Practical Electronics

NOVEMBER 1964

PRICE 2'6

EXTRA! ELECTRONIC DATA BOOKLET

PLUS

FREE

INSIDE

COLOUR CODE CALCULATOR for RESISTORS & CAPACITORS

TRANSISTORISED EQUIPMENT

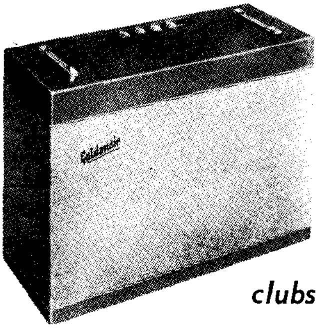
INTEGRATED AUDIO AMPLIFIER

GEIGER-MULLER RATEMETER

GROUP-MASTER 30 WATT GUITAR AMPLIFIER

Goldenair

"THIRTY" HI-FI AMPLIFIER



A VERSATILE UNIT FOR INSTRUMENTALISTS AND VOCAL GROUPS

being suitable for clubs and public address

Ideal for bass, lead or rhythm guitar, and all other musical instruments.

★ The two 12-inch 25-watt heavy duty loudspeakers are specially designed for this type of amplifier, and give outstanding reproduction.

★ Robust attractive two-tone finished cabinet of compact size, 28″ × 20″ × 10½″ fitted with carrying handles.

★ For standard AC mains 50c/s operation.

★ Four inputs provided can be used simultaneously with instrument pickups or mikes.

★ Separate Bass and Treble controls are incorporated.

42 GNS or deposit of £4.12.0 and twelve monthly payments of £3.12.5. Carriage and insurance 25/- to be sent with deposit.

A high quality 30-watt amplifier developed for use in large halls and clubs etc. Ideal for bass, lead or rhythm guitars, schools, dance halls, theatres and public address. Suitable for any type of mike or pickup. Valve line-up: two EF86; one ECC83; one GZ34; two EL34. Four separate inputs are provided with two volume controls. Bass and Treble controls are incorporated. Amplifier operates on standard 50c/s mains. 3 ohm and 15 ohm speakers may be used. Full 12 month guarantee. Factory built and tested. Perforated cover with carrying handles can be provided if required, price **21**/-.

16 GNS

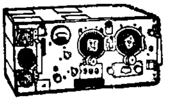
or deposit of £1.16.0 and twelve monthly payments of £1.9.2. Carriage 15/- to be sent with deposit.

Ideal for Home Use GOLDENAIR 5 WATT AMPLIFIER

Suitable for guitars, record decks and microphones. Cabinet size approx. 13″ × 18″ × 7″. The cabinet is well made and attractively finished. Volume bass and treble controls incorporated. Price **9 gns.** post paid. S.A.E. for leaflet.

GOLDENAIR TWICE THE QUALITY—HALF THE PRICE

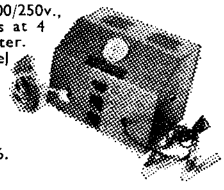
Customers are invited to see and hear these amplifiers at our shop premises in Lambert's Arcade. Send S.A.E. for leaflet.



TYPE 19 SHORT WAVE RECEIVING SET

Works straight off the mains. An excellent short wave receiver, requires only phones for immediate operation. Price **£5.19.6.** P. & P. 10/-. Suitable phones 15/- per pair. P. & P. 2/6.
During an evening's testing of this excellent receiver, we obtained clear reception from scores of stations, many of them thousands of miles distant, including ship stations, government transmissions, maritime broadcasts, etc. and also the short wave Radio Luxembourg broadcasts.

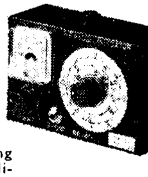
NORTHCO BATTERY CHARGER



For all A.C. mains 200/250v., 50c/s. 6 and 12 volts at 4 amps. Fitted ammeter. Robust louvered steel case. Ready for use complete with lead and battery clips. 12 months' guarantee.

Price **69/11**. P. & P. 4/6.

RF FIELD INDICATORS



Designed for checking the radiation from a transmitting antenna. The sensitivity can be controlled by adjustment of the panel control, the antenna length, or by increasing distance from the radiator. Frequency range 1-25 Mc/s. 200 mA. D.C. Complete with instruction book. Price 65/-. P. & P. 2/6

CRYSTAL SET

A wonderful educational set for all children. Provides hours of amusement while following the easy step by step instructions. It is powered entirely by wireless waves, eliminating the expense of batteries. No soldering required. Receives all main stations. Price **25/-**. P. & P. 2/6.

TRANS/RECEIVER NO. 46

Compactly carried by one man. This has a range of approx. 10 miles, and being crystal controlled tuning is avoided, and operation is as accurate as a telephone. Frequency 3.6-9.1 Mc/s. Complete stations comprising receiver transmitter rod aerial, one set of headphones and mike in canvas carrying bag, the crystal coil units can be supplied for authorised use only, **price 35/-** per set, post free. Brand new in maker's sealed cartons. Price per station **£4.10.0.** P. & P. 10/- each. Two stations for **£9.10.0.** Post free

HANDY POWER PACK

Housed in compact metal case. 200/250v. A.C. mains. Output 250v. 60 m.a. fully smoothed. 6.3 at 2 amps. Can be used for powering almost any pre amp or radio tuner. Price **39/6**. P. & P. 2/6.

NEW WALK-ROUND ELECTRONIC EQUIPMENT STORE AT NO. 4 LAMBERTS ARCADE, LOWER BRIGGATE, LEEDS 1. (NEXT TO HALFORDS CYCLE SHOP). OPEN ALL DAY WEEKDAYS AND ALL DAY SATURDAY.

C.O.D. 5/- EXTRA
NO C.O.D. UNDER 30/-
48hr. DESPATCH SERVICE
POSTAGE RATES APPLY IN U.K. ONLY

SONA

FOREIGN & TRADE ORDERS WELCOMED. S.A.E. WITH ALL ENQUIRIES PLEASE
PHONE LEEDS 34703

ALL MAIL ORDERS TO:—

SONA ELECTRONIC CO. (DEPT. P.E.1) BRIGGATE HSE., 13 ALBION PLACE, LEEDS 1

EAGLE PRODUCTS

COMPLETE WITH INSTRUCTIONS WHERE NECESSARY
SEND S.A.E. FOR FURTHER DETAILS OF ANY ITEM
ILLUSTRATED CATALOGUE OF WHOLE RANGE OF THESE SUPERB PRODUCTS AVAILABLE SOON AT 1/3 POST PAID

QUALITY TAPE RECORDER

MT 1000 or TC 601. Fully Transistorised, Self-contained, Economical, Loudspeaker, Playback, Eraser, etc. **£8.19.6.**

PROFESSIONAL RECORDER

TP 703, Six Transistor, Capstan Drive, Two Speeds, Dual Track, Push-button Controls, Tape, Ideal Speech and Music, Many Refinements, **£21.**

INTERCOM OR BABY ALARM

Fully Transistorised, Low Running Cost, Super Performance, absolutely complete, **£4.9.6.**

MULTIWAY INTERCOM SYSTEM

IP-7. Completely Transistorised Master Unit with Extension Indicators, Selector Switches, Volume Control, Completely Self-contained, Takes up to Six Extension Units, **14 Guineas.**

EXTENSION UNITS

for above, absolutely complete, **2 Guineas** each.

COMMUNICATION RECEIVER

RX. 60. 10-550 m. Continuous in Four Bands, S meter, Noise Limiter, Band Spread, B.F.O., 5″ Speaker, etc., Three Aerials supplied giving professional reception, Quality Finish, **£24.15.0.**

PROFESSIONAL COMMUNICATION RECEIVER

RX 80. Double Superhet, Five Wave Band, Calibrated Electrical Band Spread on 80m, 40m, 20m, 15m, 10m Bands, S Meter, Q Amplifier, Aetial Trimmer, etc., **£45.0.0.**

8-WATT STEREO AMPLIFIER

SA.80. Frequency Response 60-15,000 ±1db, Sensitivity 100 mV Stereo-Mono-Tuner-Phono, completely enclosed Gold/Black Quality Case, **£9.10.0.**

30-WATT STEREO AMPLIFIER

SA. 300. Superb Reproduction, Gold enclosed finish, Many features including Hum Balance, Speaker Phasing, Rumble Filter, Integrated Tone Controls, Five Inputs, Selector Switch, Function Switch, 4, 8 and 16 ohm Outputs, Fantastic Value, **£32.10.0.**

40-WATT TRANSISTOR STEREO AMPLIFIER

TSA. 218. Five Separate Inputs, Rumble Filter Scratch Filter, 18 Transistors, 115-240 VAC, Loudness Switch, Mode Switch, Input Selector, Base-Treble Balance Volume Controls, Superb Quality, Years of Trouble-free Use, 49 Guineas.

HIFI FM TUNER

FMT. 640. Matches above Amplifiers, Sensitive 8-valve Circuit, Superb Styling, A.F.C. Built-in Power Pack, Individually factory aligned, **19 Guineas** (+64/- P.T.).

AUDIO MASTER

FM-B100. Contains Tuners for Medium Wave, Short Wave and FM, Plus High Fidelity 10-Watt Amplifier with Three Inputs, Self-contained Power Supply, 12 Valves, Very **Sensitive, Many Controls** and features, **Completely Self-contained in** Superb Case 14½″ × 10¾″ × 4¾″, **£49.0.0** (+£8.10.0 P.T.).

LOUDSPEAKERS

DUAL CONE 8″

6-Watt, 50-16,000 C.P.S., 16 ohms, Total Flux 53,000, **78/9.**

CR.12.AE. 12″

Twin Cone Peak Power 20-Watts, 16 ohms, **8 Guineas.**

CR.30.AE.12″

Three-way Speaker, Woofer made Range Radiator and Tweeter all within single speaker system, **Phenomenal Realism,** 16 ohms, **10 Guineas.**

12″ Ultra Linear Speaker, Peak 25-Watts, 16 ohms, Total Flux 200,000, Unbelievable performance, 12 Guineas.

SLIM AUDIO PANEL 601 SPEAKER SYSTEM

A Built-in Crossover Network, Amazingly Realistic Performance, Superbly Finished Walnut Cabinet 21¾″ × 17⅝″ × 4¼″, Response 50-18,000 C.P.S. 10-Watts, 16 ohms, **15 Guineas** (+50/6 P.T.).

AP.801. As above, but 20-Watts, 40-20,000 C.P.S., Size 29″ × 21″ × 4¾″, **21 Guineas** (+ 70/9 P.T.).

HORN TWEETER CTN

10-Watts, 15-18,000 C.P.S., 16 ohms, High Sensitivity, Amazing Value **29/6.**

HT.20

20-Watts, Rectangular Heavy Cast Finish, 16 ohms, **69/6.**

MM-4 FOUR CHANNEL MICROPHONE MIXER

Ultra Compact, Fully Transistorised, Gain 6 db, Gold Finish, Four Volume Controls, Uses 9-V Battery, **59/6.**

MICROPHONES

MM-71. Crystal, Compact Finish, screened lead, jack plug, **12/6.**

100 C. Three-Way Crystal "Stick" mic., Professional Finish, Built In/Off Switch, Detachable Shielded Cable, Neck Cord, Chrome Finish, **39/6. MS 100 Desk Stand to** match, **8/-.**

MC. 70. Studio Crystal mic., 360° Pick-up includes Sensitive Variable "D" Cartridge, Complete Shielded Cable, Swivel Mounting, **59/6.**

DM.14.S. Miniature Dynamic mic. with Stand, Crackle/Chrome **Finish, 69/6.**

DM. 11. Dynamic mic. with Base, 360° Swivel, 60-12,000 C.P.S., Superb Mist Blue Finish, **5 Guineas.**

DM.16.HL. Dual Impedance Dynamic Striking Design, Outstanding Performance, Self-Adjusting Swivel Action, 40-15,000 C.P.S., 50 ohms Low, 50K High, **7 Guineas.**

DM.17.HL. As DM.16.HL. but Directional Heavy Chrome Stick, On/Off Switch, Stand Adaptor, **7 Guineas.**

MICROPHONE STANDS

MS.100 Desk Stand, Grey Base with Short Chrome Stick, Standard Fitting, **8/-.**

DS.2. Heavy Duty Desk Stand, **29/6.**

FS.3. Floor Stand, Heavy Duty Variable Height, Cast Iron Base, Takes Standard Microphones, **£2.17.6.**

PICK-UP ARMS

PP. 190. Adjusted Arm Rest with Mono/Stereo Quality Turnover Cartridge, Magnetic Stylus Pressure, Professional Finish, **67/-.**

MULTI-METERS

TK.20.A. 8 Ranges AC/DC/Current/Resistance 0–100K, Moving Coil.

EP.10.K. 10,000 OPV, High Quality, 15 Ranges AC/DC/Current/Resistance, Accuracy + or — 3%, **£4.12.6.**

EP.30.K. 30,000 OPV, 18 Ranges including Response to 10 meg., **£6.19.6.**

EP.50.K. Professional Quality, 22 Ranges, AC / DC / Volts / Current / Response / Decibels/Capacitance, **£9.19.6.**

TEST EQUIPMENT

1T1-1 Transistorised Signal Injector, Complete with Transistor Oscillator with Indicator Lamp, Detachable Test Probe and instructions, **39/6.**

RF Field Indicator RF.40. Tunes 1-250 Mc/S in Five Calibrated Bands with Telescopic Aerial Earphone and 200 UA Meter, **69/6.**

Tubes

HIGHEST QUALITY—COMPARE OUR PRICES

GUARANTEED

Carr. & Ins. 12/6.

MOST MULLARD, EMITRON, EMI-SCOPE, BRIMAR, MAZDA, COSSOR, FERRANTI TYPES

	6 Months	12 Months
12 in.	£1.15.0	£3.10.0
14 in.	£2. 0.0	£4. 0.0
15/17 in.	£2.15.0	£4.15.0
21 in.	£3.15.0	£5.15.0

NEW TYPES

MW 31/74
£4-0-0

MW 36/24
£5-0-0

CRM 173
MW 43/64
£6-0-0

100 RESISTORS ½—2W. 6/6

100 CONDENSERS 10/-

Miniature Ceramic and Silver Mica.

SPECIAL TEMPORARY OFFER

Due to huge Bulk Special Purchase, we are offering **MW** 31/74 Tubes at the unrepeatable price of **29/-.** MW 36/24 ditto, **39/-.** P.P. 12/6. The above are guaranteed for 6 months.

SILICON RECTIFIERS

Guaranteed performance. Top Make. Tested 250V working.

100mA (3 for 9/6) **3/9**

500mA (3 for 19/6) **7/6**

4 watt AMPLIFIER

excellent amplifier with high gain preamp stage, 10F3 driving 10P14 output stage, complete with 8in. speaker. In attractive 2-tone case, Tone control, negative feedback, ready for immediate use, individually tested. Amazing volume and clarity, ideal for guitars, record players, p.a. in small halls, baby alarms, etc. Easily worth £5. Our price while stocks last.
Carr., Packing, etc. 4/- **47/6**

GERMANIUM DIODES

General Purpose miniature detector (or **6/6** doz.) **8d.**

Gold Bonded highest quality All tested. (or **9/6** doz.) **1/-**

TRANSISTORS

Top Quality

Huge reductions. **Red Spot** standard L.F. type now only **1/6; White Spot** R.F. **2/-. Mullard Matched Output Kits** (OC81D and 2-OC81's), **12/6. Receiver Kits,** OC44, OC45(2), OC81D, OC81(2), six transistors. **24/-**

AF102	15/-	OC26	12/6	OC81	5/6
AF114	8/-	OC36	14/-	OC81D	5/6
AF115	7/6	OC44	5/6	OC82	7/6
AF116	7/6	OC45	6/-	OC170	8/6
AF117	7/-	OC71	5/-	OC171	8/6
AF127	9/6	OC72	5/6	XB104	5/6

CO-AX standard and low loss, 25 yds, **12/6;** 50 yds., **22/6;** 100 yds., **42/6.** Co-ax. Plugs **1/3.** Wall outlet boxes **3/6.**

CONDENSERS. 25 Mixed, Electrolytic. Many popular sizes. List value £5. Our price **10/-.**

CONDENSERS. Electrolytic, 25 popular sizes. List value £5. Our Price **10/-.**

25 TAG STRIPS, 2, 4, 6, 10-way, etc. **4/-**

12 POTS. Popular values. 5K to 2 Meg. Unused, mixed, pre-set, long sp., switch, etc. **4/6**

P.M. SPEAKERS. 3Ω Top Makes.
6½in. 8in. **7/6** 5in. 7 × 4in. **8/6**

MAINS TRANSFORMERS

Excellent Quality. Guaranteed Upright mounting 250-0-250V **60mA, 6.3V 3A** **Ditto semishrouded 9/6. Ditto up-right** 80 **mA 12/6** **9/6**

100 HI STABS 9/6

1% to 5% 100Ω to 5MΩ.

EKCO L.O.P.T. unused replacements for Perspex cased 1954/7 models complete with E.H.T. rect. unrepeatable **39/-**

VALUE in VALVES

BY RETURN OF POST— GUARANTEED 3 MONTHS

Satisfaction or Money Back Guarantee on goods if returned unused within 14 days ALL VALVES ARE NEW UNLESS OTHERWISE INFORMED.

FREE TRANSIT INSURANCE. POSTAGE 1 valve 6d., 2-11 1/-; FREE OVER 12.

0Z4	4/6	6K8GT	8/3	14S7	14/6	EBC81	5/9	EZ80	5/9	SP41	2/3
1A7GT	9/6	6K25	8/6	19AQ5	7/9	EBF80	7/6	EZ81	6/-	SP61	2/-
1C5GT	7/6	6L1	9/6	20D1	8/9	EBF89	7/9	FC4	8/-	T41	6/9
IH5GT	8/9	6L6	7/6	20F2	9/6	EBL21	9/9	GZ32	7/6	TDD4	7/-
1N5GT	8/9	6L6G	6/6	20L1	16/-	EBL31	19/6	HVR2	9/-	U14	7/6
1S4	7/6	6L18	7/9	20P1	9/6	EC52	4/9	KT33C	3/9	U18	7/6
2D21	5/6	6L19	12/6	20P3	11/-	ECC32	4/-	KT36	14/-	U22	6/9
3A4	4/-	6LD20	7/9	20P4	17/-	ECC34	9/-	KT44	6/-	U24	12/6
3A5	6/-	6P25	8/6	25A6G	8/-	ECC40	6/9	KT45	8/6	U25	8/3
3D6	4/-	6P28	9/9	25L6GT	7/9	ECC81	4/9	KT61	8/6	U26	7/-
3Q4	5/-	6Q7G	4/-	25Z4G	7/-	ECC82	4/9	KT73	5/9	U35	12/6
5R4GY	8/-	6Q7GT	8/-	30F5	6/-	ECC83	5/9	KT66	12/-	U50	4/6
5U4G	4/-	6SA7	5/9	30FL1	9/6	ECC84	7/6	KT76	8/6	U107	12/6
5Y3G	4/6	6SG7	4/9	30L15	8/9	ECC85	6/-	KT88	17/6	U191	9/-
5Y3GT	4/-	6SK7	5/-	30P4	9/6	ECC88	9/6	KTW61	5/9	U281	8/6
5Z4	9/-	6SL7GT	5/6	30P12	7/-	ECF80	6/-	KTW63	5/-	U282	15/-
5Z4G	7/-	6SN7GT	4/6	30PL1	9/3	ECF82	8/3	KTZ63	7/-	U301	12/6
5Z4GT	9/6	6SQ7	5/9	35C5	8/6	ECH21	11/6	MU14	7/-	U329	8/6
6/30L2	9/-	6U4GT	8/-	35L6GT	8/-	ECH35	7/6	N27	10/6	U801	19/-
6A8G	7/9	6V6G	4/6	35W4	6/-	ECH42	8/6	N78	13/-	UABC80	7/-
6AG7	7/6	6V6GT	6/-	35Z4GT	5/6	ECH81	7/-	N108	13/-	UAF42	7/9
6AK5	4/3	6X4	4/6	50L6GT	8/6	ECH83	6/3	PC86	10/-	UB41	6/6
6AQ5	5/-	6X5G	5/-	80	5/-	ECL80	6/6	PC97	7/6	UBC41	7/6
6AT6	5/-	6X5GT	5/6	185BT	19/6	ECL82	8/-	PCC84	6/6	UBC81	6/-
6AU6	7/-	7B6	9/-	185BTA	19/6	ECL83	10/6	PCC85	6/6	UBF80	7/9
6AV6	6/-	7B7	5/6	807(A)	5/-	ECL86	10/3	PCC88	11/9	UBF89	7/6
6BA6	5/6	7C5	7/3	807E	4/9	EF36	3/-	PCC89	8/6	UBL21	9/6
6BE6	5/6	7C6	7/6	813	49/-	EF39	4/6	PCC189	13/6	UCC85	7/3
6BG6G	15/-	7H7	5/-	866A	12/6	EF40	11/-	PCF80	6/9	UCF80	8/6
6BH6	5/-	7S7	8/9	954	3/6	EF41	8/-	PCF82	6/-	UCH21	9/3
6BJ6	5/-	7Y4	4/6	955	2/3	EF54	3/3	PCF84	12/-	UCH42	7/3
6BR7	8/6	10C1	9/-	956	2/-	EF80	3/6	PCF86	7/6	UCH81	7/9
6BW6	6/9	10C2	14/6	9001	3/6	EF85	6/-	PCL82	7/9	UCL82	8/-
6BW7	5/-	10F1	4/9	9002	4/9	EF86	7/6	PCL83	9/-	UCL83	10/-
6C4	2/3	10LD11	14/6	9003	5/6	EF89	6/9	PCL84	7/3	UF41	6/6
6C5	5/6	10P13	8/6	ATP4	2/6	EF91	3/-	PCL85	7/6	UF42	4/9
6C6	5/6	10P14	9/6	AZ31	6/-	EF92	3/-	PCL86	10/6	UF80	6/3
6C9	11/-	12AH7	7/-	B36	4/6	EF183	9/9	PEN25	3/9	UF85	7/6
6CD6G	17/-	12AH8	9/-	CL33	9/-	EF184	9/6	PEN45	8/6	UF89	5/9
6D6	3/-	12AT6	6/6	CY31	7/6	EL32	3/9	PEN46	4/6	UL41	7/6
6F1	4/9	12AT7	4/9	DAF91	4/6	EL33	6/6	PL33	8/6	UL44	14/-
6F6G	3/6	12AU6	9/-	DAF96	7/3	EL34	11/6	PL36	9/6	UL46	8/3
6F13	4/3	12AU7	4/9	DF91	3/-	EL35	6/-	PL38	17/6	UL84	7/-
6F14	9/6	12AV6	6/3	DF92	3/-	EL38	12/6	PL81	7/9	UR1C	7/6
6F15	9/6	12AX7	6/-	DF96	7/3	EL41	8/-	PL82	6/6	UM80	9/6
6F23	6/6	12BA6	7/-	DK91	5/6	EL42	7/9	PL83	6/6	UU6	9/9
6J5G	3/-	12BE6	6/6	DK92	7/-	EL84	6/6	PL84	7/6	UU8	11/-
6J5GT	4/3	12BH7	8/9	DK96	7/3	EM34	8/6	PY31	8/-	UY21	9/6
6J6	2/6	12E1	17/6	DL92	5/-	EM80	7/9	PY32	10/-	UY41	6/-
6J7G	4/9	12J7GT	8/-	DL94	6/6	EM81	6/9	PY80	6/6	UY85	5/-
6J7G7	7/6	12K7GT	4/-	DL96	7/3	EM84	8/9	PY81	5/9	VR105	5/6
6K6GT	6/-	12K8	9/9	EABC80	6/6	EM85	8/6	PY82	5/9	VR150	5/-
6K7	5/9	12K8GT	9/6	EAF42	3/3	EY51	7/6	PY83	5/9	X66	7/9
6K7G	1/-	12Q7GT	5/-	EB41	5/-	EY86	7/3	PY88	9/-	Y6	6/-
6K7GT	4/6	12SA7	6/3	EB91	2/-	EY88	8/6	PY800	6/3	Z66	8/6
6K8	8/6	12SK7	2/9	EBC33	4/9	EZ40	6/6	PZ30	9/6		
6K8G	5/-	12SQ7	7/6	EBC41	6/3	EZ41	5/9	R19	9/6		

Post: 2 lbs. 2/-, 4 lbs. 2/6, 7 **lbs. 3/6,** 15 **lbs. 4/-,** etc. (C.O.D. **2/-** extra). ALL ITEMS LESS 5% AND **POST FREE IN DOZENS.**

TECHNICAL TRADING CO.

