angle. Such tubes need nearly twice the deflection power.

It may be asked here why the redesign was not carried out for a wide-angle tube and the answer is that at the time it was started there were no such tubes. When they appeared it was felt to be better to carry on with the existing type than to stop and start again with the new one, for this would have entailed considerable delay.

Deflector Coils

In considering a redesign of the original receiver the line time-base was obviously the place to start for, its output being bare for a tube at 5 kV, it would obviously be inadequate for any higher operating voltage—and a higher voltage is needed for a bigger tube. When it was decided, some time ago now, to redesign the time-bases it was evident that the first essential was to improve the efficiency of the deflector coils themselves. An investigation was therefore carried out into the factors which affect this efficiency.[1] The quality of a deflector coil was expressed as the product of the inductance in millihenrys and the square of the peak-to-peak saw-tooth deflection current in amperes, the standard of deflection being 7.5 inches on a Mullard MW22-7 tube operating at 5 kV. The original deflector coils gave a figure of 2.9 mH-A^2 for the line.

It proved possible to obtain a figure of only about one-third of this which means that it is possible to obtain the same deflection for one-third of the input power at the same e.h.t. voltage or for the same input power at three times the voltage. There is much more to a deflector coil than sheer efficiency, however: it must produce a rectangular raster and introduce negligible deflection defocusing. In addition, it must be possible to make it without undue difficulty and using only materials that are obtainable. Taking all these factors into account it turned out that an efficiency of about double the original design was all that could reasonably be obtained.



Here the units are shown hinged down for access to the frame time-base.

Full constructional details of coils to this design have been published[2] and at first sight it would appear that no alteration would be needed to the time-bases, for with the greater efficiency of the coils the line time-base has sufficient output for scanning at 8–9 kV with something in hand. However, there is more to it than this. Under these conditions the e.h.t. obtainable with a voltage-doubler would be a little under 5 kV and something like a 5-stage multiplier would be needed to obtain 8–9 kV. It is doubtful if the regulation of this would be good enough.

Apart from this, it was considered very desirable to simplify the adjustment of the time-base and to remove the 10-kc/s whistle produced by magnetostriction in the core of the line-scan transformer. This transformer normally runs very hot so that the obvious remedy for the whistle—to enclose the transformer in a box packed tightly with sponge rubber—is impracticable. It was decided, therefore, completely to redesign the time-base.

The new form of deflector-coil construction led also to a need for redesigning the frame time-base. Originally, a high-inductance frame deflector coil was used, but in the new design this required such fine wire that it seemed unlikely that the coil would survive the bending process. It was felt, therefore, that it would be necessary to use a low-inductance coil. This meant a transformer for feeding it and this in turn meant a much more elaborate linearity-correcting system and so entailed a redesign of the frame time-base as a whole.

It is not always realized how interdependent the two time-bases are. It is surprising how some apparently minor change reacts to demand compensating alteration elsewhere.

Time-Bases

Space does not permit an account of all the work put into developing new time-bases. It is sufficient to say that the main difficulties with the conventional forms were all centred around the line-scan transformer. This component is a critical one, especially in the modern high-efficiency forms of circuit. It must have very low electrical losses, very high insulation, very low self-capacitance, etc., and the core material should not be magnetostrictive. Leakage inductance, too, must be kept very low if ringing is not to occur and produce vertical bars on the picture.

In addition to this, when the redesign was started suitable components and materials looked as if they might be rather hard to obtain because of rearmament. Actually, the position is much better than expected and as things have turned out it would have been possible to have used materials that have not been used. Because of the expected difficulties, however, the decision was made to use only parts and materials which would probably be readily obtainable wherever it was possible to do so. In addition, it was decided to describe the construction of all special components.

This last decision virtually ruled out a line-scan transformer of an efficient type, for it seems hardly practicable to make such a transformer without using wave-wound coils and these need machine winding. There were also doubts about the availability of suitable core materials.

After a good deal of experimental work it was decided to take the bull by the horns and remove all

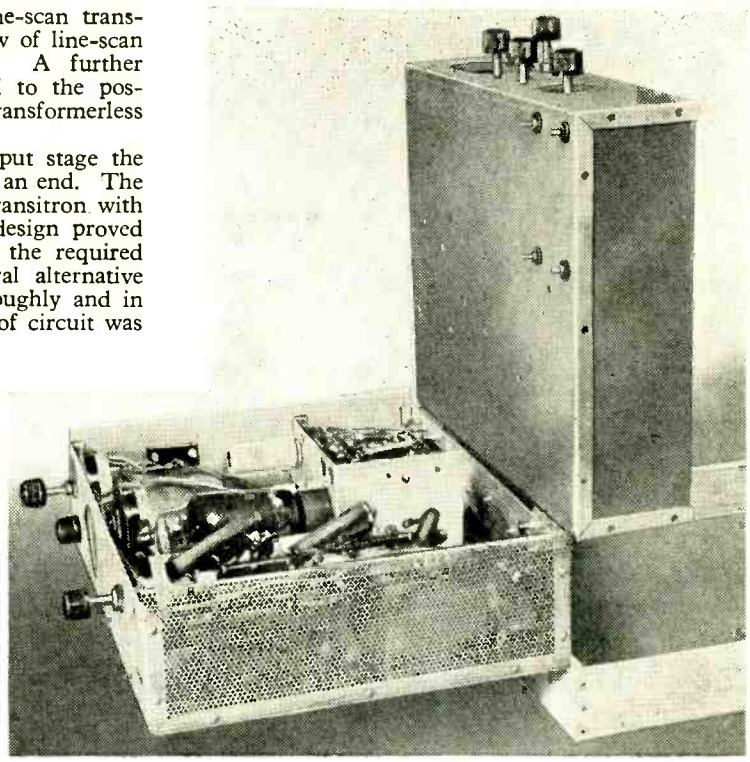
[1] "Deflector Coil Characteristics," by W. T. Cocking, M.I.E.E., *Wireless World*, March, April and May 1950, pp. 95, 147 and 176.

[2] "Deflector Coil Construction," by W. T. Cocking, M.I.E.E., *Wireless World*, December 1952, p. 480.

these difficulties by eliminating the line-scan transformer altogether. This led to a review of line-scan circuits[3] and also of e.h.t. systems.[4] A further development[5] which then occurred led to the possibility of obtaining h.t. boost in a transformerless circuit.[6]

Having thus obtained a suitable output stage the designer's troubles were by no means at an end. The output stage must be driven and the transitron with intermediate amplifier of the original design proved to have too slow a fly-back to enable the required e.h.t. voltage to be developed. Several alternative arrangements had to be tried out thoroughly and in the end a two-valve multivibrator type of circuit was chosen. It was chosen in preference to a single-valve transitron (not the Miller integrator transitron) mainly because it synchronized better. It was chosen in preference to the blocking oscillator because it is free from two defects of the latter. These are the need for a transformer, which may "sing," and the large voltage pulse fed back into the sync circuits, which is liable to upset interlacing.

As developed the new time-bases comprise a two-valve multivibrator with a single pentode output valve for the line scan and a blocking oscillator and pentode output valve for the frame. For mechanical convenience the sync separator (two valves) is included with the time-bases. Somewhat newer valve types have been chosen and, except in the output stages, all valves are of the same type, EF91. It would have been possible to reduce the number by using one or more double triodes, but the saving in cost would not be large. It is outweighed by the convenience of there being fewer valve types which need be kept by as spares. In particular, it is desirable to avoid having only one valve of a given type in a set, for when there are several alike it is possible to change a valve suspected of being faulty with another. Of course, in the case of output valves it is often too uneconomical to do this.



In this photograph the line time-base is exposed.

Purpose of the Units

The time-base units will be fully described in further articles. In the meantime it may be as well to make their purpose quite clear. They have been designed primarily to enable the owner of the original *Wireless World* Television Receiver to modify it for a 12-in or 15-in tube and obtain with it a picture of a brightness which meets present-day standards. The frame and line time-base units need rebuilding for this and many of the existing valves and components are suitable, but not necessarily all of them. A new deflector-coil assembly is required. This was described in the December 1952 issue[2] and the type of assembly required is the one having 30-mH line coils and 10-mH frame coils.

The redesign is *not* for a wide-angle tube but for types such as the G.E.C. 6705A and the Mullard MW31-16. These tubes actually represent quite diverse types, for the G.E.C. has a triode gun, whereas the Mullard has a tetrode gun and an ion trap. In spite of this the changes needed in the circuit to accommodate them are quite small and will be made clear.

The new time-bases require a few minor alterations in other parts of the equipment, mainly to the power unit and the focus-coil circuit, for the h.t. voltage needed is now lower and the focus current required is higher. These alterations will also be described in these articles.

So much for the position of those who already have a *Wireless World* Television Receiver. Something must also be said about those who do not. The superheterodyne type of receiver is still regarded as a satisfactory one and a reprint of the articles describing it is still available.[7] This reprint includes coil winding data for the London and Birmingham channels only. Details of the coils for the other channels were given in a later article,[8] and the relevant part of this is being made available. When the present series of articles is completed it will constitute, together with the article on deflector-coil construction (December 1952), the reprint "Superheterodyne Receiver Construction" and "Superheterodyne R.F. Coil Data," the full description of a complete television receiver having an up-to-date performance.

(To be continued)

[3] "Efficiency Line-Scan Circuits," by W. T. Cocking, M.I.E.E., *Wireless World*, August, September and October 1951, pp. 302, 347 and 425.

[4] "Ringing-Choke E.H.T. Systems," by W. T. Cocking, M.I.E.E., *Wireless World*, November and December 1951, pp. 444 and 513.

[5] "Reactive Time Bases," by A. B. Starks-Field, B.Sc., *J. Brit. Inst. Radio Engns.*, 1951 Convention Paper.

[6] "Simple Line-Scan Circuit," by W. T. Cocking, M.I.E.E., *Wireless World*, August 1952, p. 305.

[7] "Superheterodyne Television Unit" (London and Birmingham Areas). Iliffe.

[8] "Further Notes on the *Wireless World* Television Receiver," *Wireless World*, July 1951, p. 286.

Remote Display of Radar Pictures

Design Requirements and Performance of a Centrimetric Radio Link

By R. F. HANSFORD* and G. J. DIXON*

IN the past many radar stations have had to be operated from bad sites because the choice of site has been governed by the need to have the displays at a particular place. Conversely, when radar performance has been of paramount importance, it has often been necessary to set up the radar station, together with operating staff, at a place many miles distant from the place where the information was needed. In the one case radar performance has suffered, in the other there is often the difficulty of conducting the operation from the wrong place or of reporting all information by a lengthy telephone procedure; in both cases the result has necessarily been a lowering of operational efficiency.

There has for a long time been a requirement for a means of transmitting the information from the radar site to a remote position, where it may again be displayed on a radar indicator without loss of detail or performance. The development of the Decca Radar Link Type 2 has recently been completed in order to meet this requirement.

In addition to allowing greater freedom of siting radar installations, an effective radar link has a number of other valuable applications. It can be of great operational advantage to relay the information from a chain of air warning and fighter direction radars back to a central control room, where all the radar displays can be co-ordinated. Similarly, the central display of information from a chain of coastal defence radars has great advantages. In civil applications, the relay of pictures from ground controlled approach radars and air traffic control radars directly into the airfield control tower, where the picture is wanted, will greatly aid the efficiency of airfield control procedure; and the harbourmaster of a modern port may now have in his own building the p.p.i. display of the radar information from a chain of radars sited along a difficult estuary.

The need for a radar link has been appreciated for some time past but the delay in the provision of suitable equipment has, to a large extent, been caused by the difficult nature of the problem. The remote display of radar information demands the transmission of video signals, synchronizing pulses and data on the angular position of the scanning antenna. It is obviously desirable that these should be transmitted over a common carrier, and means have to be devised for a suitable form of modulation which will permit reliable separation at the receiving end.

* Decca Radar Limited

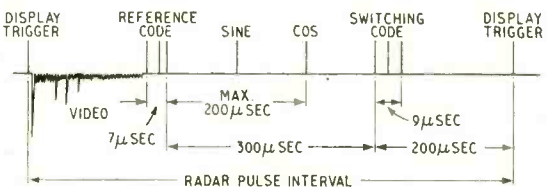
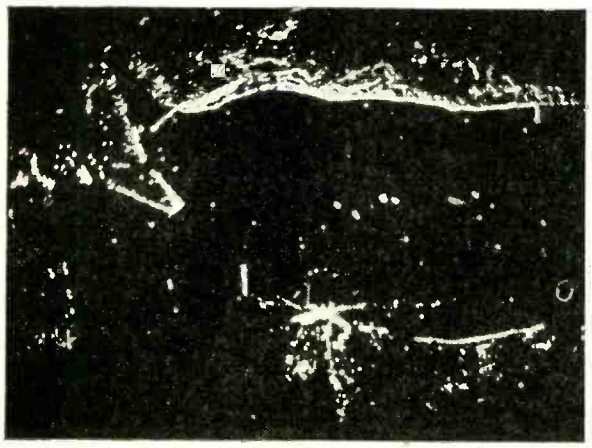


Fig. 1. Modulation waveform carrying p.p.i. video signals, bearing information and synchronizing pulses.

Photographs of p.p.i. display (left) at the harbour radar installation at Southampton Water and (right) at the end of a 5-mile link giving a simultaneous display at Warsash.



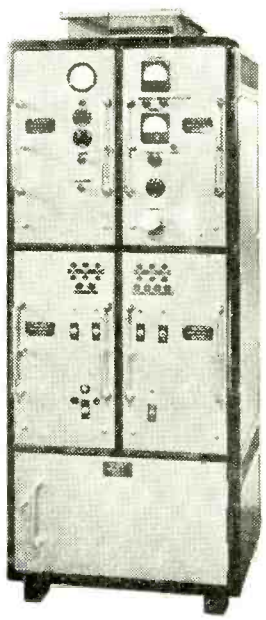
A modern radar installation is capable of very high order accuracy and an effective radar link must do nothing to lower the accuracy of information.

In examining the problems of synchronizing pulse separation and accuracy of the displayed picture the considerable complication introduced by fading along the transmission channel has to be very carefully considered. Over a long transmission path both rapid and slow fading to a considerable depth may be experienced under certain atmospheric conditions; if part of the transmission path is over water a further change in signal strength will be encountered with the rise and fall of the tide. Provision of a reliable service demands that under extremes of these conditions synchronism should be maintained, and that accuracy shall remain unimpaired. The accuracy requirements are particularly stringent in the case of the angle information.

In the past, attempts have been made to avoid the difficult problem of transmitting the angle information by driving the radar scanner with a synchronous motor, locked to the mains supply, and by driving the p.p.i. rotation also from a synchronous motor. Such a system is unsatisfactory if the radar scanner fails to rotate completely evenly as, for example, if it is buffeting into a high wind, or if any roughness has developed in the mechanical turning gear. A variant of this method which avoids the use of mains synchronism is to transmit a control frequency over the radar link (this may for simplicity be the radar repetition rate), to count this frequency down to a usable value at both the transmitting and receiving ends, and to drive the scanner and display deflection coils from it. Although a more elegant method, it suffers from the same disadvantage as the system mentioned earlier.

The direct transmission of angle information has been attempted by deriving from the aerial rotation two voltages proportional to the sine and cosine of the scanner angle, and transmitting these two voltages over the radar link. If this is done by amplitude modulation of the carrier it will be clear that any fading along the transmission channel will introduce serious errors. The use of automatic gain control could minimize the effect, but could not be relied upon to hold the received signal steady enough to ensure the required angle accuracy, which in the case of a p.p.i. display should be better than one in 360. An alternative method would be to transmit these voltages by frequency modulation of the carrier or sub-carrier, but difficulties are likely to be experienced in being able to develop for the receiving end a discriminator circuit which could be relied upon to maintain the necessary linearity. A further method which avoids fading errors is to transmit the information by a system of pulse time modulation which has the advantage of making use of time base circuits from which the required high degree of linearity may readily be achieved. It was thus decided to employ this method and exhaustive tests with the completed radar link have shown it to be reliable and capable of a high order of accuracy.

The equipment consists normally of a link transmitter, which is situated at the radar site, and a link receiver at the display position. When the information must be transmitted over a greater range than can be covered with a single transmitter and receiver, or



Link transmitter cabinet.

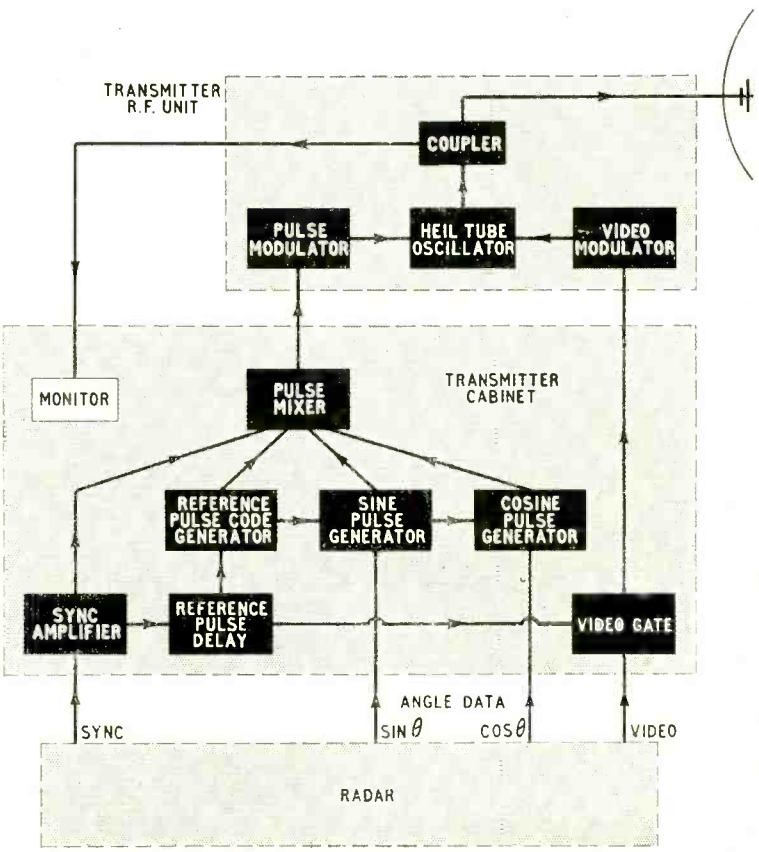


Fig. 2. Block schematic diagram of link transmitter.

when intervening hills or large buildings render a clear transmission impossible, then one or more link repeaters can be added.

The transmission takes place on a wavelength of approximately 9 centimetres (approximately 3,300 Mc/s) and employs a transmitter power of 0.5 watt.

The carrier is amplitude modulated to a depth of 80 per cent and negative modulation is employed for the video signals; pulse time modulation is used for conveying the synchronizing pulses and the bearing information, these pulses being transmitted by positive modulation of the carrier, in order that they may readily be separated from the video signals (see Fig. 1). The fact that the bearing information is transmitted by a varying time of occurrence of two pulses ensures that the accuracy of the received bearing information is completely independent of any fading which may occur along the transmission channel.

The link transmitter consists of two parts, a transmitter cabinet containing the control and modulation units, and a transmitter aerial with the r.f. unit carried in a watertight box at the rear.

The transmitter cabinet unit accepts from the radar the synchronizing, video and bearing signals; the manner in which these are converted into the requisite form of modulation for the carrier may best be understood by the block schematic diagram of Fig. 2. The synchronizing pulse is fed into the synchronizing amplifier, where it is sharpened and fed both into the pulse mixer and to the reference pulse delay unit. The reference pulse delay provides a delay which is equal to or a little greater than the required operating time of the video information, and is used both to operate the video gate, which closes down at the end of the video period, and also to trigger the reference pulse code generator. The latter produces three pulses with characteristic spacing which are fed into the pulse mixer and which are used as the reference pulses for the angle data pulses. The reference pulse code is fed to the sine pulse generator which is also fed with a voltage from the radar proportional to the sine of the angle of scanner rotation; this unit produces a pulse at a time t_1 after the reference pulse proportional to sine θ, where θ is the angle of scanner rotation. The sine pulse is fed both into the pulse mixer and into the cosine pulse generator. The cosine pulse generator produces a pulse at a time t_2 after the sine pulse such that t_2 is proportional to cosine θ.

If necessary, an additional characteristically coded set of pulses may also be fed into the pulse mixer (by a unit which has been omitted from the block schematic for the sake of simplicity) which may be used to operate any desired switching sequence; for example, turning on a heading marker once per aerial rotation.

The combined pulses from the pulse mixer are fed up to the link transmitter r.f. unit. The video pulses from the radar are passed into the video gate where, as previously mentioned, they are permitted to pass during the required video period and are shut off for the interval during which the various synchronizing and angle pulses are being formed. The output from the video gate is also passed up separately to the transmitter r.f. unit.

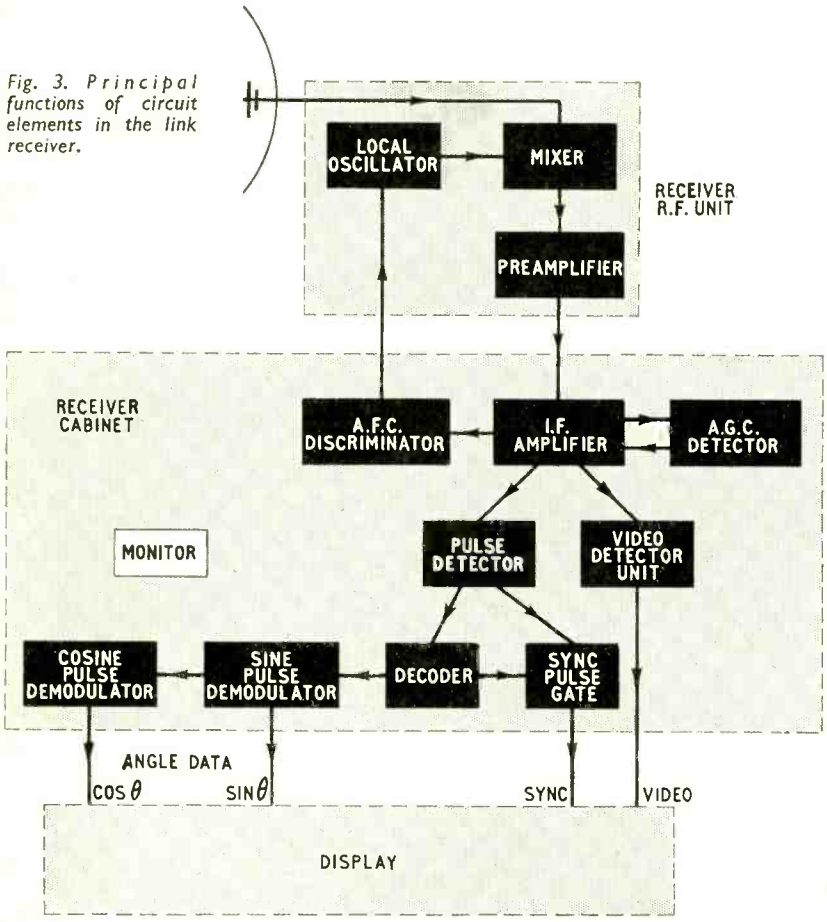


Fig. 3. Principal functions of circuit elements in the link receiver.

The transmitter cabinet also contains monitoring meters, a wavemeter and a monitor oscilloscope with which the waveforms at various points in the modulation process can be checked. All chassis may be withdrawn on runners for ready maintenance, and are all of the modern vertical chassis type to ensure maximum cooling.

The transmitter r.f. unit is housed in a watertight box mounted on the back of the aerial and contains thermostatically controlled heaters, both to keep the unit dry and to ensure an even operating temperature to assist frequency stability. The transmitter valve is a velocity-modulated valve of the Heil tube variety, and has an unmodulated output power of approximately 0.5 watt. It is positively modulated by the pulse modulator and negatively modulated by the video modulator. The valve may be remotely tuned by means of a magslip motor driven from a complementary magslip in the transmitter cabinet. Coupling

units are included so that test signals are sent back to the transmitter cabinet, in order that measurements may be made of transmitter frequency, power and modulation.

The aerial itself consists of a paraboloid, 4ft 6in in diameter, with a dipole feed. The beam width is approximately 5 degrees and horizontal polarization is normally employed. The position of the dipole may readily be adjusted over small limits as an aid to the final alignment of the beam.

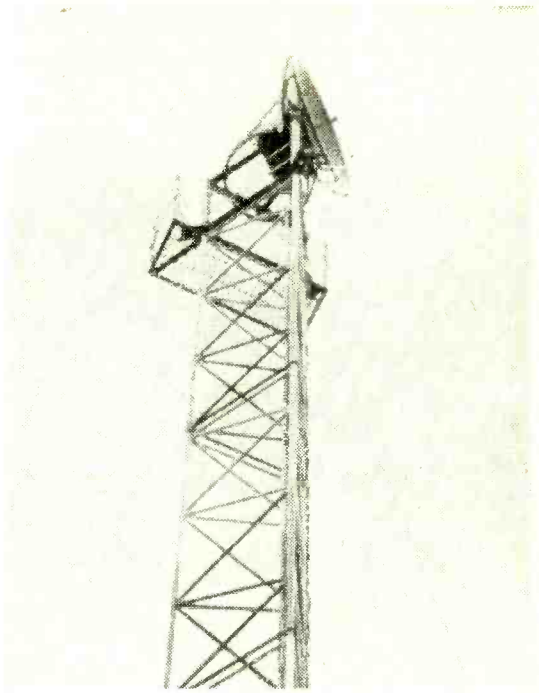
An exactly similar aerial system is used at the receiver end and the early stages of the receiver are contained in a watertight box on the back of it; the remainder of the receiver and the demodulation units are contained in the receiver cabinet. The receiver block schematic diagram is shown in Fig. 3.

The receiver is a superheterodyne with a reflex klystron as a local oscillator; this, with a crystal mixer and the first stages of the i.f. amplifier, are mounted on the back of the aerial. The local oscillator may be tuned initially by means of a magslip system; a.f.c. is then applied from a discriminator circuit to ensure that, once aligned, the receiver will remain accurately in tune with the transmitted signal.

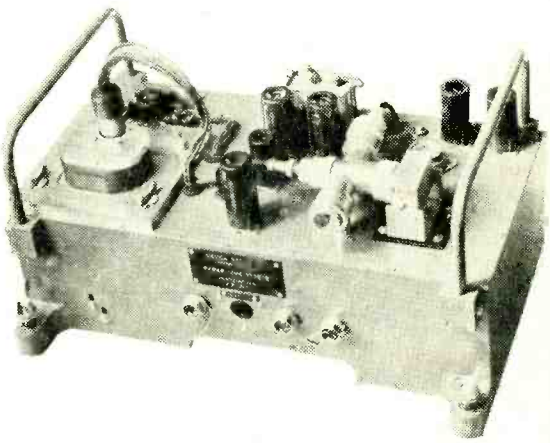
The receiver cabinet contains the main amplifier and modulation circuits, the a.f.c. discriminator and a.g.c. circuits. The signal from the pre-amplifier is fed down into the i.f. amplifier which has an a.f.c. discriminator circuit (referred to above) and three separate detector units. The video detector unit is arranged (by virtue of a biased amplifier stage) to respond only to negative modulation. It therefore provides the video information and ignores the synchronizing and angle pulses; the output from this unit is distributed directly to the remote display. The a.g.c. detector is responsive to the d.c. level of the carrier and is thus a suitable signal to feed back into the i.f. amplifier for gain control. The pulse detector unit responds to positive modulation of the carrier, and thus provides the synchronizing and angle information and ignores the video.

The output of the pulse detector is fed into the decoder which, by means of coincidence circuits, identifies the reference code pulses. The reference code pulses are fed to the sync pulse gate, where they are used after an appropriate delay to open the gate shortly before the expected arrival of the sync pulse; thus the display synchronizing pulse alone is passed through. The reference code pulses and the angle pulses are also fed into the sine pulse demodulator which produces a voltage proportional to the time between the reference code pulses and the sine pulse; this voltage is thus proportional to the original sine θ voltage fed in at the transmitting end and can be fed out to the display to control the time base circuits. The sine pulse and cosine pulse are also fed into the cosine pulse demodulator, which develops a voltage proportional to the time difference between them and is thus proportional to the original cosine θ voltage fed into transmitter; this is also fed off to the display to control the time base circuits. An additional decoder unit (not shown in the block schematic) is also available for detecting the presence of the switching code pulses and its output may be used to operate any switching circuit in the display.

The rack includes a signal distribution unit suitable for feeding up to three displays and providing outputs of synchronizing, video and bearing information. As with the transmitter cabinet, full test facilities are included, both meters and an oscilloscope



Paraboloid aerial and waterproof r.f. unit mounted on an 80-ft mast.



Transmitter r.f. unit removed from its watertight housing.

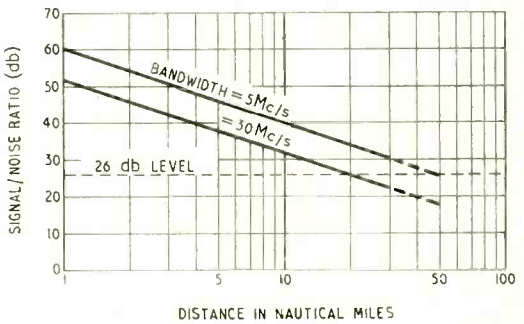


Fig. 4. Variation of signal/noise ratio with distance between transmitter and receiver in the radar link.

being provided. Vertical chassis construction is again employed and all chassis are mounted on runners.

The above equipments will provide reliable transmission of the radar data over a distance which may be up to 20 or 30 nautical miles, providing suitable terrain clearance for the transmission path can be obtained. At these distances it is usual to maintain a signal-to-noise ratio of 26 db. The signal-to-noise ratio will also be dependent upon the bandwidth employed. The performance in this respect, at various distances, is shown in Fig. 4 for two different link bandwidths.

When it is desired to transmit the information over greater distances, use may be made of the radar link repeater which has been developed. This may also be required in some cases for shorter distances when a clear transmission path cannot be obtained. The link repeater consists of two parabolic aerial units, one fitted with a receiver r.f. unit and the other with a transmitter r.f. unit. A single cabinet couples the two aerial units. The transmission takes place on a frequency different from that of the received signal. Although similar to the terminal equipment in external appearance, it is somewhat simpler since the pulse time modulation and demodulation circuits, used in the terminal equipment, are not required.

Further repeater stations may be used if required to extend the distance over which the link is required to operate; each separate transmission path may be up to approximately twenty nautical miles, under normal circumstances.

It is often required to use the link with radars of widely differing characteristics; consequently the radar link equipment has been designed to achieve a high degree of flexibility. Wherever practicable sub-unit construction has been adopted in order that the characteristics of the link may be changed as required by the use of alternative sub-units. The link has been used with radars of pulse lengths ranging from 1 to 0.06 microsecond. To achieve maximum signal-to-noise ratio with a 1-μsec pulse a bandwidth of 5 Mc/s was employed with a video response which was flat up to 2 Mc/s. Maintenance of high resolution with the 0.06-μsec pulse demanded the employment of an overall bandwith of 30 Mc/s, with a video response flat up to 14 Mc/s.

The version of the link described above is suitable for use with a p.p.i. type radar, which employs a fixed-coil type of deflection system with the scanner rotation being reproduced by controlling the amplitude of time base fed into the two pairs of coils. Some radars use a mechanically rotating deflection coil with the display, and in this case a slightly different version of the link is required. Here a mechanical rotation is accepted from the radar end and is converted into electrical signals by means of a magslip resolver. At the receiving end the two voltages are used to control a servo system which provides a rotating shaft output which can be used to drive any rotating coil equipment in the display.

Not all radars are of the p.p.i. type; for example, a ground controlled approach radar uses two displays, one a range-bearing display and the other a range-elevation display. The link can readily be arranged to deal with this type of equipment by using what was originally the sine pulse channel to convey the elevation angle data and what was originally the cosine pulse channel to convey the bearing angle data.

The link is now finding application in a variety of different radar fields, but it may be of interest to cite one example of the use of the link with a radar of extremely high discrimination. The pair of photographs on page 218 show (left) the p.p.i. picture obtained on a Decca harbour radar on the shores of Southampton water, and (right) the display derived via a radar link at Warsash about five miles away. This radar has a discrimination of 0.5 degree by 12 yards (a 0.06 microsecond pulse is employed), and it will be seen that the link reproduces the picture with negligible loss of quality.

The bearing accuracy has been carefully assessed and is better than one degree.

Manufacturers' Literature

Television Receivers; table model T.174 and console T.174C, both a.c./d.c. working with 17-in rectangular c.r. tube and edge-lit panel for pre-set controls. Illustrated leaflet from Sobell Industries, Langley Park, Slough, Bucks.

Capacitors for television receivers; paper and electrolytic types for smoothing h.t. and e.h.t. supplies; stacked mica and ceramic types for r.f. and i.f. decoupling and by-passing. Technical bulletin No. 28 from The Telegraph Condenser Company, North Acton, London, W.3.

Tape Unit, Motek model K3, with push-button controls and electrical braking system. Main features listed in a leaflet from Modern Techniques, 138, 142 and 144, Petherton Road, London, N.5.

Valve Wall Chart, 1952/53 edition, including data on germanium crystals, c.r. tubes and specialized glassware, with base diagrams, lists of equivalents and prices. From Mullard, Century House, Shaftesbury Avenue, London, W.C.2. Also a list giving the Mullard valve complements of television receivers, available to the trade either as a wall broadsheet or a booklet.

E.H.T. Concentric Connectors; demountable and moulded types with insulation adequate up to 10kV. An illustrated booklet with detailed drawings of all the parts involved, from The Plessey Company, Ilford, Essex.

Coaxial Cables; helical-membrane and solid-dielectric Telcon types described in an illustrated brochure containing electrical data, information on materials used and installation instructions. From the Telegraph Construction and Maintenance Co., Telcon Works, Greenwich, London, S.E.10.

Megohmmeter, essentially a stable d.c. valve voltmeter, capable of measuring up to 100 million MΩ, the meter giving a full deflection for an input voltage of 1V. Very full technical description in the Technical Review of Brüel and Kjær, Nærum, Denmark.

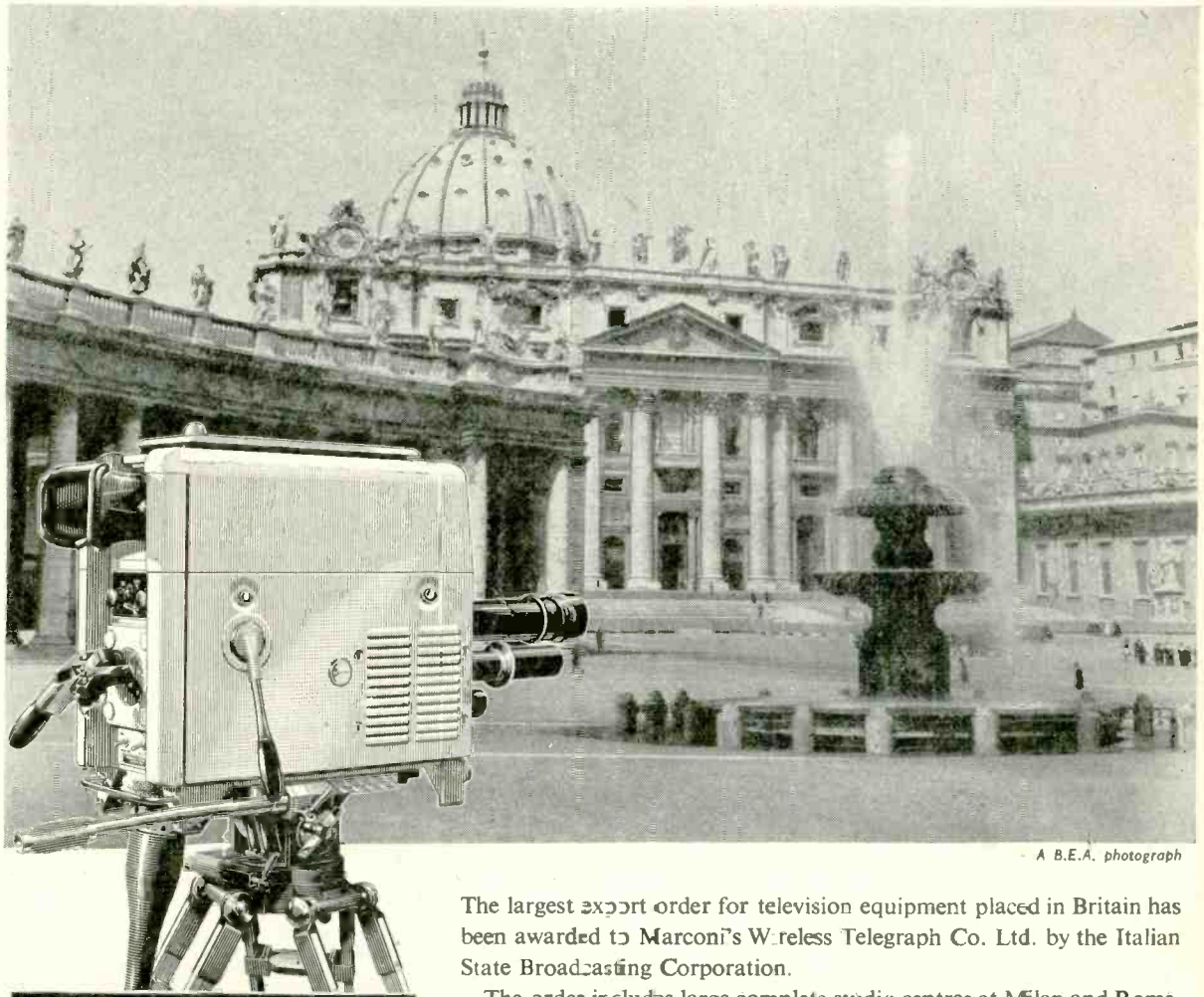
Photo Electric Cells and multipliers; monoscopes; cathode ray tubes for television, radar and oscilloscopes. Data sheets collected in a folder, also containing leaflets on other electronic apparatus made by Cinema-Television, Worsley Bridge Road, Lower Sydenham, London, S.E.26.

Special Adhesives; a quick-reference folder showing the best types for making joints between different materials, including metals, wood, glass and ceramics, plastics and rubber. From Aero Research, Duxford, Cambridge.