SHOPS RETAIL ONLY
350-352 Fratton Road, Portsmouth (Tel. 22034)
72 East Street, Southampton (Tel. 25851)
ALL MAIL ORDER, RETAIL SHOP AND HI-FI ROOM
11-12 NORTH ROAD, BRIGHTON. Tel. 67999

Amplifier by

Be first to own the only amplifier of its kind in the world

10 WATT OUTPUT

NO HEAT SINK

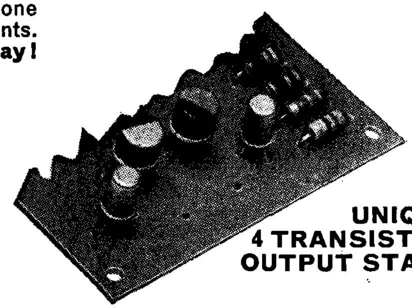
1mV INPUT SENSITIVITY

GIVES FANTASTICALLY GOOD REPRODUCTION

The Sinclair X-10 combined 10 watt amplifier and pre-amplifier (Pats. applied for) is so advanced in design that it outdates every type of amplifier ever made available to constructors, hi-fi enthusiasts, experimenters and industrial users. Its unique eleven transistor circuit solves once and for all problems inherent in conventional transistor amplifier design so that users of the Sinclair X-10 system enjoy far better reproduction, true 10 watt output for less current consumption (the amplifier will run for about 3 months from two 4/- Ever Ready 996 batteries) and great savings in space AND COST. Furthermore, the Sinclair X-10 is so designed that with the aid of the manual included with each amplifier (built or in parts) the purchaser can select the tone control and input matching system appropriate to his requirements. This is truly the amplifier of tomorrow—**and it can be yours today!**

NEW *DESIGN PRINCIPLES PERFORMANCE* !

- ★ **Number of transistors** 11
- ★ **Overall size** 6″ x 3″ x ¾″
- ★ **Input Sensitivity** 1mV
- ★ **Total harmonic distortion** < 0·1%
- ★ **Output power** 10 watts
- ★ **Frequency response** 5-20,000 c/s ± 0·5dB
- ★ **Speaker impedance** 15Ω
- ★ **Damping factor** Greater than 100
- ★ **Quiescent consumption** 75mA
- ★ **Supply voltage** 12 to 15 volts



UNIQUE 4 TRANSISTOR OUTPUT STAGE

Another Sinclair special feature—these 4 transistors do not get hot even at full output because the circuit converts almost 100% of the power from battery or mains unit into audio power for the loudspeaker.

SINCLAIR X-10

COMBINED 10 WATT AMPLIFIER & PRE-AMP

Guarantee

If you are not completely satisfied with your purchase (we are confident you will be delighted) your full purchase price will be refunded instantly and without question.
FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS

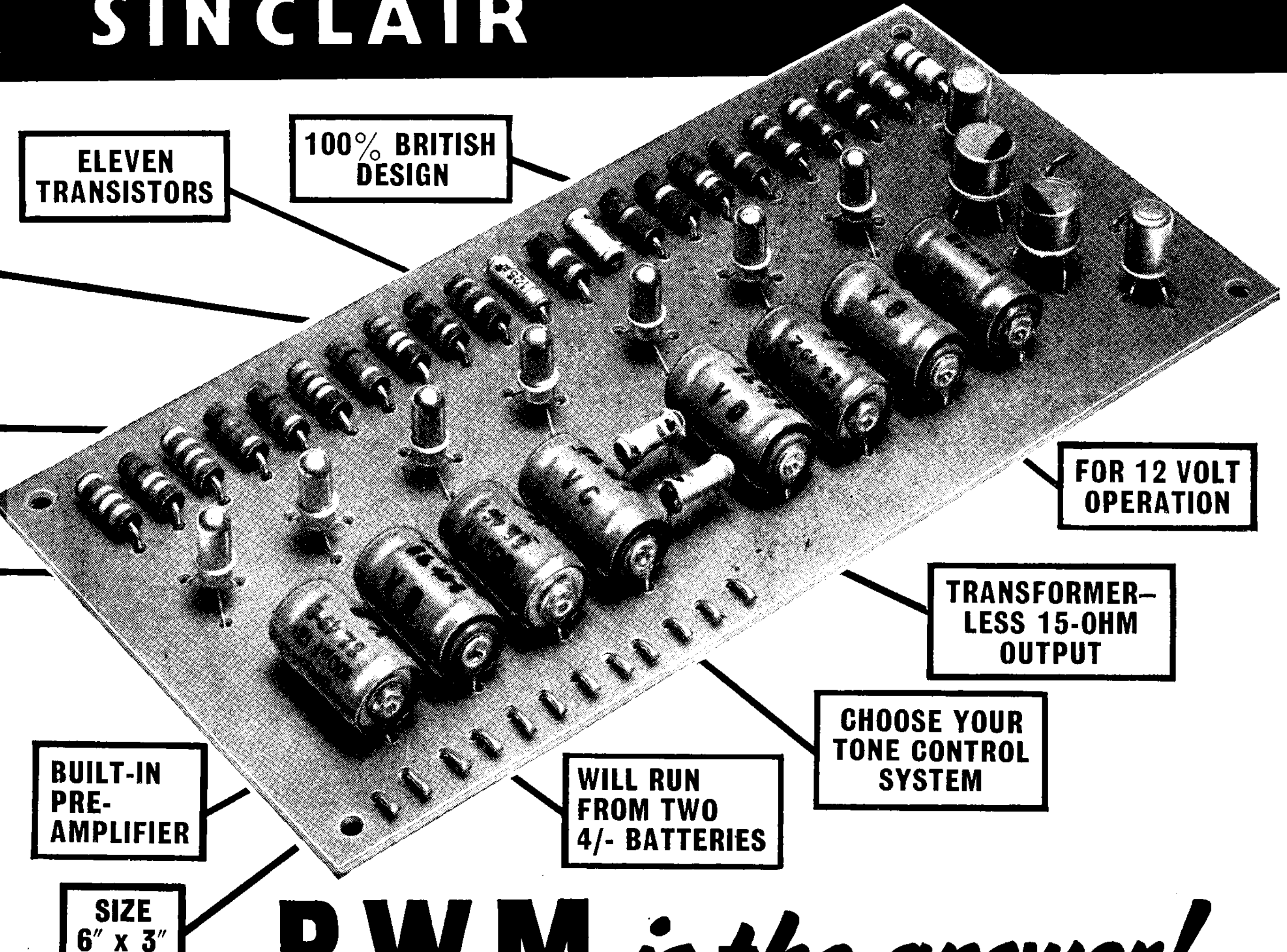
Build it for
£5-19-6
inclusive of all parts and instructions manual

READY BUILT AND TESTED
£6-19-6
including instructions manual

ANOTHER WINNING DESIGN FROM **SINCLAIR RADIONICS**

Breakthrough

SINCLAIR



PWM *is the answer!*

The Sinclair X-10 is the only amplifier in the world which gives you the benefits of this unique system. The use of Pulse Width Modulation (P.W.M.) ensures much better transient response — it is instantly noticeable the moment you hear it—no falling off in the higher audio-frequencies, no intermodulation distortion and a response curve so flat you could draw it with a ruler! Eleven transistors, four of which are used in a new type of output stage and P.W.M. plus many other circuit refinements result in an amplifier which is compact, rugged, stable and does not require a heat sink—and it costs so little. Used in pairs the X-10 brings new depths to stereo listening and there are no channel matching problems.

THE SINCLAIR X-10 MANUAL

Supplied with every Sinclair X-10 (whether purchased built or in parts for home construction) the X-10 Manual explains how the amplifier functions and how you can add the correct tone and volume control system to suit your requirements exactly. A variety of systems is shown, none of which will add more than a few shillings to the original cost of your Sinclair X-10 amplifier, and because it is so simple to modify this part of the assembly, further matching is very easy should you change your type of pick-up or other input.

MAINS POWER SUPPLY UNIT
(A.C. 200/240V)
£2-14-0

*

Order form and further Sinclair designs on next pages

EWH

LTD. COMBERTON, CAMBRIDGE. Telephone COMBERTON 682

More Sinclair designs and they are

Two fantastic micro receiver designs!

THE SMALLEST RADIO SET IN THE WORLD

$1\frac{4}{5}'' \times 1\frac{3}{10}'' \times \frac{1}{2}''$

•

WEIGHS UNDER 1oz. COMPLETE

•

100% BRITISH DESIGN

Appreciably smaller than a matchbox, this six-stage British designed transistor receiver brings in stations with amazing power and selectivity over the medium waveband. It has vernier-type tuning for easy station separation, bandspread to bring Luxembourg in like your local station and A.G.C. to cut fading. Everything is contained within the smart little white, gold and black case, including two tiny batteries and ferrite rod aerial. Listening is by means of the featherweight earpiece which plugs in to switch on. THIS MASTERPIECE OF BRITISH RADIO DESIGN CAN BE BUILT IN AN EVENING, AND IT PLAYS ANYWHERE.

All parts inc. earpiece and 8 page Instruction Manual come to **59/6**

MALLORY MERCURY CELL, ZM312 (2 required) 1/11 each Pack of 6 – 10/6

SINCLAIR MICRO-6

SIX-STAGE RECEIVER

Over 8,000 already built and in use throughout the world

TRANSRISTA black nylon strap for wearing Micro-6 like a wristwatch 7/6

SINCLAIR SLIMLINE

4-STAGE POCKET RECEIVER

A very efficient British designed receiver, particularly recommended for newcomers to transistor set building. Measuring $2\frac{11}{16}'' \times 1\frac{11}{16}'' \times \frac{3}{4}''$. Everything is contained within the gold-trimmed royal blue case, including standard PP.5 battery and ferrite rod aerial. The Slimline uses vernier-type tuning to cover the medium waveband. It gives reception of many British and Continental stations. Listening is by means of the featherweight earpiece which switches the set on when plugged in. Building this set is delightfully easy and when finished (usually after a couple of hours) it will provide endless pleasure and service to its user. The instructions make success assured, even if you have never built a set in your life before. The Sinclair Slimline has great power, quality and selectivity and makes the ideal beginning for enthusiasts starting on the Sinclair programme of transistor designs.

All parts inc. case, transistors, earpiece and instructions come to **49/6**

AN IDEAL RECEIVER FOR NEWCOMERS TO TRANSISTOR SET BUILDING

UNIQUE SINCLAIR Guarantee

All purchases from Sinclair Radionics Ltd. are covered by this unconditional guarantee:

If you are not completely satisfied with your purchase (and we are confident that you will be) your money will be refunded in full at once and without question.

WHAT CONSTRUCTORS SAY ABOUT SINCLAIR DESIGNS

Receive Luxembourg, Third and Home plus a host of foreign stations—it is fantastic. (Micro-6). *W.W.B., Whitchurch, Hants.* I pick up the Light in an area where reception is recognised as bad for this programme. (Micro-6). *J.E.N., Cheltenham.* Am very pleased with the quite remarkable performance of your Slimline design. *R.T.N., Luton.*

sinclair

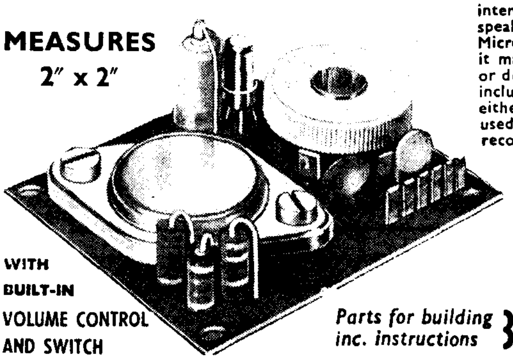
SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE
Telephone: COMBERTON 682

for you to build!
all guaranteed

SINCLAIR TR750 AMPLIFIER

Designed for use with the Micro-6 or Slimline Receivers

MEASURES
2" x 2"



WITH
BUILT-IN
VOLUME CONTROL
AND SWITCH

This highly original design is primarily intended to provide powerful loudspeaker reproduction from the Sinclair Micro-6 and Slimline Receivers. As such, it makes an ideal car-radio or portable or domestic loudspeaker set. A plug is included for connecting the TR750 to either set. The amplifier can also be used in many other ways including record player, intercom or baby alarm.

- **OUTPUT** — 750 milliwatts into any standard 25-30 ohm loudspeaker
- **INPUT**—10 mV into 10 K-ohms
- **RESPONSE** — 30-20,000 c/s ± 1dB

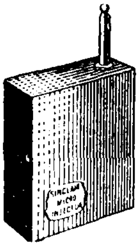
Parts for building inc. instructions **39/6** **READY BUILT AND TESTED** **45/-**

Salute to a new Journal

Now that transistors are so freely available to everyone, we feel that *Practical Electronics* had to come. We are confident that this exciting new journal is going to meet the needs of an ever-increasing band of constructors whose interests are taking them into fascinatingly new fields, and who will want more varied and ambitious activities as electronics progress. So good luck to *Practical Electronics*. As a forward looking team ourselves, we wish you every success.

SINCLAIR MICRO-INJECTOR

Invaluable to constructors for fault tracing



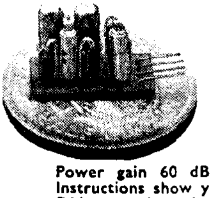
Two Sinclair Micro-Alloy Transistors (M.A.Ts) are used in a special circuit to generate and inject a test signal into any part of the equipment at any frequency from 1 kc/s to 30 Mc/s so that faults can be rapidly located in any radio or audio apparatus. This is the smallest, most efficient probe of its kind ever offered to constructors and the lowest priced too. The standard 6d. battery required to power the Sinclair Micro Injector will easily give 6 months' service. Full instructions are included with every instrument, complete or in parts. Building is very easy.

Parts inc. M.A.Ts and case come to **27/6**

Ready built and tested **32/6**

SINCLAIR MICRO-AMPLIFIER

Designed to laboratory standards



Thousands of these fantastically small amplifiers have been built by constructors, modellers, experimenters, laboratories, commercial firms, etc. Frequency response from 30 to 50,000 c/s ± 1 dB. Power gain 60 dB (1,000,000 times!). Instructions show you how to make an F.M. transmitter, broadband R.F. or subminiature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker. A fascinating unit to build and use. It is no bigger than a three-penny piece!

Parts and instructions come to **28/6**

SINCLAIR X-10

For details of this revolutionary new 10 watt combined hi-fi amplifier and pre-amp see our preceding pages.

SINCLAIR TRANSISTORS

MAT 100	High gain, low level ...	7/9
MAT 101	Extra high gain, low level	8/6
MAT 120	High gain, medium and high level	7/9
MAT 121	Extra high gain, medium and high level	8/6
ADT 140	For FM, TV, VHF and UHF	15/-
"Magnagain"	Power Output up to 30 watts	18/-

BOOKS FOR CONSTRUCTORS

★ "22 Tested Circuits Using Micro Alloy Transistors"	*Post free*	5/6
★ "Tested Short Wave Receivers Using MATs"	*Post free*	5/6
★ "Tested Superhet Circuits for Short Wave and Communication Receivers, using MATs"	*Post free*	6/6

All three ordered together, 16/6

If you do not wish to cut the coupon from this page, please mention "Practical Electronics," November, when ordering

To SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE

Please send items detailed below:– £ s. d.

....

....

....

....

TOTAL £

NAME...

ADDRESS...

....

.... Pre. 11

For which I enclose CASH/CHEQUE/MONEY ORDER

The NEW Stern-Clyne ELECTRONIC CONCERT ORGAN
TO BUILD YOURSELF

DESIGNED –

- For the Electronic amateur seeking the most fascinating project.
- For the discriminating organist seeking an instrument which DOES sound like a pipe organ.

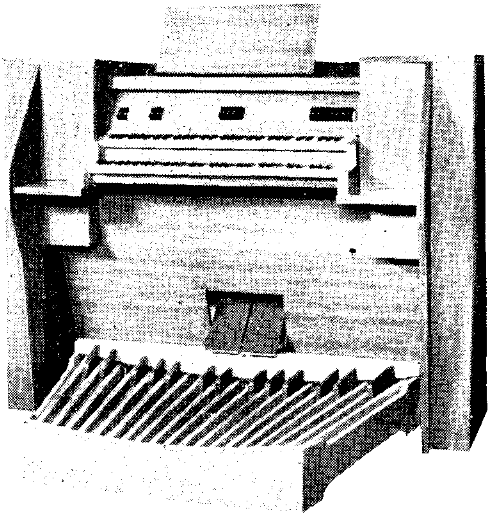
NEW –

- Constructional methods introducing "sectional complete instrument" building.
- Extended range of tone colours. Without unrealistic "Gimmick" effects.

THE MOST COMPREHENSIVE KIT OF PARTS AVAILABLE IN THIS COUNTRY

START BUILDING FOR AS LITTLE AS £68.10.0 approx. (H.P. Terms Available)

Write today for brochure (enclosing 6d. stamp) to: **Electronic Organ Dept., 18 TOTTENHAM COURT ROAD, LONDON, W.C.1,** or call at your nearest branch.



VISIT OUR SHOWROOM AT
18 TOTTENHAM COURT RD., LONDON, W.1
and hear this fabulous new Electronic Concert Organ demonstrated.

STERN-CLYNE

GREAT BRITAIN'S GREATEST ELECTRONIC HOBBIES ORGANISATION

HERE'S WHY THOUSANDS OF ELECTRONICS ENTHUSIASTS BUY WITH CONFIDENCE FROM STERN-CLYNE –

- **A wide range of exclusive equipment available including our own speciality — MULLARD DESIGNS — for the home constructor or ready assembled.**
- **The finest selection of Hi-Fi and Audio equipment by all leading manufacturers.**
- **A comprehensive range of electronic components for the build it yourself enthusiast available at all branches.**
- **Retail shops, showrooms and demonstration rooms throughout London and the provinces all carry extensive stocks.**
- **Finest Mail Order Service-geared to give prompt and efficient attention.**
- **Hire Purchase facilities available on orders of £11 10. 0 and over.**
- **Hi-Fi advisory service to help you in choosing the right equipment.**
- **After sales service — complete satisfaction guaranteed.**

VISIT YOUR NEAREST STERN-CLYNE ELECTRONICS CENTRE

LONDON

18 Tottenham Court Rd., W.1. MUSeum 5929-0095. *Half Day Sat.*
23 Tottenham Court Rd., W.1. MUSeum 3451-2. *Half Day Thurs.*
309 Edgware Rd., W.2. PADdington 6963. *Half Day Thurs.*
109 Fleet St., E.C.4. FLEet St. 5812-3. *Half Day Sat.*
162 Holloway Road, N.7. NORth 7941. *Half Day Thurs.*
9 Camberwell Church St., S.E.5. RODney 2875. *Half Day Thurs.*

CROYDON

12 Suffolk House, George St. MUNicipal 3250. *Half Day Wed.*

BRISTOL

26 Merchant Street, Bristol 1. Bristol 20261.
Now open 6 days a week.

LIVERPOOL

52 Lord Street, Liverpool. Royal 7450.

MANCHESTER

20-22 Withy Grove, Manchester 4. BLAckfriars 5379.
Open 6 days a week.

SHEFFIELD

125 The Moor, Sheffield. Sheffield 29993.

MAIL ORDERS AND ENQUIRIES TO:

Dept. P.E., 3-5 Eden Grove, Holloway, London, N.7. NORth 8161-5.

SURBITON PARK RADIO LTD.

ALL ORDERS DESPATCHED SAME DAY ● WE PAY POSTAGE AND INSURANCE

SATISFACTION OR MONEY REFUND GUARANTEE

LEADING STOCKISTS OF MARTIN RECORDAKITS AND AUDIOKITS

MARTIN RECORDAKITS

HALF TRACK

		Dep.	&	Mthly. pmts. of
TAPE AMPLIFIER FOR STUDIO DECK, with ready wired printed circuit, control and input panels, mains and output transformers, knobs, plans, screws etc.; EF86, ECC83, EZ80, EM85 and 2 EL84. 3 watts output. Magic eye, Radio & Mic. inputs, ext. speaker socket, tone and monitor controls. Can be used as an amplifier	£11.11.0	47/-	8	25/6
COLLARO STUDIO DECK, very latest model, 3 speeds, 3 motors, 7in. spools	£10.19.6	44/-	8	24/6
CASE for above with 8 x 5in. speaker, two tone grey	£5.5.0			
COMPLETE KIT with tape and microphone	£29.19.6	120/-	12	44/-

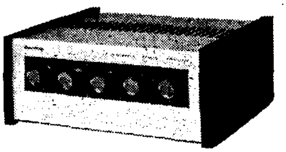
QUARTER TRACK

TAPE AMPLIFIER FOR STUDIO DECK, as above.	£12.12.0	52/-	8	27/6
COLLARO STUDIO DECK, fitted Marriott "X" Series heads	£13.19.6	56/-	12	20/6
CASE as above, two tone grey	£5.5.0			
COMPLETE KIT with tape and microphone...	£33.19.6	136/-	12	49/10

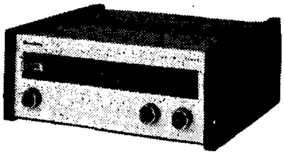
TAPE PRE-AMPLIFIERS

HALF TRACK for **STUDIO** deck, 400m/V out.	£8.8.0	34/-	6	25/8
QUARTER TRACK, as above **SELF POWERED**	£9.9.0	39/-	6	28/4
TAPE HEADS, Bradmatic Half-Track Record/Replay and Erase on plate	£1.19.6	—	—	—

ARMSTRONG AMPLIFIERS AND TUNERS



MODEL 222



MODEL 223

222 Integrated Stereo Amplifier	£27.10.0	110/-	12	40/4
223 A.M.-F.M. Tuner	£28.15.0	115/-	12	42/2
224 F.M. Tuner	£22.10.0	90/-	12	32/2
127/M Mono Tuner/Amplifier	£26.10.0	106/-	12	38/10
127 Stereo Tuner/Amplifier	£37.10.0	150/-	12	55/-
227M Mono Tuner/Amplifier	£36.15.0	147/-	12	53/-
227 Stereo Tuner/Amplifier	£52.15.0	211/-	12	77/4
226 Stereo Tuner/Amplifier	£61.0.0	260/-	12	88/-

Shelf mounting Teak Case for any of above, £3.10.0 extra

MONO AMPLIFIERS

Linear L 45/A, 3 valve, 3 watt.	£6.6.0			
Dulci GA5, Integrated, 5 watts ECL86	£13.2.6	52/6	12	19/3
Tripletone Hi Fi Major, 10 watts 2 EL84	£15.18.9	64/9	12	23/3
Leak TL12, 10 watt Main Amplifier only	£20.0.0	80/-	12	29/4
Leak Varislope Mono, Pre-amplifier	£15.15.0	63/-	12	23/1
Dulci DPA15, 15 watt with 2 valve pre-amplifier	£26.5.0	105/-	12	38/6

STEREO AMPLIFIERS

Leak Stereo 20, Pre-amplifier and Main amplifier complete	£55.9.0	229/-	12	80/8
Dulci GA505, Integrated 5 watts per channel...	£18.18.0	76/-	12	27/8
Rogers Cadet Mk2 with Pre-amplifier 4 ECL86 valves	£26.15.0	107/-	12	39/2
Leak Transistor Stereo 30, Pre-amplifier and main amplifier	£49.10.0	198/-	12	72/7

F.M. TUNERS

Tripletone, F.M. Tuner Less power	£13.19.6	56/-	12	20/6
Tripletone, F.M. Tuner With power	£15.14.6	63/-	12	23/1
Jason JTV/2, F.M. and T.V. sound, Switched, self powered	£22.5.0	89/-	12	32/7

SURBITON PARK RADIO LTD.

48A SURBITON ROAD, KINGSTON-UPON-THAMES
SURREY

Phone: KIN 5549

- ***ORDERS FOR CASH, C O D OR TERMS***
- ***HOURS 9 a.m. to 6 p.m. (1 p.m. Wednesday)***

MARTIN AUDIOKITS

The new **Martin All Transistor Ten Watt Amplifier** kits represent excellent value for money. Each unit is complete, requiring only to be connected to the next. We show only the popular units here. Others available including stereo. The following would make up a **TRANSISTORISED AMPLIFIER 15 ohms MODEL**

		Dep.	&	Mthly. pmts. of
UNIT 1—FIVE INPUT SELECTOR. Size 3¼ x 3in. Mag. PU, Crystal PU, Radio, Mic., Tape Head	£2.7.6	—	—	—
UNIT 4—PRE-AMPLIFIER AND CONTROL. Size 6¾ x 2½in. Volume on/off, bass and treble control.	£3.2.6	—	—	—
UNIT 7—MAIN AMPLIFIER, 10 watts 6 transistor, transformerless Push Pull output. Mounted on heat sink. L.S. imp. 15 ohms	£6.12.6	—	—	—
UNIT 8—POWER SUPPLY. Gives 18 & 40 volts. Heavy duty transformer, rectifier and smoothing	£2.15.0	—	—	—
CONTROL PANEL for Units 1 and 4	10.6	—	—	—
ALL ABOVE FOUR UNITS WITH PANEL. 15 ohms	£15.8.0	62/-	12	22/6
TRANSISTORISED AMPLIFIER 3 ohms MODEL				
UNIT 5 MAIN AMPLIFIER, as Unit 7 but 3 ohms	£5.12.6	—	—	—
UNIT 6 POWER SUPPLY, as Unit 8 but 18-24 Volts	£2.12.6	—	—	—
ALL FOUR UNITS WITH PANEL 3 ohms	£14.5.0	57/-	12	20/10

SEND FOR LEAFLET OF COMPLETE RANGE

Hi Fi LOUDSPEAKERS

W.B. HF812, 8in., 3.75, 7.5 and 15 ohms	£3.16.6	—	—	—
Goodmans Axiette, 8 in.	£5.5.7	—	—	—
Goodmans Axiom, 10 in.	£6.5.11	—	—	—
Goodmans 5K/20/XL, Tweeter and Crossover	£7.7.0	—	—	—
W.B. HF1012, 12in., 3.75, 7.5 and 15 ohms...	£4.12.0	—	—	—
Goodmans X05000, £2.0.11. **X0950**	£5.10.11	—	—	—
Wharfedale Super 3, Tweeter	£5.16.8	—	—	—
Wharfedale Super 5, Tweeter	£5.19.7	—	—	—
Wharfedale Super 8 RS/DD, Full range unit...	£6.14.2	—	—	—
Wharfedale Super 10 RS/DD, Full range 10 unit	£10.18.0	44/-	8	24/3
Goodmans 201, 12in. unit Full range 15 watt....	£10.17.6	43/6	8	24/3
Wharfedale RS/12/DD, 12in. unit Full range...	£11.10.0	46/-	8	25/6
Goodmans 301, 12in. unit Full range 20 watt...	£15.4.6	61/-	12	22/4

LEAFLETS AVAILABLE ON REQUEST

GRAMOPHONE UNITS

B.S.R. UA14 with TC8 Mono cartridge	£6.19.6	28/-	6	22/-
Garrard SRP10 Single player, Mono cartridge	£5.9.11	—	—	—
Garrard Autoslim, 4 Speed changer Mono ...	£7.17.0	33/-	6	24/-
Garrard A.T.6 Autoslim de Luxe, mono ...	£11.9.0	47/-	8	25/3
Garrard 4H/F, Transcription unit Mono	£17.0.0	68/-	12	24/11
Garrard LAB. "A", Transcription changer Mono	£19.14.9	79/-	12	28/11
Garrard 301 Strobe, Transcription unit	£22.0.0	88/-	12	32/3
Philips AG1016, Stereo cartridge, will change 7in. records with adaptor 10/- extra	£12.12.0	50/6	12	18/6
Goldring GL58, with arm but less cartridge...	£17.1.0	69/-	12	24/11
Goldring GL70, with arm but less cartridge	£27.9.4	111/4	12	40/1
Goldring "88", Transcription less arm	£18.18.5	76/5	12	27/8

LEAFLETS ON REQUEST

GUITAR SPEAKERS

Fane, 12in. Heavy duty unit 20 watt	£5.5.0	—	—	—
Goodmans Audiom 51, 12in. 15 watt Bass	£9.2.8	36/8	6	27/8
Wharfedale W 12/EG, 12in. 15 watt Lead ...	£10.10.0	42/-	8	23/6
Wharfedale W 15/EG, 15in. 15 watt Bass ...	£17.10.0	70/-	12	25/8
Goodmans Audiom 61, 12in. 20 watt Bass or Lead	£14.7.8	57/8	12	21/1
Goodmans Audiom 91, 18inch 50 watt Bass	£29.15.0	119/-	12	43/7

WRITE FOR GOODMANS LEAFLET "LOUD-SPEAKERS FOR ELECTRIC GUITARS"

GUITAR AMPLIFIERS

Linear Diatonic 12 watt 2 inputs	£13.2.6	52/6	12	19/3
Linear Conchord 30 watt 2 inputs with Cover	£19.4.6	77/-	12	28/2
Leak TL 25 25 watts amp and pre-amp	£42.5.0	169/-	12	61/11
Leak TL 50 50 watts amp and pre-amp	£51.5.0	205/-	12	75/2

MICROPHONES AND FLOOR STANDS

Reslo RBH/T, Ribbon High Impedance	£11.2.6	44/6	8	24/9
Reslo RBH/TS, Ribbon with on/off switch ...	£13.10.0	54/-	12	19/9
Reslo Heavy Duty Floor Stand	£7.0.0	—	—	—
Teisco DM304, Dual Impedance with switch...	£4.10.0	—	—	—
Piezo BM3, Crystal with switch, desk stand ...	£2.10.0	—	—	—
Jap, Floor Stand	£3.3.0	—	—	—

EASILY REACHED BY FREQUENT TRAINS WATERLOO TO SURBITON


The little instrument
with the
BIG
performance
1000V
1000V
250V
250V
100V
100V
25V
25V
10V
-10V
2·5V
1A
·1A
10mA
1mA
·1mA
X1
X100
D.C.
A.C.
OHMS
D.C.

YOU ARE NOW LOOKING AT

The Biggest Give-Away IN YEARS!

A LIMITED SUPPLY OF A WELL-KNOWN MANUFACTURER'S DISCONTINUED LINE

BRAND-SPANKING-NEW!

FULLY TRANSISTORISED MINIATURE

CLOSED-CIRCUIT T.V. CAMERAS

READY ASSEMBLED FOR IMMEDIATE USE (Less Vidicon Tube)

Post & Ins. 28/-

Have your own private Closed-Circuit Television System in your Factory, Office or Home.
Excellent for Security Stunts, Overflow Audiences, Traffic/Store Control, Exhibitions, Films and Dramatic Groups, Two-way Tele-view links, etc.—

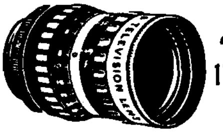
AND A MUST
for Technical Colleges and Research Labs!

Brief Specification:

- ★ 405 line R.F. output in Band I
- ★ You can tune the Camera to any Channel from 1 to 5
- ★ Mains operated, 210/250 V. A.C. 50/60 Cycle
- ★ Plugs in aerial socket of any size Domestic T.V. set
- ★ Top Grade Transistors, 100% Reliable
- ★ C type 16 mm. lens mount (lens not supplied)
- ★ Good picture quality with normal lighting
- ★ View people, objects, etc. up to 1,000ft. away—4 to 6 T.V. sets can be used off one Camera
- ★ Weight only 4 lbs.

BRAND NEW C.C. T.V. LENSES

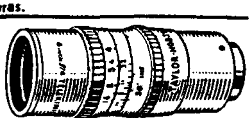
Excellent for use with The 'ICON' illustrated and all T.V. Vidicon Cameras.



JAPANESE "COSMICAR" 1in. TELEVISION LENS

'Click-stop' Aperture f/1.9 to f/22 4-element lens construction, C mount fitting. Full focusing adjustment from infinity to 24ins. Fully bloomed complete with lens caps and finished in an attractive black and stainless alloy at the ridiculous low price of only **£9.19.6**
(post and ins. 5/6)
Usually selling at £23. Also ideal for 16 mm. Movie Cameras.

4" TELE-PHOTO



F/4 Taylor Hobson LENS
For Brilliant Close-ups of distant subjects, full focusing adjustment, 'Click-stop' varying aperture down to f/32. Fully Bloomed Lens, C mount thread.
Usually selling at £54—OUR PRICE **£18** each.

VIDICON E.M.I. 'M' GRADE TUBES
Available only from us at **£9.19**
(post and ins. 16/-)

Full operating instructions and circuitry supplied with each camera

HORNTONS ELECTRONICS **LOMBARD HOUSE, GREAT CHARLES STREET** (Next to Pan American Airways) **BIRMINGHAM 3.** *Phone: CEN 6283 or MID 0972*

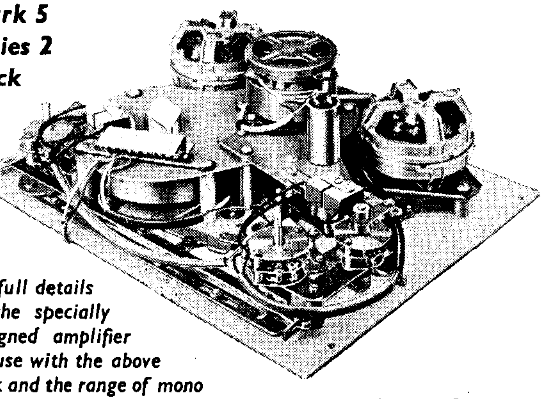
THINKING TAPE? THINK *Brenell*

If you're thinking in terms of tape recording, then the Brenell deck and complete recorders should be uppermost in your mind. The reliability, the versatility and the quality of manufacture are seldom equalled in other tape recorders (even in those costing much more).

How many can equal or better this specification?

4 record/playback speeds 1⅞, 3¾, 7½ and 15 ips • 3 motors (capstan motor-hysteresis synchronous) • low 'wow and flutter' content (0.05% at 15 ips, 0.1% at 7½ ips, 0.15% at 3¾ ips and 0.25% at 1⅞ ips) • double-gapped ferrite erase head to minimise erase noise • narrow-gapped record/playback head to give extended frequency response • pause control • superimpose control • 8¼″ dia. reels (to take 10½″ dia. N.A.B. reels at extra cost) • fast rewind • digital rev. counter.

Mark 5 Series 2 Deck



For full details of the specially designed amplifier for use with the above deck and the range of mono and stereo recorders, write or telephone the sole manufacturers:

Brenell

PLEASE NOTE OUR NEW ADDRESS:

BRENELL ENGINEERING CO. LTD.
231-5 LIVERPOOL ROAD, LONDON, N.1
Telephone: NORth 8271 (5 lines)

GD840

PROTECT YOUR TAPE RECORDER
WITH A STRONG, SMART
COVER

Smart waterproof cover to give complete protection to your tape recorder. Made from rubberised canvas in navy, wine, tan, grey and bottle green with white contrasting pipings, reinforced base, handy zip microphone pocket and name panel.

Grundig TK.1	49/6	Telefunken 75/15 &		Stella ST458	79/-
,, TK.5	55/-	76K	55/-	,, ST459	84/-
,, TK.6	67/6	Philips 8108	57/6	Saba	63/-
,, TK.8	63/-	,, 3548		Elizabethan FT.1	66/-
,, TK. 14 &		,, 3534	87/-	,, FT.3	75/-
23 & 18	59/6	,, 3459	79/6	,, LZ29	75/-
,, TK. 20	52/6	,, EL3538	63/-	Fi-Cord 1A	52/6
,, TK. 24	55/-	,, EL3542	63/-	Fidelity Argyle	55/-*
,, TK. 25	55/-	,, EL3536	70/-	Clarion (with strap)	52/6
,, TK. 30	60/-	,, EL3515	57/6	Brenell Mk.5	77/-
,, TK. 35	63/-	,, EL3541/15	57/6	,, 3 star	69/-
,, TK. 40 & 41	66/-	,, 3541H	72/-	Truvox R92 & 94	99/-
,, TK. 46	82/-	,, Starmaker	66/-	Robuk RK.3	67/6
,, TK. 55	63/-*	Cossor 1602	57/6	Ferrograph	88/-
,, TK. 60	75/-*	,, 1601	63/-	Sony 521	90/-
,, TK830/3D	63/-	,, 1604	79/-	Revox	84/-
,, Cub	35/-*	,, 1605	84/-	Optacord 414 + 412	63/-
Telefunken 85	65/-	Stella ST455	63/-		
,, 95	69/6	,, ST454	57/6	*Without Pocket	

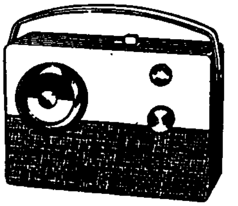
A. BROWN & SONS LTD.

24-28, GEORGE STREET, HULL TEL: 25413, 25412

'SUPER SIX'
TRANSISTOR RADIO KIT

NOW ONLY £4.17.6 **(post 5/-)**

Owing to a fortunate bulk component contract the price of this model is now reduced to £4.17.6. Purchasers who have already paid the previous higher price will have the difference refunded on application.



- All new parts.
- 6 transistors and diode.
- 350mW output.
- Superhet circuit, Ferrite rod aerial.
- Weymouth Radio printed circuit board.
- Component positions and references printed on back of board.
- Nicely styled wooden cabinet, 11 × 7¼ × 3¼in.
- Vinyl covered in various colours.
- 6 × 4in. speaker giving good bass and treble response.
- Full instruction booklet 2/-. Free with kit.
- I.F. frequency 470 kc/s.
- Lining up service if required.
- All parts supplied separately. Write for list. S.A.E. please.
- Set can be supplied fully built for £6.17.6 tax and carriage paid.
- 9v. battery required. VT9 or P.P.9 (3/9 with kit).

"MINOR" RECORD PLAYER WITH "MAJOR" PERFORMANCE fully built, rexine covered, 10 × 7 × 5¼ in. 4 transistor amplifier. Good volume. 7 in. records 45 & 33 r.p.m. **£6.7.6** (Post 5/-). Battery 3/9.

TRANSISTORS

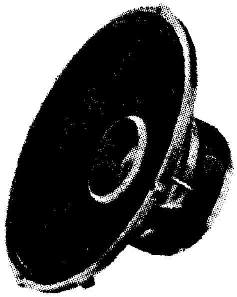
Packet of 3 coded RF transistors (equivalent of OC44/5) 7/6 post paid. Set of 6 transistors and diode with circuit diagram. Neatly packed in foam-lined box; useful for presentation. 15/- post paid.

Trade Supplied.

ELECTRONICS (Camberley) Ltd.
15 Victoria Avenue, Camberley, Surrey.
(Closed Saturday)

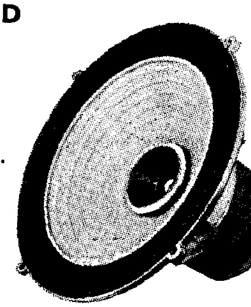
THE WHARFEDALE Super Range

Each loudspeaker in this range is fitted with roll surround for low resonance and double diaphragm assembly for extended HF response.



SUPER 10/RS/DD

Impedance 10/15 ohms.
Flux density 16,000 oersteds.
Max. input 10 watts rms
or 20 watts peak.
Frequency range 30-20,000 c/s.
Aluminium Voice Coil.
Bass resonance 38/43 c/s.
Price: 218/8 inc. P.T.

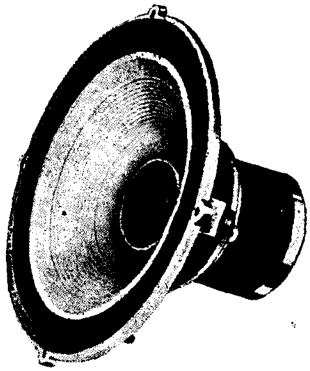


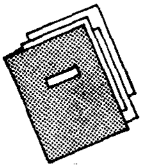
SUPER 8/RS/DD

Impedance 10/15 ohms.
Ceramic Magnet.
Flux density 14,500 oersteds.
Total flux 60,000 maxwells.
Aluminium Voice Coil.
Max. input 6 watts rms
or 12 watts peak.
Frequency range 40-20,000 c/s.
Bass resonance 50/60 c/s.
Price: 134/2 inc. P.T.

SUPER 12/RS/DD

Impedance 12/15 ohms.
Flux density 17,000 oersteds.
Total flux 190,000 maxwells.
Aluminium Voice Coil.
Max. input 20 watts rms
or 40 watts peak.
Frequency range 25-20,000 c/s.
Bass resonance 26/32 c/s.
Price: 350/- (no tax).





Write for informative and fully illustrated 12 page booklet

Wharfedale

WHARFEDALE WIRELESS WORKS LTD
IDLE, BRADFORD, YORKSHIRE
Telephone : Idle 1235/6
Telegrams : 'Wharfdel', Bradford.

RST

Cordially invite

Practical Electronics

readers

To try our unsurpassed

VALVE MAIL ORDER SERVICE

Vast quantities of modern and obsolete fully guaranteed valves available from stock at very moderate prices. Send S.A.E. for Full lists

SPECIAL 24 HOUR EXPRESS MAIL ORDER SERVICE

Callers welcome

AN EXAMPLE OF THE VALUE YOU GET from RST

BRAND NEW TRANSISTORS

OC35	10/-	OC72	8/-	OC81D	5/-
OC42	6/-	OC74	8/-	OC81m/pr	12/6
OC44	5/-	OC75	8/-	OC82	6/-
OC45	5/-	OC77	8/-	OC82D	6/-
OC71	5/-	OC81	5/-	OC170	6/-

SILICON RECTIFIERS

400 volts 350 mA ... ... 7/6 each

METAL RECTIFIERS

RM1	7/6	14A86	23/-		16RD 2-2-8-1	12/-	(FC142)
RM2	8/-	14A97	26/-		16RE 2-1-8-1	10/-	(FC150)
RM3	10/-	14A100	28/-		18RA 1-1-8-1	5/-	(FC118)
RM4	17/6	14RA 1-2-3-2	21/-	(FC301)	18RA 1-1-16-1	7/-	(FC116)
RM5	19/6	14RA 1-2-8-3	25/-	(FC31)	18RD 2-2-8-1	16/-	(FC124)

SETS OF VALVES

1R5, 1S5, 1T4, 3S4, 3V4 ... ... Set of 4, 17/-
DAF91, DF91, DK91, DL92, DL94 ... ... Set of 4, 17/-
DAF96, DF96, DK96, DL96 ... ... Set of 4, 25/-

**TERMS OF BUSINESS C.W.O. or C.O.D.
4/2 PACKING CHARGE ON ALL C.O.D.
ORDERS. POSTAGE 6d. per VALVE**

RST VALVE MAIL ORDER CO.

211a, STREATHAM ROAD, MITCHAM, SURREY

Telephone: MITcham 6202 & 6771

Mon. – Sat. 9 a.m. – 5.45 p.m.
Wednesday 9 a.m. – 1 p.m.
Lunch 1.30 – 2.30

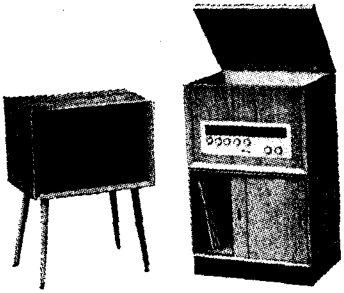
HOUSING HI-FI?

Three of a wide range of cabinets for *every* hi-fi purpose — speakers, equipment, tapes and records. Soundly designed, superbly finished, sensibly priced. Send for illustrated catalogue and name of local stockist.

Upper Right
Nordyk Equipment Cabinet
Walnut or Mahogony 7 gns.
Teak 8 gns.

Lower Right
Nordyk Storage Unit
Walnut or Mahogony £5.17.6
Teak £6.17.6

Left
Nordyk Speaker Unit
Walnut or Mahogony 7 gns.
Teak 8 gns.
Legs 29/9

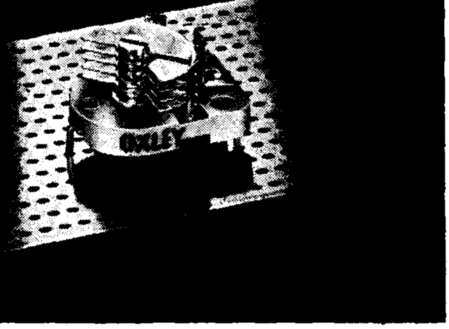


RECORD HOUSING

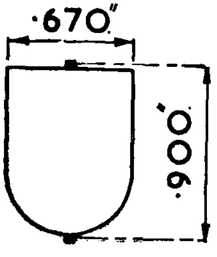
(Dept. P.E.11), Brook Road, London, N22

Telephone: BOWes Park 7487/8

OXLEY



AIR DIELECTRIC TRIMMER



NOW OBTAINABLE WITH TERMINALS FOR PRINTED CIRCUIT MOUNTING

Capacities from 4·5 — 100pF.
Insulation greater than 10,000 megohms.
Power Factor less than ·001.
Acetate dust cover optional.

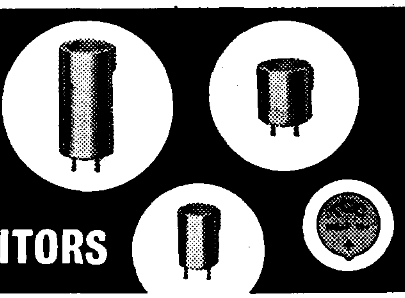
Write for technical details of these or any other Oxley products

OXLEY DEVELOPMENTS CO. LTD.