Repair Service for radio and electronic components; a leaflet giving details and listing the types of components handled, from W. Forrest, 349, Haslucks Green Road, Shirley, Birmingham.

Stabilized Power Supply with d.c. output adjustable in three ranges: 250-300 V at 0-200mA; 300-350 V at 0-200mA; 350-400 V at 0-150mA; and stabilization against changes in both mains input and load. Specification on a leaflet from The Edison Swan Electric Company, 155, Charing Cross Road, London, W.C.2.

Marconi Television for Italy



A B.E.A. photograph

The largest export order for television equipment placed in Britain has been awarded to Marconi's Wireless Telegraph Co. Ltd. by the Italian State Broadcasting Corporation.

The order includes large complete studio centres at Milan and Rome, O.B. units for Rome, and medium power transmitting stations at Rome and Pisa.

This order follows those for television installations in the U.S.A., Canada, South America and Thailand.

Marconi high power or medium power transmitters and high power aerials have been installed in every one of the B.B.C.'s television transmitter stations.

Equipment purchased by R.A.I. through Italian Marconi Company includes:

- 7½ kW vision transmitters
- 2½ kW sound transmitters
- Marconi Image Orthicon Cameras
- Complete studio installations
- Two mobile O.B. television units, complete with micro-wave links.

MARCONI

television transmitting equipment

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD · CHELMSFORD · ESSEX

Television Converter

For Sets Which Cannot be Tuned to Different Stations

By C. A. MARSHALL,* B.Sc., A.M.I.E.E.

WHILE most of the new television receivers coming on the market nowadays are capable of being tuned to different stations, there are large numbers of sets in use which do not have this facility, particularly in the south-east corner of England. It must be remembered that the tuneable receiver is quite a recent innovation and has only appeared since the opening of the Sutton Coldfield transmitter. Before that time all receivers were designed for the Alexandra Palace transmitter (Channel 1) and the possible need for changing to other channels was not anticipated. Consequently, people who own non-tuneable sets are in an unfortunate position if they move to another part of the country and want to receive a new station. Likewise if they happen to be in a fringe area and a booster station working on a different frequency is installed for their benefit.

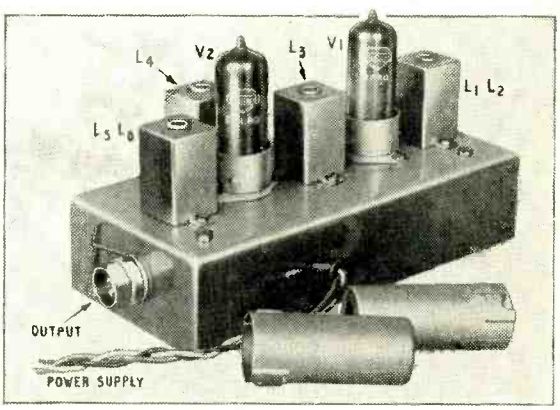
Probably the most convenient way out of the difficulty is to add a frequency converter to the set, and in this article the author puts forward a suitable design. At the moment, the viewers perhaps most in need of a converter are those in the Brighton district who would like to change from Channel 1 to their new booster station on Channel 3 in time for the Coronation. For this reason the circuit constants given are for this particular requirement, but later on the author hopes to give values for some of the other frequency conversions that may be needed.

In designing a television frequency converter there are quite a number of factors which have to be taken into consideration. For example, a great deal depends on which channel is being converted and which channel the receiver is tuned to. One must realize that the television receiver is acting as an i.f. amplifier which follows the frequency changer stage in the converter unit. As with all superheterodyne design the i.f. must be carefully considered if interference is to be avoided. If the television receiver itself is a superhet then we have in effect a double superheterodyne. This combination may give a set of interfering signals which can be predicted—but never cured! In a television system there is a further complication in that we are concerned with two transmissions—sound and vision. In any frequency changing process which occurs in a converter unit the relative position of these carriers in the spectrum must not be disturbed; the sound carrier must always be at a lower frequency than that of the vision carrier.

In most frequency changers one is free to make the oscillator frequency either higher or lower than the incoming signal frequency, but this is not so with the television converter. Only the low oscillator frequency can be used if the two signal frequencies, vision and sound, are to be kept in their correct positions. For example, take the present case of converting from Channel 3 to Channel 1, that is, vision from 56.75 Mc/s to 45 Mc/s and sound from 53.25 Mc/s to 41.5 Mc/s. Working on the vision frequencies, if the oscillator frequency were made high it would have to be 101.75 Mc/s, so that the difference frequency (101.75 – 56.75) would come to 45 Mc/s. But with this oscillator frequency the 53.25-Mc/s sound transmission would be converted, not to the required 41.5 Mc/s, but to 101.75 – 53.25 = 48.5 Mc/s. If, on the other hand, the oscillator frequency is made low, it becomes 11.75 Mc/s, and this converts the sound frequency from 53.25 Mc/s to the required 41.5 Mc/s. The same situation occurs if one wishes to convert from a lower-frequency channel to a higher one; only the "oscillator low" condition will keep the vision and sound frequencies in their correct relative positions.

With the converter oscillator at a lower frequency than that of the incoming channel there is the inevitable danger of oscillator harmonics falling in that channel. They may even fall in the original receiver channel, which means that a considerable amount of filtering will be required between the converter and the receiver. Second-channel or image interference may also occur if there is insufficient rejection in the pre-mixer stages.

The problem is therefore identical with that encountered in any superheterodyne design except that the i.f. is fixed and no choice is possible for the oscillator frequency. These represent severe design limitations and each conversion from one channel to



Top view of the chassis showing the disposition of the valves and coils.

* Mullard Research Laboratory.

another must be considered separately. It is, however, fortunate that the conversion from Channel 3 to Channel 1 can be done without the need of any special filter circuits. The oscillator frequency is 56.75 – 45.0 = 11.75 Mc/s. This has harmonics at 23.5, 35.25, 47.0 and 58.75 Mc/s—all of which are outside the two channels under consideration. (Here it should be explained that 47 Mc/s *is* outside Channel 1 if a lower-sideband receiver is used. The system cannot be made to convert a lower-sideband transmission to an upper-sideband transmission suitable for an upper-sideband receiver. Hence the older type of upper-sideband receiver cannot be converted in this way. As the output at 47 Mc/s is only small the converter should also be suitable for receivers of the double-sideband type.) The second channel band is from 29.75 to 33.25 Mc/s which is relatively free from high power transmissions.

There is, of course, the possibility that the 11.75 Mc/s oscillator frequency may interfere directly with the i.f. stages of the receiver, as some of the older sets have i.fs which are in this region. The only solution for this will be to insert an 11.75-Mc/s filter between the converter and the receiver, and the author hopes to give details of a suitable circuit later on.

Coming now to the actual circuit, the general system is shown in the block schematic Fig. 1, while Fig. 2 is the complete circuit diagram. In Fig. 2 the input from the coaxial 80-Ω cable is fed via the input transformer L_1L_2 to the grid of V_1—an EF80 r.f. amplifier. Further r.f. selectivity is achieved in the tuned circuit associated with L_3 before the signal is passed to the grid of the mixer valve V_2. An ECL80 valve is used in an oscillator mixer stage, the oscillator output (at 11.75 Mc/s) being injected via C_9. With this circuit a conversion conductance of approximately 0.9mA/V can be achieved, which is adequate for the purpose. With the values shown the optimum oscillator voltage is injected when the grid current in R_5 is 2.2μA. The value of C_8 is chosen to have a relatively high reactance at oscillator frequency to prevent the r.f. coil L_3 shunting the oscillator signal. The i.f. output from the mixer valve is taken via the tuned transformer L_5L_6 to the 80-Ω input of the Channel 1 receiver.

Winding data for the coils is given in Fig. 3. All the coils are close wound with 32-s.w.g. enamelled copper wire on Aladdin 0.3in diameter formers. The numbers in circles refer to the pin numbers stamped on the base of these formers. The coils should be soldered to the vertical spills inserted through the numbered holes. The winding direction is the same in all cases, i.e., looking from the base of the coil former the windings go in an anti-clockwise direction towards the top of the coil former. (If the pin numbers and the number of turns are correct, then the winding direction will be automatically correct.) The dust iron cores should be waxed in position after the unit has been trimmed. It is also a good plan to place a small piece of thin string down each former before the core is inserted so that the core is not a loose fit in it.

The prototype model was constructed

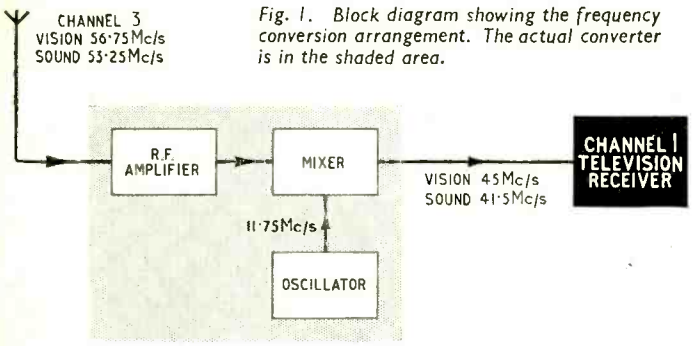


Fig. 1. Block diagram showing the frequency conversion arrangement. The actual converter is in the shaded area.

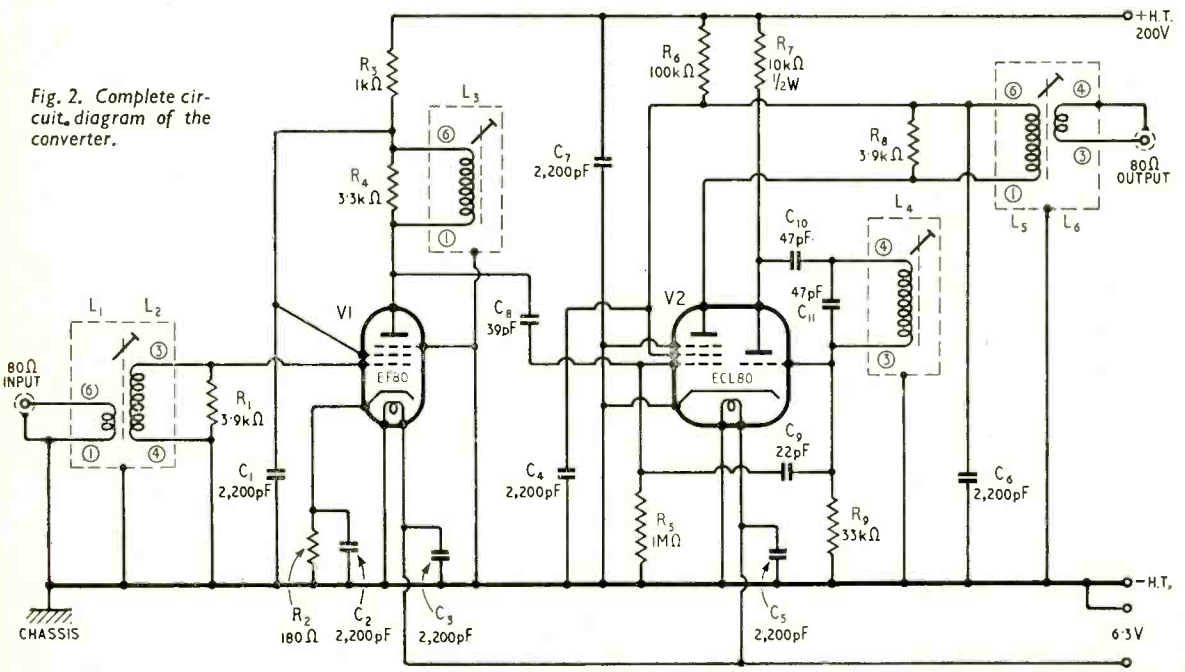
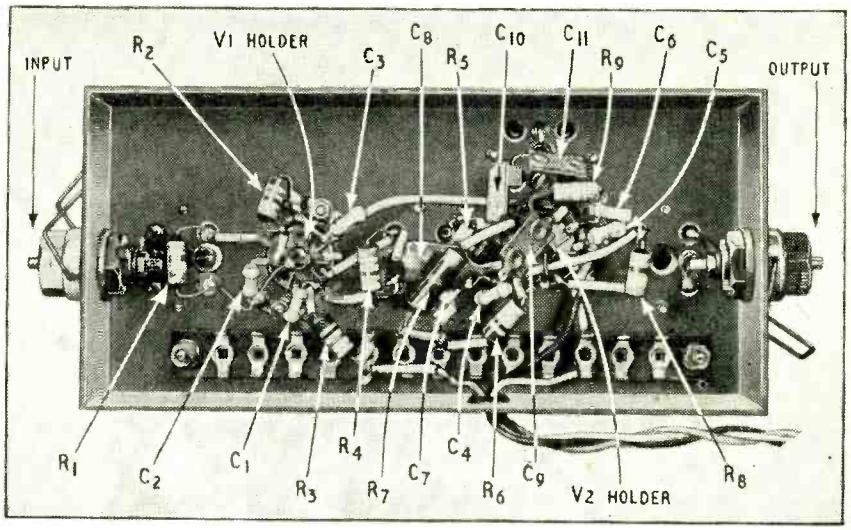


Fig. 2. Complete circuit diagram of the converter.

on an aluminium chassis measuring approximately 7in × 3in × 1½in. The valveholder for V_1 is mounted with the line between its fixing holes at an angle of 60 deg to the major axis of the chassis. V_2 is mounted in line with the major axis of the chassis. Normal r.f. wiring precautions should be adopted, e.g., all leads should be short and direct and the earthed electrodes on the valveholders should be connected by individual leads to the chassis. The use of low self-inductance decoupling capacitors for C_1-C_7 is of extreme importance.



Underside view of the chassis. Leads should be as short and direct as possible.

The h.t. voltage should be 200V and the total h.t. current 22mA. On V_1 the anode and screen voltage should be 183V and the cathode voltage 2.4V. On V_2, the triode section should have an anode voltage of 140V and anode current of 6mA, while the oscillator grid current measured at the bottom of R_9 should be 160μA. The anode and screen voltage of the pentode section should be 30V and the grid current at the bottom of R_5 should measure 2.2μA. The conversion gain of the circuit is 18db. Relative to the 56.75-Mc/s vision transmission, the rejection of 45 Mc/s is 17db, while the second channel rejection of 33.25 Mc/s is 35db.

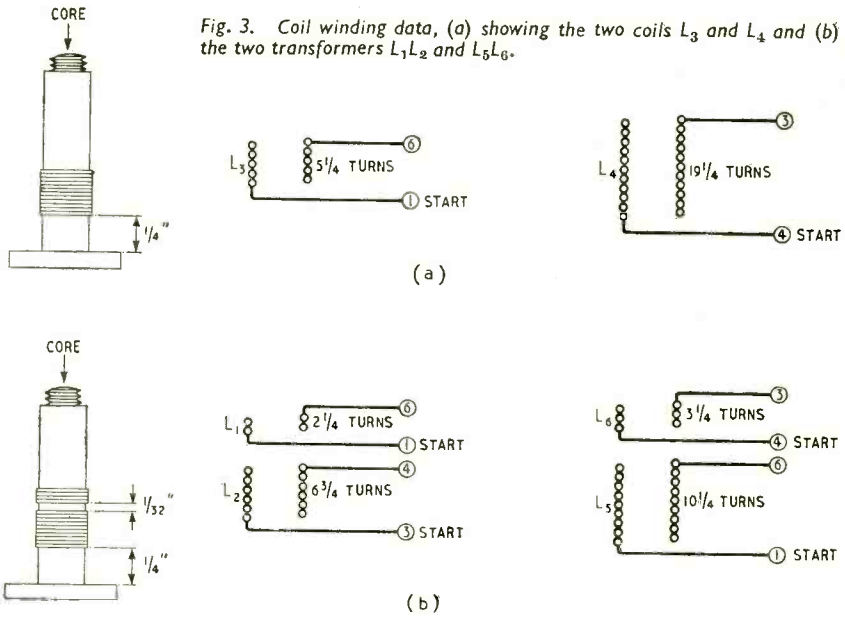


Fig. 3. Coil winding data, (a) showing the two coils L_3 and L_4 and (b) the two transformers L_1L_2 and L_5L_6.

Now for the trimming procedure. The unit should be allowed to warm up for about ten minutes before trimming is started. A correctly tuned Channel 1 television receiver should be connected to the output of the converter and an 80-Ω generator to the input. Any convenient method of noting the output from the sound and vision sections of the receiver can be adopted. To begin with, adjust all cores so that they are just about to enter the coil windings from the top. Then, with an input of 44 Mc/s, disconnect R_7 from the h.t. line and trim L_5L_6 for maximum vision output. With an input of 53.25 Mc/s, re-connect R_7 and trim L_4 for maximum sound output. Check that an output can also be obtained at the second channel sound frequency of 29.75 Mc/s. Next, with an input of 55 Mc/s, trim L_3 for maximum vision output; and then, with an input of 56 Mc/s, trim L_1L_2 for maximum vision output. Finally, on a B.B.C. Channel 3 transmission a final adjustment for maximum sound output can be made on the oscillator coil L_1.

As already stated the converter has an effective conversion gain of 18db, so the effective sensitivity of the receiver will be increased by this amount. Many simple one-valve converter units actually introduce a loss during the channel changing process, which is detrimental to their value. This converter does not have this disadvantage and the addition of the r.f. valve improves the noise factor of the system. The additional gain means that a distribution attenuator system could follow the converter so that several receivers could be fed from it.

Fig 4 shows two response curves which have been measured. The first is that of a typical television receiver which was tuned to Channel 1. The second curve was measured with the converter in front of the receiver. No deterioration in performance was indicated by these measurements.

Viewers on the south coast who have been operating high-gain Channel 1 receivers may find that the

converter will supply too great a signal when the Channel 3 transmitter comes into operation. In general, any extra attenuation that may be required should be introduced between the converter and the receiver and not before the converter. On the other hand, receivers which are very close to the transmitter may need an aerial attenuator if cross-modulation effects are to be avoided. The important thing to remember is that the receiver should not be operated at maximum gain with the converter output attenuated to suit the receiver. This is almost sure to result in a noisy picture. For a start the receiver should be operated at about half its normal gain and direct connection made between the converter and the receiver. If an "over-contrasty" picture is received then it will be in order for an attenuator to be introduced. Much will depend on the type of aerial, the site, and the distance from the transmitter, and only these general guiding principles can be given.

On the question of aerials the recommendations of the aerial manufacturer should be followed if the optimum results are to be expected. Television aerials *will* work on channels for which they are not designed but at much reduced efficiency. Many south coast areas have installed elaborate beam arrays and it is these aerials which unfortunately fall off rapidly in performance when they are not being used on the correct channel. The sound-to-vision ratio may also be altered. However, a Channel 1 aerial may prove satisfactory in many cases and it will certainly be worth a trial before a new aerial is erected. The aerial system may have to be reorientated for maximum signal pick-up.

The converter requires an h.t. supply of 200V at 22 mA and a 6.3-V heater supply at 0.6A (alternatively the valve heaters may be connected in series to a 12.6-V supply at 0.3A). Although the television receiver itself may be able to supply the above power, the author does not recommend that this technique be adopted. It would indeed be very dangerous to take the power from an a.c./d.c. receiver of the type which is now almost universally used in this country. It is therefore strongly advised that a separate power supply be made up for this converter; a suitable design is shown in Fig. 5. All the r.f. decoupling that is required is contained within the converter unit so the length of the leads between the converter and the power supply is not critical.

The author would like to thank Maitland Radio, of Edinburgh, for assistance given in testing the converter on the Kirk o' Shotts transmission.

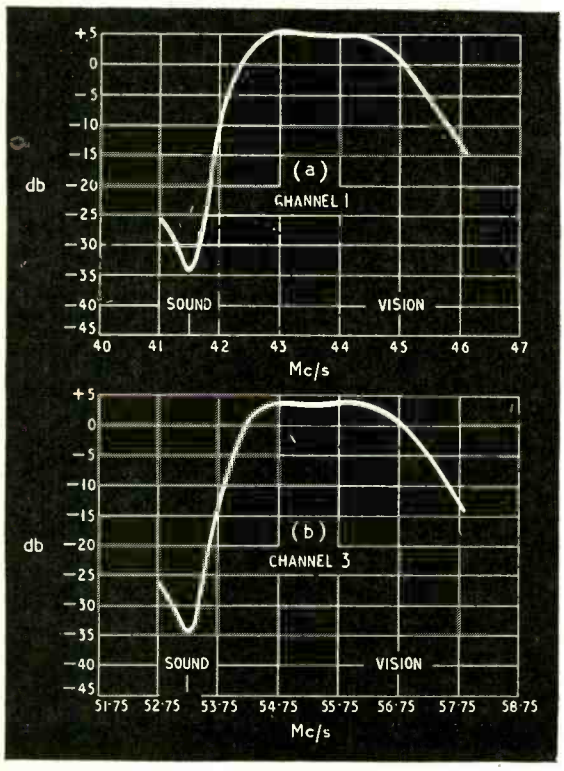


Fig. 4. Response curves of (a) a typical Channel 1 receiver and (b) the receiver and converter.

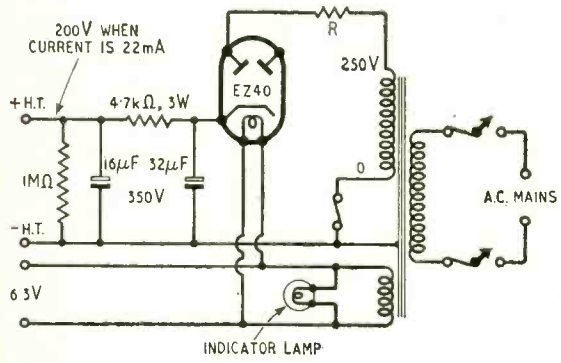


Fig. 5. Circuit of a suitable power supply. The value of R should be chosen so that with the resistance of the transformer secondary it comes to at least 80Ω.

A.R.R.L. 1953 HANDBOOK

Standard Radio Textbook for Amateurs

THE Radio Amateur's Handbook produced by the headquarters' staff of the American Radio Relay League for radio amateurs has become the recognized standard textbook for everyone interested in radio as a hobby all over the world. It has been in continuous publication since 1926.

The 1953 edition is divided into 27 chapters covering, among other things, radio and electrical laws and circuits, thermiomic valve principles, high and extra-high frequency communication principles and practice, aerials of all kinds and descriptions of a wide variety of equipment for home construction. There is a comprehensive valve data section covering modern and not-so-modern transmitting and receiving valves and c.r. tubes. Particular attention is given to the suppression of transmitter harmonics and spurious radiation as American amateurs have their TVI and BCI problems as well as us and the suppression measures described are applicable to all amateur transmitters.

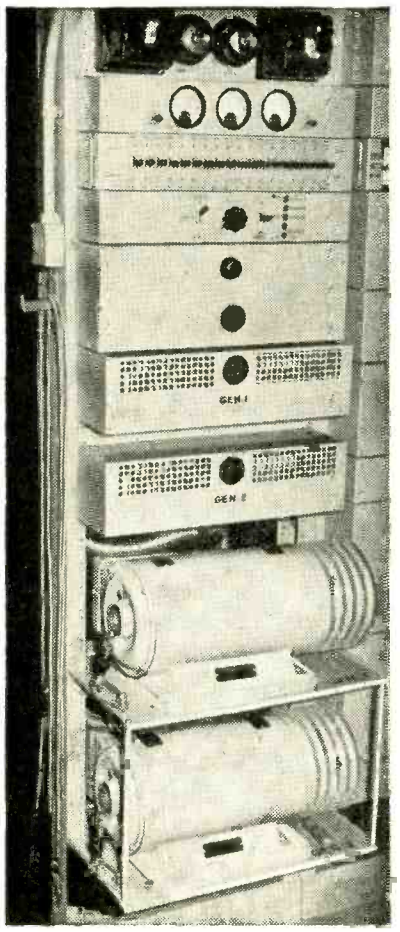
The handbook contains 548 pages of text with 1,200 illustrations, 95 charts and tables and 60 pages of valve data. Copies are obtainable from the Modern Book Co., 19-23, Praed Street, Paddington, London, W.2, at 31s, including postage, or from The Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1.

Part of the main equipment hall in the M.C.A. communications centre, at Croydon.

Below : One of the equipment racks in the G.P.O. control room showing two of the multi-frequency generators used to operate the teleprinter circuits.

Civil Aviation Communications Centre

Radio and Landline Clearing House for Aircraft Operational Messages



THE swift, accurate and economical handling of operational messages between airports, air traffic control centres and operating companies is an essential requirement of civil aviation and will increase in importance as fast jet airliners take over more of the regular air services. As flying speed increases messages announcing their departure and expected time of arrival at the destination or intermediate airports must be speeded up and the immediate aim of the Ministry of Civil Aviation is to ensure that such messages shall reach their destination within at least one-fifth of the flying time between departure and arrival.

In order to speed up the ground communications and so achieve this desired end a new communications centre has been opened at Croydon airport by the M.C.A. A network of teleprinter, radio-teletype and W/T circuits radiate from this centre to various parts of Europe, Scandinavia, South America, Canada and the U.S.A. It forms part of an extensive ground communications system set up between member states of the International Civil Aviation Organization and is the clearing house for operational messages originating or destined for the United Kingdom.

The new signals centre was planned with the following requirements in mind: (a) transmission time to be reduced wherever possible by employing automatic equipment; (b) manual transmission of messages restricted to the absolute minimum; (c) limit the number of retransmissions; and (d) mechanize the handling of messages wherever possible.

When land lines are available messages are sent by automatic teleprinters and W/T circuits are operated wherever possible by radio-teletype equipment. Some circuits still have to use hand-operated W/T owing to lack of suitable equipment at the distant end.

At the time of our visit W/T was used on circuits to Africa, Asia, some Mediterranean areas, India, Spain and South America; duplex radio-teletype on circuits to Iceland, Newfoundland, U.S.A., India and Egypt and landline teleprinters for all internal communications and to France, Italy and Scandinavia.

Teleprinter receiving equipment which records the message in the form of perforations on a paper tape has been available for some time and this tape can be used for automatic retransmission, but it suffers from the drawback that scrutiny of a message to establish its destination and content requires operators trained to interpret the perforations. This means a large staff of highly skilled personnel.

A printed copy could be attached to the message, but handling is then inconvenient and there is the danger of the perforated tape becoming separated from its printed copy. A solution to this problem has been found in the use of partially perforated tape on which the message is printed in ordinary typescript so that the operators need not be trained in interpreting the perforations. The layout of the equipment is such that

the functions of individual operators are simplified as much as possible. All incoming circuits terminate on "printing-perforators" mounted three in a rack. The racks are grouped in rows to conserve space and to allow one operator to deal with several circuits during quiet periods. The receiving operators tear off the message tapes and dispose of them by pneumatic tubes to either a "circulator" in the case of messages with a single destination or to a "tape multiplication pool" if there are several destinations. This may well be the case if the message relates to a long-distance flight involving several intermediate stopping places, as these must be informed as well as the destination without appreciable loss in transit time.

In the case of a multi-addressed message the tape is fed into a machine which produces simultaneously six copies of the original and if more are required it is fed through again until the required number have been made. Messages are usually quite short so that multiplication takes but a minute or two and the tapes of a multi-addressed message are then fed into appropriate machines for retransmission to the various destinations.

With the new centre in operation further advancement towards speedy communications can only come by more mechanization. For example, at present the manually-operated W/T circuits are centred at Birdlip where the teleprinter slips have to be deciphered; this is done mechanically, of course, and the messages are then retransmitted by hand in morse.

The first step will be to transfer the hand-operating to Croydon, so saving some of the retransmission time at Birdlip. Later the hand-operated W/T will be replaced by teletype circuits, but this depends on the speed with which the necessary equipment can be installed at the distant terminals, a matter outside the control of the M.C.A.

Draughtsmen or "Delineators"?

CIRCUIT diagrams cannot be expected to tell their own stories if the men who draw them do not understand what they are supposed to convey. For this reason draughtsmen should have a sound basis of technical knowledge and preferably should be radio technicians who have changed over to this sort of work. It is a mistake to employ mechanical draughtsmen for the job because they are realists, concerned with the actual shape of things in the metal, whereas the good "circuit delineator" is essentially a kind of impressionist.

These views were expressed at a recent discussion meeting of the Brit. I.R.E. on "The Standardization of Symbols and the Arrangement of Electronic Circuit Diagrams." Some speakers, indeed, went so far as to suggest that radio draughtsmen were sometimes unnecessary, and described various systems of "prefabrication" by which circuits could be compiled by the technicians themselves. One of these was called "sticky symbols," the symbols being printed in quantity on sticky paper and cut out and stuck on squared paper. Another system used magnetized metal symbols which could be juggled about on a sheet of iron. When assembled the diagrams were reduced and copied photographically.

L. H. Bainbridge-Bell, who opened the discussion, stressed the importance of drawing circuit diagrams to bring out their function rather than drawing them just to look pretty. He also advocated the use of standard configurations for familiar things like multivibrators and oscillators so that they could be instantly recognized wherever they were. Several speakers put forward some rather unusual suggestions on this topic. One felt that valve stages should be drawn wherever possible as four-terminal networks. The two input terminals would go to grid and earth, while the two output ones would come from anode and earth, the anode load and h.t. supply being shunted in series across them. The h.t. line would actually run somewhere below the earth line, and while some speakers thought this a bad thing others felt that a strictly logical positioning of the d.c. power lines in a circuit gives them too much importance. On this topic, mention was made of the German idea of a "three-dimensional" circuit diagram, drawn in perspective, which achieved separation of power and signal lines by representing them in different planes.

Another unconventional idea, put forward by Mr. Bainbridge-Bell, was the use of curved and sloping lines. He felt that they were especially justified when the connections were important to the circuit, for they drew attention to themselves. There was no reason, in fact, why a curved or sloping line should not slash right across a lot of other circuitry if by this means the connection could be made more direct. In practice the line did not become confused with those it crossed. It was not really essential to have right-angled connections in circuits at all, but draughtsmen were addicted to them because their T-squares and set-squares made them so delightfully easy to draw. Another thing that sometimes led to confusion was equal spacing between lines that have to run parallel for any distance—the eye is never quite sure which one it is supposed to be following. The lines should be arranged in small groups according to their functions and relationships.

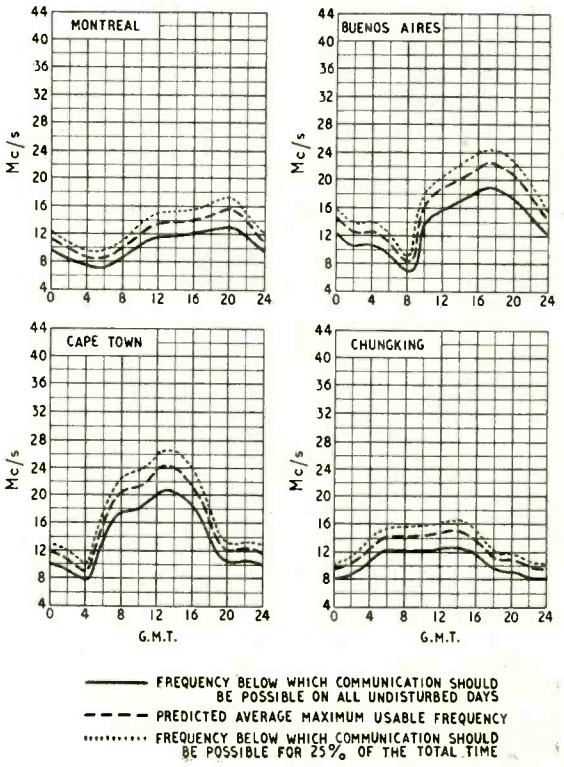
On the subject of annotating components, one speaker thought that components should be numbered according to their position in the chassis, not their position on the circuit diagram. This, he said, would be a great help to the servicing technician.

Short-wave Conditions

Predictions for May

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during May.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



VORTEXION TAPE RECORDER

FEATURES WORTH NOTING . . . . . .

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★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ The 15 to 30 ohms microphone balanced line input is fully loaded with 20 microvolts.

★ Input 1, which requires 35 millivolts on .5 megohm, is suitable for crystal P.U.s, microphones or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ Total power consumption is approximately 50 watts.

The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 31 lb.

Price **£49**, to which cost of Tape Unit to your choice, must be added

PRICE, complete with WEARITE TAPE DECK **£84 0 0**

TYPE C.P.20A AMPLIFIER

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Designing a Tape Recorder

3—The Complete Instrument : Construction and Adjustment

By

J. M. CARTER, B.Sc.*

THE circuit diagram of a complete instrument is shown in Fig. 7. All the wiring and switches shown in the upper section are contained in the "Wearite" Tape Deck which is connected to the amplifier shown in the lower section by means of octal plugs and sockets and the two screened leads which attach to the head matching transformer and equalizing network respectively.

It will be seen that a combined record/playback head is employed and switched either to T_1 on playback or to the anode lead from the output valve V4 on "Record." The head has four coils, two of which, in series, form the signal winding and two the bias winding. On "Playback" and "Record," both windings are in series, but in the latter connection the bias volts are connected across the bias winding by the main switch on the Tape Deck. It should be noted that, although not indicated in the diagram, the switch section which does this is of the "make before break" type and that the switch tag which connects on "Record" is strapped to the adjacent tag corresponding to the "Wind back" position. This, of course, is to ensure that the bias lead to the head is not broken before the oscillator volts have sunk to zero.

As previously mentioned, the earth connection to the head is kept separate from the Deck chassis and connected to a single-point common earth with the first stages in the amplifier. The three mains connections to the motors form part of an arrangement whereby use is made of the mains transformer primary taps to act as an auto-transformer and always maintain the capstan motor volts at between 240 and 250V irrespective of the supply voltage. Otherwise, the motor switching system is that previously described in Part 1.

Mention might here be made of the motor starting, stopping and brake release system employed. These functions are effected by means of the main operating bar which runs diagonally across the underside of the Deck, and the knob which protrudes through the small panel at the bottom left-hand corner. Pulling this bar towards the front of the panel operates the main motor switch, across which is the 0.1μF capacitor for noise suppression, and simultaneously pulls the brakes off the reel brake drums. The bar is held in the "on" position by the brake release solenoid, which is energized from the h.t. feed to the amplifier, and also acts as a second choke for this. To stop the tape running this solenoid is shorted by the "Press to Stop" switch, or by the contacts of the automatic stop switch, Sw4, located immediately to the left of the erase head. This allows the bar to return under its spring tension, switching off the motors, disengaging the pinch roller and applying the brakes to the reel drums.

A section of the main switch is provided to substitute automatically an equivalent load resistor (R_{27}) for the internal speaker in the "Record" position. This, of course, is primarily intended to prevent acoustic feedback taking place when using a microphone; if a radio or similar source is used the internal speaker may be reconnected to work at reduced volume by joining pins 2 and 4 with a 10-Ω resistor on the external feed socket. This also has smoothed-h.t. and l.t. connections for supplying a small tuner unit for radio recording. The circuit diagram shows a 2.5Ω internal speaker, and a jack for a 15Ω external speaker (which automatically disconnects the muting). If it is desired to use a 2.5Ω external speaker this should be connected between the live terminal of the external speaker jack and pin 4 on the external feed socket.

The amplifier circuit follows closely along the lines already described in Part 2, with the addition of bass and treble controls to the equalizing circuit, and provision for equalizing the response at $3\frac{3}{4}$ in/sec by means of the two-pole switch linked to the speed-change control on the deck. As the tone controls are in the equalizing section, on "Record" they are automatically disconnected by the jack plug, and therefor inoperative. The oscillator and peak level meter have a common h.t. supply which is switched on the Deck (tags 4 and G), and both operate only on "Record."

Layout

No specific drawings regarding the general layout of the amplifier are given, because it was thought that most people would have their own ideas as to which type of chassis, or various sub-chassis, would suit their own particular cabinet requirements. This being so, a few general recommendations on the disposition of the components may prove helpful. The most important point is to keep the record/playback head, and also the first two valve stages, away from the immediate vicinity of all iron-cored inductors carrying any appreciable a.c. This means, of course, especially the mains transformer and smoothing choke, and the output transformer also should be

* Wright and Weaire, Ltd.

kept away from these prolific sources of hum.