ULVERSTON, LANCASHIRE Tel.: Ulverston 2567

FOR THE FIRST TIME

Plug-in ELECTROLYTIC CAPACITORS



SMALL • FULLY ENCAPSULATED • PLASTIC CASED

These new T.C.C. small plastic-cased electrolytic capacitors have been specially developed for vertical mounting on printed circuit boards, and are designed for operation at temperatures from —20°C to +60°C. Three case sizes are available in rated voltages up to 50V. The standard tolerance of the range is—20% +100% of rated capacitance. The anodes are of super-purity aluminium, with all-welded internal connections. A special electrolyte ensures low impedance at all frequencies in the audio range.

LOW LEAKAGE CURRENT & LONG LIFE— assured by fully automatic winding of elements, avoiding handling of electrodes by operatives.

TERMINATIONS OF STEEL CORE COPPER WIRE— specially solder coated for fast, ripple soldering technique.

QUICKER ASSEMBLY Steel cored wire gives precision acceptance of capacitors when inserting into punched printed boards.

QUICKER IDENTIFICATION Colour coding and embossed values enable instant selection of the right capacitance and voltage.

HIGHLY COMPETITIVE PRICES

Full full details please write for Technical Bulletin No. 102

THE TELEGRAPH CONDENSER CO. LTD.

NORTH ACTON, LONDON W.3 · Telephone: ACOrn 0061 (16 lines) Telegrams: Telefarad, Wesphone, London. Telex: 261383
(also at) CHESSINGTON, SURREY · BATHGATE, SCOTLAND

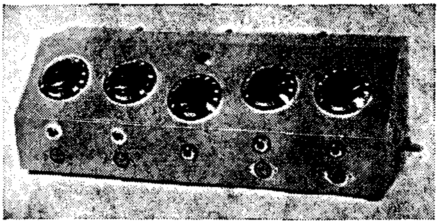
FRANCIS
OF STREATHAM

include among their customers many who call personally from all over the country, because of the stocks and service in TAPE AND HI-FI EQUIPMENT to be found there. With so many shops to choose from, there must be excellent reasons why people prefer to buy from Francis. Perhaps you would care to find out by calling or writing to us about your requirements.

★ **VERY LARGE STOCKS OF TAPE AND HI-FI EQUIPMENT**
★ **NO EXTRA FOR CREDIT UP TO 18 MONTHS**
★ **OWN SERVICE DEPARTMENT**
★ **FREE SERVICE DURING GUARANTEE PERIOD**

FRANCIS OF STREATHAM
169-173 STREATHAM HIGH ROAD, LONDON, S.W.16

Between St. Leonards Church and Streatham Stn. ● *Open all day Saturday* ● *Phone STR 0192/0466*



"THE"
E
S
I
M
I
X"

THE ESIMIX MAJOR

SELF-POWERED FOR 230-250V. A.C. MAINS

PRICE:	**Standard Model**	**19 gns.**
	4 Mic. Version	**20 gns.**

NOTE THESE FEATURES . . .

Independent Mixing and fading on each channel.
Master fader and output controls fitted.
Cathode follower output stage.
HZ. Monitoring socket.
Dual inputs and output for standard jack or Continental three-pin plugs.
Gain channels 1 & 2 approximately 35 dB.
Gain channels 3 & 4 approximately 6 dB.
Sensitivity channels 1 & 2. (Mic HZ) 2mv. in for 200mv. out.
Sensitivity channels 3 & 4. (Radio, Gram, etc.) 100 mv. in for 200 mv. out.

AUDIOMIXERS

All enquiries to: JOHN L. LOVEGROVE
(SOLE DISTRIBUTOR FOR THE MANUFACTURERS)
LEAZINGS, LEAFIELD, OXFORD, OXON. *ASTHALL LEIGH 238*

Manufactured by: E.S.I. (WORTHING) LTD.
98 DOMINION ROAD, WORTHING, SUSSEX. *WORTHING 9895*

HOME RADIO Ltd.

187 LONDON ROAD, MITCHAM, SURREY (MIT. 3282)

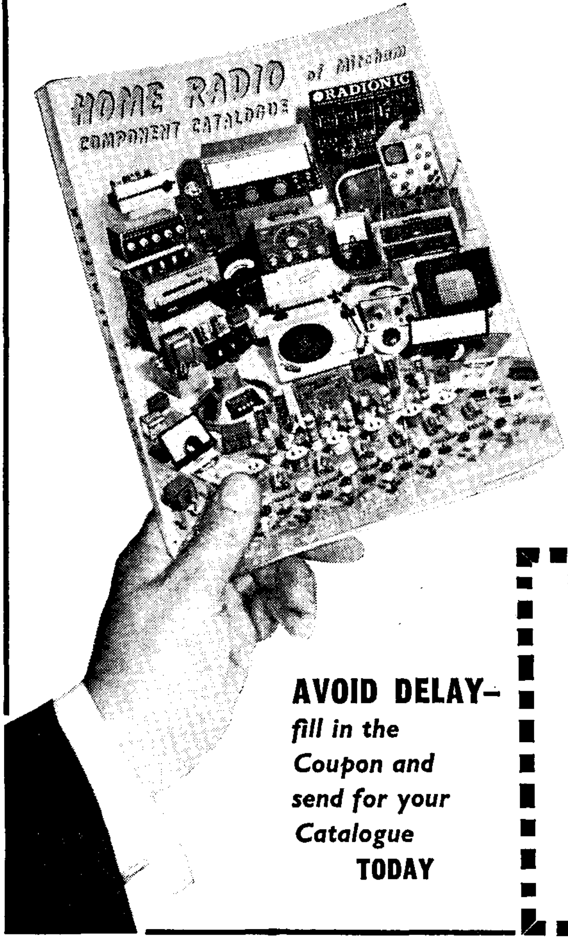
Shop hours:
9-5.30; Including Sat.
Fri. 9-6.30.
Closed all Wed.

The management and staff of Home Radio Ltd. congratulate Messrs. George Newnes Ltd. on the production of this fine monthly magazine. We are confident that it will be an instant success and will go from strength to strength.

Those of us who were privileged to have a preview of the No. 1 issue were most impressed with the wide range of contents and the high standard of articles and illustrations. You will find this magazine crammed with good things . . . *which brings us to another book also crammed with good things* — the well-known **Home Radio Catalogue.**

When you have read this copy of Practical Electronics we feel sure you will be itching to seize your soldering iron and start constructing. Then arises the problem—where to obtain all the parts? *The Home Radio Catalogue provides the answer!* It contains over 5,000 items, 800 of them illustrated, carefully indexed with extensive cross references, which make it particularly easy to use. Order forms are enclosed, and this is backed by the fastest Mail Order Service.

The catalogue costs 5/- plus 1/- postage, but five 1/- coupons are given with each catalogue, and each time you send an order valued £1 or over you enclose a coupon and deduct 1/- from the money you send. There is no time limit so if you purchase £5 worth of components from us—*even though spread over several years*—your catalogue will have cost you nothing!



AVOID DELAY–
***fill in the Coupon and send for your Catalogue* TODAY**

BLOCK CAPITALS please *Enclose P.O. for 6/-*

NAME ....

ADDRESS ....

....

....

HOME RADIO LTD., Dept. PE, 187 London Rd., Mitcham, Surrey

VOL. 1 No. 1
NOVEMBER 1964

Practical Electronics

Pleased to meet you!...

WELCOME to PRACTICAL ELECTRONICS, our new magazine for the amateur electronics enthusiast.

To those thousands already actively engaged in this exciting and fascinating hobby, PRACTICAL ELECTRONICS will offer new ideas and further opportunities for creative effort.

To those of less experience and who, maybe, have yet to take their first steps in constructional work, PRACTICAL ELECTRONICS will supply the guidance required.

If you are alert to the significance of Electronics in the world (and space) of today and tomorrow—if you are eager to participate practically in this branch of technology—if you wish to be kept informed of the latest developments in this rapidly expanding field—PRACTICAL ELECTRONICS is just the magazine you need.

★ ★ ★

It is perhaps inevitable that, notwithstanding his keen enthusiasm, the fast rate of development and the multiplicity of sources of information in the electronics field make the amateur's task rather arduous! PRACTICAL ELECTRONICS sets out to meet this need for readily assimilated and up-to-date information presented in a convenient form.

In our pages the emphasis will be given to fully detailed designs for the modestly equipped constructor. The projects described will reflect the extremely diverse applications of electronics—labour saving devices for the home, aids for motorists, photographers and others with specialised interests, equipment for entertainment and instruments for more serious pursuits of a scientific nature.

Also included will be informative articles on circuit design, components and building techniques, and these again will emphasise the strictly practical nature of our magazine.

All work and no play . . . ! There are times when the most ardent constructor feels like relaxing, laying down the soldering iron and just *reading* about electronics. Special features will bring in word and picture some of the highlights from the electronic scene—from industry, research, medicine, etc. Other articles dealing with the specialised fields of interest such as nucleonics, tape recording and amateur radio, etc., will appear at regular intervals.

★ ★ ★

This has of necessity been a very brief and cursory review of our plans. Now it is "over to you". It is our earnest hope that having perused the following pages you will be glad to reciprocate our greeting—pleased to meet you!

★ ★ ★

And remember, PRACTICAL ELECTRONICS comes from George Newnes, publishers of those other famous magazines for practical people, PRACTICAL WIRELESS, PRACTICAL TELEVISION, PRACTICAL HOUSEHOLDER and PRACTICAL MOTORIST!

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our December issue will be published on Thursday, November 12

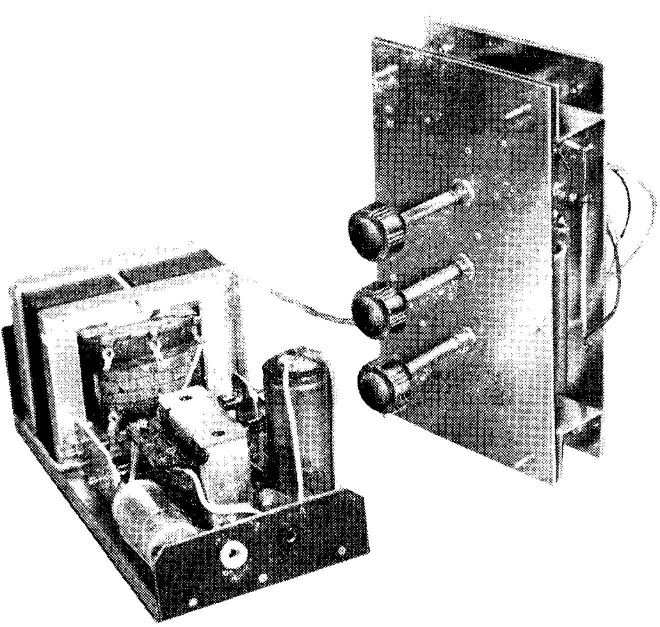
All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Editorial and Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: Temple Bar 4363. Telegrams: Newnes Rand London. Subscription Rates including postage for one year, to any part of the world, 35s.

5W INTEGRATED TRANSISTOR AMPLIFIER

By K. W. COLLINS

A quality sound reproducing system for the home can be built-up using this amplifier in conjunction with the V.H.F. Broadcast Receiver described elsewhere in this issue.

The system will be completed by a specially designed loudspeaker enclosure unit, full details of which will appear later.

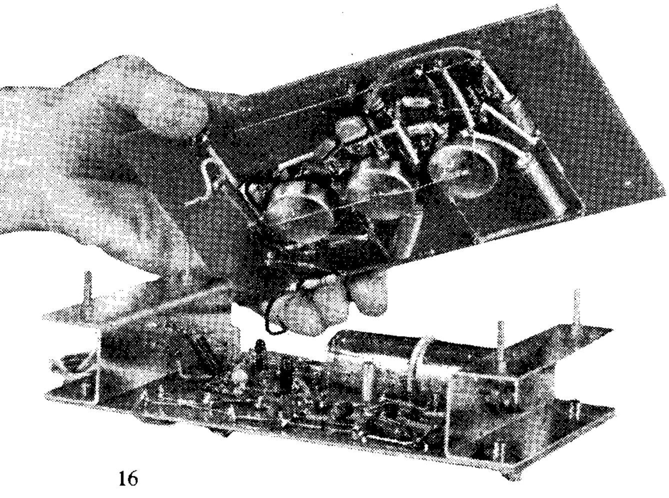


THE 5 watt transistor amplifier to be described in this and further constructional articles has been designed especially for the amateur constructor who wishes to enjoy purity of tonal reproduction over the range of 15c/s to 30kc/s. While it can be argued that this range extends considerably above the limit of audibility, the author is quite sure that the body sub-consciously feels the beneficial effects of the higher response level and coins the word "Presence" to explain the phenomenon.

Two objects were held in view when first considering the prototype design. Subsequently, a number of final amplifiers have been subjected to continuous test over the period of one year. All passed the rigid tests imposed on them and a great deal of knowledge on the behaviour of transistors in amplifiers was gained which is being incorporated in this present series of articles.

The first object considered was cost, coupled with, of course, adequate performance. Careful selection of the most inexpensive transistors operating at frequencies well within the spectrum envisaged led to the choice of one OC71, two OC72s, one ASY28, two OC35s, plus one OA10 junction diode for the power amplifier. The pre-amplifier uses an additional four OC71s.

The second object demanded a good basic layout, preferably on laminated plastics sheet, utilising small turret lugs to which the components could be soldered. This form of construction needs only a small drill, pliers, screwdriver and soldering iron.



VERSATILITY

The designer states that it is possible to build the amplifier and obtain optimum results without a meter or any other expensive ancillary test unit. Furthermore, the same unit will work with perfect quality but, of course, with a reduced output (some 300mW) when powered by a small 9 volt transistor radio dry battery. It should be noted that no component changes are required for satisfactory performance under battery operation.

The description "integrated amplifier" means that the pre-amplifier and the power amplifier stages are embodied in a single assembly, or unit. A separate a.c. operated power chassis completes the electronic equipment.

The complete amplifier assembly is compact, measuring 8in by 4½in and only 1⅞in deep excluding control spindles. The pre-amplifier and the power amplifier are each built on a separate laminated plastics panel, these two panels being mechanically linked by the metal heat sinks which carry the output transistors.

It is immediately obvious that this equipment lends itself ideally to stereophonic applications since two identical amplifier assemblies can be readily accommodated in a record player cabinet of quite modest dimensions.

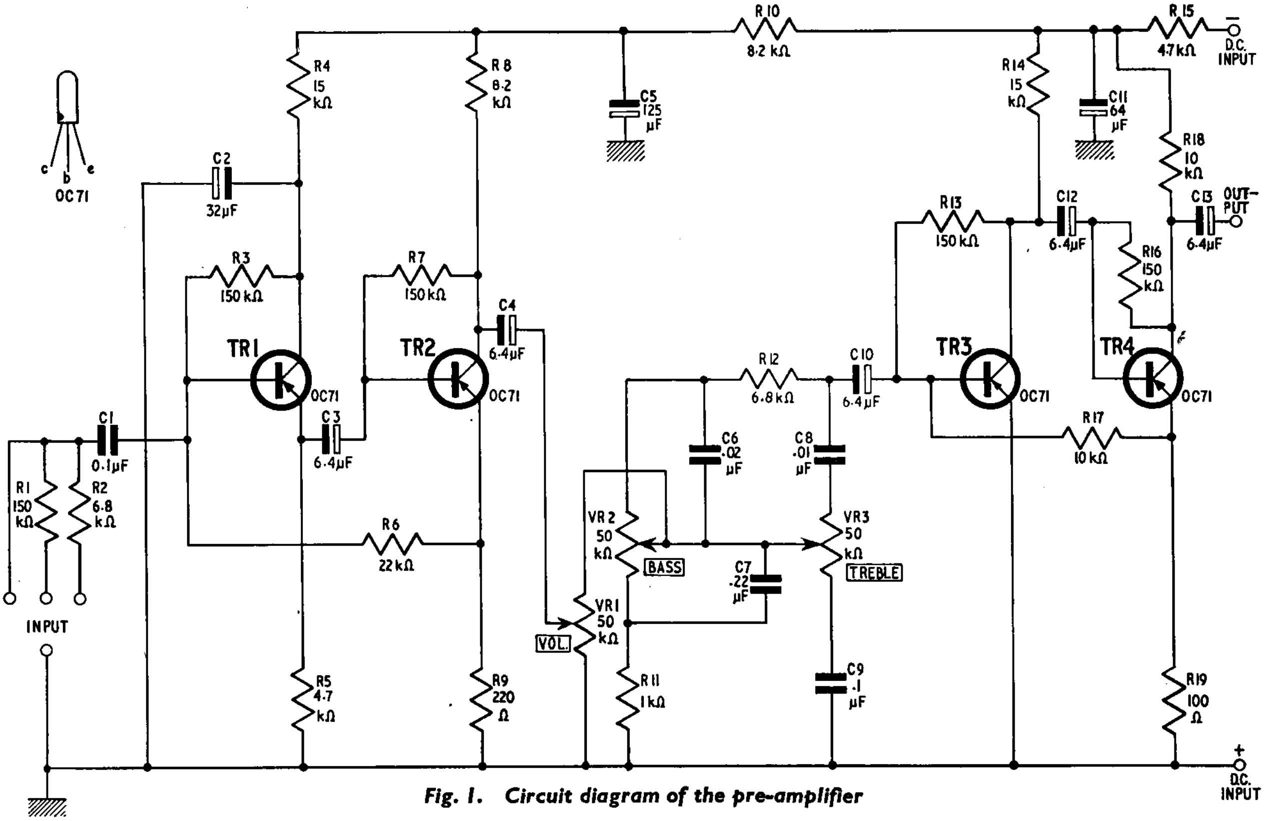


Fig. 1. Circuit diagram of the pre-amplifier

An output of 5W per channel is adequate for many domestic purposes. The output impedance of the power amplifier is less than 1 ohm, and loudspeakers of 3 to 15 ohm impedance can be used satisfactorily.

Another application that will no doubt appeal to many enthusiasts is the construction of a battery operated stereophonic unit that can be used with headphones for private listening.

The pre-amplifier and the power amplifier form convenient sub-assemblies. In this series of articles it is proposed first to describe the pre-amplifier, and following articles will be concerned with the power amplifier and the power supply unit.

THE PRE-AMPLIFIER

The pre-amplifier is an essential part of any high quality reproducing system for not only does it raise the output voltage level to enable sufficient distortionless drive to be obtained for the correct input loading of the output power amplifier, but it also compensates for the inevitable losses in gain that occur when variation in the setting of treble and bass tone controls is made. Tone control circuits used in conjunction with transistor amplifiers are somewhat different from the usual tone control devices used with thermionic valve amplifiers. This is due to the vast difference in impedance levels between valves and transistors.

The pre-amplifier described in this article enables full drive to be obtained from reluctance, moving coil, or magnetic type pick-ups.

Inputs from the normal crystal cartridges which can easily reach 500mV and thus cause severe overloading, should be connected to the input via a resistive chain of some 1 megohm and 10 kilohms in series, the output to the pre-amplifier being taken from the junction of the resistors and earth—in fact, across the 10 kilohm resistor. Transistor TR1 is connected in the emitter follower mode and therefore looks into the source as a relatively high resistance.

CIRCUIT DETAILS

The circuit diagram is shown in Fig. 1.

The input is applied via suitable resistor and capacitor networks to the base of TR1. Output is taken from across a suitable value resistor in the emitter return. The collector is grounded for a.c. by the electrolytic capacitor C2. The grounded collector or emitter follower circuit can be considered as an impedance changer, the input impedance being approximately OC′ RL and the output impedance Rs/OC′.

The output from TR1 is taken to the base of TR2, a conventional grounded emitter amplifier. This is sometimes called the common emitter connection because the emitter is not necessarily grounded to a.c. Some degree of feedback is included in this section of the pre-amplifier which reduces the stage gain but greatly assists in maintaining a low distortion output over a wide frequency range. The output at the collector of transistor TR2 is taken via an electrolytic capacitor C4 to the slider of the 50 kilohm volume control VR1, and thence to the tone controls.

TONE CONTROL CIRCUIT

The circuits for the control of bass and treble can best be understood if they are considered as simple current transfer networks rather than the voltage transfer networks usually associated with thermionic valve amplifiers. This enables a comparison to be made of the non-existence of induced hum from the transistor pre-amplifier on the one hand and the extreme precautions that have to be taken to obtain hum-free output from a thermionic valve pre-amplifier on the other.

Part of the output current of the preceding stage

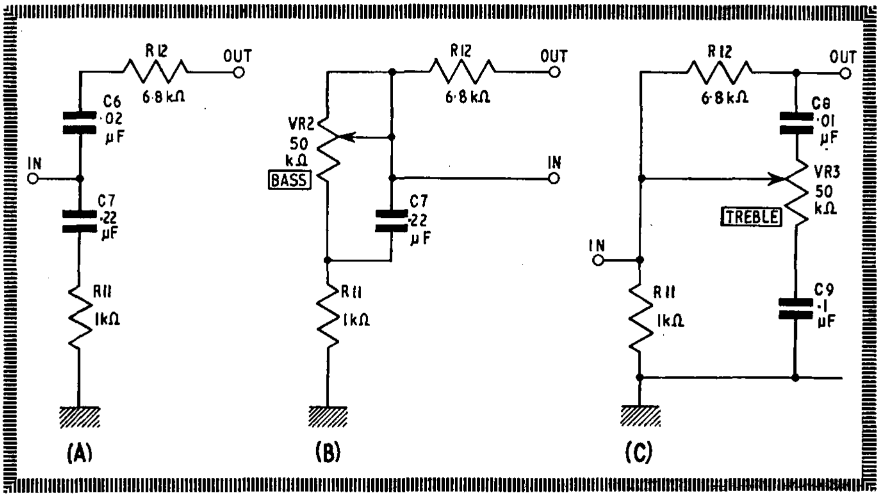


Fig. 2. Equivalent circuits which demonstrate the operation of the tone controls

appears at the junction of the 0·02μF and 0·2μF capacitors (C6 and C7) and the centre arm of the bass and treble controls.

The equivalent circuit of the tone controls is shown in Fig. 2. At 1,000c/s the current is divided so that 10/11ths is shunted to ground and the remaining 1/11th is fed to the base of TR3, see Fig. 2a.

The low frequency circuit for maximum bass is shown in Fig. 2b with the movable arm of the bass control near the top. The 0·02μF capacitor is shunted and more of the current is fed into the 6·8 kilohm resistor as the impedance of the 0·2μF capacitor increases at low frequencies.

The high frequency equivalent circuit is shown in Fig. 2c for the treble cut condition. Depending on the potentiometer setting, most of the higher frequencies will be shunted to ground as compared to the 1,000c/s signal. With the control arm in the uppermost area of the track, the higher frequency current by-passes the 6·8 kilohm resistor and a treble boost thus achieved.

The effectiveness of the tone controls is shown in the frequency response characteristic which appears in Fig. 3.

The output from the tone control section is in all cases fed to the base of TR3 via C10. The base of this stage is stabilised by means of a resistor R13 fed from the collector. TR3 also receives via R17 a negative feedback linearising potential from the emitter transistor of TR4.