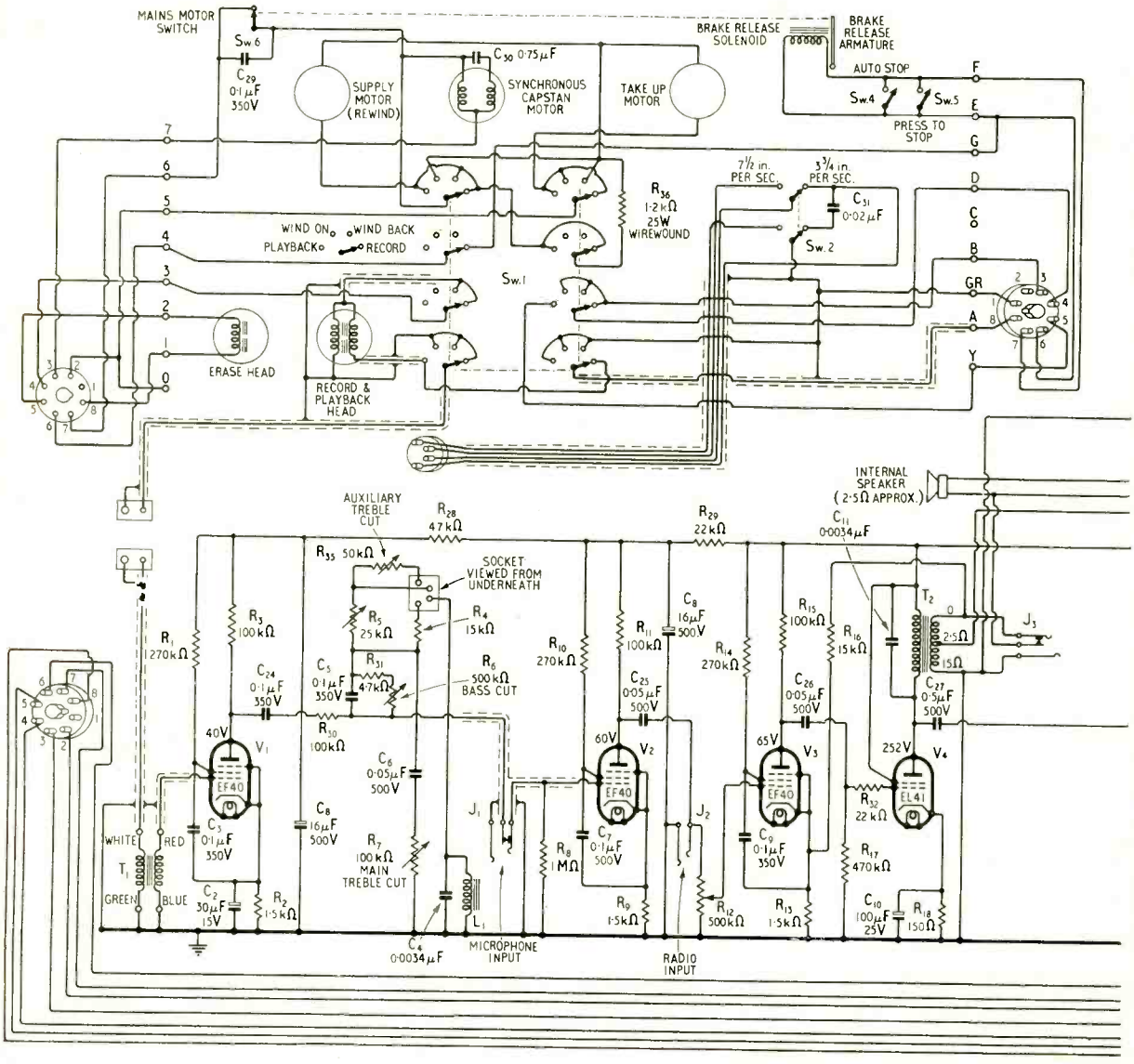
Microphonic effects can be largely avoided by some form of rubber mounting for the first two valves, and the EF40, having low hum, noise and microphony, should be selected as first valve. As always, grid leads should be kept as short as possible and covered screened sleeving will be necessary for the long grid leads in the first stages. Unless the microphone jack is well screened in the chassis a separate screening for this may be necessary. The oscillator circuit should be kept as far removed as possible from the main amplifier section, as 51-kc/s pick-up, especially on the grid leads of the last valves, is prone to occur. Finally, the pre-set variable resistances and potentiometers R_5, R_{21}, R_{25}, R_{33} and the cores of L_2 and L_4 should be readily accessible for adjustment when the equipment is completely assembled.

For the complete testing and setting up of the equipment, the following instruments are necessary:

(1) Audio oscillator having a range of 40 c/s to 55 kc/s, with a pure waveform between 400 and 1,000 c/s.
(2) Valve voltmeter measuring from 0.5 to 50 volts.
(3) Cathode ray oscilloscope.
(4) Universal voltage and current meter.
(5) Distortion meter.

For amateurs who do not possess, or even have access to the latter, a rough estimation of the distortion is possible using the cathode ray oscilloscope and audio oscillator.

Once it has been ascertained that the equipment appears to be working normally, e.g., the motors run when the starting knob is pulled on and the latter "holds in," indicating that the amplifier is drawing h.t. current through the solenoid, the amplifier gain should first be checked at 400 c/s and to do this the following dispositions made. Load the Deck with tape by dropping this through the slot in the head



cover, with the main knob set to "Wind on." Then switch to "Playback"; this will ensure that the automatic stop switch is held open and that the solenoid (which also acts as a choke) is not shorted out. Set the universal meter to measure a.c. volts and connect this, together with a cathode ray oscilloscope, to the anode of V4 (pins 3 and 7 on the external feed socket). A small calibrated voltage from the audio oscillator is now required for injection at the various points specified below. If an accurate attenuator is not available, fixed carbon resistors connected as a potential divider can be made to serve.

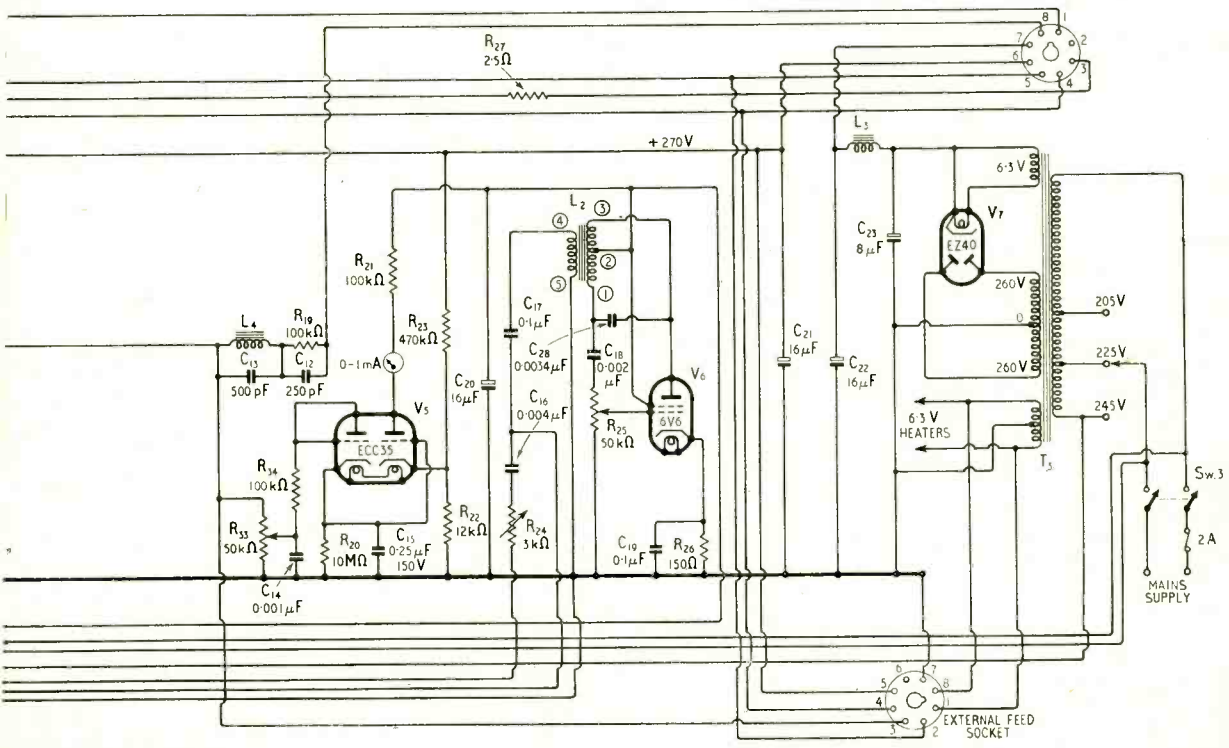
1. Overall gain (primary of T_1), 350,000—450,000.
2. Gain from microphone input (2nd stage jack), 6,000-8,000.
3. Gain from radio input (3rd stage jack), 210-240. An a.c. anode voltage of 150 corresponds roughly to 3W output from an EL41, and the waveform, when viewed on an oscilloscope, should be good up to this figure. To avoid any errors in gain measurement, however, the a.c. voltage at the anode should be kept below 130. It is also convenient now, to make a rough check of the amplifier equalization at $7\frac{1}{2}$ in/sec. With the audio oscillator set to 400 c/s and again connected to the primary of T_1, and with the bass and treble controls at maximum, adjust the volume control to give a reading of 25V on the universal meter, then proceed to check if the equalization corresponds to that shown by the figures given in Table 1. Assuming that the mains and head matching transformers are rotatable, as recommended in Part 2, the next step is to adjust these for minimum hum. Leaving the meter and oscilloscope connected as before, set the volume and bass controls to maximum and the treble control to minimum and proceed to find the best position for the transformers. If the best position with the motors running results in an increase in hum when they are stopped, this means that hum is being "bucked out," and whilst a small amount of this "bucking" is permissible a large amount is undesirable and indicative of poor layout.

TABLE I

FREQUENCY (c/s)	A.C. volts at ANODE	
	7.5in/sec	3.75in/sec
60	>75	>75
400	Set to 25	Set to 25
2,000	Set to 12 (R_6)	15–17
Top peaked frequency (10kc/s/12kc/s)	>52	>35

The waveforms seen on the oscilloscope will prove a useful guide to what is happening, and a slight tilting of the Mumetal "wing" on the head pressure pad arm will sometimes prove of assistance. In the final analysis, hum should certainly not exceed 1.5 volts with the motors running. This, of course, is not the figure which will apply in estimating the signal/noise

Fig. 7. Complete circuit diagram of Wearite Tape Deck and recommended associated electronic equipment. Unless otherwise stated, fixed resistors are of $\frac{1}{2}$-watt rating. Resistors R_3, R_{11} should be of high-stability type, and R_6, R_7 and R_{12} should be of the log-law type. Capacitors C_4, C_{11}, C_{12} and C_{13} are silvered mica. Coils and transformers to the required specifications are available from Wright and Weaire as follows: L_1 (55mH), Type 727; L_2, Type 579; L_3 (10H), Type 1497; L_4, Type 666; T_1, Type 977; T_2, Type T1428; T_3, Type T1395D. Igranic Type P72 jacks are suitable for J_1, J_2 and J_3. SW_3 is a 250V, 5A toggle switch.



ratio, as with the fully-recorded tape the volume control will require to be set back to avoid overload distortion in the amplifier.

To check the oscillator, turn the volume control to zero and the main switch to "Record," and first set the oscillator frequency to 51 kc/s. This may be done by taking a lead from the grid of V6 to the "Y" plate of the oscilloscope and feeding the full output of the audio oscillator to the "X" plate, the time base being switched off. The frequency of the audio oscillator may then be varied until a stationary ellipse or, alternatively, a Lissajous figure, is seen, indicating that its frequency is the same as, or some known multiple of that of the oscillator in the equipment. Adjust the core of L_2 until the frequency is 51 kc/s. If now a valve voltmeter is also connected to the grid of V6, the grid drive may be adjusted by means of the potentiometer R_{23} to the maximum value possible, without incurring distortion in the figure seen on the oscilloscope. As a rough guide the grid drive will usually be between 10 and 13 volts, with the tap point of the potentiometer approximately 11 kΩ above earth.

The oscillator being now set, the filter coil L_1 should next be tuned. The adjustment is most easily observed at the anode of V4. If the valve voltmeter or the oscilloscope is connected to the h.t. isolated side of C_{27}, and the grid of V4 is earthed to prevent any stray 51 kc/s pick-up partially masking the effect, the core of L_1 may be tuned with an insulated screwdriver to give a minimum reading on the valve voltmeter. With the latter next transferred to terminal strip tags 3 and 1 (earth) on the Deck, the bias volts should now be set to 12 by adjusting R_{24}. This will have a final value of approximately 1,200Ω. Finally, check the erase voltage across the erase head pins; it should be between 28 and 36 volts.

To set the peak recording level to some pre-determined point on the meter, proceed as follows. Reconnect the oscilloscope and the universal meter (a.c. volts) to pins 3 and 7 on the external feed socket and connect the "X" plate of the former to the full output of the audio oscillator, an attenuated output from which should be fed to the microphone jack. Turn the main switch to record and adjust the volume control to give a reading of 12 volts at 400 c/s. Now adjust R_{33} until the recording level meter indicates peak level (a two-thirds deflection is a convenient point to choose for this), and record a short passage at 7½in/sec at this setting. Wind back and then play back with maximum bass and treble. The ellipse which will be seen on the oscilloscope should show about 5 per cent distortion and enough output at maximum volume should be obtained to overload the amplifier and cause "squaring off" of the ellipse at each end. If the ellipse does not show any appreciable distortion, the recording level should be progressively increased (each time re-setting R_{33} to indicate peak level on the meter) until the required result is obtained. On the other hand, if the ellipse has more than 5 per cent distortion at a 12V recording level it is possible that the bias is of the wrong value, and a test for optimum bias should be instituted as follows. Record a 200-c/s note at bias values of 13, 15 and 17 volts, and at a low level of approximately 4V. Playback with all controls fully clockwise (at maximum) and note the output voltage for each different bias recording. The bias setting which gives maximum output is the correct value, and the bias should be finally set to this. It may be found that if a large bias value is required the frequency response will fall away much more quickly at the high frequencies, and if this effect is very severe it may be necessary again to reduce the bias and effect a compromise solution. In most cases, however, a level of between 12 and 14 volts at the anode will be found correct.

The final adjustments may now be made and concern the frequency response. If the circuit diagram (Fig. 7) is examined it will be seen that on the 7.5 in/sec speed an additional variable resistance (R_{35}) is switched across the treble boost inductor L_1. The purpose of this is so to limit the treble response at the top peaked frequency that a flat response with the main tone controls at maximum is obtained, the main treble control acting only as a "cut." At 3.75 in/sec this resistor is switched out and any peak occurring in the response at the top end must be reduced by the main treble control. In addition, when testing the frequency response with pure tones of constant amplitude, the recording level should be kept low to avoid overloading the tape, due to the recording pre-emphasis at the higher audio frequencies. This effect, of course, is not present to the same extent when music and speech are recorded as then an audio "spectrum" is being dealt with, in which the energy content of notes at various frequencies is widely different.

To check the frequency response at 7.5 in/sec connect the valve voltmeter (5-volt range) across a 15-Ω external speaker or equivalent load, plugged into the appropriate jack in the instrument. At a level of roughly 6 volts, record a complete frequency sweep from 60 to 13,000 c/s, pausing at 60, 400, 2,000, 6,000, 9,000, 10,000, 11,000, 12,000 and 13,000 c/s for a few seconds. On playing back, with the volume control set at a convenient deflection on the valve voltmeter, adjust R_5 at 2,000 c/s and R_{35} at the top peaked frequency to give the same output as that obtained at 400 c/s. The response should be within ±3 db from 60 to 10,000 c/s. The same procedure can now be repeated at 3.75 in/sec and any necessary adjustments in value made to R_4 at 2,000 c/s. A response of ±3 db from 60 to 5,000 c/s should be obtained.

(Concluded)

CLUB NEWS

Birmingham.—May meetings of the Slade Radio Society include a lecture on receiver selectivity by G. Nicholson (G3HKC) at 7.45 on May 15th at the Church House, High Street, Erdington. The first of the season's direction-finding contests for the Harcourt Trophy will be held on May 17th. During the month visits will be paid to Elmdon Airport and the Research Department of the Dunlop Rubber Co. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

East Grinstead.—A series of lectures on fault finding are to be given at the weekly meetings of the East Grinstead and District Amateur Radio Club, which are held on Thursdays at 7.30 at Portland Hall, Portland Road, East Grinstead. The club also holds regular morse instruction classes. Sec.: L. E. Miller, 30, Forest View Road, East Grinstead, Sussex.

Manchester.—The title of the Amateur Radio Society of the Faculty of Technology of Manchester University has been modified in view of the wider interests now covered and is to be known as the Faculty of Technology Radio and Electronics Society. The present secretary is P. J. Green, Manchester University, Sackville Street, Manchester, I.

B.A.T.C.—Five members of the British Amateur Television Club now hold television transmitting licences. A demonstration of a home-constructed 3-colour camera was given at the Ross-on-Wye Hobbies Exhibition on April 11th. Demonstrations are also planned for Dagenham, Manchester and Ely. Sec.: M. W. S. Barlow (G3CVO), Cheyne Cottage, Dukes Wood Drive, Gerrards Cross, Bucks.

Sensitive Two-Valve Receiver

High Gain Detector Directly Coupled to Small Output Valve with Negative Feedback

By H. E. STYLES, B.Sc.

THE author has, for some time, quite successfully employed a two-valve receiver based upon the "midget" design of S. W. Amos[1] but the necessity of using some form of aerial with this set is considered to detract somewhat from its value as a portable instrument. The three-valve version of the same receiver[2] would no doubt be free from this drawback, but an article by W. K. Volkers[3] dealing with the characteristics of pentodes operated with abnormally low screen potentials suggested that the difficulty might be overcome without recourse to an additional valve.

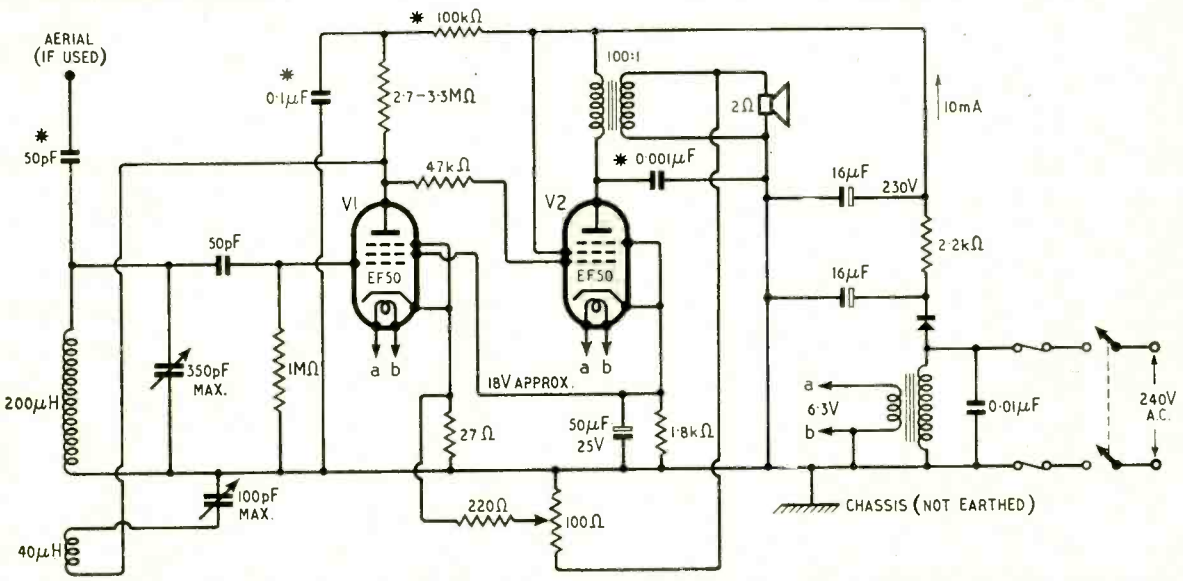
Experiments have been made to investigate this possibility and results obtained have far exceeded expectations. A receiver employing the circuit shown in the accompanying diagram has proved capable of receiving, in the Harrow district, not only the "Home" and "Light" programmes of the B.B.C. but also a number of continental stations, at good loudspeaker strength, using no more than the internal wiring of the set for signal pickup. Moreover, the circuit also permits the elimination of a number of components normally required, thus cheapening its cost.

[1] "Midget A.C. Mains Receiver" by S. W. Amos—*Wireless World*, March, 1949.
[2] "Midget Three-Valve A.C. Mains Receiver" by S. W. Amos—*Wireless World*, February, 1950.
[3] "Direct-Coupled Amplifier Starvation Circuits" by Walter K. Volkers—*Electronics*, March, 1951.

Circuit Design.—The essential feature of the circuit lies in the employment, as detector, of a pentode (EF 50) operated with a low screen potential and an unusually high value of anode load resistance. Under such conditions, the internal resistance of the valve is increased to a greater extent than its mutual conductance is diminished with the result that the amplification factor of the valve becomes very considerably enhanced. The high anode load resistance enables a considerable proportion of this enhanced amplification to be made available externally with the nett result that a very high stage gain can be obtained.

Several other advantages accrue from such conditions of operation. The anode current of the valve becomes reduced to a very small value as also does its anode potential. The latter enables direct coupling to the following stage to be employed without encountering the disadvantages normally attendant upon such method of inter-valve coupling. An economy of components thereby results from elimination of the usual coupling capacitor and grid leak, whilst removal of a possible source of phase change diminishes risk of instability arising from negative feedback.

With direct coupling, it is, of course, necessary to ensure that the cathode of the following valve is at a potential sufficiently above that of the anode of the first stage to provide an appropriate negative difference



*Circuit diagram of the receiver. Resistors can be ½W and capacitors 350V d.c. working. The 0·01-μF capacitor across the mains input must be capable of continuous operation at 250V a.c. Components marked thus * may be omitted for "local" reception. The cathode resistor for V_2 must be adjusted to fix the h.t. current at 10 mA.*

of potential between the grid and cathode of the second stage. Using an EF50 pentode for the latter, requiring a grid bias of only a volt or two, it follows that its cathode potential needs only to be maintained slightly above that of the anode of the preceding valve and such a potential proves to be quite suitable for the screen of the latter. It is, therefore, possible to connect the screen of the detector valve directly to the cathode of the output stage the potential of which is maintained steady by the normal bypass capacitor. The necessity for the usual detector screen resistor and capacitor is thereby obviated.

Connection of the detector screen to the cathode of the following valve serves also to provide automatic compensation for variations in supply voltages and valve characteristics. If for any reason the anode voltage of the detector increases, so also does that of the grid following valve. The anode current of the latter therefore rises causing a corresponding increase in cathode potential which, in turn, results in an increase of potential at the screen of the detector. The anode current of the latter is thereby increased with the result that the anode potential of the detector becomes reduced thus offsetting the rise in potential assumed to have initiated the changes outlined. The circuit thus provides a high degree of negative feedback so far as steady potentials are concerned, but this does not apply to alternating potentials which are bypassed by the capacitor in the cathode of the output stage.

The employment of an anode load resistance of the order of megohms necessitates avoidance, as far as possible, of shunt capacitance in order to obviate undue attenuation of high audio frequencies. Compensation for such loss can, however, be achieved by application of adequate negative feedback and a more serious difficulty arises from the need to ensure a sufficiency of radio frequency power output from the detector to enable satisfactory reaction effects to be obtained. This, rather than audio frequency attenuation, appears in practice to set a limit to the maximum value of anode resistance which can be employed.

A value of about three megohms has been found to be acceptable with a high tension supply at some 230 volts. Under these conditions the screen potential needed to ensure an anode potential of the same order proved to be about 18 volts, the anode current then being of the order of 70 micro-amperes. It is evident from the low value of the latter that the radio frequency power available at the detector anode must be severely limited and, to conserve this for reaction purposes, it is necessary to avoid losses as far as possible. In particular, the shunting effect of the input capacitance of the following valve must be minimized, whilst the use of normal radio frequency filtering in the detector anode circuit is precluded.

A series resistance of 50 kΩ in the grid circuit of the output valve provides a satisfactory solution to both these problems, the input capacitance of the valve then serving to attenuate radio frequency voltages without shunting the detector anode load.

A 1,000-pF capacitor connected between the anode of the output valve and earth serves the dual purpose of bypassing any radio frequency component present in the output and of eliminating excessive shrillness in reproduction when the negative feedback is reduced to zero. This capacitor is, however, by no means essential for stability and could well be omitted if reception of local stations only is desired. In such cases sufficient negative feedback will be required to obviate shrillness and prevent overloading.

By reason of the very small detector anode current, additional smoothing and decoupling for the detector stage can be attained by means of a 100-kΩ resistance and a 0.1-μF capacitor, though here again, these components may be omitted if operation without feedback is not required, as the small amount of hum arising from such omission can readily be eliminated by a moderate degree of negative feedback.

The latter is adjustable from zero to a maximum of about 1/1,000 by means of a potentiometer across the loudspeaker speech coil. The precise resistance of this potentiometer is relatively unimportant provided that it is sufficiently high to prevent any significant reduction of current through the speech coil.

Provision is made for attachment of an additional aerial, if desired, via a 50-pF capacitor connected to the grid end of the tuning coil. For safety reasons, this capacitor must be capable of withstanding the full mains voltage, as also must be the 0.01-μF capacitor shunted across the primary of the mains transformer supplying valve heater current. This capacitor serves to minimize modulation hum which cannot be eliminated by negative feedback. For purely local station reception the aerial series condenser need not be fitted as increased pickup, if required, can be obtained by connecting, internally, a few inches of wire to the grid end of the coil.

Receiver Adjustment.—The only adjustment to circuit values which may prove necessary is that of the cathode resistor of the output valve. This should be checked by measuring the h.t. current of the receiver, which ought to be about 10 mA. If the current is found to be too great the cathode resistor must be increased (and vice versa). A 5-kΩ variable resistor can be used for preliminary adjustment.

Connections to the detector anode and output valve grid should be kept as short as possible to minimize wiring capacitance, whilst reasonable care should be taken to avoid coupling between the detector input and the output from the second valve. No difficulties from instability have been encountered despite the very high overall gain, but acoustic reaction between the loudspeaker and detector valve may be troublesome with certain valves when feedback is reduced to zero. Selection of a suitably non-microphonic valve will obviate any serious difficulty from this cause, but the use of flexible valve mountings would probably help, whilst a sound absorbent shield round the detector valve may also assist. This can safely be applied owing to the low operating temperature of the valve. In any case, a small degree of negative feedback suffices to reduce overall gain to a level at which acoustic reaction is no longer troublesome without unduly reducing the sensitivity of the set.

Volume control can be effected by a combination of reaction and negative feedback, the effect of the latter being very considerable on account of the high gain available at zero setting of the control. Due to the very small signal input required adequate range of volume can be obtained by these means, though admittedly complete silence cannot be achieved without detuning (or switching off!).

The addition of an aerial consisting of 6in to 12in of wire results in astounding sensitivity, but the poor selectivity of the single-circuit tuner prevents full benefit being obtained, and the receiver is quite definitely not suitable for use with an aerial of appreciable size. Modifications to the aerial input circuit and additional screening might alter this position, but such possibilities have not been investigated.

Some Aerial Queries

Explaining How the "odd bit of wire" Fits into Theory

By "CATHODE RAY"

WIRELESS and radio are not necessarily the same thing. Last month I tried to show the difference between induction and radiation. Radio is communication by electromagnetic waves (of greater wavelength than heat), which have to be radiated. But what about the little crystal sets* that N.A.T.O. delegates carry with them, for listening to the speeches in their favourite language while moving around the building? Surely they are wireless? But they do not use radiation to any significant extent; they depend on induction, and their range is thereby limited.

Do you remember the graph (repeated here in Fig. 1) showing how rapidly the induction field strength falls as the distance from the source increases? Radiation, though relatively weak close to the source, can be detected at vastly greater distances because its fall-off is much more gradual. This greater uniformity of distribution is because radiation is an outward movement of electromagnetic energy that has broken loose from the source and has become independent. The energy of induction fields, on the contrary, returns to the source—if it is allowed. Our a.c. generator connected to a resistanceless coil alternately built up a magnetic field and then received the same amount of energy back during the other half-cycle, and (neglecting radiation, as one can at low frequencies) the net energy supplied by the generator per cycle was nil. But as the frequency is raised the time taken to build up and pull down the more distant parts of the field begins to amount to an appreciable phase shift, and the result is that more power goes out than comes back. This power is radiated, and some may happen to fall on a receiving aerial and do work in the receiver. But the sender wouldn't know about that, for it has lost touch with the radiated energy. The receiver, if beyond the effective induction zone close to the sender, is too far away to react on it.

Then what works the N.A.T.O. receivers, if all the induction energy returns to the source? Well, I said it all returns *if it is allowed*. But if a circuit—or a sheet of metal, or anything in which current can be induced—is coupled to the source (which is another way of saying it is within the induction-field or near zone) the currents so induced react on the source in such a phase as to cause less energy per cycle to return than went out. That energy is what is used up in the coupled circuit. An ordinary mains transformer is an extreme example, in which the coupling is very close. If the secondary coil is open-circuited, no current can be induced in it, so no energy is withdrawn from the primary (other than the small amount needed to cover incidental losses). But if the secondary is connected to a low resistance a heavy current flows through it, and this induces a current in the primary in phase with the applied voltage, so that the net result is practically the same as if a resistance load had been connected directly across the primary; energy is drawn from the mains. In the N.A.T.O. headquarters the coupling is very loose, so it makes little difference to the fixed primary coils when a receiver is brought in; nevertheless it does make some difference or the receiver wouldn't work.

Another thing to recall from last month is that the range at which the near or induction zone ends and the distant or radiation zone begins—the range at which induction and radiation fields are equally strong, marked by the intersection of the lines in Fig. 1 — is $\lambda/2\pi$, roughly one-sixth of the wavelength. The wavelength of Droitwich, 1,500 metres, is 4,910 feet, so $\lambda/2\pi$ is 780 feet. Now all but a very little of the total field energy of a circuit is within a radius not many times greater than the dimensions of the circuit. So if the source of a 1,500-metre field (f=200 kc/s) is a

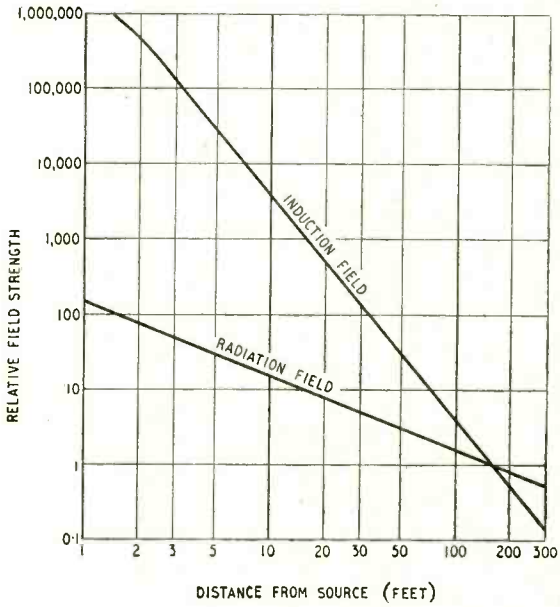


Fig. 1. Repeat of last month's graph showing how the radiation field strength, though weak compared with the induction field close to the source, falls off less steeply, and beyond $\lambda/2\pi$ is stronger than the induction. This particular graph refers to a 1-foot coil carrying 1 Mc/s current.

* *Wireless World*, February 1953, p. 69.

coil about an inch in diameter, the field strength 780 feet away is for most purposes negligible. Which means that the radiation is negligible. But if the 200-kc/s current were made to flow through a loop several hundred feet in diameter, the field 780 feet away would be quite considerable, and as half of it would be radiation field the radiation would be considerable.

If the same loop were fed with a 50-c/s current, for which λ is 6,000,000 metres or 19,700,000 feet, and $\lambda/2\pi$ is therefore 3,130,000 feet, and one compares this with the size of the loop, it is obvious that the radiation would be negligible. Yet even the 1-inch coil would be a good radiator if fed at 1,000 Mc/s, for at that frequency $\lambda/2\pi$ is less than 2 inches.

So we see that whether a circuit is a good radiator or not—in other words, whether it is an effective sending aerial or not—does not depend either on its size or on the frequency (or wavelength) alone, but on the ratio of size to wavelength. If the size is very small compared with the wavelength, then it cannot be a good aerial. If it is comparable with the wavelength —say at least one-tenth—then it *might* be a good aerial. But one has to take account of its shape, too. A parallel-wire feeder may be as long as you like, but it cannot radiate effectively if the spacing between the wires is very small compared with the wavelength, because the external field set up by one wire is nearly cancelled out by the opposite field due to the current in the other. It is only between the wires that the field can be really strong. The main purpose of a feeder is to transmit energy from one end to the other with as little loss as possible, and for this purpose energy radiated is energy lost. So the spacing must be kept very small compared with the wavelength; the shorter the wavelength the closer the spacing. The main purpose of a sending aerial being radiation, the spacing should be as large as possible. The limit is reached when the wires extend away from one another in opposite directions. A particularly good result is obtained when the length of each wire is quarter of a wavelength, as in Fig. 2. This is so not only because the $\lambda/2\pi$ distance is well within the strong part of the field, but also because the capacitance between the two wires resonates with their inductance so that a given generator e.m.f. causes maximum current to flow and builds up maximum voltage at the ends. The resulting magnetic and electric fields not only spread out well into the surrounding space but are at maximum strength.

This aerial, of course, is the well-known half-wave dipole, seen on countless roof-tops. What is good for sending is good for receiving. Resonance helps both, of course. And the e.m.f. induced is proportional to the length.

Length of the Aerial

You may ask, then, why stop at *half* a wavelength ? Resonance is obtainable at greater lengths—multiples of half a wavelength. And in fact such lengths are sometimes used, but there are results of the extra length that are not always welcome. Even at television wavelengths, λ/π is (for London) about 12 feet, which feels a good deal longer when you are actually handling the aerial than when you are surveying it from the ground. Some local councils at least seem apprehensive about the possible results of attaching it to their houses. At the longer broadcasting wavelengths the question of exceeding the half-wavelength hardly arises. Droitwich's wavelength, as we have already noticed, is 4,910 feet, and even half of this would take some accommodating in or on the typical suburban dwelling. And I have not yet mentioned that ideally it ought to be far removed from any other objects, such as the earth !

So it is only for quite short waves that even a half-wave aerial is practicable. For very short waves one can consider full-wave or longer aerials, but then another effect comes in, which may or may not be desirable. I am not going into it in detail, because it is really a subject in itself, and I did deal with it some years ago—actually September, 1946. It is the directional effect caused by the combining of radiation from different parts of the aerial. With the simple half-wave dipole, all of it works to give maximum radiation all around its "equator"; that is to say, a vertical dipole is most effective in all horizontal directions. But with a full-wave dipole the radiation in these directions due to one half is cancelled out by the other half. Maximum radiation occurs at an angle upwards and downwards. (The same goes for reception as well as radiation.) Of course, if you want to shoot your radiation up at that particular angle, then the full-wave dipole is the thing. But if not, not.

The Ideal and the Practical

The question I want to deal with now is the relationship between this apparently ideal dipole aerial which we have arrived at (though not very rigorously, I fear!) by theory, and the sorts used for ordinary "steam" radio. Judging from inquiries received, the connection is not obvious to all.

Let us start with the half-wave dipole, having a receiver coupled to its middle. For all-round reception it is both simple and good, provided that the wavelength is short enough for its installation to be a practical proposition. On medium or long waves results would be magnificent—and they would have to be, to be worth suspending hundreds or thousands of feet of dipole high above the earth! The problem of high suspension can be completely avoided, and the problem of length halved, by substituting the earth for the lower half of the dipole (Fig. 3). This dodge also solves another difficulty, by bringing the receiver to a more convenient spot. Actually, I shouldn't call it a dodge, because it is a perfectly respectable device, with a scientific proof and all that. Just as half a dipole standing on a mirror *looks* very like a whole dipole, so half a dipole standing on a perfectly conducting earth radiates or receives very like a whole dipole.

There are still two difficulties left. One is that the length has to be quarter of the wavelength of the station to be received (if one insists on working it at its best), and the other is that it is still too long anyway. Having had enough of the Home Service on 330 metres, for which a 270-foot vertical wire would be right, can one imagine oneself extending it to 1,230 feet to tune in the Light Programme? One solution of these difficulties is to use the tallest aerial that can conveniently be managed, and tune it to resonance by means of inductance and/or capacitance inserted between it and earth. In practice this means that for medium or long waves the aerial is much shorter than a quarter-wavelength, so it is much less effective as a picker-up—or a radiator. Another solution, and the one in general use nowadays, is not even to bother to tune the aerial. So reception is worse

still. And since the radio trade has for years encouraged the public to believe that a receiver that needs any visible aerial at all—other than perhaps the odd bit of wire around the picture rail—must be a poor specimen, there should be little difficulty in understanding why broadcast reception is so often bad. When people bring me their complaints about it, nine times out of ten I know the answer before they have told me the symptoms—"Use an outdoor aerial." The "bit of wire"—and still more the mains connection on which so many rely—is not only bad at picking up radio transmissions because its vertical length is only a fraction of optimum, and because it is probably untuned, and because there are no precautions against r.f. losses, and because it is inside a house which does a considerable deal of screening, but it is an excellent picker-up of undesired noises, because it is close to their sources and may even be directly connected to them.

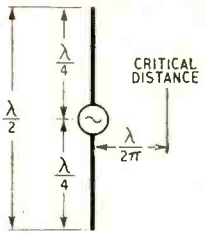
Reverting to television dipoles: the fact that the Pontop Pike and Glencairn transmissions need horizontal ones, in contrast to the vertical types that have been associated with the B.B.C. ever since 1935, brings before a wider public the matter of polarization. If the sending aerial is vertical, then its electric field is vertical, as a result of the difference of potential between top and bottom ends. The magnetic field is horizontal, as a result of the current flowing up and down. The polarization of the waves is their field direction, and in this case could be called either vertical or horizontal according to whether one had in mind the electric field or the magnetic field. One can't *see* either, so it is a great help that the electric field was chosen for naming the polarization, since it is the same as the aerial that one *can* see.

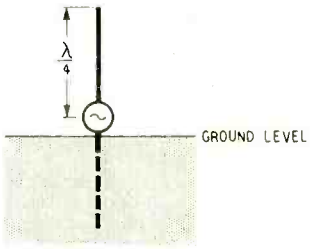
Reception is best when the receiving aerial is parallel to the sending aerial, and theoretically is nil when it is at right angles. That, of course, is why the low-power B.B.C. senders, working on the same wavelengths as the high-power ones, are differently polarized—to avoid interference. In practice, however, the waves undergo a certain amount of reflection and general pushing around *en route*, and seldom arrive with exactly the polarization with which they started. So maximum may be a little off perfect parallel, and minimum is unlikely to be quite nil.

Role of the Horizontal Top

That is part of the explanation of what some people find rather puzzling—that the ordinary all-wave domestic aerial is quite effective, even when it consists of a horizontal wire stretched from an upper window to a tree in the garden. Although the sender may radiate vertically polarized waves, by the time they reach the receiver they are more than likely to have an appreciable horizontal component. Another part of the explanation is that if the receiver is on an upper floor it receives the vertical component of the waves on its earth lead or the equivalent. Another aspect of this matter is that a horizontal top to an otherwise vertical aerial—the familiar domestic ⌐ type—does help even in a perfectly vertical field. It concerns what is known as effective height. The meaning of this can perhaps be better grasped with reference to a sending aerial. Suppose it consists of a vertical wire 100 feet high. The maximum current occurs at the lower end, because it has to charge the entire aerial. Half-way up, the current is less, because it has only the upper half of the wire to charge. And

Right: Fig. 2. The critical distance, $\lambda/2\pi$, being less than quarter of a wavelength, is relatively close up to a half-wave dipole, so the radiation field is far stronger than from a source that is small compared with the wavelength.





Left: Fig. 3. A dipole is still effective if the lower half is replaced by a conducting plane. The earth is a fair approximation to this.

the current tails off to nothing at the top. Clearly this aerial does not radiate as much as an imaginary aerial of the same height carrying the maximum current (which is what is delivered by the sender) all the way up. If the height of the imaginary aerial were reduced until its radiation was equal to that of the real aerial, its height would be the "effective height" of the real aerial. The effective height of the 100-foot vertical aerial, if operated as in Fig. 3, is something like 63 feet. Under more usual conditions it is nearer 50.

Now it is very much cheaper to erect an aerial 50 feet high, or even 63, than one 100 feet high, so anything that can be done to persuade the current to remain at nearer full strength all the way up is likely to save money. Horizontal extensions of the wire are less costly than vertical, and although they do not add directly to the vertically polarized radiation they do add to the capacitance of the aerial so that the vertical part is more like the ideal uniform-current aerial. In other words, the horizontal top increases the effective height.

There is a fable about a visitor who was regarded by his superstitious host with dismay because he could blow both hot and cold—hot to thaw his chilled fingers and cold to cool his soup. It is like that with television aerials; students are sometimes mystified because the unconnected dipole in an "H" can be used as a reflector, suppressing reception from the direction towards which it is mounted, or as a director which does exactly the opposite.

Of course both dipoles have currents induced in them by the incoming waves, so each affects the other. We are not so much interested in what the receiving dipole (A) does to the unconnected one (B) as what B does to A. Unlike A, B has no receiver to draw off the received power; almost its only resistance is radiation resistance, so most of the power it receives is re-radiated. The net signal received by A is made up of what it gets direct from the sender and what it gets indirectly from B. Whether it is greater or less than what it would be if B were not there depends on the phase difference. If the two lots are in phase, then obviously the net effect is stronger reception; and vice versa.

Now the phase difference is caused by two things: the spacing between A and B (in terms of wavelength), and the reactance of B. The part due to spacing is easy to find; the phase angle can be measured with

a metre scale, if we know the wavelength. For the wavelength is simply the distance the wave travels during one cycle. So quarter of a wavelength ($\lambda/4$) is the distance travelled during quarter of a cycle, or 90°. The phase angle of the dipole itself is more tricky, because it is affected not only by its length (again, in terms of wavelength), but also to some extent by its thickness, and certainly by the other dipole. The length is, however, the main factor. When it is about $\lambda/2$—actually a little less—the dipole is in tune and its reactance is zero. Just as with an ordinary tuning circuit, the reactance and phase angle change very rapidly each side of resonance, so the length is quite critical. And that is the main reason why the effect of B can be reversed by making it, say, a little shorter instead of a little longer. And it also explains why reflector spacing varies considerably with different makes of aerial; one manufacturer may like to reduce the spacing and bring the phase angle right by a slight alteration to the length of the reflector. Although the change may leave the phase difference as before, the performance is altered in other respects by the closer coupling. It depends on whether he is aiming at maximum reinforcement of signals from one direction, or the most complete elimination of interference from another.

So many factors come into it that the whole thing is too complicated to attempt here, but I shall just show roughly how it is that an H aerial discriminates between waves coming from different directions. For simplicity let us assume that the spacing is $\lambda/4$ and

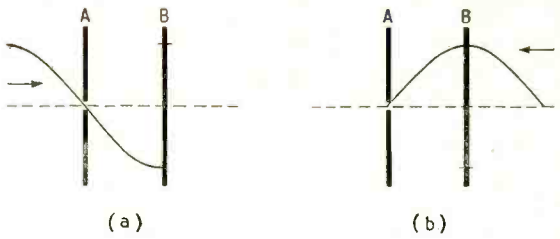


Fig. 4. A rough explanation of how an unconnected reflector dipole B enables a receiving dipole A to tell the difference between left and right. It is assumed that the re-radiation from B is 180° out of phase with the incident wave.

that the re-radiated wave from B is 180° out of phase with the wave flowing past it. Then Fig. 4 (a) depicts the situation at an instant when wave coming in from the left is passing through zero at A and is at negative peak at B. The re-radiated wave from B is therefore at positive peak. Quarter of a cycle later, the incoming wave has reached its positive peak at A, and the positive peak from B arriving simultaneously reinforces it. The result is a gain. Now consider a wave coming from the right (b), again at the instant when it is zero at A and about to become positive. At B the phase is peak positive, so the re-radiation is peak negative, and in quarter of a cycle these two will have arrived at A simultaneously. So the effect of B is all loss.

VICTORIAN WIRELESS ENGINEER

THERE were not many wireless engineers in Queen Victoria's days, and still fewer who dated back to the 19th-century part of the reign. One of that select band was Andrew Gray, formally chief engineer of the Marconi Co., whose recent death at the age of 80 we record with regret. Andrew Gray, who joined the Marconi Company in 1899 (two years after its formation), was sent by Marconi at the turn of the century to install the world's first public telegraph service—between the islands of the Hawaiian group.

In 1901 he was appointed chief-of-staff of the company and was put in charge of both the training of engineers and the organization of the Marine Company's ship-shore installations. He was appointed chief engineer in 1910 and in 1928 became technical general manager.

G. M. Wright, the present engineer-in-chief of Marconi's, writes:—

It is indeed sad to hear of the severing of another link with the early days of wireless by the death of Andrew Gray, who worked for some years as a personal assistant to Marconi. He had previously served with the West India and Panama Telegraph Company as chief electrician and so brought to the rapidly developing art of wireless communication an invaluable background of practical telegraph experience.

The time of his early work saw the development of wireless in the form of ship installations, coast stations, and later high-power point-to-point telegraph services, in all of which he played a most important part.

The late Andrew Gray.

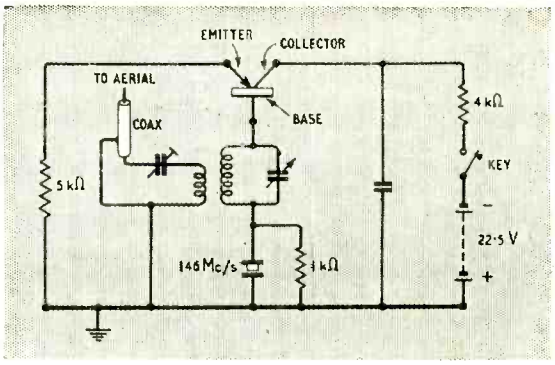
One of his major contributions was the design of a steel mast which could be pressed in sections, easily transported and erected, under supervision, by local labour. These masts were erected in all parts of the world and became the familiar landmark of a Marconi station. When the new Marconi works was built at Chelmsford two Gray masts 450 feet high were erected on the site and gave invaluable help to the company's research work.

Andrew Gray had that rare combination of qualities which goes to make the great engineer. He had a deep knowledge of his specialized branch of engineering, supported by a wide general technical background. Above all, he possessed the virtue of common-sense. He took deep interest in research and experiment and encouraged research engineers by his personal advice in discussions of their problems. In the period from the end of the first war until his retirement in 1932 he paid a visit at least once a week to the company's research department in order to keep in close touch with all that was going on, and to discuss problems.

He was a man of a most lovable character and his staff always took their personal troubles to him and never left without advice and help. Those who knew and worked with him will learn of his death with a deep sense of personal loss, and regret that he is no longer with us.

Transistor Transmitter

A Peep into the Future



Circuit of the crystal-controlled transistor transmitter described in the text.

WHEN it became known that a transistor could be made to oscillate, somebody, somewhere at sometime was bound to have an urge to try one in a radio transmitter. It is perhaps in keeping with the inquisitive spirit of amateurs that the first authenticated transmission using this device should be effected by an amateur, or more strictly speaking from an amateur-operated station.[1]

In the present state of transistor development only a privileged few have access to the kind of transistor likely to be any use in a radio transmitter and the author of the experiment[2] is fortunate in having access to some unusual types of transistor.

First mention of this transmitter was made in *QST* of February, 1953, and a description of the transmitter appeared the following month. It should be realized that the transistor transmitter is as yet a long way away, but it is technically interesting to know that this new device has distinct possibilities in the transmitting field, although no doubt limited to quite low-power work in the initial stages.

The two-metre band was chosen for this first transmission experiment for several reasons; first an exceptionally good aerial was available at K2AH for the 146-Mc/s band and secondly transistors were not supposed to be capable of stable oscillation at such a high frequency, although in the R.C.A. laboratories some special ones had been put together that behaved rationally as oscillators up to and above 300 Mc/s[3].

The circuit of the transistor transmitter is shown in Fig. 1. It is a simple keyed oscillator with crystal control and is what the author describes as basically a Colpitts. The quartz crystal is used in an unusual way, being employed as a frequency-selective by-pass element in series with the tuned circuit.

Quartz crystals can be used either as high- or low-impedance elements depending on the circuit in which they are employed and while the resonant frequencies of the two conditions are different the difference is so slight as to be almost indistinguishable and for all practical purposes they may be taken as one and the same frequency.

In this case the low-impedance or series mode[5, 6] is used and at the operating frequency the 1-kΩ resistor in series with the tuned circuit is by-passed by the crystal and the circuit oscillates. At any other closely related frequency the crystal exhibits a high impedance and oscillation does not occur.

An interesting sidelight on this experiment is that the crystal which is a 16-Mc/s unit intended for use on its 5th overtone (80 Mc/s) gave solid control of oscillation on its 9th overtone, 144 Mc/s.

Operating power for the transmitter was obtained from a miniature hearing-aid battery of 22½ volts, but the series resistors dropped the actual voltage at the transistor to about 8, which with a current of about 3 mA fixed the input power to the oscillator at 24 milliwatts. Of this an estimated 50 microwatts only reached the aerial.

Despite this low output communication was established with several amateur stations by c.w. at ranges up to 25 miles, which was by no means the possible limit, since signals were reported at RST559. An S5 signal is a good solid one and readable through quite a lot of interference, while the T9 report signifies a perfectly steady keyed note free from ripple or "chirp."

If a modulator with an output small enough to modulate the extremely low-power oscillator had been available the author of the experiment was quite confident that no difficulty would have been experienced in effecting R/T communication.

For this experiment the transistor used was one of the point-contact type. It is a current-controlled device whereas the thermionic valve is voltage controlled so that transistor circuitry will always be quite different from the more familiar valve technique, as this simple transmitter exemplifies.

[1] U.S. Amateur station K2AH operated by G. M. Rose.
[2] R.C.A. Tube Department, U.S.A.
[3] "Transistors Oscillate at 300 Megacycles," *Electronics*, November, 1952.
[5] "Series Resonant Crystal Oscillators," *Wireless Engineer*, June, 1946.
[6] "Series Mode Crystal Oscillators," *Wireless World*, July, 1952.

An Aural Anomaly

Is the Ear a "Pressure-operated Device"?

MEASUREMENTS involving the subjective assessment of sound levels have long been bedevilled by a curious discrepancy between the results obtained with earphones and those in which the sound is judged under normal conditions of hearing in a free field provided by a loudspeaker at some distance from the observer. To begin with, it was found that the minimum threshold curve obtained with earphones was higher than that given by direct listening; later, suspicion fell on the validity of earphone calibrations involving adjustment of loudness to equality with free fields of known strengths.

Experiments with probe-tube microphones, inserted in the ear canal to measure the sound pressure adjacent to the ear drum, have confirmed that when the loudness of, say, a 100-c/s tone from a closely fitting earphone is

judged to be equal to that of the same tone coming from a loudspeaker, the pressure at the eardrum is of the order of 6db higher. Alternatively, for equal sound pressure at the eardrum, the loudspeaker sounds the louder.

Like all our senses, hearing is governed not by precise physical laws, but by general relationships derived from the average of many measurements on individuals. The responses of individuals are themselves by no means fixed, but vary with age, health and the acoustic environment. However, for the short period of time required for a change-over, it seems reasonable to assume constant sensitivity of the ear, and that equal pressures will produce equal sensation, irrespective of the origin of the pressure at the end of the ear canal. At frequencies of the order of kilocycles per second, where the wavelengths of sound are comparable with the dimensions of the ear canal, discrepancies in physical measurements might be expected from resonance and standing wave effects, but not at 100 c/s where the wavelength is 11 feet.

Possible Causes

A recent investigation* at Bell Telephone Laboratories by W. A. Munson and F. M. Wiener clears the air, but does not completely resolve the mystery. After repeating earlier experiments to make sure that the pressure measurements were not in error, the possibility that increase of static pressure on the ear drum might be the cause of change of sensitivity was investigated. A good seal between the outer ear and the earphone pad is important when measurements are involved, and under these conditions an increase in pressure between the outer and middle ears is to be expected as the result of rise of temperature. It is known that such a pressure difference causes a diminution of sensitivity, and evidence from experiments on animals points to a figure of 5 mm of mercury for the pressure required to effect a reduction of 8db in the potentials developed in the cochlea. But under normal conditions the pressure rise after applying an earpiece is found to be less than 1 mm/Hg; so pressure difference, though possibly contributory, is not decisive in explaining the loss of loudness.

Another possible physiological cause is the involuntary contraction of muscles in the middle ear, when sensitive areas of the outer ear are touched. This can cause significant attenuations and is known to affect low frequencies more than high. If this is the root cause of the discrepancy, equal loudness for equal pressures should be found when the comparison is made with the middle ear muscles also contracted when listening to the loudspeaker. Three methods were used by Munson and Wiener to this end; dummy earphones with normal pads, but with an aperture in place of the receiver, and unilateral stimulations of the opposite ear, either by plugging or by a 6-kc/s tone, 100db above the 100-c/s test tone level, the assumption being that, by the known principle of bilateral action in man, the muscles of the opposite ear would also contract. All three experiments produced negative results—the 6db difference in loudness still persisted.

The possibility of sound reaching the inner ear by paths other than through the ear drum and ossicles was considered, but it was concluded that the indirect sound amplitude resulting from, say, head vibration would have to be at least half that arriving through the normal channel to account for the observed difference, and that such indirect amplitudes were unlikely.

A difference in harmonic content between the two sources was also considered, and it was noted that the tone from the earphone appeared to be less pure than that from the loudspeaker; but measurements failed to reveal any difference sufficient to affect the apparent loudness. In any case the effect would be to increase the loudness of the earphone tone rather than to decrease it.

One other possibility is listed by the authors, but was not investigated, namely, that the seat of the loudness decrease is in the central nervous system. Having regard to the thoroughness with which the initial physical conditions were investigated it seems reasonable to assume that the discrepancy arises further along the chain of auditory perception; but a rational explanation must await more conclusive evidence of the exact mechanism by which we appreciate loudness. Work so far carried out has shown that there is no simple relationship between the cochlea potentials and the patterns of stimulation in the cerebral cortex by which we recognize the qualities of sound.

It seems likely that unsuspected trace stimuli could easily falsify the cerebral pattern, and what more probable than that the acuity of hearing under artificial binaural conditions from headphones is at a disadvantage compared with the more practised and experienced function of normal hearing in a free sound field.

In the paper referred to, it is not always clear when the experiments are monaural or binaural, but one experiment is of more than usual significance. Instead of removing the earpieces when listening to the free field, they were left on the head and the sound was allowed to reach the ears by leakage under the caps or by any other available path. In this experiment, to quote the authors, " . . . we hit the jackpot. Our tests showed no significant difference between pressures in the ear canal for equality of loudness of tones from the receivers and from the sound field."

But in this experiment the "binaural" conditions of listening to the free field were quite different from the untrammelled normal use of the two ears, and it seems reasonable to suggest that if means could be found of simulating true free-field binaural listening with tones originally only in the close-fitting headphones the pressure difference anomaly might disapper. But how to be sure that no trace element of falsehood remains to be detected by the highly developed analytical powers of the cortex?

Until the anomaly is resolved we can but endorse the authors' warning that "the calibration and use of receivers will be subject to an element of uncertainty that is very real and annoying." F. L. D.

* "In Search of the Missing 6db," *J. Acous. Soc. Amer.*, Vol. 24, No 3, Sept., 1952, p. 498.

NEW R.I.C. SPECIFICATION

Component Standard for Rotary Wire-wound Resistors

VARIABLE wire-wound resistors of the rotary type form the subject of a new components specification, RIC/121, issued by the Radio Industry Council, 59, Russell Square, London, W.C.1.

Like the other specifications in this series it is divided into three sections dealing with performance requirements, production tests and a schedule of types, values and sizes, and classifies the component into red, yellow and green groups according to the climatic conditions under which it is intended to be used. The latest specification consists of sections 1 and 2 only and section 3 will follow later.

It is laid down that resistance values should conform to the series 1, 2, 5, 10, etc., and tolerances should be ±5 or ±10 per cent. The specification covers resistors ranging from 0.5 watt to 80 watts and for working voltages of 350, 500 and 1,000 d.c.

This specification has been produced by agreement between B.R.E.M.A., R.C.E.E.A. and R.E.C.M.F., whose individual contributions to the subject have been coordinated by the Technical Specification Committee of the R.I.C. For the present it is intended for use within the radio and electronics industry, but it will be submitted in due course to the British Standards Institution for incorporation in a B.S. specification.

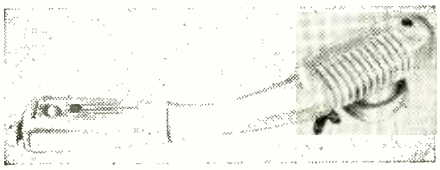
Copies of sections 1 and 2 (together) of this specification are obtainable from the R.I.C. at a charge of 5s post free. The cost of section 3 will be announced when it is available.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

New Crystal Pickups

TWO new crystal pickups have been introduced under the name "Studio" by Collaro, Ltd., Ripple Works, By-Pass Road, Barking, Essex. Both are turnover types with



Collaro "Studio" crystal pickups.

adjustable needle-point pressures and it is claimed that they will track with pressures as low as 7½gm for 78 r.p.m. and 3gm for 33⅓ r.p.m. records. Type "O," for use with normal radio receivers, has internal compensation for bass response and gives an output of the order of 0.6 V at 1,000 c/s. Type "P" has a constant-velocity type of response and is suitable for amplifiers with tone compensation and higher overall amplification. The output is 0.15 V at 1,000 c/s.

The crystals are protected from moisture and a guarantee is given for use under tropical conditions. Both types are mounted in tone arms with ball-bearing pivots, and the price of either type is £4 0s 6d (including tax). Cartridges are available separately at £2 6s (including tax).

Miniature Hearing Aid

MADE by a printed-circuit technique using silver on a ceramic base, the new "Telepak" hearing aid introduced by Bonochord, Ltd., 48, Welbeck Street, London, W.1, is housed in a polished plastic case which reduces noise arising from clothing friction, and measures 3½in × 2½in × ¾in (weight, including batteries, 4½oz).

Volume and frequency-response characteristics are adjustable to individual requirements, and the maximum air-to-air gain is 60db.

An interesting feature is the provision of an induction pick-up attachment which can be used on a telephone instrument without direct connection, or for amplifying radio or television sound programmes if a single turn loop from the low-impedance output circuit of the set is installed round the listening-room. The price of the "Telepak" is £28 7s.

Record Player

DESIGNED to play all normal and long-playing records, the Philips Model 424A "Disc Jockey" is contained in a case 13in × 11¼in × 4½in and weighs 7lb. It has a three-speed motor suitable for 110-V and 200-250-V, 50 c/s mains. The pick-up is of the double-stylus type and functions with a weight of ¼ oz at the point. As the total weight of the tone arm is only 3/5 oz, counterbalancing is unnecessary and the low mass ensures stability and freedom from groove-jumping on warped or eccentric records. An automatic stop switch for all types of run-off groove is provided.

The price is £11 11s (including tax) and the makers are Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Bonochord "Telepak" hearing aid.

Philips Model 424A record player.

RANDOM RADIATIONS

By "DIALLIST"

Components Show

THE R.E.C.M.F. SHOW or, to give its full title, the exhibition of British components, valves and test gear, organized by the Radio and Electronic Component Manufacturers' Federation, is a private show, with admission by invitation only. It is, of course, a miniature affair in comparison with the national radio exhibition; and that very fact gives it an intimacy which, to my mind, makes it one of the most enjoyable radio events of the year. Every stand is full of interesting things and you meet all kinds of interesting people. This note has to be written some days before the 1953 show opens. I know, though, that I shall enjoy every minute that I spend at the show. This annual array of new "bits and pieces," produced to meet the growing requirements of workers in industry and research, gives one some idea of the rapid progress made in radio and electronics—two of the most enthralling branches of human knowledge.

A Kindly Thought

YOU MAY RECALL that I described last month an ultra-simple "Wrotham" dipole, made by untwisting the last two-and-a-half feet of a twin flex feeder and training one wire to the right and t'other to the left. Since my home is within the 3 mV/m contour of the B.B.C.'s field-strength map, I felt that this might not give a.m. a fair chance, though it is likely to do all that is needed for f.m. I've therefore had a pukkha metal tubing dipole fixed to my tallest chimney stack as well. This aerial is over 40 feet above the surface of the nearest roadway. The flex dipole is about 20 feet lower. It will be interesting to compare the results given by the two. The receiver is not yet ready for action; nevertheless, I'm already getting quite a bit of entertainment out of the chimney-stack dipole. It catches the eyes of a lot of folk who pass by and not a few of them pause to give it a second, puzzled look. One man stopped me as I was going out the other day and said in the kindliest way: "I hope you won't mind my telling you, but your television aerial hasn't been put up properly. It should stick up like *this* and not lie flat like *that*." I thanked him gravely for letting me know.

"Sound" Broadcasting a Back-number?

NOT A FEW PEOPLE hold the view that "sound" broadcasting has had its day. It's only a matter of time, they say, until all broadcasting is of the sound-and-vision kind. But I make the bold and confident prediction that much reception, if not indeed the bulk of it, will continue to be of the "sound only" type. As I see it, the domestic receivers of the not-very-distant future will contain a three-position switch: sound-and-vision; vision only; sound only. And I believe that more often than not the switch will be turned to the third position. The things that I personally want to see by radio are not very many. Big national, civic and sporting events—YES. Plays, ballet and so on—occasionally. Orchestras and instrumentalists—not after a short preliminary glance just to find out what they look like. Singers—definitely NO. Unlike children, most singers, once they have got to work, should be heard, but not seen. Debates and discussions—again, NO, after the first few moments. Once you know what each of the participants looks like, you can follow the argument far better by just listening, instead of having your attention distracted by constant switches to close-ups, which are not always too prepossessing.

Ups and Downs

CHATTING RECENTLY with a wireless enthusiast of the younger generation, I mentioned one point which had puzzled not a few of the old hands in the late 'twenties and most of the 'thirties. As new broadcasting stations came on to the air, many were for some time received with outstanding strength in most parts of this country. The Swedish long-wave Motala, for example, gave an enormous signal when it made its *début* with (I think) 25 kilowatts. It was the same with Kalundborg and several other long-wave transmitters. But, within a comparatively short time—say, four or five years at the outside—signal strength showed a remarkable decline. That this was not due to any reduction in the power output was clear, for I wrote myself to several stations which had waned and received positive assurances that nothing of the kind had taken place. On the medium-wave band things were even more spectacular. Many new stations behaved like the astronomers' novæ, those stars which flame into sudden brilliance, remain conspicuous objects for a time and then fade away into insignificance.

What's the Reason?

Both the long- and medium-wave bands were then far less crowded.

You could, and did, receive dozens of European stations free from interference. Hence, many a transmission that is now marred, or even blotted out by mutual interference then came through clearly. That explains why you can't now obtain interference-free reception of foreign stations that were formerly first rate; but it does *not* explain why there should have been so great a decline in the signal strength of many that were once outstanding in this respect. I've talked the matter over with many transmitting and receiving experts. All agree that there is something of a mystery and many are with me in believing that the cause may be the occurrence of electro-chemical changes in the soil surrounding the earth contacts, produced by the flow of heavy, or comparatively heavy, r.f. currents.

Fast Work

HAVE YOU EVER THOUGHT about the astonishing growth of wireless and of its many offshoots in just over 50 years? At the beginning of the century all that wireless could do was to send messages in rather slow morse over very short distances. Less than twenty years later long-wave communication systems spanned the world, communications over moderate distances were established on the medium waves and the coming of the valve had made wireless telephony practicable. Wireless telephony gave birth to broadcasting. It was still a textbook maxim that long distances demanded long waves and high-power transmitters, when the amateurs began to cause the pundits to raise incredulous eyebrows by asserting that their short-wave, almost fly-power transmitters managed very nicely, thank you, to keep them in touch with fellow amateurs in Europe, America, Africa, Australia and New Zealand. That led to a revolution in long-distance communications. Meantime, one promising young branch was just beginning to appear; this was television. Most folk heard nothing of another branch, radar, until it had become a strong healthy growth, using first the metre and then the centimetre waves. The unattended and entirely automatic radio link led to the high-power, unattended broadcasting station, such as that which transmits the Third Programme from Daventry. And so it goes on. No one, probably, will ever write the complete story of wireless, for any book which tried to tell it would fall far behind the latest developments by the time it was written, printed and published.

UNBIASED

By FREE GRID

Autopœdarchics

THIS JOURNAL pioneered over a quarter of a century ago what is generally known as a "Baby Alarm." Consisting of a microphone suspended over the child's cot and connected to the broadcast receiver downstairs, it superimposes the child's cries on the broadcast programme. Since then the basic idea has been reproduced again and again in other journals with but a few trivial improvements. Indeed, until recently, I saw no scope for any improvement myself.

Wandering round a recent exhibition with my blonde—in the absence of Mrs. Free Grid—I came across an electric baby rocker. This consisted of a small "carry-cot" suspended from a metal stand to allow of easy rocking, the latter being done very simply by means of an electric motor plugged into the mains. Now

A practical demonstration.

I don't profess to be an expert in babyology, or pædetics as some people seem to call it nowadays, but even I could not help being struck by the fact that, since babies feed largely on a milk diet, continuous rocking would result in the formation of butter. This would, I feel sure, be contrary to the regulations of the Ministry of Food.

Eventually the manager of the stand was "contacted," to use the modern jungle jargon, and he hastily explained that the contraption was intended to be rocked by hand. The electric motor had been installed merely to show how the thing worked.

It occurred to me at once that, since a child only requires occasional rocking, it would be a simple matter to retain the services of the electric motor. This could be controlled by the child itself by means of a "baby-alarm" microphone, an amplifier and a series of relays, just as the voice of a person speaking on the transatlantic telephone is used for control purposes by means of the well-known "Vogad" arrangement, the principle of which "Cathode Ray" elucidated for us some years ago.

The rocking motor would be switched on by the child's initial bellow and kept going for as long as the baby continued its vocal efforts. Immediately the child had rocked itself into insensibility the device would be automatically switched off and the cradle would come to rest. I can see no technical objection to this autopædarchic arrangement; maybe there is a medical one.

Canning the Coronation

IT IS very unlikely that I shall be present in the Abbey at the coming Coronation. A literary critic, however, who forecasts posthumous popularity for my poetry, tells me that in his opinion I stand a very good chance of being present at the next one. As you may be aware, more than one poet whose work did not hit the headlines until long after his death has subsequently been disinterred and granted, what is usually termed in certain journalistic circles, "a niche in our National Shrine."

As it is, I shall probably see this year's Coronation in canned form, appropriately enough in Chicago, the Mecca of mummified meat which London-born settlers call, with nostalgic appositeness, Canning Town. I was astonished when I first heard that films of the Coronation would be seen on some television screens in the U.S.A. on the evening of Coronation Day and for the moment I thought that some scheme had been devised for firing the films across the ocean in one of our new long-range carrier rockets.

But, owing to the time lag, it is just possible for the films to go from the Abbey to New York by helicopter and fast transatlantic plane in time for the late evening programmes in New York and elsewhere. The films will be processed in the plane *en route* as was done in a specially fitted train that was used in 1911 to transport the film of another Royal occasion from Carnarvon to London.

I am disappointed at American lack of enterprise in making no attempt to get the Coronation scenes across the Atlantic radionically so that they might be seen live instead of canned. It is, of course, easy enough to think of wild-cat schemes like having a string of ships, each carrying a helicopter-borne television relay station, to provide the links in the transatlantic chain, but I do think the experts could have worked out something.

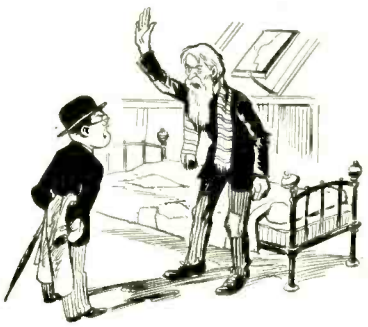
Even if the Atlantic be an impassable barrier it must be remembered that there is less than 60 miles of water separating Britain from the U.S.A. Would it not have been possible for President Eisenhower, with his well-known tact and flair for reconciling National differences, to arrange for an overland route with radio relays every 50 miles or so from Calais to the Siberian side of the Bering Strait whence it is a mere 38 miles to the shores of North America?

De Morituris

INVENTORS are popularly supposed to die destitute in garrets while hard-faced and unscrupulous financiers make millions out of their brain children. Undoubtedly this did sometimes happen in the days of long ago. I am, however, surprised to learn from the pen of the Editor of our leading photographic journal (who writes at length and with feeling in the January 7th issue of *Amateur Photographer*) that in 1920 Louis Ducos du Hauron, who forecast, if he did not actually invent, all modern processes of colour photography, died in destitution.

This rather startling revelation has left me with an uneasy feeling that somewhere at this moment there may be some wireless inventor lying hollow-cheeked and hungry in a dismal attic while we who use his inventions are smacking Lucullan lips over our caviare. The wireless counterpart of du Hauron was undoubtedly Campbell Swinton, inasmuch as in 1908 he accurately forecast, although he did not actually invent, our present system of television. So far as I am aware, however, he died in a reasonable standard of comfort.

There may be others who were not so fortunate and died in poverty, but we can obviously do nothing about it now as a posthumous plaque in Westminster Abbey is no substitute for an *ante-mortem* square meal. But there may be some who linger on and we can at least do something for them even if it be only to put them out of their misery. If, therefore, you know of any deserving cases please let the Editor or myself know so that we can remove this blotch on the wireless escutcheon. It seems a crying shame that there is no R.S.P.C.I. to look after the interests of indigent inventors with the same zeal that the R.S.P.C.A. looks after destitute dogs.

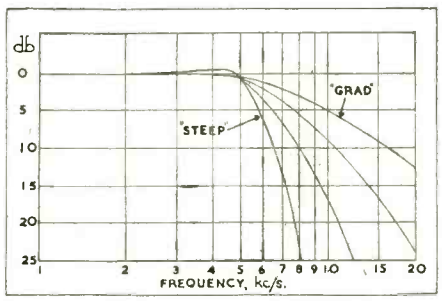


Te Morituros Saluto.

THE HIGHEST ATTAINABLE QUALITY OF SOUND REPRODUCTION

Representing a unique feedback circuit development, the "Vari-Slope" pre-amplifier gives audibly better reproduction. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s and 9kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7kc/s and 9kc/s ("−2" and "−1" positions).

The ***Vari-Slope***

The filters consist essentially of twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

b Extremely ow harmonic and inter-modulation distortion due to negative voltage feedback action.

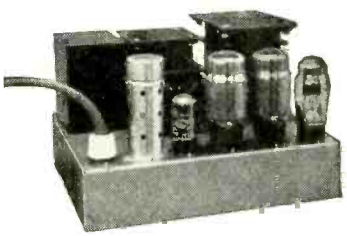
c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control, altering the terminating impedance and the insertion loss.)

d) No chokes to cause magnetic hum pick-up.

e Smaller size, lighter weight, greater uniformity in production

LIST PRICE IN BRITAIN

£12 : 12s.



The "Point-One" TL/12 Amplifier is built to a tropical specification and used throughout the world, including:
The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation
The Swiss Broadcasting Corporation.
The Italian Broadcasting Corporation.

Point-One TL/12

Triple Loop Feedback Amplifier

For laboratory use as a stabilised-gain audio frequency power amplifier For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pick-up, Radio, Microphone Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast transmitters. Used with the "Vari-Slope" pre-amplifier and the best available complementary equipment, the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price.

27 Gns.

Write for fully descriptive literature

H. J. LEAK & CO., LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

Phone: SHEpherds Bush 1173/4. Telegrams: Sinusoidal, Ealux, London. Cables: Sinusoidal, London.

ELECTRONIC PRECISION EQUIPMENT LTD

RADIO HEARING AIDER

The world for a deaf person must be particularly blank and monotonous, and a hearing aid which will function as a radio when not needed for hearing should help considerably. Due to Purchase Tax no kit of parts for this will be made available, but constructional data and technical notes dealing with this are available, price 2/6. Only standard parts are incorporated, therefore the constructor will have no difficulty in making this up.

HIGH VOLTAGE VALVE HOLDERS

For four or five pin valves. Price 2/9 each.

2¼in. TUBE MOUNTING

This comprises metal cased moulded rubber tube mounting, front escutcheon, 4 screws and Perspex window with engraved cursor lines, 5/- complete.

V.C.R. 139

Tube base with mu-metal screen, 4/6.

MU-METAL SHIELD

For 6in. tube V.C.R.97, etc., 10/- per pair.

6in. TUBE MOUNTING

Shock proof rubber mounted and adjustable, i.e., tube may be turned, with tube holder, 4/6 each.

HIGH VOLTAGE

Insulated spindle couplers, 1/6 each.

2 CIRCUIT TELEPHONE REPEATERS

Service No. YB/YA3757

For amplifying the signal in both directions of traffic and for reducing distortion of speech.
This is a 4-valve mains-operated unit with its own power supply mounted in a sheet iron box. Size 19½in. × 16½in. × 10¾in. and weighs 80 lbs.
Each instrument is complete with connecting and operating instructions, wiring diagrams, etc., etc. Price £12/10/-, plus 12/6 carriage.

6KV. EHT FOR 35/-

6KV. R.F. EHT kit, comprises 2 valves, mains transformer, condensers, coil formers and wiring instructions. Price 35/- complete. Data available separately, price 2/6.

SPECIAL LOW PRICES

AMPLIFIER UNIT A 1134A

This is a 2-stage intercom and Tx pre-amplifier with transformers, etc. Easily modified as gram amplifier or dictaphone, etc. Complete with 2 2 v. valves, QPP and Triode. Price only 9/6, plus 1/6 post and packing. Circuit diagram, free with unit, or separately, 1/6.

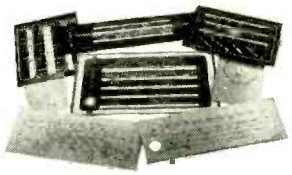
MORSE OSCILLATOR UNIT

Variable note and variable output, fitted with jack for external modulation, complete with 2 2 v. valves. Price 8/6, plus 2/- post and packing.

STOP PRESS

Weymouth miniature Coil Packs at half price. Long, Medium and Short wavebands with gram position. Size, 3½in. × 3in. × 1⅝in., single hole fixing.
Limited quantity, price 22/6, plus 1/6 post.
12 for £12, post free.

RADIO DIALS AND SCALES



Note.—**Type A.** Pointer moves from side to side.
Type B. Pointer moves up and down.
Type C. Pointer rotates centrally.
Type D. Pointer rotates in semi-circle from bottom centre.
Minimum dial openings are quoted to help you if you cannot find the right size listed, and the figures indicate to what size the dial could be cut down.

Post and packing charges. Owing to the fragile nature of these dials, 2/- extra must be included to cover post and packing.

Quantity Prices. Where 12 or more of one type are required discount is 25 per cent.; 144 or more, 33⅓ per cent. (there are no carriage charges on quantity orders).

GLASS DIALS

Type	Glass Size Wide	Glass Size High	Min. Dial Opening	Wavebands	Colours	Price	List No.
	in.	in.	in. in.				
A	12	6½	8¾ × 4¼	M., S1, S2, S3, S4	4	3/6	C73A
B	6	7¾	5¼ × 6¼	M., S1 & S2	3	3/6	C74A
B	4¾	11⅓	2 × 6	L., M. & S.	3	3/6	C77A
A	13½	3½	7½ × 2¼	L., M. & S.	3	3/6	C78A
C	3½	3¾	2⅜ × 3	L. & M.	2	1/6	C81A
A	8¼	5½	7 × 4¼	L., M. & S.	3	4/6	C83A
B	6	7¾	5¼ × 5½	L., M. & S.	2	2/6	C84A
B	6	7¾	5¼ × 5½	M., S1 & S2	3	3/6	C85A
A	9	7¾	6½ × 5⅜	L., M. & S.	1	2/6	C88A
D	6½	5½	5½ × 3½	L. & M.	2	2/6	C89A
B	7½	7½	6 × 5¼	L., M. & S.	3	3/6	C90A
D	6½	5½	5⅛ × 3½	L. & M.	1	2/6	C91A
B	7½	7½	6 × 5¼	L., M. & S.	3	3/6	C92A
A	8¾	3½	7 × 2¾	L., M. & S.	2	2/6	C93A
A	10	4	6 × 2	L., M. & S.	3	3/6	C94A
B	5¾	8¾	4 × 6¼	L., M. & S.	3	3/6	C95A
B	7½	7½	6 × 5¼	M., S1, S2	3	3/6	C96A
A	11½	4¼	6 × 5¼	L., M. & S.	3	3/6	C97A
C	5½	7	4⅜ × 5¼	L., M. & S.	3	2/6	C98A
B	4½	10	3¼ × 6	L., M. & S.	3	3/6	C99A
A	5¼	4½	3½ × 2¼	L., M. & S.	3	2/6	C100A
C	7½	5¼	5 × 5½	L., M. & S.	3	3/6	C101A
C	5	6¼	4¼ × 5	L., M. & S.	3	2/6	C102A
C	5	6½	4 × 4¾	M., S1 & S2	3	2/6	C103A

Metal, Fibre and Card Dials

A	10½	3½	8 × 2¼	M., S1, S2, S3 & S4	Metal	2/6	C75A
C	4	5½	3 × 3	L. & M.	Fibre	1/6	C82A
C	3½	3	2¾ × 2¾	L. & M.	Card	9d.	C86A
D	5⅛	5	4 × 2½	L., M. & S.	Card	9d.	C87A

SPECIAL OFFER

(Relating to 29 gns. Radiogram on page 107)

Cabinet A.C./D.C. model. Radio chassis, and auto changer, price 29 gns. H.P. terms, £10/14/- deposit and 12 monthly payments of £2/3/- plus £1 carriage and insurance.