The output from the collector of TR3 is fed through an electrolytic capacitor C12 to the stabilised base of TR4. The emitter of TR4 is returned to earth by a 100 ohm resistor which is unbypassed.

PRECAUTIONS AGAINST INDUCED HUM

Construction of the pre-amplifier is very straightforward and presents no problems in layout design. The noise level is extremely low and 50 cycle hum interference completely non-existent.

If the pre-amplifier is fed from a valve equipped front end v.h.f. unit, it is important to ensure that the h.t. supply is well smoothed and that there is no 50c/s leakage on the v.h.f. receiver chassis. Should there be even a small leakage, the pre-amplifier will amplify it to an intolerable hum level, quite spoiling the reproduction of the originating programme. The same condition can arise from a.c. leakage due to a faulty capacitor from live mains to chassis.

THE SUPPLY LINE

The pre-amplifier d.c. supply is taken from the main 9V or 28V negative rail and fed to a 4·7 kilohm resistor which drops the voltage to a suitable value for the OC71 transistors—TR1 to TR4. The pre-amplifier side of the dropping resistor is bypassed to chassis by a 64μF electrolytic decoupling capacitor C11. Further voltage dropping and decoupling is arranged between the two stages of the amplifier thus resulting in an extremely stable output.

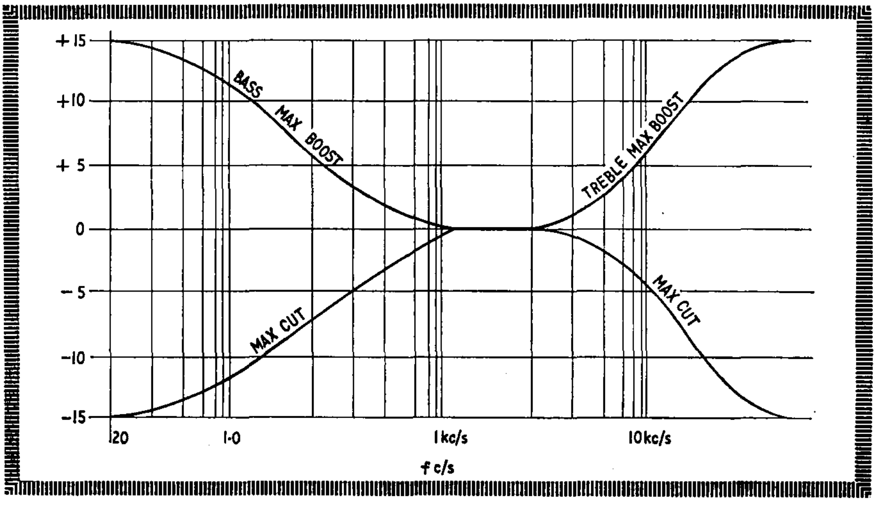


Fig. 3. The pre-amplifier frequency response characteristics with extreme settings of the tone controls

COMPONENT DETAILS

The author used small $\frac{1}{8}$W cracked carbon resistors and miniature "liquorice allsorts" capacitors for the final design. The original prototype was, however, constructed on a longer panel board using large normal components. There has been no significant difference in performance between the two extremes of layout.

This information is given to show that, apart from neatness and compactness of design, there is no need to buy exactly the same miniature components as stated in the list for the published layout.

No attempt has been made to screen the unit with metal partitions or covers, neither has it been necessary to use screened wiring in any part of the panel construction. It is advisable, however, to use screened cable *outside* the unit for the connection of the gramophone pick-up, microphone, tape head or v.h.f. receiving unit.

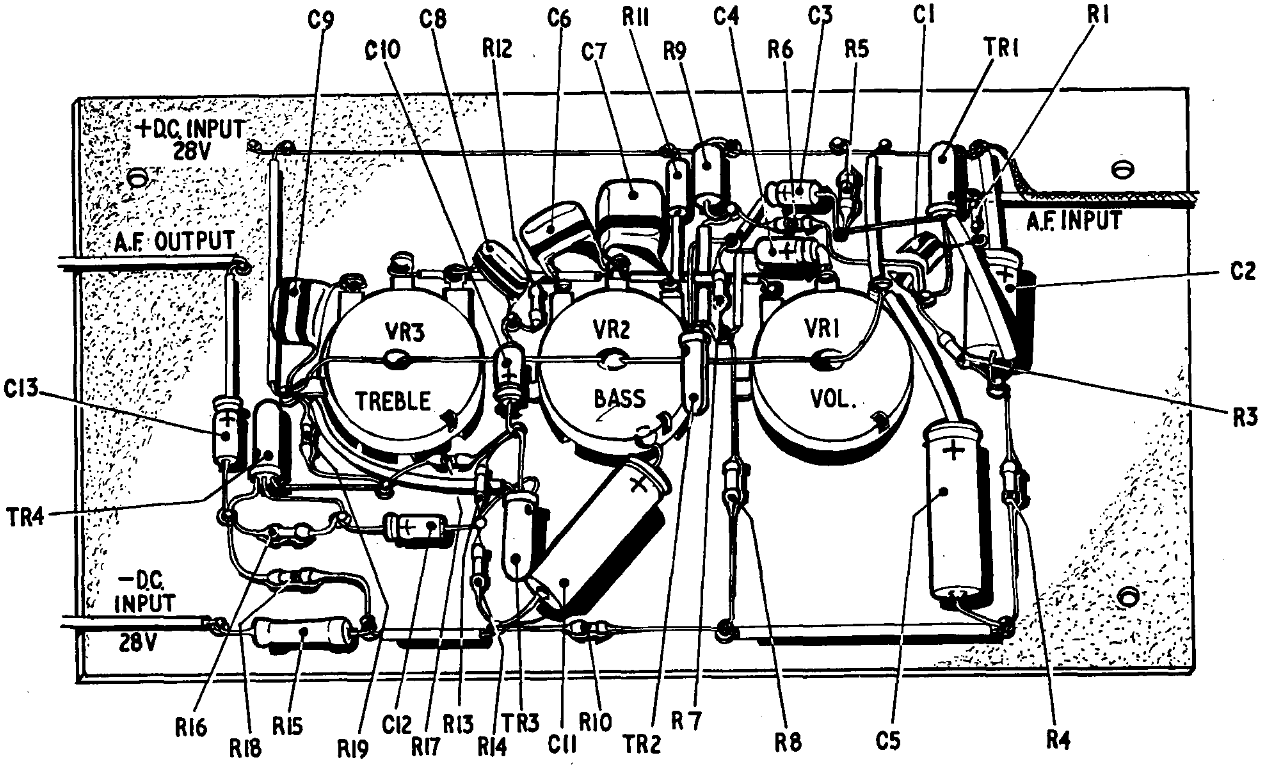


Fig. 4. Layout of components and wiring

When feeding a tape head, a paper or foil dielectric capacitor must be used, since the polarisation of an electrolytic could possibly allow a steady small d.c. potential to magnetise the head with adverse results, in the form of increased background noise appearing on the tape on subsequent recordings.

EQUALISING ARRANGEMENTS

Equalisation is a term used to define the matching of an input generator, be it gramophone pick-up (crystal, magnetic or moving coil), tape or radio, to the input of an amplifying stage. The simplest form of equalisation is a fixed resistance in series with the input.

With magnetic pick-up heads varying from some 200mH to 700mH, the series resistor will vary from 3 kilohm to 10 kilohm.

Equalisation for crystal pick-ups is a little different, the output varying in relationship to the amplitude versus frequency recording characteristic. The circuit becomes a straightforward series resistor and capacitor input feed of 470 kilohm and 0·01μF for most cartridges.

Equalisation for radio takes the form of a simple 100 kilohm series resistor.

It is, of course, important to follow closely any instructions issued by the manufacturer as to the correct values required for some special device. The above mentioned values are a simple guide for use in the absence of more specific instructions from the manufacturer.

CONSTRUCTION

The actual construction is simplicity itself. A piece of laminated plastics insulating board is cut to size. Then three small holes for the variable controls are drilled as outlined in the diagram Fig. 5.

The author used small turret tags for component anchorage. However, to cut down the cost, these can be dispensed with and the components can be laid across the three rails of 18 s.w.g. tinned copper wire as shown in Fig. 4. Where several components are joined at one point the component wires can be inserted in a bunch into a strategically drilled hole and the hole filled with a small amount of solder.

continued on page 22

DETACHED PARTICLES

By John Valence

HERE. . . . OR THERE

A SEPARATE particle of negative electricity, or part of a wave system? Such seemingly contradictory ideas of the nature of our friend the electron are (so we are told) equally valid.

The old classical physics first proposed by Newton led up to the picture of the atom as a miniature solar system with satellite electrons in orbit around a positively charged nucleus. A very neat arrangement, easy to visualise, and entirely satisfactory for an ordinary chap like me.

But now this idea is rather drastically modified by more modern theories of wave mechanics. Into this orderly pattern, with each particle at its allotted and predictable station, we must now introduce an element of chance. The correct thing now is to talk of the *probability* of an electron being in a certain position under certain conditions; and one can prove experimentally and mathematically that these sub-atomic particles also act like waves.

Charged particle or wave? I confess it is all rather beyond me. But the idea of chance or uncertainty I do indeed find easy to comprehend —at least in one particular connection. Every month when I scan the list of Premium Bond winners I am reassured of the complete randomness of the paths taken by charged particles as they gallivant about in gas filled tubes inside ERNIE.

I take it you are familiar with this fellow, but in case you are not, let me spell out his name in full: Electronic Random Number Indicating Equipment; address, G.P.O. Blackpool.

My only regret is that the chance movement of electrons and ions has not so far operated in my favour. Still, we live in hope.

SLOW TOLL, PLEASE

BENEFITS bestowed upon mankind by electronics are real and obvious: removing drudgery from everyday life, helping to inform and entertain us, and so on.

But is the art, science, or what have you of electronics always the benefactor we believe, or does it sometimes assume a sinister role?

It would appear that 40,000 Bell Ringers have reason to believe the latter. Few modern churches in England have towers capable of carrying a ring of bells, and recorded bells played over an amplifying system are becoming more the vogue. Not surprisingly the Central Council of Bell Ringers is quite alarmed at this threat to the ancient art of campanology.

One example where the elimination of manual toil is clearly *not* appreciated.

Enthusiastic as I am for the maximum exploitation of the free electron, I have a sneaking regard for these modern practitioners of an ancient craft which is deeply interwoven in the fabric of country tradition.

More decibels to their arm.

STEREO FOR ONE

BACK come the cans. Elegant lightweight sets of headphones are now becoming popular for hi fi stereo listening. Perhaps their popularity is further evidence of the all too common domestic scene—too many people occupying too little space.

Other occupants of the room can continue with their own activities —provided that these are not visually disturbing to the stereo listener, who is adequately muffled from all bar the most extreme noises off. Yes, headphones are without doubt a boon to many in such circumstances.

Is it, therefore, mean of me to carp at the aesthetic limitations such an arrangement imposes? Perhaps it is. But I do feel my enjoyment would be spoilt by the presence of others in the room who, being completely oblivious of the music, would be engaged in various other activities. I could shut my eyes, agreed. However, this would be only partially effective.

For real enjoyment of a serious musical work I find it essential either to listen in solitude, or to be in the company of others who are (at least) as appreciative as myself of the performance. Some of you will surely agree that the presence of others for whom the music has no appeal at all chills the atmosphere and diminishes one's own pleasure.

QRM de GARAGE DOOR

SEEMS the boot is now on the other foot. Whereas in the past radio amateurs have sometimes been guilty of causing BCI or TVI, users of radio control apparatus are now causing "HAM I".

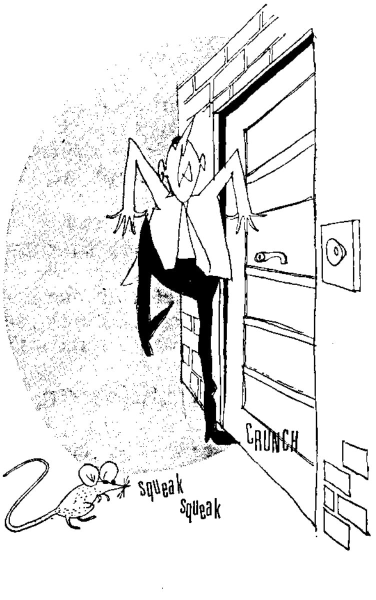
At least this is apparently so in the U.S.A., where complaints about garage door interference on the amateur bands are increasing.

Perhaps an ultrasonic or even sonic system might be better in the circumstances. Although, coming back to this country again, I understand that Stirling Moss finds his sonically operated garage door is liable to respond to brake squeaks from certain passing vehicles!

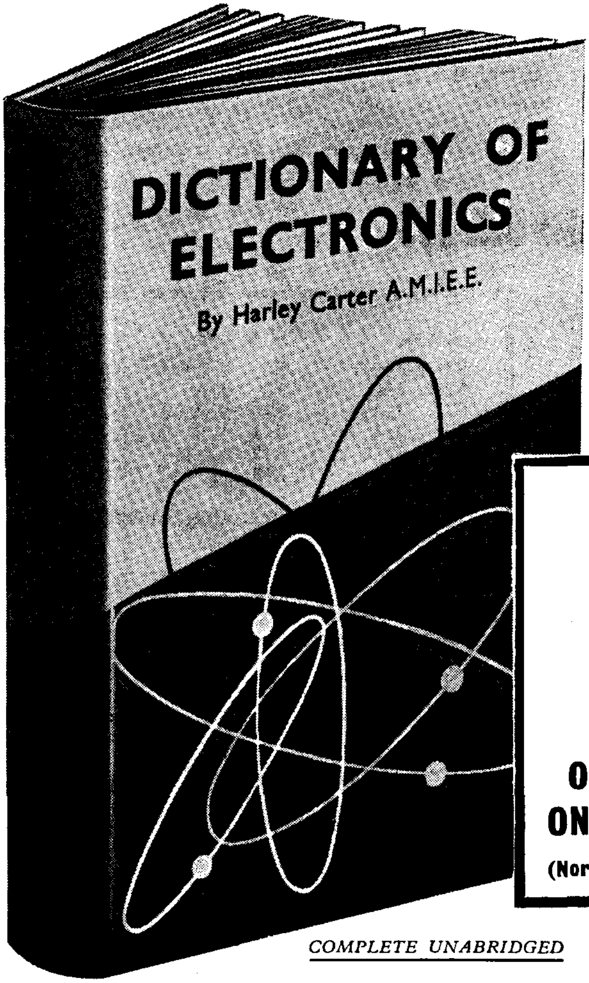
OPEN SESAME

SUPPOSING these garage door devices become more commonplace, has anyone considered the possible effect as the postman and the milkman come jauntily whistling down the road early in the morning?

I imagine a simple solution to this hazard from odd "noises off" would be to use a two (or more) tone system. By use of coincidence circuits it would be possible to make certain that the door opening device operates only upon receiving the correct tones in correct sequence. In other words, a kind of electronic combination lock.



IN NEXT MONTH'S Practical Electronics



Special Edition of

DICTIONARY OF ELECTRONICS

by HARLEY CARTER, A.M.I.E.E.

OFFERED AT THE AMAZING PRIVILEGE PRICE OF ONLY 10/6

(Normal Edition sells at 35s.)

AN INDISPENSABLE DESK REFERENCE VOLUME FOR
ENGINEERS
TECHNICIANS
EXECUTIVES
APPRENTICES
AND STUDENTS

COMPLETE UNABRIDGED

This comprehensive Dictionary contains concise, explanatory

5 W AMPLIFIER

continued from page 19

When soldering the transistors, great care should be taken to make a clean quick joint. If the soldering iron is allowed to stay on the joint and wire for more than about three seconds, enough heat can travel up the wire and damage the internal connections in the transistor, completely destroying the tiny base and collector junctions. The author always holds the wire in his wetted fingers just above the proposed join and if the iron is kept in position too long one receives due warning!

Make sure that the electrolytic capacitors are placed the correct way round in the circuit. Remember, if you are a valve man and new to transistor construction, that the polarity can be somewhat confusing. The positive rail is earthed and the negative rail is what we might technically refer to as the "hot" side. Electrolytics, therefore, have their positive connections earthed.

Next month: The Power Amplifier

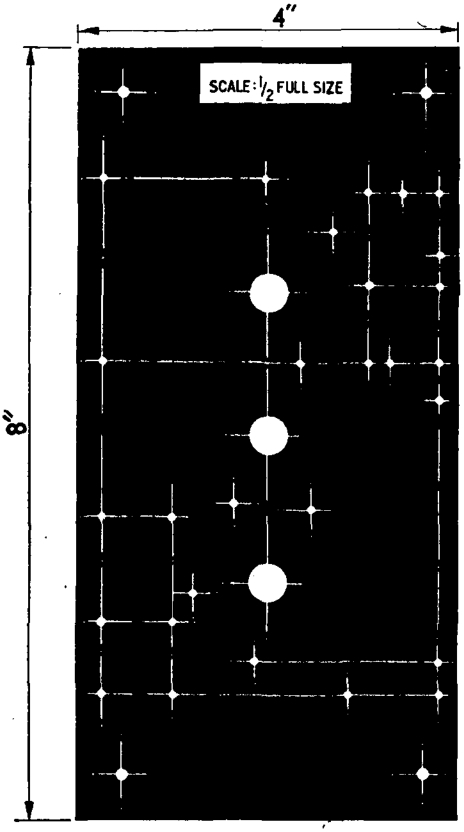


Fig. 5. Drilling details of the plastics board

COMPONENTS . . .

Resistors

R1	150kΩ	R8	8·2kΩ	R14	15kΩ
R2	6·8kΩ	R9	220Ω	R15	4·7kΩ
R3	150kΩ	R10	8·2kΩ	R16	150kΩ
R4	15kΩ	R11	1kΩ	R17	10kΩ
R5	4·7kΩ	R12	6·8kΩ	R18	10kΩ
R6	22kΩ	R13	150kΩ	R19	100Ω
R7	150kΩ				

All $\frac{1}{8}$W, cracked carbon, high stability 5%

Potentiometers

VR1	50kΩ carbon, linear
VR2	50kΩ carbon, log
VR3	50kΩ carbon, log

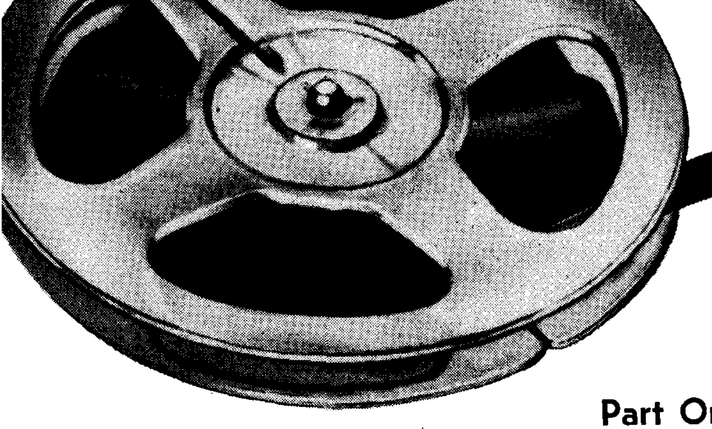
Capacitors

C1	0·1μF plastic	C8	0·01μF plastic
C2	32μF 40V	C9	0·1μF plastic
C3	6·4μF 25V	C10	6·4μF 25V
C4	6·4 μF 25V	C11	64μF 25V
C5	125μF 25V	C12	6·4μF 25V
C6	0·02μF plastic	C13	6·4μF 25V
C7	0·22μF plastic		

All miniature types

Transistors

TR1-4 OC71 Mullard (4)



Sound on Tape

A SHORT SERIES FOR THE HOME RECORDING ENTHUSIAST

By H. W. HELLYER

Part One

IN THIS FIRST ARTICLE THE PRINCIPAL FACTORS INVOLVED IN THE MAGNETIC RECORDING PROCESS ARE OUTLINED AND SOME OF THE FEATURES INCORPORATED IN COMMERCIAL TAPE DECKS ARE DESCRIBED.

FUNDAMENTALLY, the tape recorder is a device for storing sound. It accepts the output from a microphone, radio tuner, gramophone pick-up, or other programme source and amplifies and "shapes" this signal before it is applied to the recording head. At the head, the signal causes a variation of a magnetic field across which the tape passes. The tape is coated with a readily magnetised oxide and thus retains a pattern of varying magnetism in proportion to the signal which caused it.

To replay this stored signal, the tape is again passed across the head, or across another, referred to as the playback head. The varying pattern of magnetism sets up a proportional variation of current in the coils forming the head winding. This signal is then amplified and ultimately passed to a loudspeaker.

The foregoing explanation has probably caused the purist to run howling from the room! There is, of course, much more to tape recording than that.

In the first place, a high frequency bias voltage is necessary, pre-emphasis of the signal is needed and, during playback, equalisation has to be introduced.

A means of erasing the signal from the tape for recording purposes has to be arranged.

The speed at which the tape passes the heads, both in its regularity and its rate, is vitally important for correct performance. The tape itself, the width of the gaps in the recording and playback heads, some method of indicating the recorded signal, all have to be considered.

Briefly, and with as little technicality as possible, the principal factors in the tape recording process are summarised below.

H.F. BIAS

Magnetism is a non-linear quality. If a current flows through the coil of an electromagnet, is varied regularly and as regularly removed, as for example, when a sine wave is applied, the magnetism thus induced does not follow the same curve of increase and decrease. Fig. 1.1 shows the BH curve normally associated with a recording head. The B axis represents the flux density, or strength of magnetism, while the H axis represents the magnetising force, the current.

It is readily seen that the rising current causes a rising flux which reaches a peak at saturation point of the material. But as the current starts to fall, the magnetic curve does not follow it to zero. Instead, it reaches a point *b*, which represents the remanent flux. As the current goes negative, the flux returns to zero, but at point *c*, and as the current swings through its negative peak and back to zero, the flux curve reaches first another saturation point *d* then returns to another remanent point *e*. The only way the flux can be returned to zero is for the material to be de-magnetised.

There are reasonably straight portions of the curve, and it would be simple if we could record our signal, using these. The way this is achieved is by superimposing the audio frequency signal on another regular voltage at a frequency some three to five times the highest frequency we expect to record, so that the composite waveform we obtain is against the straight portions of the curve, as in Fig. 1.2.

A typical bias frequency is 50–70kc/s. The amplitude of bias depends on the characteristics of the individual head, and to some extent on the tape being used, and is chosen to give not maximum output but *minimum harmonic distortion*. This should be in the order of less than 2 per cent, a 1,000c/s pure tone being used as a test signal.

The oscillator which produces this bias can also be used to energise an erase head. By producing a strong, rapidly varying field at the gap in the erase head, the magnetic patterns of the audio signal which are on the tape can be broken up in a random manner.

GAP WIDTH

The recording and playback heads (often combined in the single unit) are, basically, electromagnets. The construction takes the form of a ring-shaped ferromagnetic material, or set of laminations, with a small gap at the front. There is also a gap at the back, much wider than the front gap, and this is required to swamp variations in reluctance and maintain a constant relationship of current to flux.

In the front gap a non-magnetic shim is inserted to concentrate the eddy currents and force the flux into the space just before the gap. The width of the gap is limited by the wavelength of the highest frequency to be recorded. If a half-cycle of current produces a magnetic pattern of a length less than the gap width, there would be a loss of output during replay. The higher the speed at which the tape passes the gap, the longer the magnetic pattern for a given half-cycle, so we would expect that higher frequencies could be recorded with both narrower gaps and higher speeds.