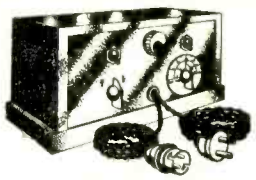
THIS MONTH'S SNIP

This month we are able to offer at an extra special price 250v. 60mA metal rectifiers by Standard Telephones. Size 3½ins. x ¾ins.

Price 5/6 each, or 4 for 20/-.

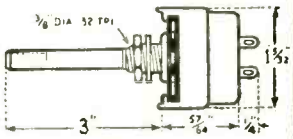
COLLARO AUTO-CHANGER

Last year we purchased a large quantity of the Collaro Auto record changers type RC/511, 3 speed, suitable for all types of records with the latest crystal pick-up, but these have been selling very rapidly, and it may well be that unless you buy one this month you will not be able to again, at this special price. We urge you, therefore, to order right away, the price is 11 gns., plus 7/6 carriage and insurance.



ELECTRONIC TIMER

With this instrument processes which operate over a specified time can be controlled automatically, e.g., in photography use it to control exposures, etc. The instrument can be set to any length of time from a fraction of a second up to three minutes, and it can be made to switch the appliance on or off. Circuit diagram and instructions, 2/3. Complete kit of parts, including valves, mains transformer, power pack, sensitive relay, potentiometer and metal case, 69/6.

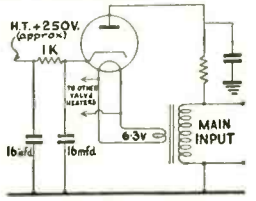


VOLUME CONTROLS

We carry a full range of standard-size volume controls from 2K to 2 meg. Prices are: less switch, 3/-: Single pole switch, 4/-: double pole switch, 5/-. We can also supply midget-type controls, less switch, 4/-: single pole switch, 5/9: double pole switch, 6/6. Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.

SHORT WAVE TUNING HEART

Coil Pack, 2 gang condenser, F transformers and calibrated s le for frequency coverage of 13-37 metres, 37-100 metres and 200-500 metres. Price 39/6 complete with circuit diagram.



A POWER PACK FOR 15/-

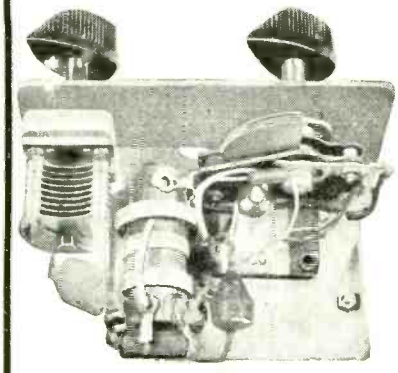
Efficient power supply, O.K. for operating a receiver, amplifier, instrument or other device requiring up to 60 mA. at approx. 250 v. Parcel consists of filament transformer, rectifying valve, smoothing resistor and 16 × 16 mfd. 350 v. electrolytic condenser. Note the filament transformer will supply enough current to operate 3 or 4 other 6.3 valves.

PLASTIC EYE SHIELDS

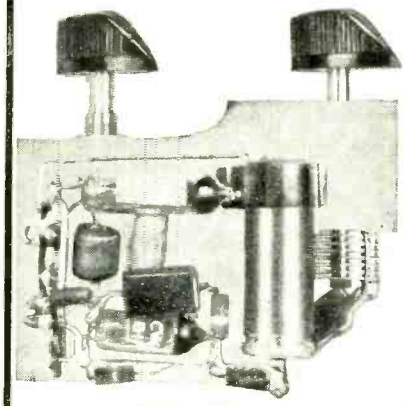
Ideal for hundreds of jobs such as C.R. Tube testing, motor cycling, paint spraying, etc. The illustration shows them being used to keep soap out of the eyes during hair washing. Price 6 pairs for 1/-.

THE Elpreg "HANDY THREE"

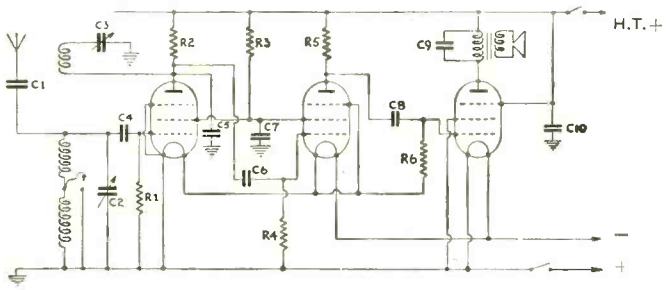
A small, self-contained set which can be carried about from place to place must be a valuable addition to your personal belongings. When the family want Television, for instance, you may wish to hear a special Radio item, if you have a long job to do in your shed or greenhouse or even whilst having a bath, an important programme need not be missed. Cycling, too, can be made more enjoyable if you can listen to music and singing (of course under these conditions a loudspeaker would not be too successful but an earphone of the deaf-aid type is ideal).



Above Chassis



Below Chassis



Theoretical Diagram

The little set described here uses sub-miniature valves and can be built for only 80/-. It will receive long and medium waves at good strength with only a short throw out aerial. The circuit used, i.e., single-coil tuning with reaction is one which was very popular in the early kit set days. We have chosen this type of circuit because it works well with the miniature valves and does save the heavy cost of the midget 2-gang I.F. transformers, etc., which are necessary with a superhet. Also this set is much cheaper to run having only three valves and needing only 45 volts H.T. in most areas and 1½ volts L.T.

We give enough details on this page for most readers but a blueprint showing point to point wiring is available, price 1/6.

Notes

1. For L.T. use 1.5 v. battery type U2.
2. For H.T use 45 v. Ever Ready battery B106.
3. In most areas a 15ft. aerial slung around the picture rail is plenty.
4. To receive the station adjust tuning and reaction controls together.
5. In weak reception areas try a longer aerial, an earth, and/or increase the H.T. to 90 v., i.e., Ever Ready battery B126.

Components, valves and prices

Resistors

R1, R3, R4—2.2 megohms.
R2, R5—560 k ohms.
R6—1 Megohm.
Total 6 available for 2/-.

Fixed condensers

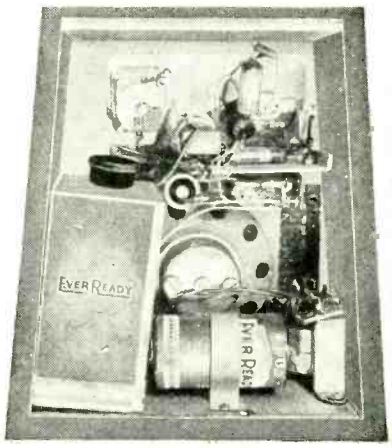
C1, C4, C6, C8—1,000pF.
C5—100 pfd.
C7—.1 mfd.
C9—.01 mfd.
C10—2 mfd.
Total 8 available for 4/-.

Variable Condensers

C2—.0005 mfd.
C3—100 pfd.
Both available for 7/-.

Valves

V1, V2—CV443, 5/9 each.
V3—CV385 6/9 each.



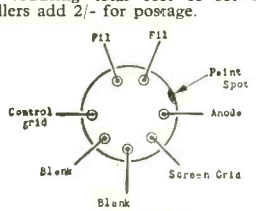
Assembled Receiver

Other components

Metal chassis	4/6
Miniature output transformer	4/6
Dual wave coil	3/6
3½in. loudspeaker	14/6
On/off switch	2/6
Knobs (2)	1/-
Cabinet	15/9
Sundries, nuts, bolts, battery, plugs, wire etc.	3/6
Blueprint	1/6

Special Offer

All above parts bought separately come to £4/2/6, but if you buy them all from us within 30 days we will supply the cabinet at 13/3 thereby reducing total cost of set to £4. Non-callers add 2/- for postage.



Valve Connections

ELECTRONIC PRECISION EQUIPMENT LTD

ELECTRICAL BARGAINS

In addition to our large range of radio accessories we also carry a good stock of electrical wiring accessories; details of a few of these can be found below :—

WOOD BLOCKS

Varnished Walnut.

Size	New	Slightly Scratched
2½in. × 2½in. × 1in.	7d	5d
3in. × 3in. × 1in.	8d	5d.
6in. × 3in. × 1in.	1/1	8d.
9in. × 3in. × 1in.	1 × 4	6d.
3in. × 1in.	8½d.	6d.

CARBON BRUSHES

Pre-bedded with springs.
¼in. × ⅜in. × ⅜in., **8d.** pr.
¼in. × ½in. × ⅜in., **6d.** pr.

RUBBER TAPE

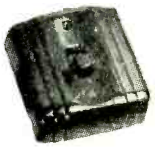
8 oz. reels, **6d.** each.

ARROW ROTARY SWITCHES

4 position on/off hot/cold. Suitable for hair dryers, etc. Price 6/6.

ROSS COURTENAY TAGS

Packet of 100 assorted, price 3/6. Rev. counter and many other interesting uses. Price 8/6, post free.



5 AMP SURFACE SWITCHES—HICRAFT

Oblong Brown Plastic 1-way, 1/3 each.
Oblong White Plastic 1-way, 1/3 each.

Oblong Brown 2-way..	1/6 each
Oblong White 2-way..	1/6 „
Round Brown 1-way ..	1/3 „
Round White 1-way ..	1/3 „
Round Brown 2-way ..	1/6 „
Round White 2-way ..	1/6 „

SOCKETS HICRAFT

Flush type for skirtings, 5 amp. 3-pin shuttered, 1/3 each; ditto with switch, 2/3 each.

CEILING SWITCHES—HICRAFT

With cord and acorn. Brown or White, 1-way, 3/9 each; 2-way, 4/3 each.

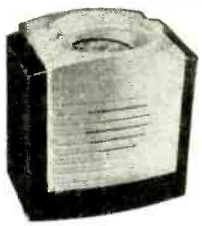
LAMP HOLDERS

Bakelite, 1/- each or 10/6 doz.
Bakelite skirted Batten holder, 1/6 or 15/- doz.
Bakelite type threaded for ⅜in. with HO skirt. 1/6.
10 per cent. discount if bought in dozens.

ADJUSTABLE THERMOSTAT

250 v. heavy silver contacts can be adjusted to operate between 70°—300° F. These are suitable for aquarium heaters, electric blankets, etc.
1 Amp. Model, 3/6.
2 Amp. Model, 5/6.
5 Amp. Model, 14/6, post, etc., 6d. each.

BARGAIN FOR CONSTRUCTORS



Special this month is the Portable illustrated alongside. We offer a bakelite cabinet with carrying handle, metal chassis, battery housing and two waveband dial, all for 27/6, plus 5/- carr. and insurance. This cabinet and set of parts is ideal for making up either an all dry battery receiver for holidays, picnics, etc., or a battery mains set for everyday use. Constructional details of two suitable circuits using 1.5 v. valves 1R5, etc., will be given free with cabinet assembly, or is available separately price 1/6 post free.

SPECIAL RADIOGRAM OFFER

To those who want an auto radiogram at a low price, we offer the cabinet illustrated alongside complete with Collaro three speed record changer with dual purpose crystal pick up, at a special bargain price of **£17/16/8**, plus 12/6 carriage and insurance or H.P. terms **£6/7/-** deposit.

3 colour scale, scale pan, chassis, pulley, driving head, springs, etc., etc., to suit the radiogram and two radio cabinets are available as a parcel at **15/-**, plus 1/6 post.

Cabinet separately **£7/10/-** (or **£2/10/-** deposit), plus 10/- carriage and insurance.

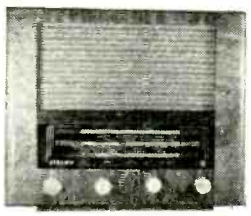
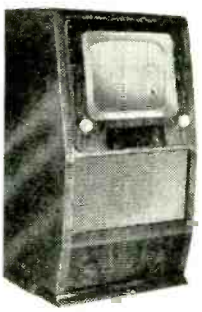


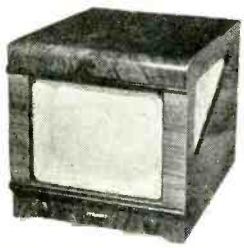
TABLE MODEL RADIO

This very nice-looking cabinet will take the same scale and chassis as the radiogram above, and we are able to offer this at the bargain price of 37/6, plus 3/6 post and insurance.



T V OFFER—LAST CHANCE

The 12in. T.V. with front flap for controls as illustrated alongside is still available at **£7/10/-** or **£2/10/-** deposit, plus 10/- carriage and insurance, but stocks are rapidly going and this in all probability is your last chance to secure one of these really superior cabinets.



The table model also illustrated is still available in fair quantity at **£3/17/6**, plus 7/6 carriage and insurance, which price includes the armour plate glass and surround.
Mechanical details for the Console or Table Model are available as a parcel: Punched and prepared metal chassis, punched outrigger valve plate with spacers, 12in. Tube Clamping ring, tube rear support brackets, etc. Price 25/-, plus 2/6 post.

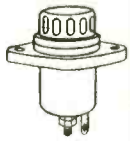
"MIDGETRONIC" Radio Cabinet

This pleasing small cabinet is in bakelite and is supplied complete with dial ring, pointer as illustrated but less knobs, also included is metal chassis and hardboard back. Price 15/-, plus 2/6 postage and packing.

To ensure receiving prompt reply, please enclose stamped addressed envelope, when writing for additional details.

SUNDRIES

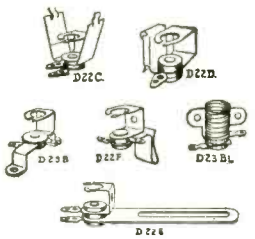
INDICATOR LAMP



This is fitted with a clear Perspex top; it is therefore highly suitable as an indicator lamp or for illuminating inside a radiogram or similar cabinet or even as a map-reading light in a car. Takes standard screw-in flash light bulb. Price 1/6 complete.

LAMP HOLDERS

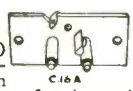
We carry a large assortment of dial lamp holders. Price 6d. each. Order by list numbers.



2-PIN PLUG (C20B)

Split Pin type, fits most of our sockets, C16A, C16B, etc., 6d. each.

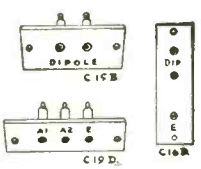
SPECIAL SWITCHED PANEL (C16A)



This is a 2-socket panel with optional switching for internal and external L.S. Just inserting two-pin plug, C20B, gives both speakers, pushing it right home cuts out internal speaker. Price 9d. each.

SOCKET STRIPS

Paxolin mounted.



Two socket engraved L.S., 6d. each. Bin. C16B.

Two socket engraved A.E., 6d. each. Bin. C18A.

Two socket engraved P.U., 6d. each. Bin. C19B.

Two socket engraved Dipole, 6d. each. Bin. C19B.

Two socket plain, 5d. each. Bin. C18B.

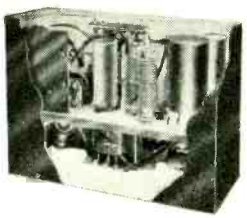
Three socket engraved DIP and E, 9d. each. Bin. C16D.

Three socket engraved A1, A2 and E, 9d. each. Bin. C19D.

Four socket engraved A.E. Pick-up, 9d. each. Bin. C19E.

Four socket engraved P.U. Ext. L.S., 9d. each. Bin. C16E.

Five socket plain, 9d. each. Bin. C16C.



VIBRATOR UNIT

This unit gives 150 v. at 50 mA. from 4 or 6 v. car battery, also gives L.T. supply, suitable for all dry valves. 1T4, IR5, etc. Ex. W.D. Price 29/6, plus 2/6 post.

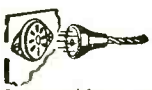
RADIO STETHOSCOPE

A novel device aptly called a Radio Stethoscope is described in a recent edition of the "Radio Constructor." With it in most districts a receiver can be checked from the grid of the first valve right through to the output. The only parts needed to make the simple circuit tracer are a pair of crocodile clips, a germanium crystal, and a paper tubular condenser, and we will supply whole outfit for 6/6, post free, and with each outfit we will give re-print of the article as it appeared in the "Radio Constructor."

NOTE.—If you wish to make it up as a pocket unit then you will need a few other odds and ends, solder tags, etc., from your spares box.

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6 in. × 1¾ in. square in ebonite case, pre-charged, only need filling with acid, 4/9 each, plus 9d. post and insurance.

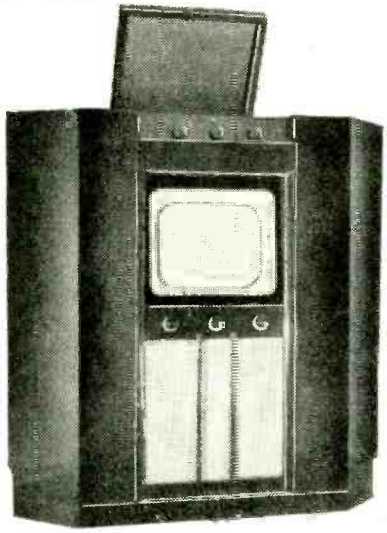


PLUGS FOR MODERN VALVE HOLDERS

Each is fitted with a rubber shroud. For B7G button base. Price 1/4 each, discounts for quantities.

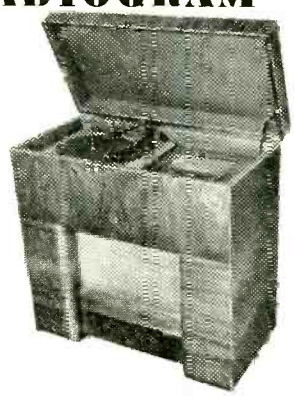
CORONATION CONSOLE

A combined Radio, Radiogram and 15in. Televisor in a magnificent cabinet valued at a shop price of £300-£400 can be yours for about £75 if you adopt our plan.



We are now taking orders for this very handsome cabinet which will put your TV into the £200 class.
The tube cut-out is designed for standard 15in. tube.
The storage space at the top if desired can be used for an autochanger or tape recorder, and the sloping panel at the top can be used as a control panel or for a pre-set radio.
The cabinet is 47in. wide, 31in. deep, to the corner, and 50in. high. It is already polished and supplied flat for you to screw together. Price is **£18** plus 10/- carriage, and insurance, or you can buy it on Hire Purchase if you wish, the deposit is £6 and then 12 monthly payments of 25/-.

29 Gns. RADIOGRAM



Console Type Cabinet. With full grained walnut finish, will take standard type auto change gram unit. Price **£11/10/-.** H.P. Terms, £3/17/- deposit. and 12 monthly payments of 16/9, plus 15/- carriage.

Radio Chassis to Suit. Long, medium and short wavebands, three colour illuminated scale. A.C./D.C. model. Price **£8/19/6.** H.P. terms, £3 deposit and 12 monthly payments of 13/- plus 7/5 carriage. A.C. only model, price **£9/19/6.** H.P. terms £3/7/- deposit and 12 monthly payments of 14/6 plus 7/6 carriage.

Auto Change Units. For long playing and standard records with suitable pick-up head. **£11/11/-.**

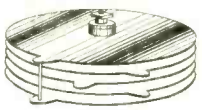
THE ELPREQ GENERAL PURPOSE AMPLIFIER

A self-contained A.C./D.C. mains operated amplifier which has 101 applications such as for dance band in small halls, factory call system, gram. amplifier, baby alarm, etc., will drive 4 extension speakers. Complete with hand microphone and built-in speaker in portable carrying case, fully guaranteed, 9 gns., or H.P. £3/4/- deposit, plus 5/- carr. and ins.

CONNECTING WIRE SNIP

P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red Orange, Pink, Yellow, White, Transparent, 4 coils for 10/-.

METAL RECTIFIERS



The one illustrated is a special bargain, being available at considerably below cost. It is a selenium type rectifier rated at 12 v. 2½ amps., it is of course a full wave type highly suitable for battery chargers. Limited quantity. Price 17/6 each.
Also available 6 v. 1 amp. Type. Prices 5/- each. 12 v. 1 amp. Type. Price 9/- each.

SPECIAL OFFER

Metal Rectifier, 100 mA. 250 v. Ex new equipment but unused and perfect. Price 7/6 each.

SLIDER RESISTORS

Heavy Duty Type.

Size 7in. × 1¼in. 11 ohms 4.5 amp., 22/-; Size 9in. × 1¼in. 1.2 ohms 15 amp., 15/-; size 13½in. × 1¼in. 3 ohms 10 amp., 15/-.

ELECTRONIC PRECISION EQUIPMENT LTD.

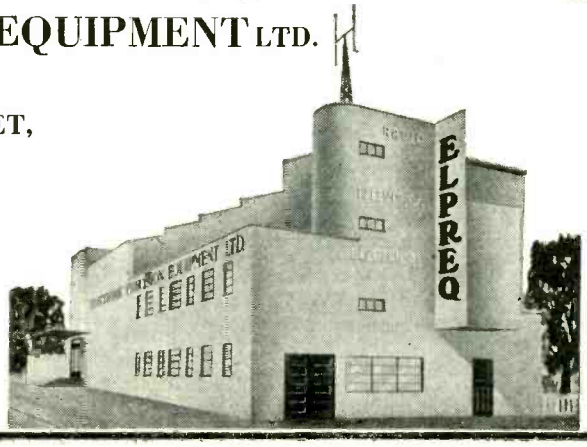
Post orders should be addressed to:—

ELPREQ HOUSE (Ref. 2), HIGH STREET, WEALDSTONE, MIDDX.

Personal shoppers however must continue to call at:—

42-46, WINDMILL HILL, RUISLIP, MIDDX.
Phone: RUISLIP 5780
(Half-day Wednesday),

152-153, FLEET STREET, E.C.4.
Phone: CENTRAL 2833
(Half-day, Saturday)



RADIO SUPPLY CO. (LEEDS) LTD.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under £1. 1/6 extra under £3.

Post Orders to 15, Wellington St., Leeds, 1.

Callers to 32, The Calls, Leeds, 2

Open to Callers: 9 a.m. to 5.30 p.m. Saturdays until 1 p.m.

FULL PRICE LIST 5d.

TRADE LIST 5d.

Please enclose S.A.E. with all enquiries.

SPECIAL OFFERS. Germanium Crystal Diodes, **2/9.** Midget Mains Transformers (size approx. 2½×3×2½in.). Drop-through chassis type. Screened Primary 220/240 v. 50 c/s. Output: 250-0-250 v. 60 mA., 6.3 v. 2.5 a. Only **10/9.** Small Filament Transformers, 220/240 v. input, 6.3 v. 1.5 a. output, **5/9.** Auto Transformers (with separate h.t. 6.3 v. 1.5 a.), 0-110-200-210-230-250 v. 50 watts, **4/9** each.

BATTERY SET CONVERTER KIT. All parts for converting any type of Battery receiver to All Mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed h.t. of 120 v. 90 v. or 60 v. up to 40 mA., and fully smoothed l.t. of 2 v. at up to 1 a. Price complete with circuit, point-to-point wiring diagrams and instructions only **48/9.** Or ready to use, **7/9** extra.

PERSONAL SET BATTERY SUPERSEDER KIT. A complete set of parts for construction of a Unit (housed in Metal Case) to replace Batteries where A.C. Mains supply is available. Input 220-250 v. 50 c/s. Output 90 v. 10 mA. and 1.4 v. 250 mA., fully smoothed. For 4-valve receivers. Price complete with circuit. Only **32/9.** Or ready for use, **7/9** extra.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Input 200-250 v. A.C. Output 120 v. 40 mA. fully smoothed, and rectified supply to charge 2 v acc. Price with steel case and circuit, **29/6.** Or ready for use, **7/9** extra.

BATTERY CHARGER KITS

For Mains 200-250 v. 50 c/s.
To charge 6 v. acc. at 2 a., **25/6.**
To charge 6 or 12 v. acc. at 2 a., **29/6.**
To charge 6 or 12 v. acc. at 4 a., **49/9.**
Above consist of transformer, full wave rectifier, fuse, fuseholder and steel case. The kits can be supplied fully assembled at an extra cost of **7/9** each.

EX-GOVT. ITEMS. Pye coaxial plugs and sockets, **7/6** doz. prs. Belling-Lee moulded type 5-pin and 7-pin plugs and sockets, **1/11** pr. Int. Octal Valve Screening Cans, 3 piece, **1/3** each, **11/9** doz. Bak. Tubulars, .02 mfd. 5,000 v., **1/9.** .05 mfd. 3,500 v., **2/11.** Meters, moving coil, 2in. diameter, 0-5 amps. **15/-.**

ELECTROLYTICS (Current production. **Not** ex-Govt.).

Tubular Types		Can Types	
8μF 350 v.	1/9	8μF 450 v.	2/3
8μF 450 v.	1/11	8μF 500 v.	2/11
8μF 500 v.	2/11	16μF 450 v.	2/9
16μF 350 v.	2/3	24μF 350 v.	2/11
16μF 450 v.	2/9	32μF 350 v.	2/11
16μF 500 v.	3/11	40μF 450 v.	4/11
24μF 350 v.	3/6	8-8μF 350 v.	3/9
32μF 350 v.	3/6	8-8μF 450 v.	3/11
32μF 500 v.	5/9	8-16μF 450 v.	4/6
8-16μF 500 v.	4/11	16-16μF 450 v.	4/11
25μF 25 v.	1/3	16-32μF 350 v.	5/3
50μF 12 v.	1/3	32-32μF 350 v.	4/11
50μF 50 v.	2/3	32-32μF 450 v.	5/11

CAN TYPES

32-32-8μF 350 v. (small)	5/11
32-32 mfd. 350 v. plus 25 mfd. 25 v.	5/11
16-16μF 450 v. plus 20μF 25 v.	5/3

MASTER INTERCOMM. UNIT with provision for up to 4 "Listen-Talk Back Units." A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. An attractive walnut veneered wood cabinet is included. Mains input is 200-250 v. 50 c/s. to 300-0-300 v. trans. Sound amplification 4 watts. Price only **£5/19/6.** "Listen-Talk Back Units" can be supplied at **£1** each. Full descriptive leaflet. **1/-.**

A PUSH-PULL 3-4 watt HIGH-GAIN AMPLIFIER FOR £3/12/6. For Mains input 200-250 v. 50 c/s. Complete kit of parts including circuit diagram and instructions (Point-to-point wiring diagrams available for 2/6 extra.) Amplifier can be used with any type of Feeder Unit or Pick-up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. trans. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by R. & A. at **31/-.**) The amplifier can be supplied ready for use for **£1** extra. Full descriptive leaflet **1/-.**

EX-GOVT. SMOOTHING CHOKES

330 mA. 5 H. 50 ohms, potted	12/9
220 mA. 5 H. 50 ohms, potted	10/9
50 mA. 50 H. 1,250 ohms, potted	8/11

EX-GOVT. BLOCK PAPER MANSBRIDGE TYPE CONDENSERS

4μF 500 v.	2/9
4μF 1,000 v.	3/3
8μF 500 v.	4/9

COAXIAL CABLE, 75 ohms, ¼in., **10d.** yard.

DIAL BULBS, M.E.S., 6.5 v. 0.15 a., 8 v. 0.15 a., **6/9** dozen.

SELENIUM RECTIFIERS. 230 v. 50 mA., H.W. (small), **6/9.** 120 v. 40 mA., H.W. (small), **4/6.** 2/6 v. ½ a. H.W., **2/11.** 2/6 v. 1 a. H.W., **3/11.** 6/12 v. 1 a. H.W., **4/6.** 6/12 v. 2 a. F.W. (bridge), **10/9.** 6/12 v. 4 a. F.W. (bridge), **18/9.**

CHASSIS. 16 s.w.g. Undrilled Aluminium Receiver Type 6×3¾×1½in., **2/6**; 7¼×4¾×2in., **3/3**; 10×5¼×2in., **3/9**; 11×6×2½in., **4/3**; 12×8×2½in., **5/3**; 16×8×2½in., **7/6**; 20×8×2½in., **8/11**; Amplifier Type (4 sided), 12×8×2½in., **7/11**; 16×8×2½in., **10/11**; 14×10×3in., 20×8×2½in., **13/6.**

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 150, 200, 230, 300, 400, 470, 500, 1,000, 2,000 pfd. All at **5d.** each; **3/9** doz. one type.

FOR ONE MONTH ONLY. Brand New Electrolytics, 8μF, 16μF, 32μF, 350 v., **1/9** each. Vol. controls, ½ meg. L/S., 1¼in. Spindle, **1/6.**

BAKELITE (Brown or White) and **WOOD** (Walnut veneered) **CABINETS.** Size approx. 12×6½×5in. Very attractive appearance. For illustration see our List. Supplied complete with fully punched T.R.F. 3-valve or Superhet 4-valve Chassis back, 2 or 3 wave. Glass scale with coloured station names, Dial Backplate, **25/-,** plus carr. **2/6.** All parts available for construction of T.R.F. or Superhet Receiver in above cabinets.

COLLARO TAPE DESK MOTORS. Shaded pole type, clockwise or anti-clockwise, **31/-** each.

VOLUME CONTROLS with long (½in. diam.) spindles, all values less switch, **2/9,** with S.P. switch, **3/11.**

WIRE WOUND POTS.: 20 ohms, 5K, 20K, 25K, 50K (medium length spindles), **2/9.**

P.M. SPEAKERS. All 2-3 ohms, 5in. Plessey **13/9,** 5in. Goodmans **14/9,** 6½in. Elac **14/11,** 6½in. Goodmans **16/9,** 8in. Plessey **15/9,** 10in. Rola **29/6,** 10in. Plessey **18/6.**

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola field 700 ohms, **11/9.** 8in. R.A. field 600 ohms, **12/9.** 10in. R.A. field 2,500 ohms **23/9.** 10in. Rola, with Trans., Field 1,600 ohms **27/9.**

R.S.C. MAINS TRANSFORMERS (Fully Guaranteed)

Interleaved and Impregnated. Primaries 200-230-250 v 50 c/s Screened.

TOP SHROUDED, DROP THROUGH

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	12/11
260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.	14/11
260-0-260 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	15/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	17/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA. 6.3 v.-4 v., 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

FULLY SHROUDED UPRIGHT

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2½-3-3in.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 0-4-6.3 v. 4 a., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	29/9
300-0-350 v. 100 mA., 0-4-6.3 v. 4 a., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 0-4-6.3 v. 4 a., 0-4-5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a. 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a. for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a., c.t. 6.3 v. 4 v. 4 a., c.t. 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	51/-
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6
325-0-325 v. 20 mA., 6.3 v. 0.5 a., 6.3 1.5 a. for Williamson Preamplifier	17/6

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s., 120 v. 40 mA.	7/11
120 v. 40 mA., 6-0-6 v. 1 amp.	14/9

FILAMENT TRANSFORMERS

All with 200-250 v. 50 c/s. primaries: 6.3 v. 2 a., **7/6**; 0-4-6.3 v. 2 a., **7/9**; 12 v. 1 a., **7/11**; 6.3 v. 3 a., **9/11**; 6.3 v. 6 a., **17/6**; 0-2-4-5-6.3 v. 4 a. **16/9**; 12 v. 3 a. or 24 v. 1.5 a., **17/6.**

CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., **14/9**; 0-9-15 v. 3 a., **16/9**; 0-9-15 v. 6 a., **22/9**; 0-4-9-15-24 v. 3 a., **22/9**; 0-9-15-30 v. 3 a., **23/9.**

SMOOTHING CHOKES

250 mA., 8-10 H., weight 12 lb.	16/9
200 mA., 3 H. 80 ohms	5/9
80 mA., 10 H. 350 ohms	5/6
60 mA., 10 H. 400 ohms	4/11

E.H.T. TRANSFORMERS

4,000 v. (5,000 v. smoothed) 5 mA., 2 v. 2 a.	39/6
2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, etc.	35/-

OUTPUT TRANSFORMERS

Midget Battery Pentode 66: 1 for 3S4, etc.	3/9
Small Pentode, 5,000Ω to 3Ω	3/9
Small Pentode, 8,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Pentode 10,000Ω to 3Ω	4/9
Multi-ratio 40 mA., 30:1, 45:1, 60:1, 90:1, Class B Push-Pull	5/6
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker	22/9
Push-Pull 20 Watts, high-quality sectionally wound 6L6, KT66, etc., to 3, 7.5 or 15Ω (secondary in 4 sections of 3.7Ω each)	47/9
Williamson type exact to authors specification	85/-

THE VIEWMASTER

ALL COMPONENTS IN STOCK

ANY SINGLE ITEM AVAILABLE SEPARATELY

LASKY'S RADIO — World Renowned for Service & Reliability

COILS

All models available including filter chokes. Price (except Alexandra Palace), 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

CHASSIS

Sound-Vision, 18/6. Power-Pack/Time base, 18/6. Support for S.V. chassis, 6/-.

W/B & PLESSEY

Line EHT trans.	32/6
Frame trans.	25/6
3 Mc/s boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke	15/6
Focus ring	22/6
Heater trans.: WB/103	42/-
WB/103A	52/6
Front and rear C.R.T. supports	21/6

METAL RECTIFIERS

WX3 and 6. Ea.	3/9
14D36	11/8
14A86	20/4
14A100	21/6
36EHT45	23/8
36EHT50	26/1
36EHT100	29/6

PLESSEY

Scan coils per pair 25/-
Width Control 6/6

NOW AVAILABLE. LARGE SCREEN, WIDE ANGLE CONVERSION DETAILS FOR THE VIEWMASTER. Send 3d. stamp for full data. Fully itemised price list of all Viewmaster components now available.

ALL T.C.C. CONDENSERS exactly as specified for use in The Viewmaster can now be supplied from stock.

The television set you can build at home from standard parts.

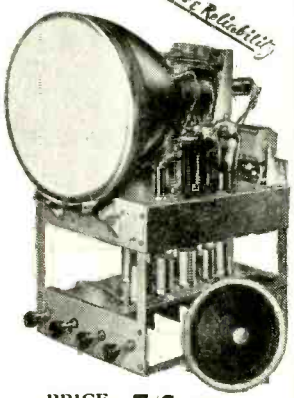
A MODEL FOR EACH FREQUENCY. State station required.

Brilliant high definition black and white picture. Superb reproduction. Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model. Incorporates all the latest developments.

Television for the home constructor at its finest.

Send to-day for the CONSTRUCTION ENVELOPE, 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions.

Alexandra Palace, Sutton Coldfield, Holme Moss, Kirk o'Shotts, Wenvoe, Pontop Pike, Belfast. State model required.



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G.B. T.V. COMPONENTS

Line Trans.	29/6
Frame Trans.	22/6
Main choke	12/6
Width Coil	6/11
Boost Choke	3/9

All suitable for Home Construction T/V.

TELEVISION SELENIUM

The very latest "Sentercell" S.T.C. range.

K3/40, 3.2 kV	7/6
K3/45, 3.6 kV	8/2
K3/50, 4.0 kV	8/8
K3/100, 8.0 kV	14/8
K3/160, 12.8 kV	21/6

C.R.T. MASKS. Brand new.

LATEST ASPECT RATIO

10in.	7/6
12in.	15/-
12in. flat face	15/-
14in. rectangular	21/-
16in. Double-D	31/6
17in. rectangular	25/-

Rear neck protectors for c.r tubes. Price 2/6 each.

SOILED. NEW ASPECT RATIO

9in. sorbo	5/-
12in.	7/6
12in. with fitted armour plate glass	11/6

DARK SCREEN FILTERS (LATEST TINT)

12½in. × 14½in. For 16 and 17in. c.r. tubes 25/-
11in. × 13¾in. For 9, 10 and 12in. c.r. tubes 15/11

ARMOUR PLATE GLASS

15in. Actual size 18⅛in. × 19¼in. × ⅛in. 7/11

12in. Actual size 13in. × 10½in. × ⅛in. 4/-

9in. Actual size 9in. × 8in. × ⅛in. 3/-

LATEST 12in. PLASTIC MASK

Incorporates gold finish tube escutcheon and dark screen filter. Overall dimensions: 13¾in. wide, 10¾in. high. 17/6. Post 2/6 extra.

15 INCH CATHODE RAY TUBE MASKS.

New Aspect Ratio.
No. 1. Cream rubber. Brand new and unused. Overall size: 17in. wide, 13in. high. PRICE 17/6. Post 2/- extra.
No. 2. Plastic, incorporating gold finish tube escutcheon and dark screen filter. Overall size: 15in. wide, 12in high. PRICE 21/-. Post 2/- extra.

PORTABLE TAPE RECORDERS

Brand New — Unused — Complete. Fully assembled and wired. Ready to operate.

- ★ **Attractive carrying case.**
- ★ **Twin track recording.**
- ★ **Instant playback.**
- ★ **Size of case: 17 × 12 × 7in.**
- ★ **Total playing time of 66 minutes.**
- ★ **6 Valves.**
- ★ **Weight only 31 lbs.**
- ★ **A.C. Mains 200-250 volts.**
- ★ **Fast rewind.**
- ★ **Record level indicator.**
- ★ **Complete. Ready to switch on.**

Write for full illustrated details and circuit diagrams.

LASKY'S PRICE £34.19.6 Carriage 15/- extra.

Co-Axial Cable. 70–80 ohms impedance.
Single core, 9/- doz. yards.
Twin core, 12/- doz. yards.
Twin feeder, 6/- doz. yards.

Co-Axial Connectors. For standard ¼in. cable, 1/11.

PERSPEX. 13½ × 10½ × ⅛in. Neutral shade, slightly marked. 5/11 per piece.

ANTENNA ROD SECTIONS. Steel, heavily copper plated. Each rod is 12in. long, ¼in. diam. Any number can be fitted together. PRICE 2/6 PER DOZ. Post Free.

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

(Cathodray).

.001 mfd. 15 kV	10/-
.001 mfd. 25 kV	18/-
.0005 mfd. 25 kV	18/-
.0005 mfd. 12.5 kV	10/-

Plastic case, single bolt fixing. Other high voltage condensers

.1 mfd. 7 kV	15/-
0.04 mfd. 12.5 kV	7/6
.001 mfd. 12.5 kV	7/6

DINGHY AERIALS WITH REFLECTORS

Umbrella type, with wire mesh reflector complete with setting up instructions. Mast not supplied.

LASKY'S PRICE 7/6 Post 1/6

The tape recording amplifier can be purchased separately. Price £8/19/6, complete with valves. Carriage 10/- extra.