Due to the physical characteristics of the recording head, a high frequency loss is sustained. This has to be allowed for in the amplification of the recorded signal.

PRE-EMPHASIS

The lower turnover frequency may be from 40 to 50c/s, and the signal is boosted at this lower end for recording. This allows a constant current technique to be used for recording, to take advantage of the magnetic curve, as described above. But the peculiarity of the technique is that the surface induction of the tape which is recorded upon increases with the frequency of the signal. This is because flux density depends not on the magnetising force but on its rate of change—which is, of course, greater as the frequency of the signal increases; i.e. more cycles in a given time.

LOSSES

This increase is theoretically linear. Doubling the playback frequency doubles the playback voltage. But in practice some losses occur, and must be allowed for in amplifier design and adjustment. The theoretical 6dB per octave curve shown solid in Fig. 1.3 may be more like the dotted (a) curve in actual practice.

CHARACTERISTICS

The foregoing, plus reactance loss due to head impedance, self-capacity of leads, etc., head gap losses, tape loss, and demagnetisation loss, could be compensated in any one machine by individual adjustments. But this means that tapes recorded on a machine thus compensated could not be played back on other machines, and vice versa. A standard compensation has to be arranged so that recordings are compatible. This compensation is termed the recording characteristic. In practice, two are used: the European standard, CCIR, and American standard NARTB. There is only a little difference between these two standards.

If a graph is drawn of the replay characteristic and the 6dB per octave slope superimposed so as to cut it at a particular frequency when the impedance of a capacity equals a resistance in an imaginary circuit across a perfect recording head, then a curve can be calculated which has a particular shape for that CR combination, and is thus called the time-constant curve for that particular combination. Pre-recorded tapes are stated to be recorded to so many microseconds, e.g. 3¾in/sec at 120 microseconds. Thus, the replay can be standardised against this known characteristic.

EQUALISATION

The equalising curve during playback is particular to a given machine, and should be carefully adjusted on a standard test tape. Typical curves are given in Fig. 1.3, showing the effect of the high and low frequency losses previously mentioned.

SIGNAL LEVEL INDICATION

It is necessary to record at the correct level, to prevent distortion, and most machines have some means of indication. Earlier tape recorders used neons which struck for normal signal level and overload level respectively. Many different electronic indicators have been used, mainly differing in the way the indication is displayed.

On better class machines, a meter is employed to allow more accurate setting up. But whereas the electronic indicators react to peak signal, a meter circuit can be made to respond both to this and/or to average signal level, a knowledge of both being helpful to good recording.

MULTIPLE TRACKS

Standard tape is a quarter-inch wide, and along its length any number of tracks of information can, theoretically, be recorded. But in practice, the width of the recorded track is limited by loss factors, and two or four-track recording is common practice. This may be referred to as half-track and quarter-track. A two-track machine has one gap only, and the tape passes the recording head, is magnetised along approximately half its width (a safety lane being left in the middle to prevent interaction of the tracks), then the spools reversed or tape inverted to give a recording of the other track.

Four-track machines have two gaps, and again the tape is inverted to obtain the alternative tracks. But the use of twin-gapped heads allows further facilities. By connecting amplifiers to each gap, stereo replay is obtained, and if recording amplifiers are also duplicated, stereo recording is possible. Many machines have a stereo output socket, to which an external amplifier can be fitted for stereo replay. Contrary to common belief, this does not have to be identical with the internal amplifier.

Four-track working also allows the device of *multi-play*, by which a track recorded by one gap can be replayed through the amplifiers and re-recorded on another track. In this way one can sing personal duets, or even build up an entire orchestra with one instrument.

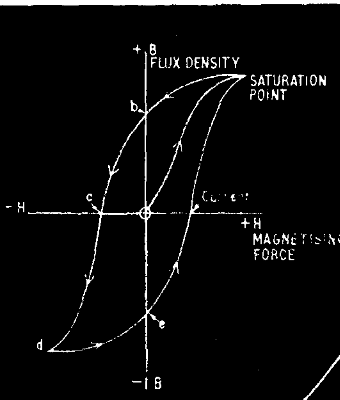


Fig. 1.1. Magnetic hysteresis (BH) loop. This illustrates the non-linear characteristic of magnetism

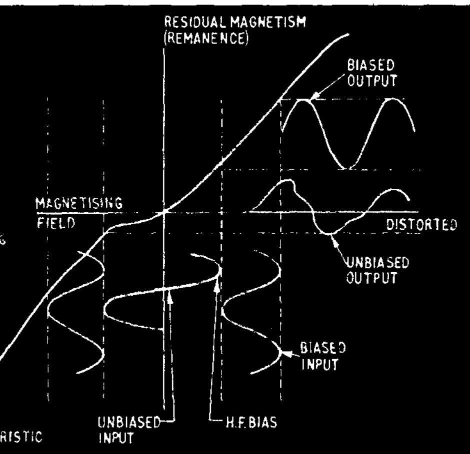


Fig. 1.2. Operation on the straight portion of the curve is achieved by the use of h.f. bias

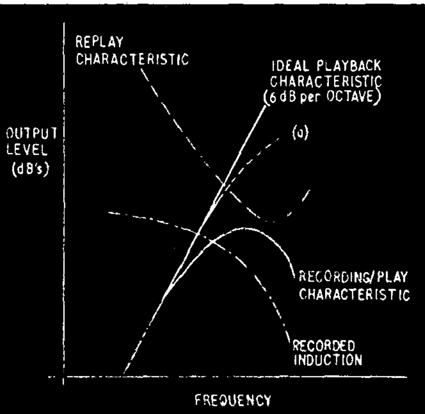
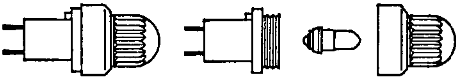


Fig. 1.3. Showing losses incurred during recording and the playback characteristic required to compensate

3 COLOUR INDICATOR

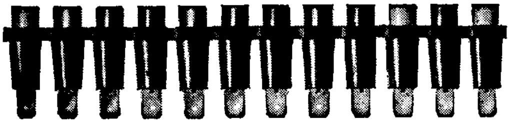
These red-amber-green indicators contain 3 lamps which glow individually via coloured filters through a common lens. The lamps are Atlas Midget Panel Lamps operating at 6, 12 and 28 volts. This indicator has very compact dimensions and can be installed into a single panel hole with fixing ring and lock nut. Exceptionally reliable, these indicators are invaluable for many signalling applications. Supplied complete with three S6/8 cap filament lamps. Overall dimensions (including earth tag) 2.230″ x .812″ dia.

SUB-MINIATURE LAMP AND HOLDER



A sub-miniature lampholder that allows easy lamp replacement from the front: a lamp that combines an output of about 1 lumen at the maximum rated voltage of 6v. Together they represent an outstanding design achievement. Life expectancy of the lamp is 10,000 hours at 6v, when derated to 5v the average should be in excess of 60,000 hours. The lampholder conforms with R.C.S. 11 in respect of damp heat and tropical exposure tests (H.1). Temperature range of - 40°C to + 70°C (operating). One hole fixing is by a speed nut (supplied). Lenses, meeting B.S. 1376 are in red, green, amber and blue. Clear also available. Overall dimensions (including tags) .900″ x .394″ dia.

MULTI-SOCKET INDICATORS



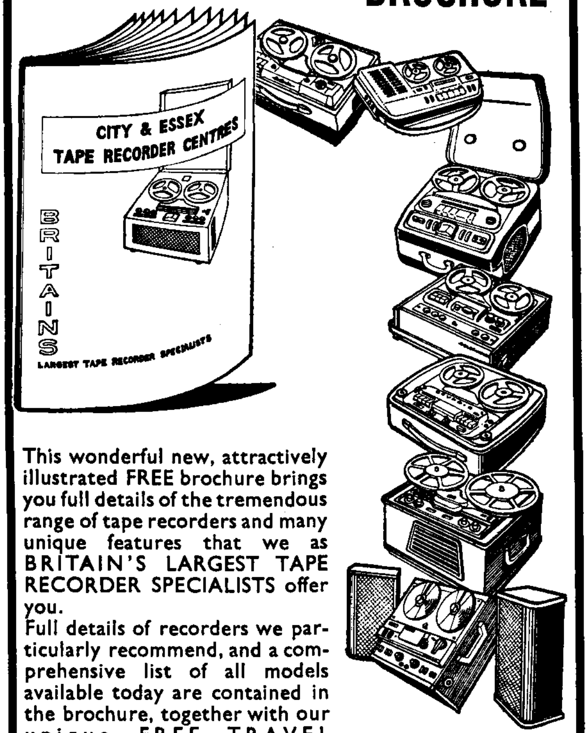
Ideal for use in computers and illuminated read-out devices. Produced in strips of twelve sockets with ½″ or ¼″ centres. An 'easy-mount' single socket, similar to the indicator strip is also available and can be used separately or in conjunction with multi-socket strips. Lamps are available for 6, 12 or 28 volts, 35-45mA, with a burning life of 3,000-5,000 hours. Plastic nylon caps are obtainable in white, red, yellow and green; they fit directly over the lamp and eliminate the need for prismatic jewels.

THORN

THORN ELECTRICAL INDUSTRIES LIMITED,
SPECIAL PRODUCTS DIVISION,
105-109 JUDD STREET, LONDON, W.C.1.
TELEPHONE: EUSTON 4433

DTV/11

FREE! COLOUR BROCHURE



This wonderful new, attractively illustrated FREE brochure brings you full details of the tremendous range of tape recorders and many unique features that we as BRITAIN'S LARGEST TAPE RECORDER SPECIALISTS offer you.
Full details of recorders we particularly recommend, and a comprehensive list of all models available today are contained in the brochure, together with our unique FREE TRAVEL VOUCHER entitling you as a customer to full refund of your travelling expenses to and from any of our showrooms. Send for your FREE copy today, or call into any of our showrooms to see, hear and compare our fantastic selection of recorders.

5 STAR FEATURES

- ★ **FREE TRAVEL TO AND FROM OUR SHOWROOMS**
- ★ **FREE DEMONSTRATIONS IN YOUR OWN HOME**
- ★ **OVER 300 MODELS FROM 15-243 GNS.**
- ★ **FREE ONE-YEAR SERVICING**
- ★ **FREE TECHNICAL ADVICE**

Please send me your **FREE BROCHURE**

Name..

Address..

....

CITY & ESSEX TAPE RECORDER CENTRES (P.E.1)
Head Office: Citex House, 191 Plashet Rd., London, E.13

CITY & ESSEX
TAPE RECORDER CENTRES

242/4 Pentonville Rd., N.1 (200 yds. from Kings Cross Station)	TER 8200
228 Bishopsgate, E.C.2 (Opposite Liverpool St. Station)	BIS 2609
2 Maryland Point Station, Stratford, E.15 (Adj. Station)	MAR 5879
205 High St. North, E.6 (Opposite East Ham Station)	GRA 6543
232 E. India Dock Rd., Poplar, E.14 (Adj. Blackwall Tunnel)	EAS 5978

NOTE: Bishopsgate Showrooms open Mon.-Fri. 9 a.m.—6 p.m. Sunday 9.30 a.m.—2 p.m. Closed Sat. Other Showrooms open Mon.-Sat. 9 a.m.—6 p.m. Thursday to 1 p.m.

FOR – IMMEDIATE – DESPATCH – PHONE – US – TODAY

BUILD YOUR OWN RECORD PLAYER

4-speed Autochange 2-tone Cabinets 17×15×8½in., high flux loudspeaker and 3 watt 2 valve amplifier ready built. Quality output. Volume and tone controls. All items fit together perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' written guarantee. Autochange Kits Complete—as above.

B.S.R. Monarch	£11/10/-	P.P.	5/-
Garrard Autoslim	£12/18/-	P.P.	5/-

QMAX CHASSIS CUTTER

The cutter consists of four parts; a die, a punch, an Allen screw and key.

½in.	14/6	1⅛in.	18/-	2in.	34/3
⅝in.	14/6	1¼in.	18/6	2 3/32in.	37/9
¾in.	15/6	1 5/16 in.	20/-	2½in.	44/9
⅞in.	15/9	1⅜in.	20/-	1in.sq.	31/6
1in.	18/-	1½in.	20/6	11/16 in.sq.	28/-
1 1/16 in.	18/-	1¾in.	22/6		

CRYSTAL MIKE INSERTS. High output.

Miniature size, 1½in dia. × ⅜in	6/6
Acos Mike Insert 1¾in × ⅜in	8/6
Acos Stick Mike 39-1	35/-
T.S.L. De Luxe Stick Mike	25/-
Telephone Contact Mike	10/6
Guitar Contact Mike	15/6
Moving Coil Mike 90/-, Floor Stand	57/-
Tannoy Carbon Mike	7/6

FULL WAVE BRIDGE SELENIUM RECTIFIER: 2, 6 or 12v, 1½ amp, 8/9; 2 a. 11/3; 4 a., 17/6. **CHARGER TRANSFORMERS.** Tapped input 200/250v. for charging at 2, 6 or 12v., 1½ amps., 15/6; 2 amps., 17/6; 4 amps., 22/6. Circuit included. **4 AMP CAR BATTERY CHARGER** with ammeter, Leads, Fuse Case, etc., for 6v. or 12v., 59/6.

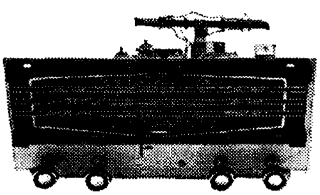
MINIATURE PANEL METERS

Size 1⅝in sq Precision jewelled bearings, 2% accuracy, silvered dials, fine pointers, 0-1 mA. 27/6; 0-5 mA. 27/6; 0-300 v. 27/6; 0-50μa 39/6; 0-500μa 32/6. "S" meter 35/-.

MOVING COIL MULTIMETER TK20A. 0-1000v. A.C./D.C. ohms .0-100lk, etc., 49/6. 0-150 mA. Pocket size 2in. scale.

VALVE HOLDERS. EA50 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6 and 7-pin 1/-. Printed circuit B9A, B7G, Int. Oct. 1/-. Morse Key 4/6; Buzzer 4/6. Moulded Int. Oct. or Mazda Oct. 6d.; B7G, B8A, B8G, B9A 9d. B7G with can 1/6. B9A with can 1/9. Ceramic EF50, B7G, B9A, Int. Oct. 1/-. B7G, B9A cans, 1/- each. Valve base plugs B7G, B9A, Int. Oct. 2/3.

1964 RADIOGRAM CHASSIS



Three Wavebands — Five Valves
S.W. 16 m.-50 m. — Latest Mullard
M.W. 200 m.-500 mm. — ECH81, EF89, EBC81
L.W. 800 m.-2,000 m. — EL84, EZ80

12-month guarantee. A.C. 200-250 v. 4-way switch. Short-Medium-Long-Gram. Ferrite Aerial. A.V.C. and Negative Feedback. 5 watts 3 ohm. Chassis 13½in. × 7in. high × 5in. deep. Glass dial size 13in. × 4in. horizontal wording. Two Pilot Lamps. Four Knobs. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9.15.6 Carr. 4/6.

Matched Speakers 8in. 17/6; 10in. 25/-; 12in. 30/-.

Famous Manufacturers Surplus Bargain

Ferguson Quality Amplifier 4 Watts

Size 6½in. × 5 × 4in. 200-250 A.C. double wound mains transformer. Volume and tone controls. Sensitivity 200 mv. Response 25 to 20,000 cps. Price 49/6 each. Complete with valves, etc. Brand new. 2 units matched for stereo etc., 89/6.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7×4in., 4/6; 9×7in., 5/9; 11×3in., 5/6; 11×7in., 6/9; 13×9in., 8/6; 14×11in., 10/6; 15×14in., 12/6. **ALUMINIUM PANELS.** 18 s.w.g. 12×12in., 4/6; 14×9in., 4/-; 12×8in., 3/-; 10×7in., 2/-; 8×6in., 2/-; 6×4in., 1/6.

MAINS TRANSFORMERS 200/250 AC Post 2/- each

Standard 250-0-250, 80 mA. 6.3 v. 3.5 a., tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped 5 v. or 4 v. 2 a.	22/6
Ditto 350-0-350	29/6
Miniature 200 v. 20 mA., 6.3 v. 1 a.	10/6
Midget 220 v. 45 mA., 6.3 v. 2 a	15/6
Small, 250-0-250 v. 45 mA, 6.3 v. 2 a.	17/6
Standard 250-0-250 65 mA., 6.3 v. 3.5 a.	17/6
Heater Trans. 6.3 v. 1½ a.	7/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	8/6
Heater Trans. 6.3 v. 4 a.	10/6
General Purpose Low Voltage. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	22/6
Auto Trans. 150 w., 0, 115 v. 200, 230, 250 v.	22/6
Auto Trans. 500 w. 0, 115, 200, 230, 250 v.	82/6
Mullard 510" Mains Trans. to Spec. 300-0-300 120 ma., 6.3 v. CT 4a., 0, 5, 6.3 v. 2 a.	33/6

Mains Power Packs. Ready built with Mains Transformers, Rectifiers and Condensers etc., providing H.T. and L.T. 200 v. 20 mA. D.C. ½ wave 6.3 v. 1 a. A.C. 25/6; 220 v. 50 mA. D.C. ½ wave 6.3 v. 2 a. A.C. 35/6; 250 v. 80 mA. D.C. Full wave 6.3 v. 4 a. A.C. 45/6.

THE POWER MITE 45/-

PM9 Mains Unit 9 volt for Transistor Radios. Same size as P.P.9 (200/250V.) Miniature P.P.3 model. 19/6

4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

Size 3×1¾×⅞in.

A ready built miniature push-pull amplifier with Driver and output transformers, 4 transistors. Ideal for use with record players, intercoms., BABY ALARMS, etc. Complete with full instructions and circuit. Price 47/6. 9 v. Battery 2/3. 2½in. Speaker 15/-.

NEW MULLARD TRANSISTORS. OC71 6/-, OC72 7/6, OC81D 7/6, OC81 7/6, AF115 10/6, AF114 11/-, OC44 8/-, OC45 8/-, OC171 9/-, OC170 8/6, AF117 9/6 Transistor Holders 1/3. **SUB-MINIATURE CONDENSERS.** 0.1 mFd., 30 v., 1/3, 1, 2, 4, 5, 8, 16, 25, 30, 50, 100 mFd., 15 volt 2/6 each.

TRANSISTOR 4-CHANNEL MIXER with 4 separate input-output controls, 59/6.

VOLUME CONTROLS

Long spindles. Midget 5K ohms to 2 Meg. L/S 3/-. D.P. 4/6.

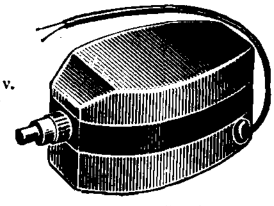
Stereo L/S 10/6. D.P. 14/6. Linear or Log Tracks.

80 Ohm CABLE Coax

Semi-air spaced 6d. yd. 40 yd. 17/6, 60 yd. 25/-.

Low loss 5dB per 100ft. at 500 mc/s. Ideal 625 lines 1/6 yd.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER

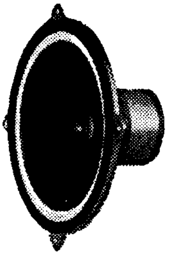


200/250 v. A.C.

Leaflet S.A.E.

B.T.H. TAPE MOTORS 115 v. A.C. 28 w. 12/6 pair, for 230 v. (in series)

BAKERS 'Selhurst' LOUDSPEAKERS



THE CONNOISSEUR'S CHOICE

8in. JUNIOR SPECIAL, 8 w. 17,000 lines. **5 gns.** Foam Suspension 40-20,000 cps.
12in. STALWART HEAVY DUTY 15w. 5 gns. 3 or 15 ohm voice coils. Unlimited applications. Response 45 to 13,000 cps. Magnet 12,000 lines. Quality unbeatable.
12in. STANDARD HEAVY DUTY 20w. 7 gns. More powerful magnet 14,000 lines special suspension. 40-14,500 cps. Recommended wherever a high standard of reproduction is desired.
12in. BASS HEAVY DUTY 25w. 12 gns. New 1964 high power model. Aluminium coil former with magnetic damping 25-15,000 cps. Ideal for all electric guitars.
15in. AUDITORIUM MODEL 35w. 18 gns. Improved magnet alcomax with heavy plated assembly, weight 16 lbs., 17,000 lines, 20-12,000 cps. Solid heat proofed Paxolin Coil Former. Ideal for all Electric Guitars.

BOOKS *(List S.A.E.)*

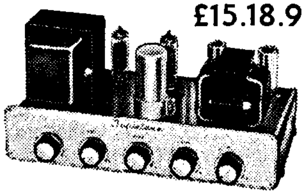
"W.W." Radio Valve Data	7/6
High Fidelity Speaker Enclosures	5/-
Valves Transistors, CRT Equivalents	9/6
At a Glance Valves, CRT Equivalents	3/6
TV Fault Finding	5/-
Mullard Audio Amplifier Manual	8/6
Radio Valve Guide, Books, 1, 2, 3, or 4	ea. 5/
Practical Radio Inside Out	3/6
Master Colour Code	1/6
Coil Design and Construction Manual	5/-
Radio, TV and Electronics Data Book	3/6
International Radio Stations List	2/6
Boys' Book of Crystal Sets	2 6
Stroboscopic Disc 33, 45, 78 r.p.m.	1/-
How to Receive Foreign TV	5/-

Wave-change Switches

2 p. 2-way, or 2 p. 6-way, long spindle	3/6
3 p. 4-way, or 1 p. 12-way, long spindle	3/6
4 p. 2-way, or 4 p. 3-way, long spindle	3/6
8 p. 4-way, 2 wafer, long spindle	6/6

Wavechange "MAKITS" Wafers available: 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 12/-. Extra wafers up to 12, 3/6 each. **TOGGLE SWITCHES.** s.p., 2/-; d.p. 3/6; d.p.d.t., 4/-. Rotary Toggles, s.p., 3/6; d.p. 4/6. Min. Slide d.p 3/6. **JACKS.** English open-circuit 2/6, closed-circuit 4/6. Grundig type 3-pin 1/3; Grundig Lead Type 3/6. Phono, Plugs 1/-. Socket 6d. Banana Plugs 1/-. Sockets 1/-. **JACK PLUGS ENGLISH** Screened 3/-. Grundig 3-pin 3/6. **BULGIN NON-REVERSIBLE PLUGS and SOCKETS.** P74 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6. P360 3-pin 4/-; Mains selector panel with plug 1/-.

TRIPLETONE HI-FI MAJOR £15.18.9



12 watts 15 to 20,000 cps. 5 valves A.C. mains isolated. 12in. × 5¾in. × 6in. high. Built-in pre-amp. and mixer. Two inputs and volume controls. Sensitivity mic. 10 mV.; Gram 250 mV. 3 tone controls, Bass, Treble and Middle. Auxiliary power supply. Ideal for all electric guitars. Cabinet with handle, 30/- extra.

★ *RETURN OF POST MAIL ORDER SERVICE* ★ *EXPERTS ANSWER ALL ENQUIRIES* ★ *48-HOUR MAIL ORDER*

RADIO COMPONENT SPECIALISTS

377, WHITEHORSE ROAD • WEST CROYDON • *Telephone:* THO 1665

Our written guarantee given with every purchase. Buses 133 and 68 pass door. S.R. Stn. Selhurst. *P. & P. charge 1/-, Full List, 1/-, C.O.D. 2/- extra.*
(Export welcome. Send remittance and extra postage, no C.O.D.)