MAGNETIC RECORDING TAPE

Scotch Boy. 1,200ft. Reels, 35/-. 600ft. Reels, 21/-.

DE LUXE TELEVISION CABINETS

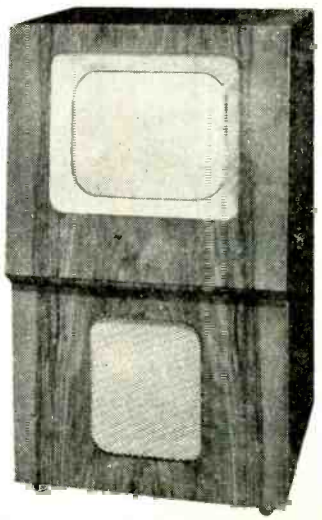
For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster, "Practical Television," "Practical Wireless," and "Wireless World" televisors.

LASKY'S PRICE £8.10.0

Carriage 12/6 extra.

Outside dimensions of cabinet 17½in. × 16½in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

This cabinet can also be supplied cut out for a 16in. C.R. tube.



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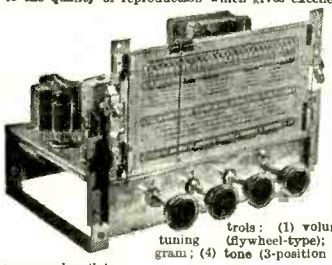
TERMS: Pro Forma, Cash with order, or C.O.D. on post items only. Postage and package on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

TWO COMPLETELY ASSEMBLED "ALL-WAVE" SUPERHET CHASSIS

(a) **MODEL B.3.** A 5-valve 3-waveband superhet Receiver.
(b) **MODEL B.** A 5-valve 6-waveband (4 bandspread) Superhet Receiver. Both receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent, clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.



Brief specifications: **Model B.3.**—Valve line up: 6BE6, 6BA6, 6AT6, 6BW6, 6X4. Waveband coverage, short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel-type); (3) wavechange and gram; (4) tone (3-position switch operative on gram and radio).
Negative feedback is employed over the entire audio stages. Chassis size: 11in. × 7½in. × 8½in. high. Dial size: 9½in. × 4½in. Price, complete and READY FOR USE, excluding speaker, **£12/12/-.** (Carr. and Pkg. 7/6 extra).
Model B employs a similar valve line up as the B.3, but covers 6 wavebands. Short wave 11-16, 16-25, 22-33, 31-46 and 43-120 metres, and medium wave 187-550 metres. The first four short bands are bandspread. The controls employed are as used on the B.3 model, but the tone control operates a six-position switch, having three additional positions for varying bass and treble on gram reproduction. Negative feedback is employed over the entire audio stage. Size of chassis and dial is as given for B.3. Price complete and READY FOR USE, excluding speaker, **£15/15/-.** Carriage, packing and insurance 7/6 extra.

NEWS! WE NOW INTRODUCE THE "TELE-VIEWER" NEWS!

5 CHANNEL TELEVISOR

A Design of a Complete SUPERHET T/V RECEIVER FOR THE HOME CONSTRUCTOR

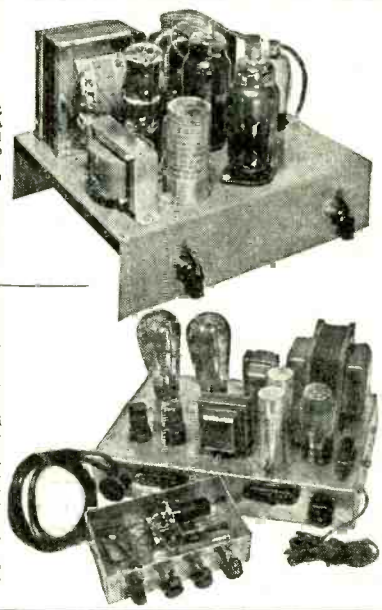
This receiver has been developed after most careful research to provide a Televisor employing **SUPERHET** circuit for 12in. or 9in. tubes, which can be readily assembled by the home constructor. In designing it we had three objectives :—
(a) OUTSTANDING QUALITY AND DEFINITION, (b) EASE OF ASSEMBLY, (c) ECONOMY IN COSTS.
We confidently believe that not only have we achieved a T/V receiver that surpasses in efficiency any other designed for the home constructor, but also the stage by stage diagrams permit the inexperienced to successfully assemble it at about half the total cost of a similar type of commercial receiver.

SOME OUTSTANDING FEATURES

- A **SUPERHET CIRCUIT** suitable for reception of all present transmissions, i.e., **LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE** and **KIRK-O-SHOTTS.**
- A **BRILLIANT** and **SHARP PICTURE** afforded by provision of high E.H.T. (approx. 10 K.V.).
- Outstanding **QUALITY** and **DEFINITION** for daylight viewing.
- **NEGATIVE FEEDBACK** in the Audio Frequency Stages.
- Simple control. Only two controls on the front of receiver.
- Simple and compact design with rigid C.R.T. mounting.
- The complete Televisor, including all Valves can be built for only **£28 . 0 . 0** (plus cost of C.R.T.).
- As no hire purchase terms are available the receiver can be bought in five separate stages (practical diagrams and circuits are provided for each stage) thus enabling hire purchase interest rates to be avoided.

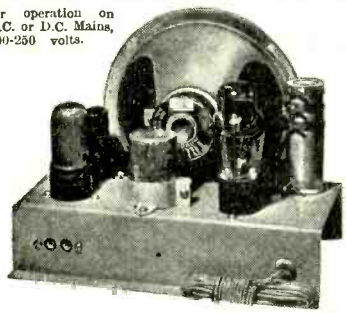
The complete set of **ASSEMBLY INSTRUCTIONS** will be available about 23rd May, price 5/- (refunded against first order). The instructions include really detailed **PRACTICAL LAYOUTS, WIRING DATA AND COMPONENT PRICE LIST.**

ALL COMPONENTS ARE AVAILABLE FOR INDIVIDUAL PURCHASE.
A CABINET WILL ALSO BE AVAILABLE.



A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

for operation on A.C. or D.C. Mains, 200-250 volts.



This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.
A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. × 5in. × 7in. and valve line up 25Y5-bsH7-25L6.
Price of complete kit, including drilled chassis and valves, **£4/2/9,** plus 6½in. P.M. (which fits on chassis), **16/-,** or 8in. P.M., **18/9.**
Price of fully assembled chassis ready for use, **£5/5/-** (plus cost of speaker).
Copy of assembly instructions and components price list available for **1/3.**

!! AMPLIFIERS !! TWO COMPLETE KITS OF PARTS

A 6-8 watt QUALITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, incorporating a simple arrangement to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.
The overall size of the assembled chassis is 10in. × 8in. × 7½in. high, and full practical diagrams are supplied. Price including drilled chassis and valves, of complete kit, **£6/17/6.** Price of assembled chassis, supplied ready for use, **£8/12/6.** Full descriptive leaflets are available separately for **1/-.**

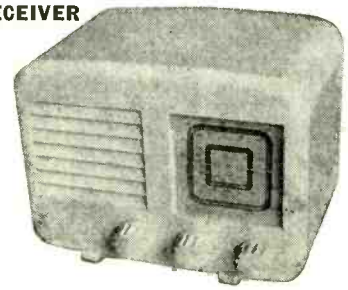
A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Preamplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 × 4 × 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volt, at 2 amps and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, **£14/-/-.** Complete specification and layout, **2/-.** We can also supply completely assembled and ready for use at **£17/-/-.**
THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THE COST.

A 5-VALVE "ALL-WAVE" SUPERHET RECEIVER

For use on A.C. Mains 200 to 250 volts.
This small attractive Receiver, embodying modern circuit technique, is designed to cover Short, Medium and Long wavebands, and incorporates the following outstanding features :

- A superhet circuit designed for high efficiency on all three wavebands.
- A 3½in. P.M. Speaker accurately matched for good quality reproduction.
- The latest range of new 6-volt B.V.A. miniature valves.
- Built-in frame aerial with provision for external aerial for distant stations.
- A white plastic cabinet of very attractive appearance. overall size 7½in. × 5½in. × 5½in.
- THE RECEIVER AS ILLUSTRATED CAN BE BUILT FOR APPROX. **£10/10/-.**

Send 2/6 for the fully descriptive stage by stage assembly and wiring diagrams, with which complete price details are given.



A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume/Mixer Control.

It can be used with any amplifier and with any pick-up, the range of frequency control provided, by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long playing, without recourse to pick-up correction.
The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier.
Response characteristics are given in 12-watt amplifier advt.
The unit measures only 7in. × 4in. × 2in., including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and 6J5), **£3/16/9.** Complete assembly data is available separately for **1/-.** Completely assembled and ready for use, **£5/5/-.**

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

Primary 200-250 v. P. & P. on each, 1/6 extra.
300-0-300, 100 mA., 6 volt 3 amp., 5 volt 2 amp., **25/-**.
Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6**.
Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., **16/6**.
Drop thro' 110-0-110 60 mA. 6 v. 0.5 amp., **8/6**.
280-0-280. drop-through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., **16/6**.
Auto-wound, H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separates 4 v. 3 amp., rectifier winding (upright or drop-through), **10/6**.
Auto-transformer, 110 v. 70 watts, **10/6**.
250-0-250, 80 mA. 6 v. 4 amp., **14/-**
Pri. 230 v. Sec. 200-0-200 35 mA. 6 v. 1 amp., **8/6**.
Pri. 200/250 v. secondary 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., **13/-**.
Semi-shrouded drop-through 200/250 v. primary; sec. 280-0-280 250 mA., 6 v. 6 amps., 5 v. 3 amps., **29/6**. P. & P. 3/-.
Heater Transformer, Pri. 230-250 v. 6 v. 1½ amp., **6/-**; 2 v. 2½ amps., **5/-**. 2, 4 or 6 v. at 2 amps., **7/6**; 2 v. 2½ amp. and 6 v. 0.6 amp. E.H.T. insulated, **8/6**. P. & P. each 1/-.

P.M. SPEAKERS (Closed field)

	with trans.	less trans.
2½in.	—	15/6
3½in.	—	13/6
5in.	16/6	12/6
6½in.	16/6	12/6
8in.	18/6	15/-

P. & P. on the above 1/- each. 10in. less trans., **25/-**. P. & P. 1/6.
R. & A. 8in. M.E. Speaker field coil, 1,600 ohms O.P. trans. 5,000 ohms, impedance, **18/6**. Post and packing 2/-.
6½in. Energised Television Speaker by PLESSEY. Field resistance 68 ohms. Will pass up to 300 mA. to energise, **9/6** each, 2 for **18/-**.
5in. M.E. Speaker field coil 750 ohm with O.P. trans. **17/6**. P. & P. 1/-.
Extension speaker cabinet, in contrasting walnut veneers, size 15 x 10½in. Will take 6½ or 8in. speaker. **17/6**. P. & P. 2/-.
Volume Controls, by famous manufacturer. Long spindle less switch, 50K, 500K, 1 meg., **2/6** each. P. & P. 3d. each.
Expanded aluminium speaker fret, 13¼ x 9in., **2/-.**
Volume Controls by famous manufacturer. Long spindle and switch, ¼, ½, 1 and 2 meg., **4/-** each; 50 K., **3/6** each. ½ and 1 meg., long spindle double pole switch, miniature, **5/-**. P. & P. 3d. each.
Trimmers, 5-40 pf., **5d.**; 10-110 10-250, 10-450 pf., **10d.**
Twin-Gang .0005 Tuning Condenser, 5/-. With trimmers, **7/6**. P. & P. 1/-.
Line Cord. 3-way 0.3 amp. 180 ohms, per yard, **1/3 per yard.**
Twin-gang, .0005 with feet, size 3¼ x 3 x 1⅝in., **6/6.**
3-gang .0005, with feet, size 4¾ x 3 x 1⅝in., **7/6.**
Television Coils wound in alican, size 2⅜ x ⅞in., with former and iron core, **1/-** each.
Twin-Gang Midget .00037 with perspex, dust-cover and trimmers, **8/6**. Post and Pkg. 6d.
Hoover Variable Speed 600-1,200 revs. Tape Recording Motor. Silent running, 200/250 v. A.C. Shaded pole with fixing. Weighr 5lb., **27/6**. Plus P. & P. 2/6.
A.C. Mains 230 v. 4 pole induction motor, originally made as a gram motor. **9/6**. P. & P. 1/6.
PERSONAL SHOPPERS ONLY. 9in. Enlarger **17/6**, 12in. **27/6.**

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Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and lists, S.A.E.

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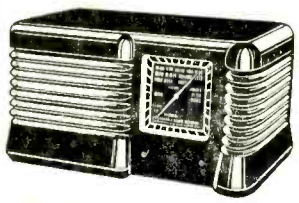
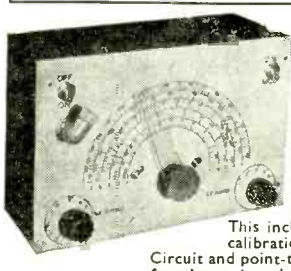
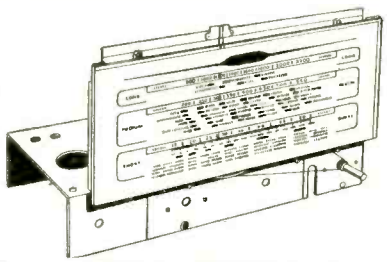


CABINET as illustrated, 11¼ x 6½ x 5½, in walnut or cream, complete with T.R.F. chassis, 2 waveband scale, station names, new waveband, back-plate, drum, pointer, spring drive spindle, 3 knobs and back, **22/6**. P. & P. 2/6.
AS ABOVE but complete with 5in. speaker and O.P. trans. (these speakers have been used but tested O.K.) **30/-**, P. & P. 2/6. Metal rectifier **7/6**. Gang with trimmers, **7/6**. Medium and long T.R.F. coils **5/6**. 3 obsolete Ex Govt. valves, 3 v/holders, and circuit of an A.C. mains 3 valve plus rec. T.R.F. which can be built for approx. **£4., 8/6**. Heater trans. **6/-**. Volume control with switch **3/6**. Wave-change switch **2/-**. 32 + 32 mfd. **4/6**. Bias condenser **1/-**. Resistor kit **2/-**. Condenser kit **4/-**.



KIT OF PARTS FOR SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 320 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s-8.5 Mc/s., 8.5 Mc/s.-20 Mc/s., Metal case 10in. x 6¾in. x 4¼in., size or scale 6½in. x 3½in. 2 valves and 1 rectifier valve, A.C. mains 230/250. Internal modulation 400 c.p.s. to a depth 30 per cent. Frequency calibration accuracy plus or minus 1 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts, **£3/10/-**, P. & P. 4/-. This includes the return to us for checking and calibration. We will build same for **15/-** extra. Circuit and point-to-point wiring diagram, **3/6. Kit of parts** for above, less checking and calibration, **£3**, plus 2/6 P. & P.



Constructor's parcel, comprising chassis 12½ x 8 x 2in., cad. plated 18 gauge, v/h., IF and trans. cut-outs, back-plate, 2 supporting brackets, 3 waveband scale, new wavelength station names. Size of scale 11½ x 4¾in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs, and pair of 465 IF's., **16/6**. P. & P. 1/9.

CRYSTAL PICK-UP by famous manufacturer, complete with sapphire trailer needle and volume control, **21/-**, post and packing on each 1/-.

EX-GOVT. RECEIVER TYPE B28. Complete coil unit. 6 bands, 60 kc/s.-420 kc/s., 500 kc/s.-30 Mc/s., **21/-**. Plus 2/- P. &P. Circuit for above, **4/-. Variable selectivity IF Switch** to suit above. **7/6.**
WATERHOUSE 5in. EXTENSION SPEAKER, complete with vol. control, in gold and green, **22/6**. P. & P. 1/-.
MAINS OR BATTERY SUPERHET PORTABLE COILS. Medium-waved frame aerial and long-wave loading coil, used as aerial coils. Midget iron-core screened L/M osc. coils, with circuit I.F. 465 Kc., **9/6.**
465 KC. MIDGET I.F.s. Q 120, size 1½in. long, 1in. wide, ⅝in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, **12/6.** Both these items **£1**, post paid.
CONSTRUCTOR'S PARCEL comprising chassis 8in. x 4in. x 1½in., with speaker and valveholder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, iron-cored, four valveholders, 20 K. volume control and wave-change switch, **23/-**. P. & P. 1/6.
OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, **4/9**; 42-1 speech coil 2-ohm with extra feed-back windings, **4/3**; Miniature 42-1 2-ohm speech coil, **3/3.** Multi-ratio 3,500, 7,000 and 14,000 2-ohm speech coil, **5/6.** 10 watt push-pull, 6V6 matching, 2 ohm speech coil, **7/-.**

Television Chassis: Size 9¾ x 9½ x 3½in., 18 gauge steel cadmium plated complete with 5-coil cans size 1¼ x 1in. with iron cored former. These are wound for television frequency, **6/6**. P. & P. 1/6.
Push-back connecting wire. Doz. yds. 1/6 post paid.

Standard Wave-change Switches, 6-pole 3-way, **2/-**; 4-pole 3-way, **1/9**; 5-pole 3-way, **1/9**; 3-pole 3-way, **1/9**; 9-pole 3-way, **3/6**; Miniature type, long spindle, 3-pole 4-way, 2-pole 5-way, 4-pole 3-way, **2/6** each. P. & P. 3d.

Valve Holders, moulded, octal, Mazda, and loctal, **7d.** each. Paxolin, octal, Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded with screening can, 1/6 each.

32 mfd., 350 wkg.	2/6
16 x 24 350 wkg.	5/-
4 mfd., 200 wkg.	1/3
40 mfd., 450 wkg.	3/9
16 x 8 mfd., 500 wkg.	5/-
16 x 16 mfd., 500 wkg.	5/9
8 x 8 mfd., 450 wkg.	3/6
32 x 32 mfd., 350 wkg.	5/-
32 x 32 mfd., 350 wkg. and 25 mfd., 25 wkg.	6/6
25 mfd., 25 wkg.	11d
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
Ex-Govt. 8 mfd., 500 v. wkg., size 3¼ x 1⅜, 2 for	2/6
60+100 mfd., 280 v. wkg.	7/-
16 x 32 mfd., 350 wkg.	6/-
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60+100 mfd., 350 wkg.	8/6
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/6
50 mfd., 50 wkg.	1/9

Miniature wire ends moulded 100 pf., 500 pf., and .001 ea. **7d.**
Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet, **17/6**. P. & P. 2/-.
Frame Oscillator Blocking Transformer, 4/6.
Frame O.P. Transformer. Inductance 10 hy. ratio 10 : 1, **9/6.**
Tube Mounting Bracket, size 9½ x 4¾in., 12in. tube clamps, **2/-.**
Smoothing Choke, 2 henry 150 mA., **3/6.** 250 mA. 4 henry, **5/-**; 250 mA. 5 henry, **6/-**; 250 mA. 10 henry, **10/6**; 250 mA 8 henry, **8/6.**
P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, **15/-.** P. & P 1/6.
P.M. Focus Unit for Mazda 12in. with Vernier adjustment **17/6.** P. & P. 1/6.
Energised focus coil, high resistance with mounting bracket **17/6** plus 2/- P. & P.
Ion Traps for Mullard or English **Electric Tubes, 5/-,** post paid.
465 Kc. I.F.s, size 2½ x 1⅜in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored I.F's. 4 x 1½ x 1½in., per pr. **7/6.** Wearite standard iron-cored 465 Kc. I.F's, 3½ x 1⅜ x 1⅜in., per pr. **9/6.**
Iron-Cored 465 Kc. Whistle Filter, 2/6.
Television Masks. White Rubber, 9in. with glass, **7/6.** Cream rubber, 12in. with armour-plate glass, **15/-**, plus 1/6 P. & P.
T.V. Width Control, 3/6.
Two-piece Octal Screening Can, 9d. P. & P. 3d.
Three-bank, 50 pf., 1/3. Four-bank, 50 pf., **1/8.**
Mains Droppers, 0.3 amp., 460 ohms, tapped 280 and 410, **1/6.** 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, **1/6**; 0.3 amps., 950 ohms, tapped 700 and 825, **2/6**; 0.2 amp., 1,000 ohms, vitreous, tapped, **2/6.** Vitreous .3 amp. 700 tapped 680, 640, 600, **3/6.** P. & P. on each 3d.
E.M.I. potted low resistance Pick-up Matching Transformer, 7/6.
Speaker Material, 12in. x 10in., **1/6.** post paid.
Used C.R. Tubes with ion burn 9in. **35/-**, 12in. **55/-.** Heater Cathode shorts 9in. **45/-**, 12in. **75/-.** P. & P. 7/6 each.

Germanium Crystal Diode, 2/3 post paid.

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UNIVERSAL AVOMETERS MODEL 40. These have had very little use and have been thoroughly checked and tested. Wonderful opportunity to acquire a first-class multi-range test meter at the BARGAIN PRICE of ONLY **£9/19/6.**

HALLICRAFTERS COMMUNICATION RECEIVER SKYRIDER DEFIANT SX24 covers 550kc/s to 45Mc/s (550 to 6½ metres) without gaps. Specially designed for the "ham"—controls include R.F. Gain, A.F. Gain, AVC On/Off, 3 position I.F. selectivity, Xtal Filter, Automatic Noise Limiter, BFO, Phone jack, etc., etc. "S" Meter is incorporated, BAND SPREADING ON ALL BANDS. Complete with all valves and crystal, ready for operation from 200/250 volt A.C. supply. Aerial tested prior to despatch or demonstrated to callers. Price **£27/10/-**, plus 10/- carriage.

COMMUNICATION RECEIVER R1155 for world wide reception. Can be heard at any time during shop hours. Air tested prior to despatch. Brand new at **£11/19/6.** A few soiled at **£7/19/6.** Also have a limited number of R1155N's at **£17/19/6.** Carriage in original transit case is 10/6 extra on all models.

A.C. MAINS POWER PACK/OUTPUT STAGE enables the R1155 to be used to operate speaker from 200/250 volts A.C. mains without any modification whatever. Guaranteed 6 months. Price **£4/10/-**, plus 3/6 carriage. Send 1/3 for details of the R1155.

SAVE MONEY BY PURCHASING THE NEW R1155 AND POWER PACK AT THE SAME TIME. ONLY **£15/19/6** PLUS 12/6 CARRIAGE.

RECEIVER TYPE R1132A covers 100-124 Mc/s with variable tuning. Complete with all valves and Jones plug. Requires only 250 volts and 6.3volts, when it is ready to operate. Price **79/6**, plus 10/6 carriage. BRAND NEW. Will operate from our R1155 power pack using special lead—price **£4/10/-**, plus 3/6 carriage. (Lead only **10/-**.)

RECEIVER TYPE R1481 covers 65-85 Mc/s—Callers only this item.

TYPE 3 RACK MOUNTED POWER PACK for above receiver. For callers only. Brand New, and tested.

RECEIVER 68P. A four valve battery superhet receiver. Uses standard 465kc/s I.F. Transformers. Complete with all valves. Frequency range 1.5 to 3 Mc/s (100 to 200 metres). Circuit supplied. ONLY **32/6.**

RECEIVER R1225 covers roughly 100-150 Mc/s., though sold primarily for break-up purposes. As it contains 5-EF50's, 2-EF39's and 1-EB34 and hosts of other valuable short wave components it should represent a very good buy at ONLY **25/-** plus 2/6 carriage.

RF26 and **RF27** uses 2-EF54 and EC52. RF26 covers 50-65 Mc/s and RF27 covers 65-85 Mc/s. Brand new and boxed, either type **59/6.**

SPECIAL PURPOSE VALVES VT501 (TT11) **5/-**, 954 **2/6**, VR136 (EF54) **6/6**, VR65A (SP41) **3/-**, 2C34 (RK34) **2/6**, VR135, CV6, E1148 at **1/6** or **15/-** per doz. post free. Hundreds of other types in stock, including Magnetrons and Klystrons.

SYLVANIA RED EF50's. Brand new at **8/6** each. British types tested, at **5/-** each.

THREE WAVE BAND COIL PACKS covers 16-50, 190-550 and 900-2,000 metres with gram. position for 465 kc/s I.F.'s. Circuit data provided. Iron cored coils, tropicalised. A first-class job. Size 3½in. x 2½in. x 1½in., single hole fixing. Price **16/-.**

SPECIAL OFFER of above coil pack and pair of iron cored, I.F.'s to match for only **22/6** complete.

STANDARD MAINS TRANSFORMER Primary 200/230/250 volts 50 cycles. Sec. 325-0-325 volts 70 mA, 6.3 volts 2.5 Amps, 5 volts 2 Amps. Half shrouded, drop through, with mains panel. Size 4in. x 3½in. Brand new at **12/6** each plus 1/6 post.

E.H.T. TRANSFORMER for the VCR97, etc. Mains input. Output 2,500 volts. 4 volts 2 Amps, 2-0-2 volts 2 Amps. Fully guaranteed at **35/-** plus 1/- post.

METAL RECTIFIERS SELENIUM 230 volts 60 mA at **5/-**, 250 volts 80 mA at **7/6**, RM2 at **4/3** or 2 for **8/-**, RM3 at **5/-**, RM4 at **17/-.**

50 MICRO-AMP METER 2½in. panel mounting at **65/-.**

1 MILLI-AMP METER 2in. square **15/-.**

INDICATOR UNIT 62A complete with VCR97 and mu-metal screen, 12-EF50, 4-SP61, 3-EA50 and 2-EB34. Brand new condition, **£7/10/-**, plus 9/6 carriage.

INDICATOR UNIT 182A contains VCR517, 3-EF50, 1-5U4G and 4-SP61, Tubes demonstrated. BRAND NEW (less relay) at **79/6** plus 7/6 carriage.

45MC/S PYE STRIPS Vision unit for London frequency, complete with 6-EF50's and 1 EA50. Circuit provided. Price **£3/10/-**, plus 2/6 post.

T.V. PRE-AMP uses 2-EF50 and tunes to 45 Mc/s. Easily altered to other frequency. With valves **19/6**, less valves **10/-**. Post 1/- extra.

R.C.A. SPEAKER 8in. P.M. unit in beautiful black crackle cabinet. A de luxe job. Brand new at **45/-** plus 2/6 carriage.

SPEAKER CABINET—rexine covered 5 ply, takes heavy duty 12in. speaker. Size 19in. x 19in. x 14in. Brand new at **59/6** plus 4/6 carriage.

"INEXPENSIVE TELEVISION". How to build a T.V. receiver from ex-Govt. surplus. Price **2/9** post paid.

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U.S. NAVY OSCILLOSCOPE UNITS—Containing 5 BPI. 5in. Tube with fully screened mu shield isolating heater trans. Dozens of H.V. Cond., Resistors, Pots, etc. The finest value offered to date in "Scope" units. "W.W." T/V 'scope circuit included. Price **57/6.**

LABORATORY TEST EQUIPMENT. For aligning and checking Trans./Receivers covering 150 to 234 Mcs. comprising:
Type BC906. Frequency Dip Grid Meter. 145-235 Mcs.
Type 1-196-B. Signal Generator. 150-234 Mcs.
Type BC1066-B. Radio Receiver. 150-234 Mcs. Price **£12** the Set. Carriage extra.

VALVES. IS4, **10/6**; 6AG5, **10/6**; 117Z6, **12/6**; 6SH7, **6/6**; EF50, **8/6**; 955, 954, **6/-**; SG215, **6/6**; Pen 220A, **6/6**; TT11, **8/6**; VR 150, **10/6**; 42, **10/6**; CK512AX, **9/-**; 6AG5, **10/6**; 9001, 9002, 9003, **7/6**; 954-955, **6/6.**

MAINS TRANSFORMERS. Input 200/240 v. Output 350-0-350 or 250-0-250 volt 80 mA. and 4 and 6.3 v. 4a. and 4 and 5 v. 2 a. Price **21/6.** Input 200/240 v. Output tapped 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 volts, 2 amps., **21/6.** All with one year's guarantee.

D.P.D.T. RELAYS. Operate at 200/300 volts D.C., **8/6.** D.P. make and break, **8/6.** We can supply any type of voltage and contacts at varying prices.

NEW SELENIUM RECTIFIERS. F.W. 12/6 volt 3 amps., **14/6**; 4 amp., **22/6**; 6 amp., **30/-**; 1 amp., **8/6**; 12 v. 100 mA., **3/-**; 250 v. 100 mA. H.W., **9/-**; 80 mA., **6/6.**

TYPE IN34—GERMANIUM CRYSTAL DIODES, 5/6.

B.C. 603 RECEIVER AND B.C. 604 TRANSMITTER. 20 to 28 Mc/s. Including 80 crystals, **£35**, carriage extra.

U.S. MANUALS for Test Equipment IE-56-A, SCR-729-A and SCR729A.Z. Contains all the gen on Freq. Meter B.C. 906, Receiver B.C. 1066 and Sig. Gen. 1-196-B, **21/-.**

VCR97 CRTs. New and crated. Picture tested, **45/6.** Bases, **3/6.**

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CARBON MICROPHONES with Matched Trans., **10/6.**

0-500 MICROAMMETERS 2in. 16/6.

M/C MICROPHONES with matched Trans., **15/-.**

4ft. ROD AERIALS, set of three **6/-.** Base **3/-.**

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METAL MINE DETECTOR UNITS. This detector gives warning of the presence of metal objects in water, timber, underground, etc., and there are probably many applications for which this equipment can be used in addition to its original one. We supply them complete in strong wood transit cases the principle items being an AF. amplifier employing 3-ARP12 (VP23) valves mounted in metal case with battery space 11×11×4½ins., search coils, control box front and rear pole sections, high resistance headphones, connectors and various carrying satchels. Power requirements are 60-90v. HT. and 6-"8" type 1.5v. cells for LT. (Not supplied.) Condition is as new and unused. Working instructions included. **PRICE £3/12/6**, carriage 10/6.

HAND GENERATORS Mk 2. Manually operated generators originally designed to provide the operating voltages for the American trans/Rcvr. types 18 and 48 but of course suitable for a variety of other purposes. Nominal rating is HT. 162v. D.C. at 60mA. and 3.1v. D.C. at 0.3A. which with suitable series resistance will provide for 2v. or 1.4v. heaters. A built-in filter unit provides adequate smoothing and suppression. Ideal for portable rig. In brand new and unused condition. **PRICE 25/-**, carriage 7/-.

MILLIAMMETERS. An 0/1mA and an 0/10mA. Moving coil 2½in. square bakelite cased meters mounted side by side on the front panel of a neat metal cased unit measuring approx. 5½×5½×2ins. Also fitted on the front panel is a DP/DT. toggle switch, a 2 way wafer swt., and a 12 point plug. Condition as new an unused. **PRICE 22/6**, post 1/9 or without the 0/1mA. meter **PRICE 10/6**, post 1/9. (Regret not available with only the 1mA. meter.)

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RELAYS — P.O. TYPE 3,000

BUILT TO YOUR SPECIFICATION—EARLY DELIVERY. QUOTATION BY RETURN—PLEASE STATE RESISTANCE OF COIL REQUIRED AND CONTACT BUILD UP.

RACKS. Standard 6ft. P.O. type for 19in. panels, steel channel sides correctly drilled, heavy angle base.

TEST SET 205. Wavemeter range. 3.05 to 3.35 centimetres, built-in oscillator with 9 valves including Klystron type CV.129, etc., in good condition, **£25.**

MICROAMMETER. 0-50 2½ Flush type, contained in Test Set 28. A very sensitive meter. Scaled 0/100. **£3/10/-** complete.

VOLTAGE REGULATORS. Input 230 volt A.C. 21 amps., output 57.5 to 228 volts in 16 steps. With current limiting Reactor. **£10.**

VARIAC TRANSFORMERS. Type 80 CO. Input 200/240 v. Output 220 v. 7.5 amps. **£7/10/-** each.

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COLLARO RC511 single-speed Autochanger. Magnetic, price **£11/14/11**, incl. P.T. Crystal, price **£12/3/2**, incl. P.T.
COLLARO 3/RC511 3-speed Autochanger with two heads, **£18/14/1.**
B.S.R. MONARCH 3-speed Autochanger with reversible pick-up, price **£17/17/-.**
GARRARD RC.75 3-speed Autochanger, **£16/6/6.**
COLLARO AC47 single-speed turntable and motor. Centre driven by heavy induction motor. Price **£6/13/4**, incl. P.T.
COLLARO AC514 Record Player. Single-speed rim-drive with pick-up. Price **£6/19/-**, incl. P.T.
B.S.R. single-speed motor and turntable MU.15. Price **£3.** Fitted in portable bakelite cabinet, **£4/10/-.**
DECCA 3-speed Gram. motors. Price, incl. P.T., **£6/8/6.**
DECCA Turnover Pick-up for use with above motors. Price, incl. P.T., **£3/19/4.**
ACOS G.P.20 Standard or long playing, price **£3/11/5.** Spare heads, **£2/3/4.**
B.S.R. GRAMOPHONE UNIT. 3-speed motor with pick-up, mounted on plastic playing table. Price **£9/19/11**, including purchase tax.

GARLAND ACIV AMPLIFIER (C)

Providing exceptionally wide frequency response and low harmonic distortion at a maximum output of 11.5 watts. High and low gain inputs with bass, treble and volume controls. Standard valves throughout, **15** gns., plus 15/- carriage, etc.
GARLAND KIT for ACIV, **£13**, plus 15/-, carriage, etc.

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Incorporates volume and tone controls, providing 4 watts output. H.T. and L.T. supplies are from mains transformer. Standard valves throughout. Amplifier wired and tested, **£6/2/6**, plus 5/- carriage.
GARLAND KIT for ACII, **£5/2/6**, plus 5/- carriage.

HIGH-QUALITY AMPLIFIERS (C)

LEAK "Point One" TL12/12 watt, **27 guineas.** LEAK RC/PA/U remote control pre-amplifier, **9 gns.** LEAK "Varislope" pre-amplifier, **12 gns.** ACOUSTICAL QUAD 12-watt Amplifier (including pre-amplifier), **£35.** ROGERS "WILLIAMSON" AMPLIFIER, **£31.** ROGERS "WILLIAMSON" PA/TC/UNIT, **£10/7/6.** ROGERS "RD BABY DE LUXE" including pre-amplifier, **£18.** ROGERS "JUNIOR DE LUXE" 10 watt, **£26/10/-.** ROGERS "MINOR" 4 watt, **£11.**

CONNOISSEUR 3-SPEED TRANSCRIPTION QUALITY GRAMOPHONE MOTOR AND TURNTABLE

Full 12in. turntable, 33⅓, 45 and 78 r.p.m. The synchronous motor is virtually vibrationless and suitable for standard, transcription and micro-groove recordings. Including P.T., **£23/13/-.**
CONNOISSEUR. Super lightweight pick-up with interchangeable heads for standard or micro-groove recordings, fitted with easily replaceable semi-permanent sapphire. Price complete with two heads, **£10/0/8.**

AMPLION TESTMETERS

10 ranges A.C. and D.C. up to 500 volt. Resistance up to 200,000 ohm; 1,800 ohm per volt, A.C. and D.C. Price **£5.**

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6in., clear, **19/6**; 9in., clear or filter, **50/-**; 12in., clear or filter, **70/-.** Please state which and add 5/- for carriage and packing.

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They set a new standard in quality and value, and we confidently recommend them for use with tape recording and public address systems.

TYPE 7D. A directional microphone with a frequency response from 60 c/s to 8,000 c/s; chromed frame with black grid. Price **£4/13/6.**

TYPE 9ND. A multi-directional high output microphone, with a response from 100 c/s to 6,000 c/s. The frame is of black bakelite; the grid is cadmium plated. Price **£2/6/6.**

TYPE 11A. This model is specially designed for amateur transmitting, and is fitted in a brown case with chromed grid. The frequency response is substantially flat from 40 c/s to 8,000 c/s. Price **£6/17/-.**

TYPE 13U. A highly sensitive microphone with outstanding frequency response (70-10,000 c/s), mounted on a flexible tube enabling the directional properties to be adjusted. Finished in black with chromed fittings. Price **£7/17/6.**

DECALS.
500 ⅛in. high transfer letters and words for marking electronic equipment. These labels give your apparatus that "finished" appearance. Available in black or white; price **4/9** per book. The new Decals book is now available specially for the amateur; 29 words per page, 4 pages radio and audio, 4 pages television and oscilloscope, 2 pages miscellaneous including transmitting and tape recording. Price **3/6**; state whether black or white required.

TAMSA TYPE 100 TAPE RECORDING HEADS. This new range of tape recording heads incorporates many new features; chromium plated brass shell; adjustable mounting for ease in alignment; designed to require the minimum of frequency correction in the amplifier; record-playback heads have half-track .00025in. gaps; erase heads have half-track .0025in. gaps. These heads are of high impedance. Price **45/-** each. WE ARE SOLE DISTRIBUTORS OF THESE HEADS TO THE RETAIL TRADE.
These heads are suitable for use with our UE7B record/playback amplifier as described in the adjacent column, or with a high gain amplifier and our Oscillator Unit which supplies all high frequency bias and erase potentials. This unit with valve is priced at **35/-.** The high impedance oscillator coil as used in this unit is available separately for **6/9.**

GARLAND UE7B RECORD PLAYBACK AMPLIFIER

A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Control panel included. Supplied complete with 8in. P.M. loudspeaker. Price **£13/2/6**, plus 7/6 carriage, etc. Trade supplied.

THE LATEST LANE TAPE TABLE

Incorporating three heavy duty Lane motors; automatic braking; fast forward and rewind without tape handling; high impedance half-track heads; hub locking device. Tape speed 7½in. per second. Price **£17/10/-.** Carriage, etc., 10/-.

MAGNETIC TAPE

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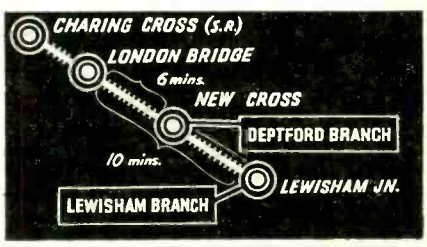

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Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day: June 1953 issue, Wednesday, May 6th. No responsibility accepted for errors.

WARNING

Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee: Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

CRYSTAL microphone inserts (Cosmocord mic-6) guaranteed brand new, 15/6 post free; Cosmocord mic-30 hand stand microphones, black or white, £4/4 each, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Bickford Rd., Witton, Birmingham, 6 (Eas. 0435), the Midlands specialist manufacturers of high fidelity sound reproduction equipment for the world-famous Williamson amplifier and associated accessories including tone control stages, loudspeaker crossover units, distortionless contrast expanders and radio feeders; send for details and prices. [0105

THINKING of investing in a new radiogram chassis? Then why not buy your chassis direct from the manufacturers? We specialise in high-quality radio receivers and feeder units; our E534 is a particularly fine performer a 3 wave-band 5-valve superhet; latest miniature-type valves, 4 watts output, handsome floodlit glass dial in 3 colours; we also recommend model RF33 feeder unit; 2½d stamp for literature; trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [9948

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

R.C.A. AR-77E, good condition. £30 o.n.o.; R.C.P. valve volt ohmeter, model 664, perfect order, £20.—Tel. Sou. 2852. [9915

1132A V.H.F. receiver, power unit, partly modified 144 mc/s, as new; £5.—42, Kings Rd., New Haw, Weybridge, Surrey. [9888

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

SPENSER-WEST TV converter A.P. to Holme Moss frequency, model AC4 HL, power pack has 4 of 6F13 and 1 UU9; offers.—Bowler, Garthgwyn, Holywell, Flintshire. [9906

HALLICRAFTERS SX42 AM/FM/CW receiver, 540 kc/s-110 mc/s, best offer over £110; S36A AM/FM/CW VHF receiver, 28-145 mc/s, £65; AR88D, £50; SX28A, £65.—Box 6024. [9882

WHARFEDALE W12CS, as new, £9; W10CS, £6/10; Vitavox K12/20, used, £5; Premier tape recorder complete, unused, £35; McCarthy 12in table T.V., as new, £38.—Taylor, 191, Ashton Rd., Denton, Manchester. [9957

EDDYSTONE 680 super communications receiver, 480 kc/s to 32 mc/s, in mint condition, used only a fortnight, with matching speaker; a bargain at 69gns; may be inspected at Brown's Radio, George IV Bridge, Edinburgh.—Robertson, Royal Bank, Ardrossan. [9874

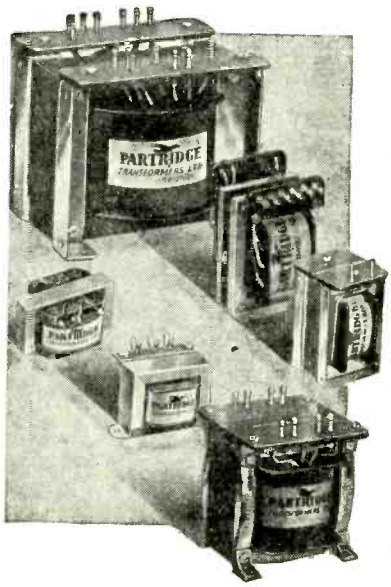
MULTI-LOUDSPEAKER, radio and radiogram installation for hotel, restaurant or club; the installation includes a Decca sound system radio receiver (long, medium and short wave), fitted with loudspeaker control panel, 8 loudspeaker stations mounted on baffles, and one Garrard auto record changer model R.C.65, all for operation on 230v A.C., 50 c/s; a voltage control panel and 50v D.C./230v A.C. converter is also included; the equipment cost £500, but will be sold for £200 or nearest offer.—W. E. Hedges, 21, Douglas St., London, S.W.1. Victoria 3404. [9901

LOUDSPEAKERS—SURPLUS AND SECONDHAND

11 55 p/pack, 10in spkr., good condition; £7/10 or nrst.—Bain. 63, Castlecroft Rd., Wolverhampton, Staffs. [9934

NEW DYNAMOS, MOTORS, ETC.

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C.; any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0112



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ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.
DIESEL Electric generating plants, 3kva, 230v with push-button remote control, starting equipment, ready for use; £250.
CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

THE Pearce new model diesel alternator plant, on welded steel frame, 230/1/50 3kva plus 32v 15a d.c., Petters latest AVAI, air-cooled diesel engine, alternator, self-energized, automatic voltage control by winding on stator, at govern. speed 1,500rpm d.c. output trickle charges or charges lighting and starter battery up to 15amps. 24v lighting is used when plant is not in use; start and stop by remote control push-button; complete with main switch and fuses, battery cables, 24v 72 amp/hr batt., instruction book, spares; engine covered by Petters' inspection service; £275, free delivery; where remote start and stop not required, but only push start on plant, reduction of £6/10; a few from stock, others quick delivery; if you collect, or we deliver, battery is charged and a 10 cu ft concrete bed given free.
SEND p.c. for full description and photographs.
ALSO above plant fitted Lister slow-speed water-cooled diesel, and electric flywheels.
ALTERNATORS, 230/1/50, 400VA, self-energized, 3,000rpm, ball bearing, £23/15 del.; also special television model same price; voltage regulator 30/- extra.
TELEVISION for the Coronation.
SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb d.c. input, 12v 200va out, 24v, 32v, 50v, 110v, 230v d.c. to 230v out, 250va, £27/10 del.; also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £24/10 del., immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield, a 24v
TELEVISION converter was tested on Ekco television, 12in tubes, stated consumption 135watts, d.c. current from battery only 9½amps, picture and sound were perfect and completely free of interference or flutter.
THE above are the latest products of British manufacture, and are guaranteed for one year; fullest details of plant, alternators or 400VA alt. or rotary converters, by return post; state which required; terms c.w.o., pro forma invoice c.o.d. (post goods only).
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DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

TV without mains, picture equal to mains supply, as supplied to the B.B.C., special Chorehorse A.C./D.C. petrol electric generators, self-starting, self-contained, compact, A.C. voltage 220/250, 50/60 cycles, 250/350 watts; will also run radios, vacuum cleaners, small tools, etc.; D.C. output will charge batteries for permanent lighting.
PRICE £47/10 plus 10/- delivery.—Below.
STORAGE batteries, finest possible specification, dry, uncharged, 12v 75 a.h. heavy duty, 19 plates, separate cells, in hardwood cases, price £7/17/6 plus 9/6 delivery.
6V 90 a.h. 15 plate hard rubber cells, also suitable for cars, tractors, lorries; price £3/7/6 plus 7/6 delivery.
TEDDINGTON ENGINEERING Co., Ltd., Dept. "D," High St., Teddington, Middx. [0023

TEST EQUIPMENT—SURPLUS AND SECONDHAND

AVO 7; £12 or near offer.—Lee 0589. [9966

EVERSHED 500v Bridge Meggor, £28; Marconi TF340, £30; Cossor 3332 oscilloscope, £15; wanted, s/h modern valves.—Box 6436. [9965

MODEL 7 Universal Avometer, as new, for sale.—Weinstock, 341, City Rd., London, E.C.1. Ter. 6145. [9945

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986.

NEW GRAMOPHONE AND SOUND EQUIPMENT

TAPE constructor's envelope, 5/6. Swift radio (M.O.).—21, Hibbert Rd., Harrow, Middx. [9730

LONG-playing records played on your gramophone with our speedchanger; 21/6.—B.D. Co., 591, Green Lanes, London, N.8. [9953

TAPE recorder motors, 230v, a.c., powerful, quiet, brand new, 13/11; post, etc., 1/1.—K. W. Logan, Westalley, Hitchin, Herts. [0232

FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE NO. 141.

NEW GRAMOPHONE AND SOUND EQUIPMENT

WEARITE tape decks, £35; 9 watts P.P. R./P. amplifiers to suit, £25; these are first-class amplifiers, freq. res. 25-19 kc/s, with sep. bass and treble controls; amplifiers for Bradmatic desks, £30; for Truvox, 18gns (9 watt P.P.); for Lane, etc., 14gns and 17gns, or built to order.—Harding Electronics, 120a, Mora Rd., London, N.W.2. [9875

POLLOCK lightweight m/c pick-up, response 40cs to 20kc/s, h.f. resonance 25kc/s approx.; complete set of parts for constructing head, 25/- plus 1/- post and packing; building instructions, 5/-; sapphire stylus .001in or .0025in, 7/6; model also for thorns; 100:1 input transformer, steel case, 20/- plus 1/- post, etc. —S.a.e. for details to A. M. Pollock, 31, Brooklawn Drive, Manchester, 20. [9909

FREQUENCY modulation.—Amos & Johnstone's new receiver; enjoy the superb reproduction offered by this service, with the added advantages of silent background and great volume range; sets in kit form (see New Components also), 145/-, or complete ready to drive amplifier; demonstrations dly. exc. Fri.'s 3-4.30. —Ring Arc. 5078. Bel Sound Products Co., Marlborough Yard, Archway, N.19. [0185

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

LANE tape table Mark III, as brand new, unused; £13.—Box 6437. [9967

TAPE recorder, complete, Grampian Microphone, as brand new; £55.—Box 6378. [9942

B.B.C. type prof. disc rec. 78 and 33⅓ motor scroll, 150hms; £88.—Taylor, 3, Clover Mews, S.W.3. [9956

CLIFTON tape desk, three motor, two speed, new, osc. coil, two reels tape; £13/10.—27, Lime Grove, Ruislip, Mddx. [9933

FERROGRAPH tape recorder, model D, only slightly used; £65; write to the Evangelical Electric Co., Ltd., 316, Vauxhall Bridge Rd., London, S.W.1. [9926

M.S.S. portable disc recording machine, latest LED model, unused and guaranteed, £35; Ferrograph magnetic tape recorder, £69; 12 unopened spools, Emitape, 25/- each; Leak Varigroove pre-stage unit, £9.—Box 5548. [9743

SOUNDMIRROR tape recorder model TP445, mahogany case, used for demonstrations only, new; £40.—Wycombe Electrical Supplies, Ltd., 51, Oxford St., High Wycombe, Bucks. [9925

MAGNETIC recorders; all types of magnetic recorders bought, sold, hired and exchanged; comprehensive repair service; mechanical and electronic repairs carried out by specialists; Magnegraph Limpet telephone pick-ups, 25/-. THE MAGNEGRAPH RENTALS Co., 1, Hanway Place, Oxford St., W.1. [0236

WEARITE tape decks, as new, £30; Truvox tape desk, as new, 20gns; E.M.I. 12in recording blanks, 3/- each; Emicorda, as new, 80gns; Ekco television pattern generator, £10; Truchord reproducer (listed 44gns), perfect, 36gns; Truchord tuning unit (listed 20gns), as new, 16gns.—Rex Radio, 329, Kilburn Lane, W.9. Lad. 1770. [9931

NEW COMPONENTS

SWIFT RADIO.—Send for our free component catalogue to-day, Viewmaster, tape, gram., etc.—21, Hibbert Rd., Harrow. [9918

ROTARY switches, bakelite enclosed type, 8-way 10amp, a.c.; 15/6; p.p. 9d.—Champion, 43, Uplands Way, London, N.21. [0100

ENTIRE liquidation stock of wholesaler; must be cleared immediately.—Lists from Box 4a, P. & G., 123, Queen Victoria St., London, E.C.4. [9949

LIMITED quantity new Labgear I.F. transformers, 1st and 2nd core, standard capacity, 465 k/c; per pair 6/6 post free.—Encl. P.O. to Box 284, 15, Monmouth St., London, W.C.2. [9773

VIEWMASTER kits, brand new specified parts, less speaker tube, valves and cabinet; 9in £25/10, 12in £28/10, assembled £3/10 extra; sound/vision chassis assembled, £7/7; s.a.e. details.—Betts, 53, Mirfield Grove, Hull. [9910

FOR really good results you can do no better than use Osmor coils and coilpacks, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new coil-data leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, all Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1. OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9. [0046

FREQUENCY Modulation.—Parts for the Amos & Johnstone receiver; input 50μV for 0.3v AF, from the Wrotham high fidelity station at 91Mc/s; avg. London field produces 3 volts, audio output ready to feed amplifier consumes 30ma at 250v, 6.3v at 0.9a, described Oct., '52; complete set of parts including valves, wound coils, germanium diodes, drilled chassis down to nuts and bolts, price, post free, 145/-; add full frequency range transmission to your set or amplifier; programmes 6-11 p.m. and daytime; trade enquiries also invited.—Bel, Marlborough Yard, London, N.19. Arc. 5078. [0186

NEW COMPONENTS

MALDEN TRANSFORMER SUPPLIES offers 80W fluorescent chokes, 230v with circuit, 17/6; glow starters, 2/6; 6 and 12v metal rectifiers, 2 amp, 8/6, ½ wave, 250v 300 mill-amp, 13/6, supplied to any specification; ex-Government safety heaters 230v 350W, 14/6; rotary converters, 12v or 24v d.c. input and giving 250v 60 mill-amp and 6.3v at 2.5 amp, 6/8; speaker cases, 5in, bakelite, 5/8.—200, Cambridge Rd., Kingston-on-Thames. Kin. 5501. [0038

COMPONENTS—SURPLUS AND SECONDHAND

MORRIS, 89, Tottenham Court Rd., W.1. (Goodge St. Tube).
MIDGET radios, complete 1953 Cadet, universal a.c./d.c. portables, ivory plastic with handle, fine tone and volume, 5in speaker, maker's guarantee; £6/19/6.
DULCI 1953 all-wave 5v superhets, ivory plastic, maker's guarantee; £10/19/6.
B.S.R. gram motors with turntable, brand new, 59/6; Rothermel S8 crystal pick-ups, 27/6.
VALVES: VR108 (Sp13C), 3/11; VT171 (DK92), VT172 (DAF91) VT173 (DF91), VT174 (DL92), 11/6, VU39 (MU12/14), 9/6; HL2/K, 5/6; 500 other types, this month's list, s.a.e. please; trade welcomed; 9-6 week-days, 9-1 Saturdays.

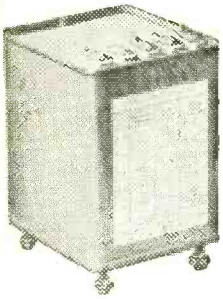
P. B. CRAWSHAY, 166, Pixmore Way, Letchworth, Herts. Tel. 1147.
VOLTAGE regulators, Ferranti 230v motor-driven moving coil, 480va, £18; 1,410va, £28.
METADYNE generators, 45v, 60a type MD70EX, new, £28; Servo d.c. motors, 1½hp, 1,000 r.p.m., for use with MD70EX metadyne, fitted e.m. brake and worm drive for inching, new £15.
POWER-SERVOS, AP 55938 motor torque transmitters, £8.
AMPLIDYNE motor generators, in 78/110v d.c. out 250v. 1a, 3,800/5,000 r.p.m., G.E. (U.S.A.) £7.
SELSYN motors, B.T.H. type SJ2512 230v a.c., 45lb in torque, wt. 38lb, 95/-; type 54, 50v a.c., wt. 13lb, 45/-; Diehl (U.S.A.), wt. 8½lb, 115v a.c., new, 45/-.
MAGSLIPS, 3in resolvers AP 10861, new, in tins, 45/-; large quantity; other types.
MULTIVIBRATOR, 100 kc/50 cps, G.E.C., 230v a.c., rack mounting, complete unit, new, £55.
MOTOR alternators, in 230v d.c. out 210/420v, 3ph, frequency variable 25/50 cps, 25/50 kva, B.T.H., £12, in 230v d.c., out 115/1/60, 33a, G.E., £18; in 400/3/50, out 180/1/500, 27a, £24; in 24v d.c., out 80v, 1.200c, 6.25a, £5.
FREQUENCY meters, 40/60 cps, 230v 6in, £9; ditto 130v, 5in, £5; ditto 12/16v, 5in, for use with alternators below, new, 40/-.
ALTERNATORS, small, 12/18v, 3,000 r.p.m. 18/-.
AMMETERS, 5in 0/14a, MI, a.c./d.c., new 25/-; ditto, M.C., d.c., new 25/-.
PROCESS timing controls, Londex ASR/IMP, automatic repeating, 230v a.c., 0/60 secs, £8.
SELENIUM rectifiers, S.T.C., 12v 4a bridge, 112mm discs, heavy duty tags, new, 17/6.
RECTIFIER units for 230v a.c. complete, 90v, ½amp, £6; 24v, 10a, £11; 30v 40a, £18.
PHOTO-RELAY sets, G.E.C., 230v a.c., complete set of 2 massive watertight units, £9.
TRANSFORMERS, 15 kva, HV: 528, 480, 432, 264, 240, 216, 132, 120, 108v, LV 240, 120v, double wound, 1ph, 50/60 cps, £22; 5kva, in 230v, out 100/270v by 10v steps, auto, £10.
VARIACS, in 230v out 0/230v, 8 amps, type 100L as new, last few, to clear, £14.
BRIDGE-MEGGERS, by E. & V., 250v, self-contained type, accuracy tested, last few, £14.
P. B. CRAWSHAY, 166, Pixmore Way, Letchworth, Herts. Tel. 1147. [0240

MAGSLIPS at 1/10 to 1/20 of list prices, huge stocks, please state requirements.—K. LOGAN, Westalley, Hitchin, Herts. [0233

SOUTHERN RADIO SUPPLY Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 134. [0016

RADIO UNLIMITED, Elm Rd., London, E.17. Electrolytics, fresh stock, 450vw, 16 mfd, 3/-; 24×24, 3/9; 32 mfd, 3/6; 16×16, 4/-; 32×32, 4/9; 500vw BR series, 8 mfd, 2/3; 16, 3/3; 8×16, 4/3; 32 mfd, 4/3; bias 25/25, 1/6; 50/50, 1/9; Fil trans, 200-250v, 6.3v at 1.5 amp, 6/9; STC M/recs., RM1 and RM2, 4/6 each; RM4, 16/6; A.C. mains amplifier, 2-valve+rec., vol. and tone cntrls, etc., complete with valves, ready for use, 75/-; in kit form, 59/6; I.F. trans 500 series, 465 K/cs, 9/6 pair; Midget 465s, 10/6 pair; v/cntrls, all values, 2/9; SP/sw, 4/6; wire-wound pre-sets, all values, 2/9; wire-wound standard size, 5/-; non-mag, 6½in speakers, 13/6; H.R. phones, 14/6 pair; full stock list available.—Tel. Key. 4813. [0062

G. A. RYALL, "Utopia," Mayfield Rd., Herne Bay, Kent, offer post free bargains; switches, Yaxley type, 2B S.P. 6-way, no stop, switch plate drilled for this, 1/4; smaller type, 3B 2P 6-way, total five poles only, 2/3; also 2B 3P 3-way with coloured high-voltage leads, 1/4; one type 2B 4-way, five poles total, soldered tags, 1/4; toggles, Bakelite, 250v A.C., close either two poles 1/3, and 2P D.T. change over 1/6, all single-hole fixing; and heavy duty 10amps bakelite panel mtg., four-hole fixing marked on/off, 1/6; radio mains suppressor units, four division, fixing feet, terminals in case, 5/9 each; high resistance headphones, padded headbands, sponge earcaps, all wired into 4 cleft plug, ex-R.A.F., good condition, 8/9; trimmers on ceramic, in separate cartons, 25mm 3/6 doz., or 50 7/6; sliding resistances on stand worm drive, 25amp 0.4ohms, can be 0.8ohms, with slight alteration, resistance wound in parallel, 10/- each; sleeving high voltage 3½mm and 4mm, 100 yards for 7/6. [0205



Three-in-one Transformer suitable for (a), Modulation or Output using P/P807's etc. (b) Mains Auto 230 to 110 volts 75 watts (c) Mains to 150.0.150 volts at 100 m/a. U.S.A. manufacture 6/- each.

Indispensable in the Shack

Meters marked AIR/OIL Moving Coil, basic 200 microamps., 2½in. square, very sensitive, 7/6 each.

Resistors, grey, vitreous, 15 watt, 5 : 2,500 : 4,000 : 11,000 ohms (ex-equipmt.), 1/- each.

Driver Transformers, S.T. & C., single plate to P/P. grids, tapped primary to give ratios 1 to 1.1 or 1.1 to 1. Primary to half-split secondary. Suitable for most pentodes to drive P/P807. Fully potted, 3½in. × 3½in. × 2¾in., 7/6 each.

NORMAN H. FIELD

The Ham's Shop with the helping hand—G3DBL.

Dept. A.5, 68 Hurst St., Birmingham 5.

COMPONENTS—SURPLUS AND SECOND-HAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid, in that order: 400, 6v, 1×2in, lug, 2/3; 250+250, 6v, 1×2in, lug, 2/6; 500+500, 6v, 1×3in, lug, 2/6; 40+40, 150v, 1⅛in×2in, clip, 3/-; 40, 150v, 1×2in, clip, 2/6; 20+20, 275v, 1×2in, lug, 3/6; 16+32, 275v, 1×2in, lug, 3/6; 16+16, 275v, 1×2in, clip, 3/6; 32+32, 275v+50mf 25v, 1×3in, lug, 4/-; 60+100, 275v, 1⅜×3in, lug, 5/6; 100, 275v, 1⅜×2in, clip, 3/9; 32+12, 350v, 1⅜×2in, clip, 4/6; 16+16+16, 350v, 1⅜×2in, clip, 5/-; 40+40+20, 350v, 1⅜×3in, lug, 5/-; 16, 350v, ¾×2in, lug, 2/-; 40+40, 300v, 1×3in, lug, 4/-; 10, 450v, ¾×2in; lug, 2/-; 16, 450v, ⅞×2in, 3/-; 20, 450v, 1×2in, lug, 2/9; 32, 450/525v, 1⅜×2in, clip, 4/-; 16+16, 450v, 1⅜×2in, clip, 5/6; 32+32, 450v, 1⅜×3in, clip, 5/9; 30+30, 450v+20mf 25v, 1⅜×3in, lug, 5/6; 15+15, 450v+20mf 25v, 1⅜×3in, lug, 5/3; 200, 6v, ⅝×1¾in, clip, 2/-; 100, 12v, ⅝×1¾in, wire, 1/9; 8, 450v, 1×2in, clip, 2/3; 50, 12v, ¾×1⅝in, wire, 1/6; 150, 25v, ¾×1⅜in, clip, 2/-; 250, 12v, ¾×1¾in, wire, 2/3; 350, 25v, 1×2¼in, clip, 2/6; 16+16, 450v, 1⅛×2in, clip, 4/-; 40+40, 275v, 1⅜×2in, clip, 3/6; 16+32, 450/525v, 1⅜×2in, clip, 5/6; 24+24+16, 350/425v, 1⅜×2in, clip, 4/9; 60+200, 275/350v, 1⅜×4½in, clip, 6/6; 1,000, 12v, 1×2¼in, clip, 2/9; 4, 150v, ⅝×1¾in, clip, 1/1; 60+100, 350/425v, 1⅜×4½in, clip, 6/6; 500, 12v, 1⅜×2¾in, clip, 2/6; 8, 350v, ¾×2in, 2/-; 6,000, 12v, 1⅜×4½in, lug, 4/6; 100+200, 275/350v, 1⅛×4½in, 6/6; 100+175, 275/350v, 1⅜×4½in, clip, 6/-; 8+16+16, 450/525v, 1⅜×2in, lug, 5/9; 32+32, 350/425v, 1⅜×2in, clip, 5/-; 2,000, 6v, 1×3in, clip, 3/3; 8+16, 450/525, 1×2in, clip, 4/3; 2, 450/525v, ¾×1⅜in, tag, 1/6; 2, 350v, ¾×1⅜in, tag, 1/3; 8, 350/425v, ¾×2in, clip, 2/-; all are all cans, some with sleeves.

ALL new stock, all voltages WKG, with surge v where marked; trade supplied most types.

TELEVISION! Set of 3 components, comprising line output trans., with E.H.T. winding to give 7kV. using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res. 10,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post, diagram of line trans. supplied.

PERSONAL receivers, 3 valve T.R.F. using 1T4s, contained in handsome bakelite case with lift-up lid, size 7×6½×5in with lid closed, plastic carrying handle, fram. AE in lid, these receivers cover the medium waveband and operate from self-contained dry batts., standard types, W1435 and U2, output to a pair of lightweight 'phones (H.R.) controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids hosp, patients, etc., these receivers are not Govt. surplus and are offered ready to play; carr. paid; £4/10/-.

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SEE our displayed advt. on page 116 for surplus bargains.—Radio Exchange, Bedford. [0012

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. Ilford 1260. Est. 17 years.

WE are famous for radio bargains of good quality at the right price.

SMALL vol. controls with long spindle and D/P switch, 1 meg. or ½ meg. 3/- ea. Buy now while they last!!

STANDARD size vol/controls with long spindle and S/P switch, 250K ohms, 100K ohms, 25K ohms and 5K ohms—our price 2/3 ea.

ALSO the following values, less switch, 250K ohms, 100K ohms, 2 megohms, 10K ohms, and 5K ohms, cannot repeat at 1/6 ea.

JUST arrived!! Mains trans. top shrouded, drop through, primary:—0-210-230-250v 50 c/s with screen; sec. 300v or 275v at 100 M/A 6.3v 3a, 5v 2a; bargain price, 28/6.

SUPER bargain line in mains trans:—by Parmeko—Universal fixing, primary tapped, 0-200-220-240v, sec. 290-0-290v 80 m/a, 6.3v 3a and 6.3v tapped at 4v 2amp with screen; our price 15/11 incl. post and packing.

HEATER trans. Primary 0-250v, sec. 6.3v at 1.5 amp, 6/3 ea. or 6.3v at 3 amp type, 9/3 ea.

P.M. speakers—real snips—absolutely bargains: All less trans., 2-3 ohm v/coil, 5in, 10/6 ea.; 6½in 12/11 ea.; 8in 13/11 ea.; 10in 18/11 ea.; output trans: 40 m/a type matched for 5,000 ohms to 2 ohms, 4/6 ea.; push-pull type, 6/11 ea.; ideal for a pair of 6v6 valves.

METAL can type electrolytic cond.: Real snip line. 32+32+16 mfd 350v, 3/6 ea.; 32+32 mfd 450v, 5/11 ea.; 64+120 mfd 350v, 425v surge, 12/6 ea.; 16+16 mfd 450v, 4/11; 200+200 mfd 25v, 1/- ea.; cardboard electrolytic cond.: 8 mfd 500v tub/tagend cond., 2/- ea.; 8 mfd 500v, tub/cardboard wire-end small cond., 2/9 ea.; 100 mfd 12v tub/cardboard wire-end bias cond., 1/6 ea.

PERMANENT magnet focus units with Vernier adjustment, tetrode type, 21/- ea.; high flux model for tubes operating up to 15 k/v and also for use with some triode tubes which are difficult to focus at lower voltages, 25/- ea.; twin balanced feeder, 80 ohm, for television, 4d per yard.

MANY other bargain lines in stock in radio and television component parts.

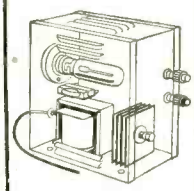
TERMS c.w.o., no c.o.d., send 9d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

CABINETS

WALNUT radiogram cabinets; stamp details.—E Wisker, 501, Hale End Rd., Highams Park, E.4 [9787

"AUTOMAT" HOME CHARGERS, CHARGER KITS, SELENIUM H.T. & L.T. RECTIFIERS

New Goods with Full Guarantee



"AUTOMAT" 3 AMP. HEAVY DUTY HOME CHARGER for car or radio cells our latest design supreme in value and performance. Virtually unwreckable, selenium rectification, fine workmanship and appearance, damp-proof, 12 months genuine guarantee, wt. 9 lb., in grey finish steel case, 12 v. 3 amp., 72/-, post 2/-, or 6 v. 3 amp./12 v. 2 amp., 72/-. Our well established 6 v./12 v. 2 amp. output model, 59/6, post 2/-.

FOOLPROOF CHARGER KITS. Really trouble free and reliable with full data sheet and circuit, standard kit 12 v. 2 amp. selenium rectifier 45 watt impregnated transformer, ballast bulb for 2 v., 6 v., 12 v. charger, 38/6, post 1/8, or with handsome steel case, 52/-, post 2/-, senior model 12/14 v. 3 amp. Westalite rect., 65 watt trans., ballast bulb for 2 v., 6 v., 12 v., 46/-, post 1/10, or with our latest design steel case, 58/6, post 2/-, also 12 v. 4 amp. rect., 75 watt trans., ballast bulb for 6 v./12 v. charger, 55/-, ditto but 3 amp. S.T.C. rect. and 85 watt trans., with ballast bulb, 75/-, minor kit 6 v./12 v. 1 amp. rect., trans., case, ballast bulb, 42/-, post 1/10.

HEAVY DUTY ELIMINATOR KIT. Large trans., selenium h.t. and l.t. trickle charge rects., electrolytic 12 plus 12, handsome steel case, for 120 v. 20/30 mA. eliminator with ½ amp. trickle charge, for 150 v. no extra, 43/-, post 1/6, or less case, 35/-.

SELENIUM RECTIFIERS, H.T. and L.T., new stock, not surplus, 2 v./6 v. ½ amp. h. wave, 4/10; 12 v. 1 a.h. wave, 6/-, post 6d.; full wave 6 v. 2 amp., 9/-; 12 v. 2.5 amp., 15/6; 12/15 v. 3 a. to 3.4 a., 16/6, all post 8d.; 6 v. 4 amp., 16/6; 24 v. 1.5 a., 15/-; 12 v. 5 amp., 27/6; 24 v. 5 amp., 54/-; large finned type F2 v. 6 amp., 33/-; all post 11d. H.T. rects., small space selenium, all new, 250 v. 60 mA., 7/6, post 5d.; 250 v. 120 mA. bridge, 14/6, post 8d.; 250 v. 200 mA. bridge, 24/-; ditto 300 mA., 34/6. Elim. rect. 135 v. 30 mA., 6/6, post 5d.

RENEWBAT, battery desulphater and conditioner, car size, 3/-.

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43 Uplands Way, LONDON, N.21 Phone LAB 4457

SOLONS FOR ESSENTIAL JOBS!

Use SOLONS for the jobs that matter—this modern precision tool makes soldering speedier, simpler and more reliable. 5 models: 65 watt with oval tapered and round pencil bit; 125 watt with oval tapered and round pencil bit; 240 watt with oval tapered bit; each with 6 feet 3-core Henley flexible. Voltage ranges from 100 to 250.

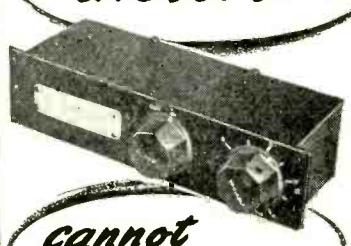
W. T. HENLEY'S TELEGRAPH WORKS CO. LTD.,
51-53 Hatton Garden, London, E.C.1

HENLEY SOLON ELECTRIC SOLDERING IRONS

FOR INDUSTRIAL USE

Write for Folder Y.10.

Free from distortion



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E.M.G.

STEEP-CUTTING INFINITELY VARIABLE FILTER

No other filter combines all the advantages of this model which are, briefly, to cut response above any desired level between 4,000 and 8,000 c.p.s. at an average steepness of 30 db. per octave, easy fixing (connects between 15 ohm speaker and amplifier output), robust construction, no distortion or appreciable loss of volume. Recommended for reducing surface noise on '78' records, cutting 'edge' on some L.P. records, and eliminating high-pitched interference on radio. Price £4/10/0. Leaflet on request.

E.M.G. HANDMADE GRAMOPHONES, LTD.
6, Newman St., Oxford St., W.1
Telephone: Museum 9971-2-3

CABINETS

WALNUT radiogram cabinets; details.—Cabinetware, 1a, Heyes St., Blackburn.

WALNUT radiogram and television cabinets, soundly constructed; stamp details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11.

NOTICES

THE University of Southampton.

SCHOLARSHIP in Electronics.
APPLICATIONS are invited for a joint Post-graduate course in Electronics at the University of Southampton and at Vickers Armstrongs, Ltd., Weybridge. The graduate selected will attend the Diploma course in Electronics at the University during the first year, and will spend the second year training in special projects in the Electronics Laboratory of the firm. The value of the scholarship will be that appertaining to the firm's graduate training scheme, approximately £400 per annum.
APPLICATIONS should be made to the Professor of Electronics, University of Southampton. [9861

BRITISH Sound Recording Association.

MEMBERSHIP is essential to all who are actively engaged or particularly interested in the many aspects of sound recording and reproduction. Excellent progress has been made in the Northern Centre, meeting at Manchester, and the Portsmouth Centre. The Annual Convention will take place in May from the 16th to the 18th. This is the event of the season.—Particulars of the Association are available from H. J. King, 48, Mount View Rd., North Chingford, London, E.4. [0119

COUNTY BOROUGH OF BOLTON—Education Committee.
BOLTON Technical College.
A THREE-YEAR full-time course in Electronic Engineering commences in September, 1953.
APPLICANTS should be in the age range 16 to 18, and have obtained, or be taking, General Certificate (Ordinary Level) in Mathematics or Physics, or equivalent courses in technical institutions.
THIS rapidly developing industry offers new and attractive openings to qualified men.
APPLICATION forms and particulars may be obtained from the Principal, Technical College, Bolton, Lancs.
W. T. SELLEY Chief Education Officer.
Education Offices,
Nelson Square, Bolton. [9855

WANTED, EXCHANGE, ETC.

WANTED.
BC610 Hallicrafters, also spares; RCA ET 4336 series with spares; BC348 receivers, also TCS6, TCS12 and components.
McELROY ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., W.6. Tel. Fulham 1138-9. [0194

45/- each offered for 813 type valves.—Write Box 5203. [9711

WANTED.—"Wireless World," April, 1952; any price considered.—Box 6132. [9890

WANTED, receivers A.P.R.4, also T.N. 16, 17, 18, 19, etc., and any radio test gear.
LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

WANTED.—S.T.C. ball mike with transformer.—Simpson, 15, Stainsby Drive, Mansfield. [9911

WANTED, RCA 4331 transmitters.—P.C.A. Radio, Cambridge Grove, Hammersmith, W.6. Tel. Riverside 3279. [0093

WANTED, HRO coils, Rxs, etc., A.R.88s, BC348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

WANTED, laboratory test equipment, including standard signal generator, watt meter, oscilloscope, bridges, recorders; send price and details to:
HATFIELD INSTRUMENTS, 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779. [0038

WANTED, set manufacturers' or ex-Government radio equipment, large or small quantities of valves, electrolytics, speakers, meters, also components.
LOWE BROS., 5, Fitzroy St., London, W.1. Tel. Museum 4389. [9745

WANTED, BC-610 Hallicrafters, RCA ET-4336 transmitters, SX-28, Ar-88, S-27, HRO receiver and spare parts for above; best prices.—P.C.A. Radio, The Arches, Cambridge Grove, W.6. [0081

WE purchase all types of domestic or ex-Government radio receivers and equipment; send full details or call and collect cash; large or small quantities.—Walton's Wireless Stores, 48, Stafford St., Wolverhampton. [0146

VALVES wanted urgently, any quantity, highest prices, types 805, 807, 813, 829, 832, TZ40, 723 A/B, 2J36, 2K33, 931A.—Details to Messrs. Pype-Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. Tel. Erdington 4942. [9506

ALTHAM RADIO Co. pay highest prices in the trade for all American equipment, including test sets, transmitters, receivers, teleprinting gear, etc.—Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0228

WANTED, R.C.A. speech amplifiers, type MI-11220 J or K and aerial tuning units BC 939 A; Hallicrafters speech amplifiers BC 614.—Offers, stating quantity and price, to P.C.A. Radio, The Arches, Cambridge Grove, W.6. [0080

WANTED, EXCHANGE, ETC.

WANTED, H.M.V. 2300H portable disc recorder, in good condition; easy terms if possible.—Box 6380. [9943

WANTED, AN/APR-4 receiver, any units; any other good quality U.S. surplus radio and radar tubes, test sets; laboratory equipments, etc.; give condition and price in first letter.—Engineering Associates, 434, Patterson Rd., Dayton, 9, Ohio, U.S.A. [0234

WANTED, good quality communication rxs., domestic radios, test equipment, etc.; top prices paid; established since 1937.—Miller's Radio, 38a, Newport Court, 1 min. from Leicester Sq. Tube. Tel. Ger. 4638. Call, write or send. Hours of business 10-6 p.m. Open all day Saturday. [0199

WANTED; we will pay 10% more for the following American equipment; test sets with TS prefix, BC221, APR4 receivers, APR4 tuning units, BC342, BC312, power units No. 15 and PE98, teleprinter equipment.—Altham Radio Co., Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0227

URGENTLY wanted.—VHF test equipment TS147AP, TS174U, TS34, TS148/UP, TSX-4SE, BC221s and any other types; valves, klystrons, magnetrons, 723/AB, receivers, APR4 and TN-16-17-18 tuning units, RCA, AR88s, S27s, SX28s, S27CA and any late types; microwave equipment or spares; highest prices given; please write, call or telephone Gerrard 8410; prompt attention assured.—Universal Electronics, 27, Lisle St., Leicester Square, London, W.C.2. [0219

REPAIRS AND SERVICE

ARMATURE Re-winding Service to the Trade. VACUUMS, drills, grinders, hood dryers, dental motors, vacuum cleaner armatures replaced from stock; 24-hour service; every job guaranteed; all vacuum cleaner parts, hoses, etc., in stock for any make.
REGAM ELECTRIC. 95, Park Lane, Leeds, 1.

ANNOUNCING a 48-hr. transformer rewind service—with a difference.
A FIRST-rate job for a first-rate engineer.
E.H.T.s, Mains, Fields, O.P.s, etc.
NEW transformers made to suit your requirements, designed on "C" core or conventional methods.
WILLIAMSON'S O.P. to original spec.: 80/-.
ALL work fully guaranteed.
WOODROW Transformers, Ltd., 28, Balmoral Rd., Willesden, N.W.2. Tel. Willesden 2014. [9950

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 3855.