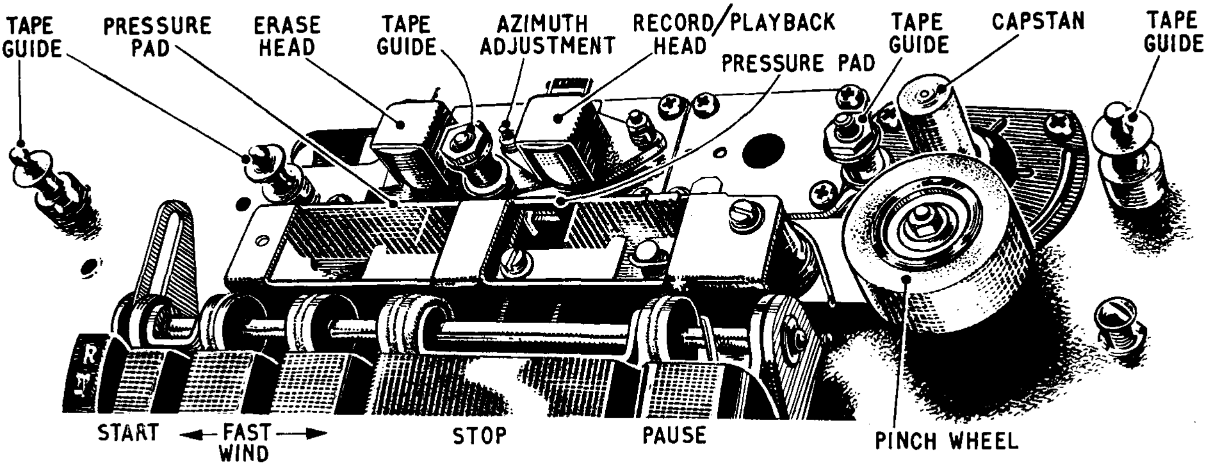


Fig. 1.4. The magnetic heads and tape drive system of the Magnavox Studio tape recorder

STANDARD SPEEDS

The speeds used nowadays are 30in/sec and sub-multiples of this. The average domestic machine may have three speeds, and these may be $7\frac{1}{2}$, $3\frac{3}{4}$, and $1\frac{7}{8}$in/sec, while slightly better class machines tend to use instead a 15in/sec top speed. As noted previously, higher speeds allow a better high frequency response.

The lower speeds are used more for speech recording, where some frequency loss can be tolerated—indeed, is often desirable for clarity—and this, of course, gives longer tape playing time. Some dictating machines use the further sub-multiple of $\frac{15}{16}$in/sec. Other machines have inconstant speed, where the tape is driven not by a capstan but by the pull of the take-up spool. Speed of tape then varies as spooled diameter, and tapes recorded on these machines cannot be correctly played back on a "normal" constant-speed machine.

WOW AND FLUTTER

Regularity of speed is very important. A slow variation in speed causes pitch changes that are very obvious on sustained notes; this is known as "wow".

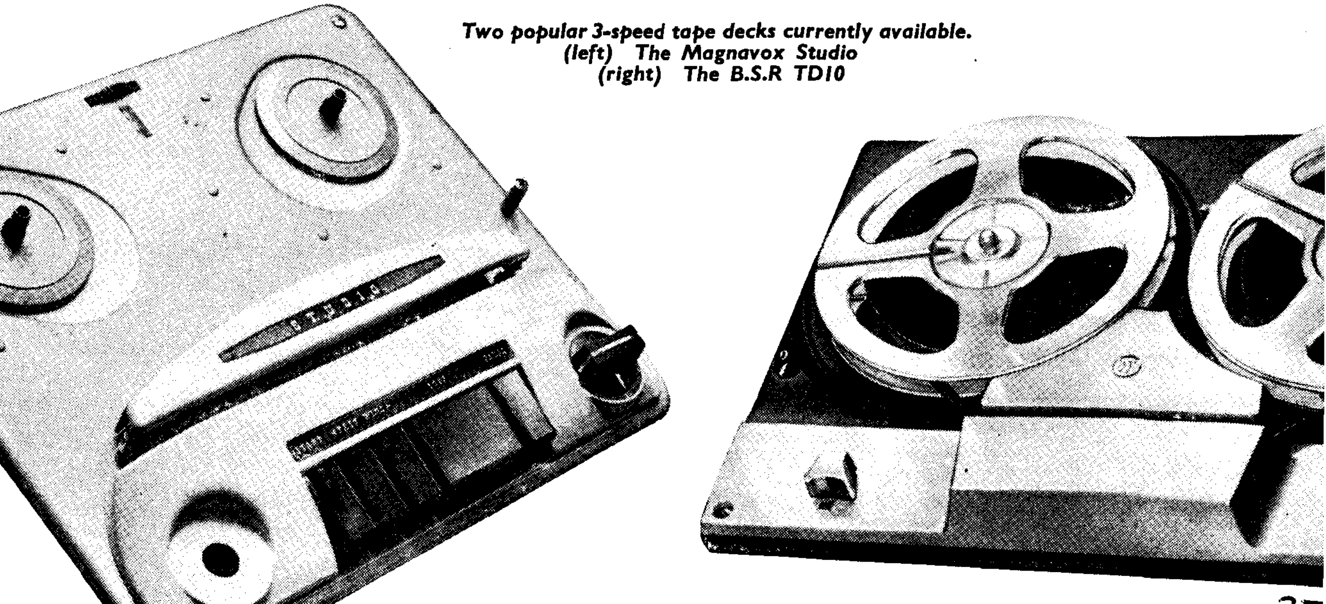
Rapid variations that show up as a harshness or rough tone are caused by a flutter effect, which may be the result of incorrect contact of tape with heads, wrong spooling tensions or faulty guides. Deviation from constant speed must be less than a half per cent for these effects to be inaudible. A figure of ±0·2 per cent is often quoted, and is acceptable for domestic equipment.

SIGNAL-TO-NOISE RATIO

Because of the nature of the medium, a certain amount of background noise is inherent, and good design (both mechanical and electronic) does much to keep the noise due to tape irregularity, contact effect, head impedance, etc. beneath audible levels. The signal-to-noise ratio of the amplifier should not be less than 45dB. This is a fairly stringent requirement for an amplifier which may have to provide a gain of some 120dB from a head signal of only one or two microvolts.

Random noise is more evident at the upper end of the audio frequency spectrum, the result being a pronounced hiss. This can be troublesome when heads become magnetised. Many commercial tape recorders incorporate circuits which reduce the risk of magnetisation by causing head currents to decay instead of cutting off sharply when the function switch is operated.

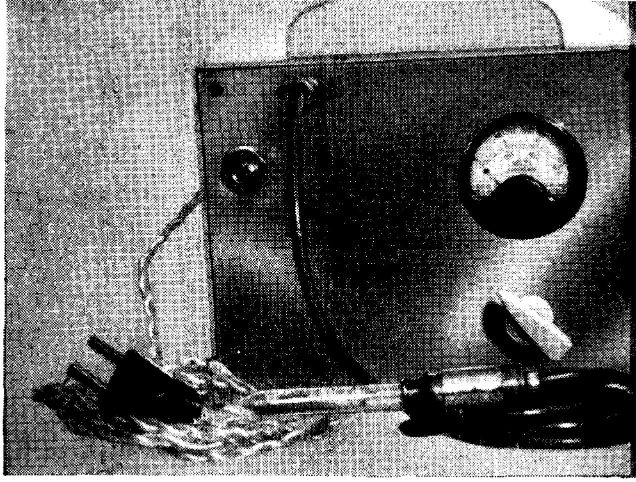
In any case, regular de-magnetisation is good practice. The domestic tape recorder, like the family car, is better for a regular servicing.



Two popular 3-speed tape decks currently available.
(left) The Magnavox Studio
(right) The B.S.R TD10

A Simple GEIGER-MULLER Ratemeter

by J. F. ROWLES



Radioactivity has come very much into the fore in recent years with the advent of the atomic power stations, and the testing of the might of the atom. To quote one instance, the presence of the dangers of radioactivity was brought very sharply to the notice of the British public with the discovery of radioactive iodine in milk, and of the possible consequences to the younger members of the population.

The possibilities for amateur study of the occurrence of radioactivity in rainwater, in soil and in food material are extensive. Scientists in the botanical field use radioactive isotopes to trace the absorption of minerals by plants, and there is no reason why the amateur should not perform similar experiments. It is in this way that many of the advances in this field have been made.

Recently the trend in the G.C.E. syllabuses has been to include more and more "Modern Physics". This needs more equipment for teaching which, in the case of radioactivity, can be very expensive. The ratemeter described in these pages will serve very well for school use, it comparing favourably with commercial equipment, which is usually designed for the more advanced work and is necessarily much more expensive.

The uses for a ratemeter by amateurs and schools is extensive, many lines of investigation being open in addition to the standard work.

One possible application for school groups in suitable locations would be a survey of soil radioactivity. A map could then be drawn up of the distribution of radioactive ore.

A RATEMETER for use with Geiger-Muller tubes enables a reading of radiation intensity to be obtained with the minimum of delay. The principle of the ratemeter is to average the count from the Geiger-Muller tube and to register this as a deflection on an ordinary meter. The ratemeter described here achieves this in a very simple way, but despite this is accurate enough for average amateur purposes.

Before commencing the actual details of the instrument, the author feels that a brief diversion into the theoretical field would be of advantage.

THE GEIGER-MULLER TUBE

The Geiger-Muller tube consists simply of an anode and a cathode encased in an envelope. The cathode is a cylindrical electrode of metal, or conducting layer on the inside of the envelope (such as graphite), surrounding the anode which is a stainless steel or tungsten wire mounted along the axis of the tube. This assembly is encased in an envelope, usually glass, one end of which terminates in some form of plug, and the other end may or may not be fitted with a thin mica window, depending on whether weakly penetrating radiation is to be detected or not.

The tube is air-tight and is filled at about 10cm Hg pressure with a mixture of gases, generally an inert gas with small amounts of quenching agent, such as a halogen or an organic vapour. Generally the organically quenched tubes operate at higher voltages (above 1kV), and the halogen quenched tubes around 400V.

In operation a suitable potential difference is applied to the tube. When ionising radiation passes through the gas in the tube electrons are removed from the inert gas to give ion pairs (i.e. pairs of positive ions and free electrons). The electrons move swiftly to the anode under the influence of the applied p.d. If the field is strong enough the electrons are accelerated

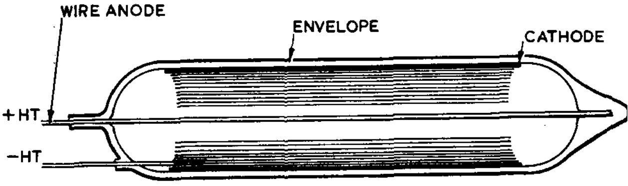
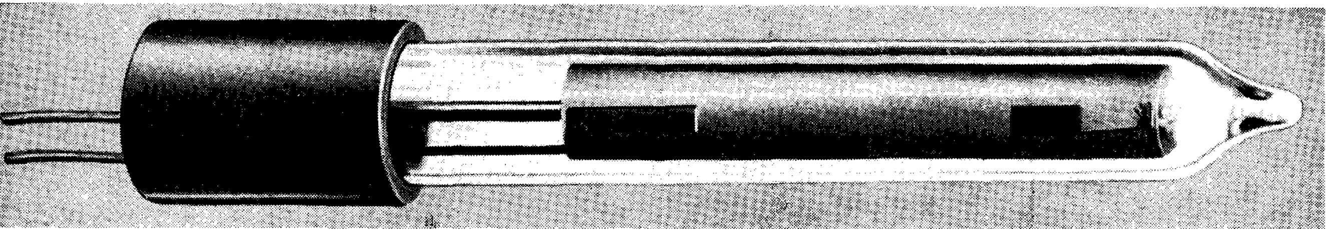


Fig. 1. The Geiger-Muller tube in diagrammatic form

The photograph below shows the type HC4 tube



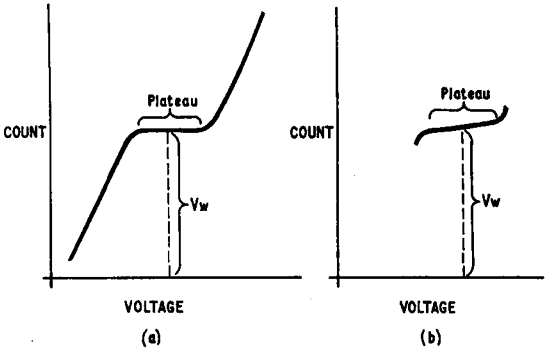


Fig. 2. G-M tube characteristics. In (a) is shown the theoretical curve, while (b) depicts the practical form of the plateau

to such an extent that they produce further ionisation by collision with other atoms of the inert gas. The free electrons produced repeat the process.

On reaching the anode the electrons cause a drop in potential which constitutes the output pulse.

When the potential applied to the tube is high enough, any ionisation caused in the tube produces an *avalanche discharge* to spread along the anode wire. The potential at which this just occurs is known as the *threshold* of the G-M tube, and subsequent increases in the applied potential produce the same output pulse for either strong or weak ionising particles that enter the tube.

Considering the steady increase of the applied potential above the threshold, further increases in potential cause very small increases in the count rate. This is known as the *plateau region* of the G-M tube, and may extend for 100 to 200V depending on the particular tube. The nearly constant count rate over the whole of the plateau indicates that all of the particles that enter the tube are being recorded.

Beyond the plateau the count rate increases rapidly with an increase in applied p.d., because of continuous discharge of the tube. *Operation in this region must be avoided to prevent damage to the tube.*

The operation of the G-M tube can be shown graphically, as in Fig. 2.

The output pulse from the Geiger-Muller tube is taken across a load resistor, and fed via a capacitor to the ratemeter circuit (Fig. 3).

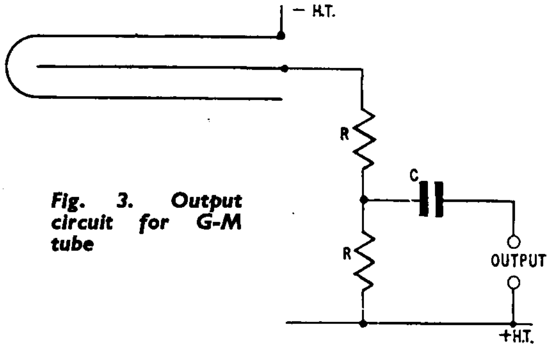
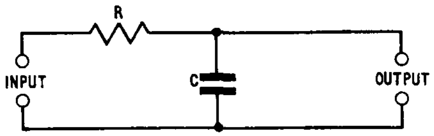


Fig. 3. Output circuit for G-M tube

AVERAGING NETWORK

The circuit used to average the count rate in the Geiger-Muller unit here under discussion is an integrator, the basic circuit of which is given in Fig. 4. This integrator is a phase shift circuit and its action is to smooth out sudden changes in any waveform.



$$\text{Tan } \Phi = 2\pi f RC$$

Fig. 4. Basic circuit of the integrator

Since the output from the G-M tube consists of pulses, which are, of course, sudden changes in the potential, the action of the integrator is to attempt to represent these as a constant potential. Hence, putting a meter across the output terminals will show not sudden pulses, but a constant reading (if the values of the capacitor and resistor are of suitable value for the frequency of pulse involved). The values of C and R are always such that Vc has the smallest usable amplitude.

The mathematics of the circuit is as follows:

$$V_{out} = \frac{1}{C}\int i\,dt \therefore i = C\frac{dV_{out}}{dt}$$

$$\text{and } V_{in} = CR\frac{dV_{out}}{dt} + V_{out}$$

$$\therefore \int V_{in}\,dt = CRV_{out} + \int V_{out}dt$$

$$\therefore V_{out} \simeq \frac{1}{CR}\int V_{in}\,dt \text{ provided that } \int V_{out}\,dt \ll CRV_{out}$$

As with all similar circuits, the more perfect the integration the greater the attenuation, thus a compromise must be reached.

APPLICATION IN THE G-M RATEMETER

Having a circuit to average the count rate, the effect of this on the accuracy of the reading must be considered. For the above circuit the integrating time is given by the product of the values for R and C. (R measured in megohms and C in microfarads gives the integrating time in seconds).

The accuracy of any reading taken in radioactivity measurements is expressed as the ratio of the arithmetic mean of a whole series of readings to the count rate obtained for the reading whose accuracy is required.

$$\text{i.e. Accuracy} = \frac{\sigma}{r}$$

where σ = arithmetic mean
r = count rate

This is known as the standard deviation.

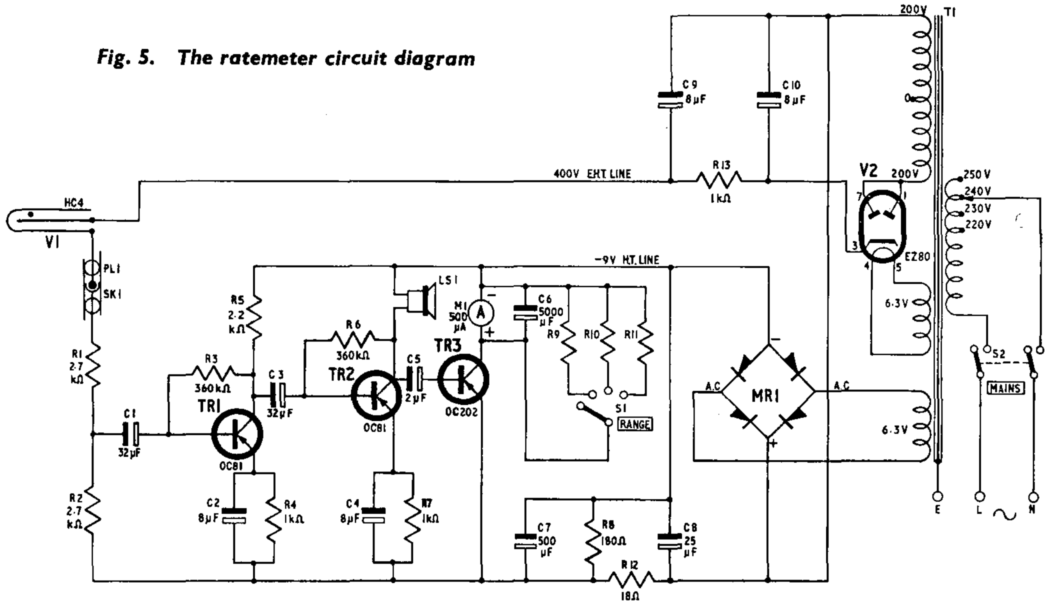
For a single reading from a source, the accuracy is given by,

$$\frac{\sigma}{r} = \left[\frac{1}{2\pi RC}\right]^{\frac{1}{2}}$$

Thus, the larger the value of RC the greater the accuracy (small value for σ/r).

For any required statistical value the choice of RC also depends on the magnitude of the reading for the count rate obtained (r). When r is large small values of RC may be employed.

Fig. 5. The ratemeter circuit diagram



EQUILIBRIUM TIME

The period required for the reading of the ratemeter to attain a steady state is referred to as the equilibrium time and depends primarily on the selected time constant RC in the integrating circuit.

If the initial count rate is zero then a practical equilibrium time t_e is given by,

$$t_e = [RC\tfrac{1}{2}\log_e(2rRC) + 0{\cdot}39]$$

From the equation it is clear that the time required for equilibrium to be reached is also dependent on the count rate r. In practise it is unnecessary to calculate the equilibrium time for each reading, a rough rule being to allow about four or five times the integrating time for equilibrium to be attained.

Often the needle of the ratemeter will be flickering, and to obtain a reading a mental average is taken of the maximum and minimum deflections of the needle.

THE RATEMETER CIRCUIT

Having considered the basic theory of the ratemeter, the practical circuit will now be considered. Reference to the circuit diagram (Fig. 5) will show the circuit to consist of four parts:

1. THE GEIGER-MULLER HEAD

This has already been considered in an earlier part of the article.

2. TWO-STAGE AMPLIFIER

This is of conventional design, and has been included in the circuit so that an audible signal is available and, also, so that a meter of not too great a sensitivity for full scale deflection could be employed.

3. INTEGRATOR

Incorporating an amplifier, this circuit aids in increasing the magnitude of the output. Reference to the previous notes on integrators will aid in understanding its action. The meter itself is used as a multimeter having switched ranges, the shunts for which are very easily constructed.

4. POWER PACK

The power for the G-M tube is taken from a conventional circuit, and although a valve rectifier was used in the prototype by the author, there is no reason why a metal rectifier should not be used, its use being advantageous as regards heat dissipation.

The power for the transistor circuit is obtained from one of the heater windings on the mains transformer T1, a full-wave bridge metal rectifier circuit being employed.

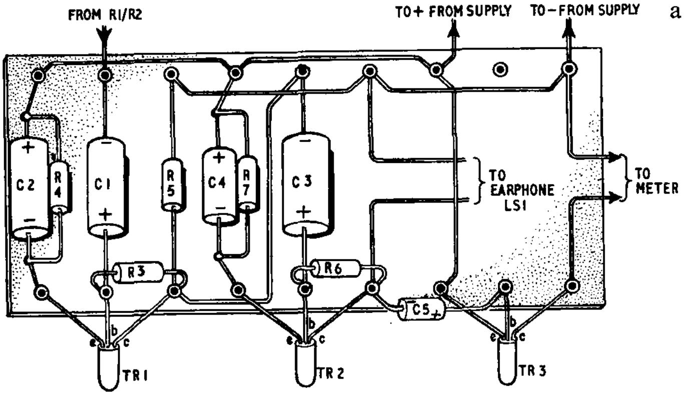


Fig. 6. Tagboard layout of main amplifier-integrator

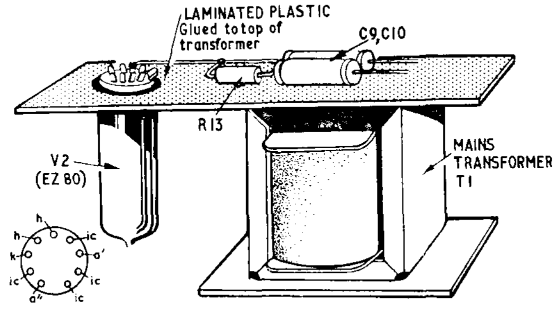


Fig. 7. Mains transformer and associated components

CONSTRUCTION

The ratemeter is contained inside a commercially available 8in × 6in four-sided chassis. The actual size of the case is determined largely by the size of mains transformer obtained.

The component parts of the unit can all be attached to the case using contact adhesive, the mains transformer likewise because of its small size and weight.

The voltage amplifier and integrator circuit are built on a standard tagboard which is glued to a sheet of laminated plastics and stuck into the case. The tagboard is best wired up before glueing into the case.

The transistors employed for the voltage amplifier may be of any of the branded or unbranded a.f. types. The following transistors have been used successfully in the circuit by the author: OC71, OC72, OC76, OC81, V/10/50A, red spot, and yellow/green spot.

The transistor employed for the integrator should be one of the silicon type transistors as these have a very low non-signal current which is desirable as this is registered by the meter, but if the silicon transistors are employed the deflection obtained on the 500 microampere meter under no signal conditions is minute.