REPAIRS.—E.H.T. mains and O.P. transformers, field coils and chokes; also armatures and motors; new transformers designed to any specification; all work fully guaranteed.
WILLESDEN TRANSFORMER Co., Ltd., Rear of 21, Church Lane, Church Rd., N.W.10. Tel. Willesden 7093. [0076

REWINDS and conversions to mains and output trans., clock coils, fields, pick-ups, etc., from 4/6; pp equipment a speciality; all work guaranteed.—N. L. Rewinds, 32, Blackbird Hill, N.W.9. Tel. Wordsworth 7791. [9959

24-HOUR service, 6 months' guarantee, any transformer; rewind, mains outputs and i.f.s., etc.; all types of new trans., etc., supplied to specification; business heading or service card for trade prices.—Majestic Winding Co., 180, Windham Rd., Bournemouth. [6520

ALL types of transformers, chokes and field coils for radio and television, etc., promptly and efficiently rewound or manufactured to any specification; 36 hours' service; 12 months' guarantee.—Ladbroke Re-wind Service, Ltd., 34, Rainham Rd., Kensal Rise, N.W.10. Lad. 0914. [0222

MISCELLANEOUS

SURPLUS radio, radar, aircraft instruments, etc.; lists free; trade only.—N. R. Bardwell & Co., Sellers St., Sheffield, 8. [9679

AVO model 8 Wearite tape decks, £35; Motek Desks, 15gns.—Alfred Rose, 134, Lewisham Way, S.E.14. Tideway 3696. [9892

METALWORK, all types cabinets, chassis, racks, etc., to your own specifications; capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd. (G4B1), Chapman St., Loughborough. [0208

ORGAN 3-octave keyboards, 19in×4in; fine professional job in ebony and imitation ivory, no key contacts.—H. R. McDermott, 10, Duke St., Darlington, Co. Durham. By return £4/15, carriage paid. [9640

TELEVISION aerial mast brackets all types, or manufactured to your design; competitive prices, immediate delivery; also enquiries invited for sheet metal and press work.—C.B.F. Industries, Ltd., Watts Lane, Teddington. [9703

ALLSCREWS, Ltd., for B.A. screws, nuts, washers, studding, grub-screws, bolts, soldering tags, woodscrews, etc., plain or nickel or cadmium plated, one-gross packets or large quantities; stamp for lists.—270a, King St., Hammersmith, W.6. Riv. 7762. [0225

MISCELLANEOUS

24v motors, 6/-; PVC, 1d yd; cable, 5w, 1/- yd; 13w, 8d yd; recrs., MW2, 50/-; nut-drivers, soiled, 2/6; post extra.—Annakin, 25, Ashfield Place, Otley, Yorks. [9937

HIGH vacuum impregnators for £280; suitable for all impregnation requirements, other specialised vacuum equipment manufactured to customers' specifications.—Vactite Components and Assemblies, 505, Lordship Lane, S.E.22. Tel. Forest Hill 7089. [0310

ENGRAVING amateurs and trade could take the opportunity of engraving problems in the future by getting in touch with A.G. Engraving, 19a, Windmill Rd., London, S.W.18. Bat. 5793. Brass, bronze, erinoid, Perspex dials; one knob or repetition equally retained. [0034

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges: B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod; headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [0138

DECALS labels for marking radio and electronic equipment, clear permanent lettering ⅛in high, no background, easily applied, permanent. Govt. approved; available in book form, each book containing approx. 750 titles, covering all aspects of radio and electronic equipment; price 4/9 plus 3d post, in black or white.—Alexander Equipment, Ltd., Childs Place, Earls Court, London, S.W.5. [0243

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

CROWN Agents for the Colonies.

METEOROLOGICAL assistant for radio/radar duties required by the East Africa High Commission. Option of appointment either (a) on probation for two years leading, subject to satisfactory service, to permanent and pensionable employment, or (b) on contract for one tour of 30-48 months with gratuity of 18¾% of total salary earned. Salary (including allowances) according to qualifications and experience in scale £715 rising to £1,170 a year; outfit allowance £30, free passages, liberal leave on full salary. Candidates must have had good experience of operation and maintenance of ground radar equipment and be capable of undertaking radio-sonde/radar-wind operation, including the determination of results, and the operation and maintenance of meteorological electronic equipment including ionospheric sounders, "Sferics" and diesel electric equipment.
APPLY at once by letter, stating age, full names in block letters, and full particulars of qualifications and experience, and mentioning this paper to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting on letter M.35571B. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration. [9863

THE PLESSEY COMPANY, LIMITED.

HAS vacancies in its laboratories for senior and junior engineers in the following fields:—
DOMESTIC radio development.
A GROUP leader—a man of outstanding ability and drive, capable of assuming complete charge of a programme of domestic radio development; able to organise a development team and to impart his own enthusiasm to the members of his group.
THIS post offers quite exceptional opportunities to the right man.
APPLICATIONS for this vacancy should be addressed to the Technical Director, who will attend to all applications personally and in strictest confidence.
COMMUNICATION equipment and general electronics development.
SENIOR engineers—men experienced in the development of communications equipment; able to undertake the most advanced development work, and capable of assuming complete responsibility for their own projects.
JUNIOR engineers; vacancies suitable for ambitious young men between the ages of 21 and 26, preferably with some experience of laboratory work in either the domestic radio or communication field.
PROSPECTS in all these posts are excellent, and very adequate salaries are envisaged; the appointments are permanent and pensionable.
APPLICATIONS should be addressed for the attention of the Personnel Manager, The Plessey Co., Ltd., Vicarage Lane, Ilford, Essex. [9903

ST. Thomas' Hospital, London, S.E.1.

REQUIRE young Technician to assist in construction experimental electronic apparatus.
EXPERIENCE light mechanical engineering essential and have completed or be exempt from National Service.
APPLY in writing Personnel Officer. [9955

D. NAPIER & SON, Ltd., Luton Airport, Luton, Beds.
URGENTLY require an electronic laboratory assistant, preferably familiar with C.R.O. practice, for interesting development work on engine testing and allied projects.
PLEASE apply to the Personnel Manager, giving full details of experience. [9891

SITUATIONS VACANT

PRECISION engineering company have the following vacancies:—
(1) LABORATORY Assistants with qualifications in electronic engineering or physics with practical experience on electronics, preferably audio frequency equipment and recording machines.
(2) SENIOR Designer with the above qualifications but with sufficient experience and ability to work on own initiative.
COMPANY operates 5-day week, pension scheme and canteen facilities are available.—Write stating age, salary and experience to Box 6045. [9886

VICKERS-ARMSTRONGS, Ltd., have vacancies in their Guided Weapons Department for the following Staff:—
ELECTRONIC Engineers of degree standard, with at least three years' experience in one of the following: V.H.F. Transmitter and Receiver Design, Pulse Techniques, Aerials, Transformer Design, Servo-Mechanisms and Electro-mechanical Devices.
TECHNICAL Assistants with H.N.C. or C. & G. standard, for development work, electronics, servo-mechanisms and hydraulics.
DRAUGHTSMEN with experience in electronics, electrical, or electro-mechanical design.
JIG and Tool Draughtsmen.
APPLY, quoting reference G.W.1. to Employment Manager, Vickers-Armstrongs, Ltd., Weybridge Works, Weybridge, Surrey.
APPLICATIONS, with certain exceptions, are subject to the approval of the Ministry of Labour & National Service. [9952

INSTRUMENT mechanics required to serve as reesarch and experimental mechanics at Ministry of Supply, Sellafield.
ALL applicants must have served a recognised relevant apprenticeship.
INSTRUMENT mechanics (Electronic) must have sound theoretical knowledge of electronics (Ordinary National Certificate standard desirable) with practical knowledge of pulse amplifiers, D.C. amplifiers, electronic scalers, discriminations, and general trigger circuits, and in wiring and assembly of electronic apparatus. Experience of test gear and general instrument calibration an advantage.
INSTRUMENT mechanics (physical) must have experience of industrial instruments used in measurements and control of temperature, specific gravity, pH and flow; knowledge of vacuum techniques and measurement of gaseous properties an advantage.
INSTRUMENT mechanics (general) must have experience of relay circuits and automatic telephone exchange maintenance; knowledge of X-Ray and electrical measuring apparatus an advantage.
RATES of pay for 44-hour 5-day week: 153/1 on entry with early assessment for merit pay; merit pay agreed after first assessment will be applied from date of entry; possibility of advancement to 195/1.
HOUSING accommodation will be available within a reasonable period for married applicants.
APPLY, giving details of apprenticeship, training (including Forces training), qualifications and experience, to Senior Labour Manager, Windscale Works, Sellafield, Cumberland. [9869

INSTRUMENT makers and precision fitters urgently required by Ministry of Supply for services as research and experimental mechanics at Harwell.
APPLICANTS must have served a recognised apprenticeship or its equivalent and have had at least 5 years' subsequent experience as a craftsman with a firm of scientific instrument makers, or with a firm making or maintaining electronic, electrical, pneumatic, horological or optical instrument mechanisms.
RATES of pay for 44-hour, 5-day week: 165/4 on entry with assessment later for merit pay; merit pay agreed after first assessment can be applied from date of entry; possibility of advancement to 189/4.
APPLY, giving details of apprenticeship, training (including Forces' training), qualifications and experience, to Director, A.E.R.E., Harwell, Didcot, Berks, marked "For attention of Senior Labour Manager." [9904

EXPERIENCED TV engineers required for retail service; permanent positions at good salary.—Full details to Shenstones (op. Town Hall), Leyton, E.10. Ley. 1362. [9266

A.T. & E. (BRIDGNORTH), Ltd., subsidiary of Automatic Telephone & Electric Co., Ltd., have immediate and future vacancies for senior and junior electronic engineers, design draughtsmen and draughtsmen.
A NUMBER of senior engineering posts are available for suitably qualified engineers with knowledge of VHF/UHF radio communication systems; there are also vacancies for technical assistants; salaries according to qualifications and experience.
SENIOR design draughtsmen having at least 5 years' experience are required; experience in mechanical design of electronic equipment or installation layout of radio stations would be an advantage.
DRAUGHTSMEN should have completed their National Service and have some experience, with education up to National Certificate standard.
STAFF conditions of service, including company superannuation scheme and 5-day week.
APPLICATIONS should be made to The Chief Engineer, A.T. & E. (Bridgnorth), Ltd., Bridgnorth, Shropshire, giving full details of age, qualifications, experience and salary required. [9833

AIRCRAFT radio mechanics, skilled in workshop practice, are required by Skyways at Stansted Airport, Essex.—Apply in writing to the Personnel Manager, Skyways, Ltd., 7, Berkeley St., W.1. [9907

SITUATIONS VACANT

DETAIL draughtsman required, experienced in the preparation of production drawings, preferably of a light mechanical nature, also DRAUGHTSMAN required for design and production of light electro-mechanical apparatus: varied and interesting work.
PREVIOUS experience in the radio industry an advantage.
PLEASE apply, stating age and full details of past experience to Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [9873

E.M.I. ENGINEERING DEVELOPMENT, Ltd. (Wells Division), Penleigh Works, Wells, Somerset, have vacancies for the following:—
SENIOR electronic engineers, with degree in physics, A.M.I.E.E. or equivalent; at least five years practical experience in circuit development work is essential.
JUNIOR electronic engineers, with H.N.C., C. & G. or equivalent qualification, and a minimum of two years practical experience.
SENIOR and junior draughtsmen, design and layout experience of electronic and electro-mechanical equipment and/or mechanical computers essential.
MECHANICAL inspectors, experienced in the inspection of high quality scientific instruments.
ELECTRICAL inspectors, testers, preferably with experience in small transformers and/or electronic equipment.
ASSEMBLY wiremen must be first-class, used to small intricate chassis work.
APPLY by letter stating age, nationality and experience. [9769

FURZEHILL LABORATORIES, Ltd., offer the following vacancies for staff to assist in the development and production of precision electronic instruments.
(a) JUNIOR development engineer, preferably with previous experience of instrument circuit design: qualifications from O.N.C. standard to university degree acceptable: salary £450-£650 p.a.
(b) ELECTRONIC engineer to be responsible for the design and construction of test equipment and for non-routine testing: previous experience of instrument circuits essential and theoretical knowledge to H.N.C. standard, an advantage: salary £450-£520 p.a. (c) Test engineers, previous test department experience essential: salary £420-£520 p.a.
APPLICATIONS should be made in writing to the Chief Engineer, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [0244

EXPERIENCED radio testers and technicians required, 5-day week, good rates.—Apply or write to The Dulci Co., Ltd., 97, Villiers Rd., London, N.W.2. [9885

ELECTRONIC engineers.—(a) Section leaders, and (b) assistant engineers required for working on special experimental field trials of guided weapons.
SECTION leaders should have at least H.N.C. and 5 years' experience in the development of electronic devices in the micro-wave, pulse or communication field, and be capable of taking responsibility for the serviceability of weapons for trials and of undertaking parallel development work in the laboratory.
ASSISTANT engineers having a similar background or considerable experience of small prototype electro-mechanical instruments, are required to work under the section leaders.
APPLICANTS may have the opportunity of carrying out some of the work in Australia at a later date. Good salaries. Subsistence allowances while working away from base. Pension scheme.—Details should be sent to the Assistant Manager (A), The Fairey Aviation Co., Ltd., Dept. W, Research and Armament Development Division, Heston Aerodrome, Hounslow, Middx. [9960

TECHNICAL Writer required for Publicity Department of leading valve manufacturers, advertising experience an advantage, age 26-30. —Apply stating salary required to 487, Box 6131. [9889

CHIEF planning engineer required for electro-mechanical work; factory situated mid-Surrey.—Write fully, giving details of experience, salary required, Box 5941, c/o W.W. [9866

DECCA RADAR, Ltd., invites applications from experienced microwave engineers to join the company in its extensive work in a wide field of microwave link and radar development.
THE company offers excellent starting salaries and first rate opportunities for men to exploit their initiative and to rise rapidly to responsible posts. Graduates without industrial experience who are prepared to undertake intensive training are also invited to apply for junior posts.
APPLY in writing to Research Director, Radar Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [0242

THERMIONIC technical assistant required: must be keen on industrial electronics: experience of audio equipment; please state age, experience and salary required to—The Rover Co., Ltd., Lode Lane, Solihull. [9757

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for all parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0242

THE De Havilland Engine Co., Ltd.—Electronic engineer required, interested in physical measurement rather than construction of apparatus, required for vibration measurement and analysis on gas turbine and piston engines. —Please write in confidence, stating age and full details of previous experience to the Personnel Officer, The de Havilland Engine Co., Ltd., Stag Lane, Edgware, Middlesex. [9951

SITUATIONS VACANT

ENGINEERS and Assistants required in Test Rooms for the manufacture and adjustment of Precision electrical apparatus; write or apply in person to—H. Tinsley & Co., Ltd., Werndee Hall, Stanger Rd., S. Norwood, London, S.E.25.

TELEVISION/RADIO engineer required by Bush & Murphy dealer, able to drive, furnished flat available to successful applicant.—Write, giving experience, references, etc., to "Stute" Pinnington, Malpas, Cheshire. [9946

EXPERIENCED V.H.F. service engineer required by old-established London firm specialising in the installation and maintenance of mobile R/T equipment; excellent opportunity available to right person.—Apply Box 5969. [9872

T/V Junior Engineers required for the testing of cameras and associated equipment; state details of television experience and education, degree standard not necessary; this work offers good training and prospects in this field.—Apply Box 5184. [9704

TECHNICAL representative required by old-established firm to handle electronic acoustic correction equipment from a London H.Q.; excellent scope for ambitious man to develop and expand completely new field.—Full particulars to Box 5968. [9871

FIRST-CLASS radio and television engineers required by old-established, expanding business; good salary and prospects; permanent; all leading agencies, including Murphy, Bush, Pye, Ekco, etc.—E. P. Fox, Ltd., East Molesey, Surrey. Molesey 2721. [0242

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, have vacancies for applications engineers (electrical) on the suppression of electrical interference, minimum standard required Grad. I.E.E. or equivalent and preferably an interest in radio.
AGE range 25/38; pensionable permanent position.
APPLICATIONS (in confidence) to give full details of education, experience and salary range envisaged. [9923

VACANCIES exist in expanding marine radio company for 3 energetic sales engineers, required for North-East and East England and South Wales; preferably living on territory, with car.—Apply at once with full details of past experience, Box 5942, c/o W.W. [9867

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

DESIGN draughtsman, under 35, required for immediate employment with progressive company in N.W. London area; the post requires sound experience in light electro-mechanical and electronic fields; full details of experience and qualifications.—Box 6287, c/o W.W. [9913

ENGINEERS with experience of radio and television design are required for work in the development department of a large wire broadcasting firm in South-West London.—Write, giving particulars of qualifications, experience and salary required, to Box 4960.

RADIO Service Engineer required by Trewin Bros., Queens Rd., Watford (under the same management as John Lewis & Co., Ltd., London, W.1). Good salary, permanent and pensionable position for suitable applicant.—Applications, either in writing or person, to the Registrar. [9708

WIREMEN required, fully experienced wiring electronic productions from theoretical circuits on own initiative without constant supervision; general workshop experience an advantage; good rates of pay and conditions; West London area.—Reply in first instance Box 6435. [9964

TECHNICAL development engineers required, senior, intermediate and junior, for interesting work in electronics, including defence contracts; excellent salaries for suitable applicants.—Apply to Technical Director, All-Power Transformers, Ltd., Chertsey Rd., Byfleet, Surrey. [9693

TELEVISION receiver development; two vacancies exist for experienced junior engineers with enthusiasm for this work; excellent opportunities for advancement.—Applications should be addressed to the Chief Television Engineer, Pye, Ltd., Radio Works, Cambridge. [9939

FERGUSON RADIO CORP., Ltd., Great Cambridge Rd., Enfield, require Draughtsmen (senior and junior) with experience of radio and television receiver design also small mechanical details; progressive post; A.E.S.D. rates; 5-day week.—Apply Employment Manager. [9919

MURPHY RADIO, Ltd., have vacancies for two or three senior engineers to lead development teams in their electronics division; applications are invited from men with engineering or physics degrees or equivalent, and with first-class experience in the fields of Radar navigational aids, V.H.F. communications receivers and low-power transmitters; salary upwards of £650 per annum according to qualifications and experience; candidates prepared to bring energy and drive to their work may address their applications in confidence to the Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9884

SITUATIONS VACANT

LABORATORY Engineer, B.Sc. or H.N.C., with experience in miniature electronic equipment design and development; work in Slough/Marlow area, 5-day week, canteen, pension scheme.—Full details of age, experience, salary required to Box M.251, Haddons, Salisbury Square, London, E.C.4. [9894

AIRCRAFT Radio Mechanic required, preferably with aircraft radio maintenance engineer's licence but not essential; to be based at White Waltham, nr. Maidenhead; apply in writing giving full particulars to—The Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlx. [9849

EXPERIENCED fault finders wanted by Midland manufacturers of radio equipment, permanent posts located in the Midlands are offered to men with experience of radar, radio control, v.h.f. equipment.—Write, stating fully, experience and salary required, to Personnel Manager, Box 5744. [9792

RADIO and radar testers, first-class men required for work on v.h.f. communication gear and Government contracts for radio and radar equipment by Midland manufacturers; men with wide experience of fault finding in any of the fields mentioned should write, giving full details to Box 5743. [9791

ELECTRONIC engineer required to work on development of service projects in small organisation situated on South coast; experience of V.H.F. and pulse work essential; some F.M. experience an advantage; degree or equivalent desirable; write full details and salary expected.—Box 6303. [9921

GRADUATES in chemistry, physics or electrical engineering required for very interesting development of new materials for use in telecommunications.—Apply to Personnel Manager, Standard Telephones and Cables, Ltd., North Woolwich, E.16, stating age, qualifications and salary required. [9927

RADIO, test gear, design and maintenance man required in North-West Kent area by well-established company in their test gear dept.; man with original ideas and up to Higher National Certificate standard in electronics.—Write giving full particulars of experience and wages required to Box 5967. [9870

TESTERS required for electronic equipment; experience of laboratory instruments desirable; ex-Service radar machanics make suitable candidates; also skilled wiremen for light electrical engineering assembly; good rates of pay, bonus, canteen.—Apply Personnel Officer, Airmec Ltd., High Wycombe, Bucks. [9868

SENIOR and junior design draughtsmen required; applicants should have previous knowledge of radio, television and associated equipment; excellent salaries to men of proven ability; good staff conditions; East London area; please write, quoting reference WW/D, giving details of experience, to—Box 6234. [9899

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge, have vacancies for senior and junior engineers; experience in V.H.F. design and engineering is essential, vacancies also exist for engineers with specialist experience in multi-channel V.H.F. Telephony; salary according to qualifications and experience. PLEASE apply, stating age, qualifications and experience to the Personnel Manager. [0209

REQUIRED for electronic valve production unit, an experienced chargehand-mechanic to control valve pumps and automatic glass-working equipment; at least five years' experience in this field is essential; all applications will be treated in confidence.—Write stating age, salary required, etc., to Personnel Officer, Ericsson Telephones, Ltd., Beeston, Nottingham. [9935

TEST gear design engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these appointments are permanent and progressive; company pension scheme in operation; London area.—Please write, in confidence, quoting reference WW/13, giving full details of qualifications to Box 6288, c/o W.W. [9912

ELECTRONIC engineer is required for an interesting development project involving D.C. amplifier, servo and pulse techniques. Applications are invited from young engineers aged 24-30, well educated and qualified to H.N.C. or equivalent. Experience in one or all of the aforementioned techniques would be an advantage.—Write full details to Box 6359. [9932

T.C.C. invite applications for the positions of technical sales representatives in the radio, electronic and electrical industries; applicants should state, in detail, their age, qualifications, experience and salary required; only first-class men are being entertained; preferably those with previous experience in the industry.—Write (in confidence) to Sales Director, The Telegraph Condenser Co., Ltd., N. Acton, W.3.

THE G.E.C. Stanmore Laboratories have started an investigation into the performance of electronic valves under the conditions to be found inside guided weapons, with particular reference to reliability, length of life, and the incidence of microphony and its effect on circuit operation; an electronic engineer or physicist is required to take part in the day-to-day work involved, and to co-operate in th design and construction and operation of the special test and display equipment needed for the work; experience of audio-frequency circuits is desirable, and some familiarity with statistics or the handling of data would be an advantage —Applicants should apply in writing stating age, qualifications and experience to the Staff Manager (Ref. SS/JP4), The Grove, Stanmore Common, Stanmore, Middlesex [9876

SITUATIONS VACANT

THE ENGLISH ELECTRIC Co., Ltd., Luton, have vacancies for electronic engineers for development work on V.H.F. radio sub-miniature equipment and/or recording techniques; some field trials engineers and assistants also required.—Applications, stating age, experience and qualifications, and quoting ref. 456L, should be sent to Central Personnel Services, English Electric Co., Ltd., 336/7, Strand, London, W.C.2. [9930

AN engineer is required for an electronics research laboratory; applicants should have a broad scientific interest and a good working knowledge of either radio or telephone circuit practice and theory; salary £650–£850, according to experience and qualifications; the work covers new developments in telecommunication systems and techniques, in the central laboratories of a large manufacturing organization.
APPLICATIONS should be in writing and addressed to the Personnel Manager, Standard Telecommunication Laboratories, Ltd., Progress Way, Enfield, Middx. [9902

SENIOR and Junior Development Engineers required for responsible work in radio and television development laboratories. Applicants for senior position should be able to undertake development work with minimum supervision. Excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British nationality. [9713

A HOUSE is available for a qualified electronic engineer required by The English Electric Co., Ltd., Luton, to develop equipment and techniques for testing, measurement and analysis of vibration and shock phenomena on guided missiles; experience in allied fields would be suitable.—Write stating age, qualifications, experience and salary required to Central Personnel Services, Marconi House, 336-7, Strand, London, W.C.2., quoting ref. 850D. [9878

MEDICAL RESEARCH COUNCIL. Radio-biological Research Unit, Atomic Energy Research Establishment, Harwell, want electronics technician to be responsible for development and maintenance of equipment for detection and measurement of ionising radiations; previous experience in this branch of electronics desirable; salary in the ranges £410–£475 or £495–£580.—Applications within fortnight, giving names two referees, to Director. [9936

ASSISTANTS (Scientific).—The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to 31st December, 1953, but an earlier closing date may be announced either for the competition as a whole or in one or more subjects. AGE at least 17½ and under 26 years of age on 1st January, 1953, with extension for regular service in H.M. Forces, but candidates over 26 with specialized experience may be admitted. CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science subject, and of thorough experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces, covering a minimum of two years in one of the following groups of scientific subjects:—
(i) ENGINEERING and physical sciences.
(ii) CHEMISTRY, bio-chemistry and metallurgy.
(iii) BIOLOGICAL Sciences.
(iv) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
SALARY according to age up to 25: £236 at 18 to £363 (men) or £330 (women) at 25 to £500 (men) or £417 (women); somewhat less in Provinces. Opportunities for promotion.
FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S 59/53. Application forms should be returned as soon as possible. [9916

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radio-telegraphy. Selected candidates will be considered later for permanent pensionable posts.—Application should be made to any local office of the Ministry of Labour and National Service, quoting Order No. City 4728. [9721

MULLARD Research Laboratories require experienced wiremen for interesting work on electronic equipment; applicants must be able to work from theoretical wiring diagrams; high frequency wiring experience with a knowledge of components assembly preferred; staff conditions of employment; salary according to age and experience, 5-day week; pension scheme.—Apply, Mr. G. A. Taylor, Mullard Research Laboratories, Cross Oak Lane, Salfords, Nr. Redhill, Surrey. [9920

SALES engineer for Scotland required by well established radio component and accessory manufacturers (present man is resigning for family reasons), preferably Scotsman; qualifications equivalent to City and Guilds or National Certificate in Radio Engineering and Radio Communications; existing connection with wholesale and retail trade an advantage; permanent, pensionable position; remuneration—salary, commission and expenses, adequate car allowance; applications giving full details of age, qualifications and experience (in confidence).—Box M6304. [9922

SITUATIONS VACANT

AN important firm of import/export merchants established in the Middle East require an assistant for the manager of the department handling the sales of radios, lamps and electrical equipment generally, some experience in a similar capacity and ability to handle the departmental correspondence essential, technical knowledge an advantage, three-year contract at outset, followed by five months' leave on full pay; board and quarters provided.—Write, with full particulars to Box 6192. [9895

INSPECTION superintendent wanted by a firm making electrical and mechanical components for the communications industry; to supervise inspection through all stages of manufacture for a variety of components; also to supervise the test laboratories; previous experience in control of staff as well as technical training in light electrical engineering is essential; salary between £500 and £650 per annum, subject to qualifications.—Apply Painton & Co., Kingsthorpe, Northampton. [9908

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E. or possess equivalent qualifications, together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [0230

MINISTRY of Supply: Senior Principal Scientific Officer: Directorate of Electronics Research and Development, London. The Civil Service Commissioners invite applications for a permanent and pensionable appointment. Candidates must have been born on or before December 31, 1921. Required to plan and coordinate all electronic research in the Ministry to review continually the whole field of electronics and advise on the need to initiate new lines of research, particularly of a basic nature. CANDIDATES must have 1st or 2nd class honours degree in physics or electrical engineering, or equivalent qualification provided that a candidate without this qualification but of high professional attainments may be considered. Candidates should have had several years' experience in electronics, with responsibility for experimental and development work. INCLUSIVE salary scales: Men £1,600-£1,850; women £1,423-£1,680. Starting salary determined on assessment of successful candidate's qualifications and experience. FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S4197/53. Application forms to be returned by May 7, 1953. [9938

PHYSICISTS and electronic engineers.—Interesting opportunities exist for versatile physics or electrical engineering graduates on the development of transducers and associated electrical/electronic apparatus for measurement of transient and steady state phenomena in precision mechanical engineering projects at D. Napier and Son, Ltd., Acton.—Applicants with suitable experience please forward full details, quoting ref. 861A, to Central Personnel Services, English Electric Co., Ltd., 336/7, Strand, London, W.C.2. [9929

SENIOR mechanical designer: two or three vacancies exist in our electronics division for senior design draughtsman on electronic equipment; candidates should be of at least Higher National Certificate standard and should be capable of leading a design team in this class of work; salary £650 per annum upwards according to qualifications and experience; applications should include full details of experience to date and may be forwarded in confidence to the Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9883

DECCA RADAR Ltd., have vacancies for men with a sound knowledge of radio and/or radar as installation and service engineers; other vacancies exist for instructors, repairmen (to work on radar and radio navigational equipment) and wiremen. The work is interesting and varied and in all cases specialist training is given; write in the first instance giving details of past experience and salary required, to—The Manager, Decca Radar Ltd., 50, Southwark Bridge Road, London, S.E.1. [0243

ELECTRONICS Technician required for nuclear physics work in the Clarendon Laboratory, Oxford University, age 25-35, Higher National Cert. or C. & G. desirable; experience of this kind of work not necessary, but ability to construct apparatus from circuit diagram essential. Salary £6/15/- X 5/- to £8/5/- p.w., with possibility of further promotion; pension scheme, good holidays.—Apply to the Administrator, Clarendon Laboratory, Oxford, giving full details of qualifications and experience. [9862

PLANNING engineer required by Ministry of Supply, London for planning and progressing production Army radar and signals equip.: qualifications: British of British parentage, recognised apprenticeship or equivalent, experienced modern machine shop practice, knowledge production methods and plant layout for electronic and light engineering work, O.N.C. desirable; salary: within £623 (at age 30)—£733 p.a.; appointment unestablished but opportunities to compete for establishment may arise.—Application forms from: Ref. E.A.242, Ministry of Labour and National Service, London Appointments Office, 1-6, Tavistock Sq., London, W.C.1. [9879

SITUATIONS VACANT

THE ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, Essex has several attractive vacancies, junior and senior, for physics and engineering graduates to undertake research and development work on vacuum tubes; applications from graduates who have recently qualified as well as those with industrial and research experience will be considered.—Please write, giving full details and quoting ref. 419H to Central Personnel Services, English Electric Co., Ltd., Marconi House, 336-7, Strand, London, W.C.2. [9877

WELL established radio component and accessory manufacturers have vacancy for an assistant sales manager for one section of the business; experience in running small distribution department with stock control, technical and commercial correspondence, statistics and liaison with outdoor staff essential; practical experience in radio and television useful; age limits 30/40 years. salary £700/£800; pensionable; applications which must give details of education, training and experience (in confidence) to Box 6305. [9924

RADIO (Meteorological) Mechanics required by Meteorological Office. Qualifications: Basic knowledge of radio and radar and experience in maintenance/operation of radar equipment including oscilloscopes; successful applicants serve in U.K. and overseas; commencing London wage £7/17/6 at age 25 or over, rising annually to £9/10/6, deduction of 3/- for each year below 25; overtime, night duty allowances, etc.; promotion prospects.—Apply to Borough Employment Exchange (Dept. W.W.2), 236, Walworth Rd., London, S.E.17. [9753

DECCA RADAR, Ltd., require draughtsmen and junior draughtsmen for research drawing office, preferably experienced in any of the following fields: radar, radio and electronic circuits, electro-mechanical devices, light mechanical engineering; knowledge of workshop practice essential. Applicants must possess Ordinary National Certificate or equivalent, positions permanent and progressive; salaries based on A.E.S.D. rates.—Write, giving full details, to Chief Draughtsman, Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [0240

DEPARTMENT of Scientific and Industrial Research require Experimental Officer (unestablished) in Radio Research Organisation, Teddington, Middlesex, for abstracting scientific and technical articles on radio research and development; H.N.C. or higher qualifications with considerable knowledge and experience of some branch of radio research or development; ability to read technical French and German useful, minimum age 26, salary in the range £628-£786.—Forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, S.W.1, quoting D268/52A. [9896

PHYSICISTS and engineers required for development work on cold cathode tubes for use in communications. Applicants should possess a degree in physics or engineering or H.N.C. in electrical engineering, preferably with previous experience in similar work. The posts are pensionable and carry salaries commensurate with qualifications and experience.—Applications, with full details, are to be addressed in the first instance to the Managing Director, Hivac, Ltd., Greenhill Crescent, Harrow, Middlesex, and will be treated in confidence. [9880

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires senior and junior electronic development engineers for work on guided weapons and like projects, particularly in the field of microwave and pulse applications; mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar type equipments, also required for the above projects; salary according to age, qualifications and experience; houses will be allocated to selected staff.—Apply by letter, stating age and experience, to The Personnel Manager (Ref. R.G.). [0239

B.B.C. requires a limited number of technical assistants in operations and maintenance department, for service at transmitter, studio and television centres throughout the United Kingdom; knowledge of mathematics, electricity and magnetism to School Certificate standard; experience in electrical or radio engineering an advantage, preferred age 20-25, others with experience considered; salary £360 p.a. with annual increments to £470 p.a. maximum; promotion prospects.—Application forms from Engineering Establishment Officer, B.B.C., London, W.1 (enclosing addressed foolscap envelope). [9887

APPLICATIONS invited by Ministry of Supply for Experimental Officer Class vacancies in R.A.F. Signals Establishments at: Ruislip, Middx., for general experimental work and tests in connection with design of radio communications and radar systems; Medmenham, nr. Marlow, Bucks, for work on installation design of airfield communications and landing aid systems, equipment investigations and siting problems; Henlow, Beds. (Asst. Exp. Officers only), for experimental work on calibration of transfer standards involving bridge, frequency and pulse measurements. Quals.: Higher School Cert. (Science) or equiv. but further training in physics or elec. eng. to H.N.C. or degree standard may be an advantage. Knowledge of R.A.F. signals equipment desirable. Salary according to age, quals., exp. and location. Exp. Officer (min. age 26) £597-£770, or Asst. Exp. Officer £264 (at age 18)—£571. Women somewhat less. Posts unestablished.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King St., London, S.W.1, quoting D.90/52A. Closing date 12 May, 1953. [9897

SITUATIONS VACANT

THE ENGLISH ELECTRIC Co., Ltd., Luton, has a vacancy for a responsible electrical engineer for installation and trials work on an important Guided Weapon Project. Applicants should have a degree or Higher National Certificate in electrical engineering and practical experience of servo systems; a knowledge of electronics and/or hydraulics and/or electro-mechanical instruments would be an advantage; the successful applicant would be considered for taking charge of this work in Australia; salary according to qualifications; applications should be addressed to Central Personnel Services, Marconi House, 336/7, Strand, London, W.C.2, quoting Ref. 1108. [9864

ELECTRONIC, radar and radio engineers, senior and junior, are urgently required for new division of the General Electric Company, at their Stanmore Laboratories; applicants for the senior posts should be capable of directing the work of a small team engaged on the electrical development of electronic equipment for guided missiles or radar; knowledge of M.O.S. specifications and procedure would be an advantage.—Applications should be made in writing, stating age, qualifications and experience to the Personnel Manager, G.E.C., Stanmore Laboratories Brown's Lane Division, The Grove, Stanmore Common, Stanmore, Middlesex, quoting ref. RG/BLS. [9881

TELECOMMUNICATIONS engineers required on overseas shore staff of Cable and Wireless, Ltd.; applicants should have technical knowledge and practical experience of operation and maintenance of wireless communications plant and possess at least 1st class P.M.G. or C. & G. Radio II certificates; desirable age limit 29; basic commencing salary £324 (age 22) to £456 (age 29) per annum; free accommodation or allowance in lieu; foreign service and expatriate allowances (up to £240 and £550 p.a. respectively) additional; tax paid; permanent and pensionable positions for suitable candidates.—Apply in writing, giving experience and qualifications, to Managing Director, Cable and Wireless, Ltd., Electra House, Victoria Embankment, London, W.C.2. [9804

A LARGE engineering company manufacturing aircraft instruments requires an assistant engineer for the staff of a new laboratory in Surrey; the duties of the engineer will cover a wide field in the design, development and testing of airborne electrical equipment; the post will provide valuable training for a young man interested in the field of electronic or magnetic amplifiers and automatic control; applicants must possess, or be studying for, an engineering degree or Higher National Certificate in electrical engineering; age 20-30.—Apply, giving full details of experience and qualifications, to the Chief Development Engineer, Waymouth Gauges & Instruments, Ltd., Station Rd., Godalming, Surrey, quoting reference E.13. [9963

A COMPANY whose laboratories are committed to be established commercial and Government research and development projects are anxious to secure the services of several engineers of outstanding experience and ability in the design and layout of, and measurements on, H.F. radio receiving and transmitting equipment and components; only sound, practical engineers of at least five years' experience, capable of showing considerable ingenuity and imagination, as well as working with the minimum of supervision, will be considered; knowledge of miniaturisation, printed and potted circuit techniques, would be an advantage; the work is interesting and the positions vacant carry a generous salary, commensurate with ability, experience and any other qualifications.—Apply by letter, without delay, giving age, experience and any other qualifications, to the Personnel Dept., E.M.I. Research Laboratories, Ltd., Hayes, Middx. All applications will be considered carefully and acknowledged. [9905

ADMIRALTY, Royal Naval Scientific Service; engineers and physicists (particularly with electronics) required for appointments in (a) Senior Scientific Officer and Scientific Officer grades (Ref. A246/52A), and (b) Experimental Officer and Assistant Experimental Officer grades (Ref. A247/52A) in experimental establishments in London, Portsmouth, Weymouth areas and Scotland; candidates, British subjects, for (a) must possess first- or second-class honours degree in physics or engineering, or high professional attainments such as corporate membership of appropriate professional institution with suitable experience and responsibility, and for (b) should possess one of following qualifications: University degree in science, engineering or mathematics, Graduate membership of appropriate professional institution, Higher National Certificate, Final Certificate of five-year grouped course in relevant subject at City and Guilds of London Institute or comparable institution, Higher School Certificate with mathematics or science as principal subject or equivalent qualification; S.S.O.s at least 26 years of age with at least three years' approved experience, London salary (men) £812-£1,022 per annum; S.O.s at least 21 years £440-£707; E.O.s at least 26 years £628-£786; A.E.O.s at least 17½ years £274-£586; rates for women and posts in Provinces somewhat lower; starting salaries above minima may be granted according to age and experience; all appointments unestablished (with F.S.S.U. for S.S.O. and S.O.), but with some opportunities to compete for established posts. —Application forms from M.L.N.S., Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1, quoting appropriate reference. [9917

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TECHNICIAN, also works foreman wanted, both experienced in amplifier design and development, preferably with tape recorder knowledge.—Reply Box 6402. [9958

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McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [0198

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SERVICE manager of large Television organization seeks suitable position in Midland area. —Box 6227. [9914

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GRADUATE Brit. I.R.E., full cert. C. & G., 25, 3 years research instrumentation, previous radio, radar experience, seeks an interesting, progressive job with small firm; north preferred; present salary £590.—Box 6399. [9954

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