The recommended transistor for use in this circuit is the Mullard OC202. This does, however, retail at a rather high price, and in the interests of economy an ordinary transistor that does not have too great a collector current could be employed. (Various other transistors have been tried by the author, their action being found similar to the OC202, the only objection to their use being the relatively high collector current.)

The layout for the tagboard is given in Fig. 6. The whole unit can be assembled out of the case with flying leads for connection to power supply, G-M tube, and earphone.

H.T. SUPPLY

The power pack components for the high tension supply are mounted on a piece of laminated plastics board which is stuck to the top of the transformer core (see Fig. 7). If a metal rectifier is used a contact cooled type should be employed, this being bolted to the case next to the transformer. The transformer can now be affixed in the left-hand bottom corner of the case (Fig. 9).

The mains lead is run out through a hole in the back of the case. It would be advisable to coat all the terminals of the transformer with a sealer before sticking into the case so as to minimise the risk of accidental shock; before doing this, however, remember to attach two leads to an unused heater supply for feeding the bridge rectifier.

Having installed the mains transformer, the amplifier-integrator tagboard can be stuck in so that it occupies the top half of the right-hand side (Fig. 9). The earphone can now be fixed in position over the hole cut for it in the bottom right-hand corner.

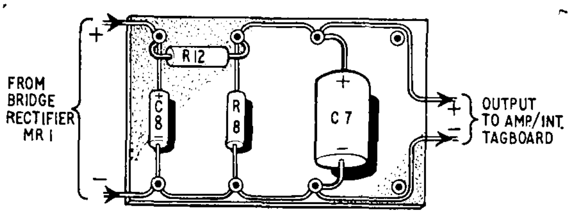


Fig. 8. Smoothing circuit for transistor supply

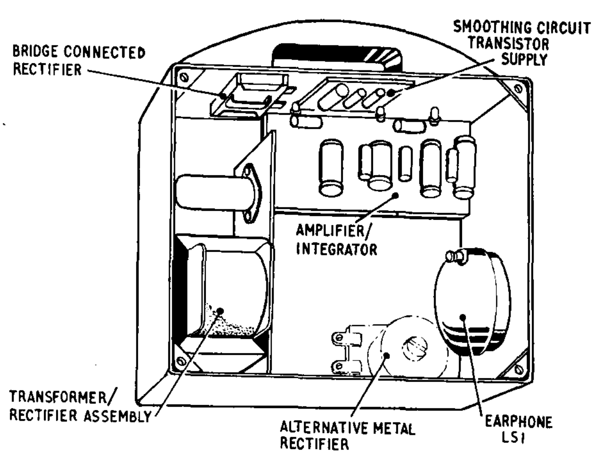


Fig. 9. Layout inside the case

The cover of the 'phone is removed and the diaphragm stuck to the magnet case of the 'phone by the edge only. When this is quite securely set, test the phone by connecting a l.t. battery across its terminals. This ensures that the diaphragm has free movement. Stick this assembly over the hole punched for it, again only applying glue to the edge of the diaphragm. When in place test the earphone as before. After ensuring that all is in order cut the flyleads from the amplifier to the earpiece to a suitable length and attach them to the 'phone.

The next stage in the assembly is to make up the bridge rectifier to supply the transistors. All the components except the rectifier are mounted on a miniature tagboard as in Fig. 8. Short flyleads to the rectifier are connected.

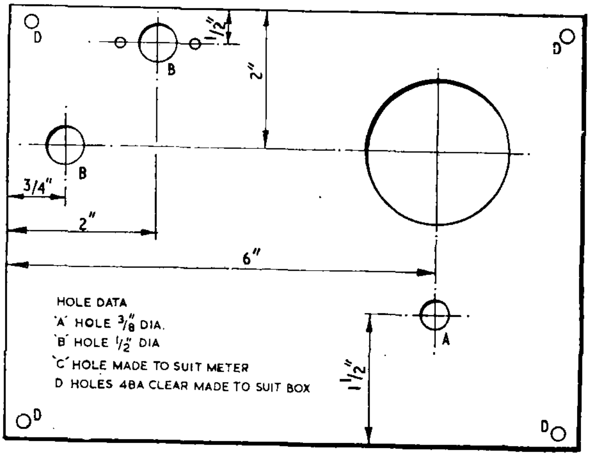
The rectifier is mounted by a bolt through the case in the top right-hand corner and the rest of the components on the tagboard are mounted next to it as for the larger tagboard (see Fig. 9). The flyleads from the transformer and the larger tagboard are cut short and soldered in their respective positions.

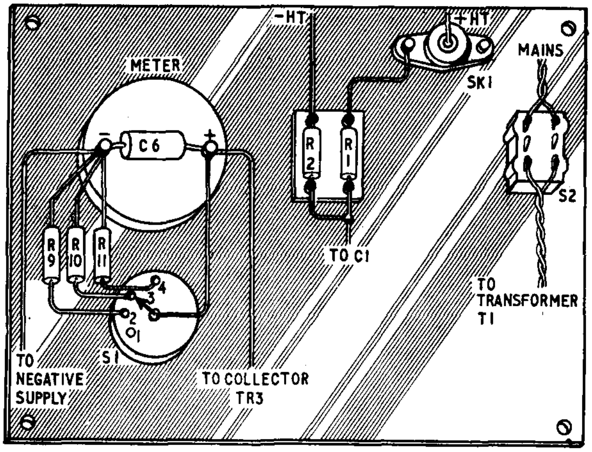
This completes the main assembly in the case.

THE FRONT PANEL

A suitable front plate is now cut out from 18 gauge aluminium and drilled according to Fig. 10. The meter, range switch, and coaxial socket are then

Fig. 10. Front panel drilling





mounted. The limiting resistors are carried up on a small two-way tagboard. The 5,000μF capacitor C6 is soldered across the terminals of the meter (Fig. 11).

The shunts can then be wired across the meter via the switch. The exact value for the shunts depends on the characteristics of the meter being employed, and to save research for those unfamiliar with the formula, this is reproduced in Fig. 12.

The meter shunts should be calculated to give full scale deflections of:

Switch Position	F.S.D.
1	½mA
2	1mA
3	5mA
4	10mA

Use high stability resistors to the nearest value below the calculated value, and add a suitable length of resistance wire to bring the total resistance to that required.

This completes the wiring of the front plate, it only remaining to connect a flex of suitable length from the h.t. supply to the G-M head (see Fig. 11), from the G-M head to the amplifier and from the meter to the integrating circuit.

The face plate can be screwed to the main assembly either by self-tapping chassis screws or by using tapped holes for standard bolts.

A final check on the wiring should now be made, with particular attention to the polarity of the transistor and G-M head supplies. A check with an ohmmeter between the mains leads and chassis would be advisable (with the front plate in position) to check for shorts or bad insulation in the sealer used on the mains transformer, the use of which is essential for complete safety.

The unit is now ready for testing. Plug the ratemeter into the mains and plug the G-M head into the ratemeter. Switch on. Allow a minute or so for the valve rectifier to warm up.

Turn the ratemeter range switch to its lowest range. Occasional clicks should be heard issuing from the earphone, coupled with corresponding movements on the ratemeter needle.

Bring the G-M tube near to a luminous watch or clock dial; the count rate and clicks should now increase, the ratemeter needle now giving a more steady reading.

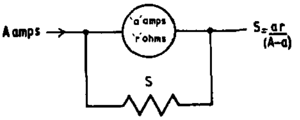


Fig. 12. Formula for meter shunts

Fig. 11. (left) Wiring of components on front panel

CALIBRATION OF THE RATEMETER

Calibration of the instrument need only be carried out by experimenters who require a reading of radiation level in direct units. For average use a reading of the relative increase in radiation is all that is required and this can be obtained using the scale already on the meter.

Calibration can be achieved in several ways. The first is by comparison with a standard commercial ratemeter, the method being to set up the two units with their detecting heads side by side and place sources of varying strength in front of them, noting the reading on the ratemeters and then plotting a graph of rate against needle deflection. (This is preferable to marking the scale on the meter as this can never be achieved to any extent of accuracy by the amateur, and the homemade scale is not usually very neat.)

The second method of calibrating the unit is to feed in a pulsed output from a signal generator, of exactly the same amplitude as the output from the G-M head. This is fairly difficult to achieve and the better method is by comparison with a standard instrument.

Next month: some basic experiments and investigations into radioactivity which can be performed with this ratemeter

COMPONENTS . . .

Resistors

R1	2·7kΩ	R6	360kΩ	*R10	—
R2	2·7kΩ	R7	1kΩ	*R11	—
R3	360kΩ	R8	180Ω	R12	18Ω
R4	1kΩ	*R9	—	R13	1kΩ
R5	2·2kΩ				

All 10%, ½W carbon
* Meter shunts—see text

Capacitors

C1	32μF 6V	C6	5,000μF 6V
C2	8μF 6V	C7	500μF 12V
C3	32μF 6V	C8	25μF 12V
C4	8μF 6V	C9	8μF 600V
C5	2μF 6V	C10	8μF 600V

All electrolytics

Transistors

TR1	OC81	TR2	OC81	TR3	OC202

Miscellaneous

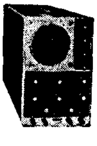
LS1	Moving coil earphone 1–2kΩ
M1	Moving coil ammeter 500μA f.s.d.
MR1	Full wave bridge metal rectifier 6V
S1	Rotary switch, single pole 4 way
S2	Toggle switch, d.p.s.t.
SK1	Coaxial socket
T1	Mains transformer. Secondaries: 200–0–200V 40mA; 6·3V 1A; 6·3V 1A
V1	Geiger-Muller tube Halogen quenched (20th Century Electronics type HC4)
V2	Bi-phase h.t. rectifier EZ80

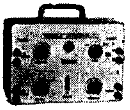
THE WORLD-FAMOUS KIT—SETS ANYONE CAN BUILD WITHOUT PREVIOUS EXPERIENCE

THE PRACTICAL WAY to ENJOY ELECTRONICS

A WIDE RANGE OF WELL DESIGNED KIT-SETS TO CHOOSE FROM

YOU CAN SAVE £££s BY BUILDING ANY HEATHKIT MODEL


IO-12-U


S-3U

"MALVERN" HI-FI EQUIPMENT CABINET. Will house all your Hi-fi equipment. "Left in the white." Size: 39⅛ x 32 x 21⅝ in. Kit **£18.10**

A wide range of other cabinets. Please send for details.

"COTSWOLD" HI-FI SPEAKER SYSTEMS. Acoustically designed enclosures, complete with 12 in. bass speaker, elliptical mid-range speaker, and tweeter to cover full frequency range of 30-20,000 c/s. Cross-over unit, level control, etc. "Left in the white." **Standard "Cotswold"**, Size: 26 x 23 x 14 in. Kit **£23.4.0**

MFS "COTSWOLD" for the smaller room. Size: 36 x 16½ x 14 in. Kit **£23.4.0**

A wide range of speakers available. Send for details

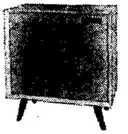

FM TUNER


S-99

5 in. FLAT-FACE GENERAL PURPOSE OSCILLOSCOPE. Model IO-12U. An outstanding 'scope. "Y" sensitivity, 10 mV rms per cm at 1 kc/s; Bandwidth 3 c/s to 4.5 Mc/s. T/B 10 c/s to 500 kc/s in 5 steps. Kit **£32.12.6.** Assembled **£41.10.0.**

ELECTRONIC SWITCH, Model S-3U. Convert your 'scope to dual trace. Kit **£12.18.0.** Assembled **£18.10.0.**


MALVERN

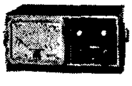

COTSWOLD

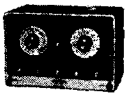
HI-FI FM TUNER. Range 88-108 Mc/s. Available in two units, sold separately. TUNER (FMT-4U) 10.7 Mc/s IF **£2.15.0** (inc. P.T.). IF AMPLIFIER (FMA-4U) power supply and valves **£13.3.0.** Total Kit **£15.18.0.**

9 + 9W HI-FI STEREO AMPLIFIER, Model S-99. Ganged controls. Stereo/Mono Gram. Radio, Tape inputs. P.C. board construction. Attractive presentation. Kit **£27.19.6.** Assembled **£37.19.6.**

"OXFORD" LUXURY TRANSISTOR PORTABLE, Model UXR-2. Beautiful solid leather case. Kit **£14.18.0**

GENERAL COVERAGE RECEIVER, Model RG-1. Freq. coverage 600 kc/s-1.5 Mc/s. 1.7-32 Mc/s in 6 switched bands. Many features incl. ½ lattice crystal filter. Kit **£39.16.0** Assembled **£53.0.0.**

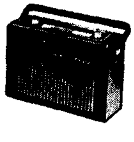

IM-13U


HFW-1

6 in. DE LUXE VALVE VOLTMETER, Model IM-13U. Measures ac and dc volts 0-1.5 to 1,500V in 7 ranges. Res to 1,000 MΩ in 7 ranges. Modern styling, with gimbal mount. Kit **£18.18.0.** Assembled **£26.18.0.**

VALVE VOLTMETER, Model V-7A. DC volts to 1,500, AC to 1,500 rms and 4,000 V pk. to pk. Res. 0.1-1,000 MΩ. Kit **£13.18.6.** Assembled **£19.18.6.** RF Probe 309-CU **£1.13.6** kit. HT Probe HV.336 **£2.19.6** kit. Will extend range of models V-7A or IM-13U.

TV ALIGNMENT GENERATOR, Model HFW-1. 3.5 to 220 Mc/s on fundamentals. Unique electronic sweep oscillator. Built-in fixed and variable marker generators (5 Mc/s crystal). Kit **£30.15.0.** Assembled **£44.10.0.**


UXR-2


RG-1

Send for FREE British Catalogue of Heathkit Range of Models

Deferred Terms over £10 in U.K.

Prices quoted include postage U.K.

6W STEREO AMPLIFIER. Model S-33H. An inexpensive stereo/mono amplifier. Ideal for use with the Decca Deram lightweight pickup. Modern attractive styling. Kit **£15.17.6** Assembled **£21.7.6**

"GARRARD" AUTO RECORD PLAYER. Model AT.6. A four-speed stereo/mono unit with auto. record selection. Fitted with R.105 crystal pickup **£13.12.1.** With Decca Deram pickup **£14.6.1.**

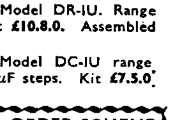
5W MONO AMPLIFIER. Model MA-5. A general purpose amplifier based on model S-33. Separate bass and treble controls, gram and radio inputs. Printed circuit. Kit. **£10.19.6.** Assembled **£15.10.0.**

ELECTRONIC WORKSHOP, Model EW. 20 exciting experiments can be made. Special solderless connections. Kit only **£7.13.6.**

MULTIMETER. Model MM-1U. Ranges 0-1.5v to 1,500v A.C. and D.C. 150 μA to 15A D.C.; 0.2 to 20 MΩ. 4½" 50 μA meter. Kit **£12.18.0.** Assembled **£18.11.6.**

2¾ SERVICE 'SCOPE, Model OS-1 Light (wt. 10½ lb.), compact, 5" x 8" x 14½". The idea portable for servicemen. Kit **£22.18.0.** Assembled **£30.8.0.**


PA-1


AT-6

R.F. SIGNAL GENERATOR, Model RF-1U. Freq. coverage from 100 kc/s-100 Mc/s or six bands, on fundamentals and up to 200 Mc/s on calibrated harmonics. Kit **£13.8.0.** Assembled **£19.18.0.**

DECADE RESISTANCE, Model DR-1U. Range 1-99,999Ω in 1Ω steps. Kit **£10.8.0.** Assembled **£14.8.0.**

DECADE CAPACITOR, Model DC-1U range 100μμF to 0.111μF in 100μμF steps. Kit **£7.5.0.** Assembled **£10.8.0.**

INTERNATIONAL MAIL ORDER SCHEME covering the American Heathkit range of 250 models. Illustrated American catalogue and full details can be obtained from us for 1/- post paid.

50W PUBLIC ADDRESS AMPLIFIER, Model PA-1. A multi-purpose unit, suitable for vocal and instrumental groups. 4 inputs for guitars, mics, etc. 2 heavy duty speakers, vol. indicator, variable tremolo, modern cabinet. Kit **£54.15.0.** Assembled **£74.0.0.**

50W POWER AMPLIFIER, Model MA-50. Ideal for sound reinforcing systems, etc. Kit **£19.18.0.** Assembled **£27.18.0.**

"MOHICAN" TRANSISTOR GENERAL COVERAGE RECEIVER, Model GC-1U. Freq. coverage 580 kc/s to 30 Mc/s in 5 bands. Electrical band spread on 5 additional bands covers "amateur" freq. from 80-10 M. B.F.O. Tuning and Zener diode. Send for details. Kit **£37.17.6.** Assembled **£45.17.6.**

80-10m AMATEUR TRANSMITTER, Model DX-40U. Crystal controlled. Power input 75w. c.w. 60w. peak controlled carrier phone. Output 40w. Kit **£33.19.0.** Assembled **£45.17.6.**

TRANSISTOR INTERCOM, Models XI-1U and XIR-1U. Ideal for home or business. Each master (XI-1U) will operate up to 5 remote stations. 9v. battery operation. XI-1U (Master) kit **£10.19.6.** Assembled **£16.19.6.** XIR-1U (Remote) kit **£4.7.6.** Assembled **£5.16.0.**

DAYSTROM LTD.

Dept. P.M. 11, GLOUCESTER, ENGLAND

WORLD'S LARGEST SELLING ELECTRONIC KITSETS

Please send me FREE BRITISH CATALOGUE (Yes/No)

Full details of model(s) ....

....

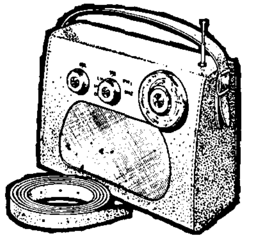
NAME ....
(BLOCK CAPITALS)
ADDRESS ....

PM-11

....

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS...

BACKED BY OUR SUPER AFTER SALES SERVICE



ROAMER SEVEN Mk III

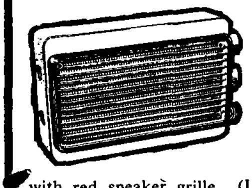
5 WAVEBAND PORTABLE OR CAR RADIO

Amazing performance and specification ★ ***Now with PHILCO MICRO-ALLOY R.F. TRANSISTORS***

● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room filling volume from rich toned heavy duty 5in. speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M & L Waves and telescopic aerial for S Waves. Real leather-look case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere).

Total cost of parts now only **£5.19.6** P. & P. 5/6
Parts Price List and easy build plans 3/-



TRANSONA FIVE

Home, Light, A.F.N., Lux. all at good volume.
G.P. Durham

●7 stages—5 transistors and 2 diodes

Fully tunable over Medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 2¾in. speaker, etc. Attractive case. Size 6½ × 4½ × 1¼in. with red speaker grille. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

COMPONENT BARGAINS ALL POST FREE

TRANSISTORS

PHILCO MADT Type 2N1727 Maximum frequency of oscillation 150 Mc/s	8/6.
PHILCO MADT Type 2N1728 Maximum frequency of oscillation 150 Mc/s	9/6.
PHILCO MADT (Micro Alloy Diffused) Type 2N503 Maximum frequency of oscillation over 500 Mc/s	15/-
Diodes	1/6
Standard interleaved output transformers for valve output stages	3/6

SWITCHES

Slide, single pole, heavy springs	2/3
Yaxley 6-way, 2 pole	4/9

TUNING CONDENSERS

Air spaced fine quality German manufacture with slow motion drive. 0·0005 with oscillator section	9/6
Subminiature similar 00 with tuning and oscillator sections	7/6
Subminiature mica dielectric with trimmers. Tuning 200 pf, Oscillator 50 pf	5/6
Mica dielectric 0·0003 mfd,	3/10

BELLPHONES

Ex-G P.O. Suitable as sound powered telephones. Resistance of coil 60 ohms approx. 3in. U-shaped magnet	5/9

HEADPHONES

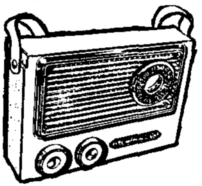
High fidelity miniature magnetic earpieces (2) on slim band with lead and plug. Easily converted to stereo. American manufacture	13/6
Miniature crystal earpiece with lead plug and socket	6/6

DIALS AND KNOBS

3in. dial with polished brass insert and M/L calibrated disc	6/6
1in. cream knobs with polished brass insert and rim	1/3 each

CASES

Real leather-look cases in chestnut shade with holes punched for tuning, volume control and switch. Also holes punched for car aerial socket and tone control. 9½ × 3½ × 7½in. approx. Complete with carrying straps	35/-
Plastic cases in grey polystyrene with red ornamental grille, 6½ × 4½ × 1½in. approx.	6/9
Telescopic aerials with fixing socket	6/6



SUPER SEVEN

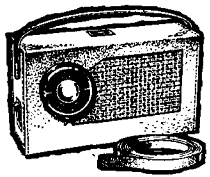
● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves and Trawler Band. The ideal radio for home, car, or can be fitted with carrying strap for outdoor use. Completely portable—has built-in Ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF Stages, push-pull output, 3in. speaker (will drive large speaker). Size 7½ × 5½ × 1½in. (Uses 9v battery, available anywhere.)

Total cost of all parts now only **£3.19.6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

MELODY SIX

"... amazed at volume and performance, has really come up to my expectations". S.G., Stockton-on-Tees.

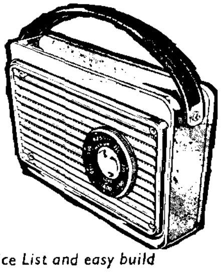


● 8 stages—6 transistors and 2 diodes

Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6¾ × 3¼ × 1⅞in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.9.6** P. & P. 3/-

TRANSONA SIX



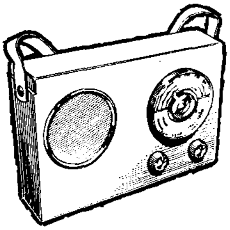
●8 stages—6 transistors and 2 diodes

This is a top performance receiver covering full Medium and Long Waves and Trawler Band. High-grade approx. 3in. speaker makes listening a pleasure. Push-pull transformers for ample power. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1½in. (Uses PP4 battery available anywhere.)

Total cost of all parts now only **59/6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

ROAMER SIX *NEW!!*

NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS



● 6 WAVEBAND!!

● 8 stages—6 transistors and 2 diodes

Listen to stations half a world away with this 6 waveband portable. Tuneable on Medium and Long Waves. Trawler band and three Short Waves. Sensitive Ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1½in.

★ Extra band for easier tuning of LUX., etc.

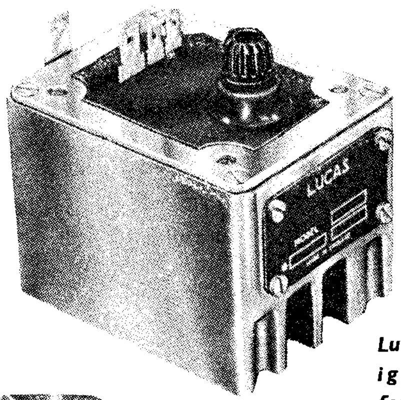
Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.19.6** P. & P. 3/6
(Carrying Strap 2/6 extra.)

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at fixed prices stated.

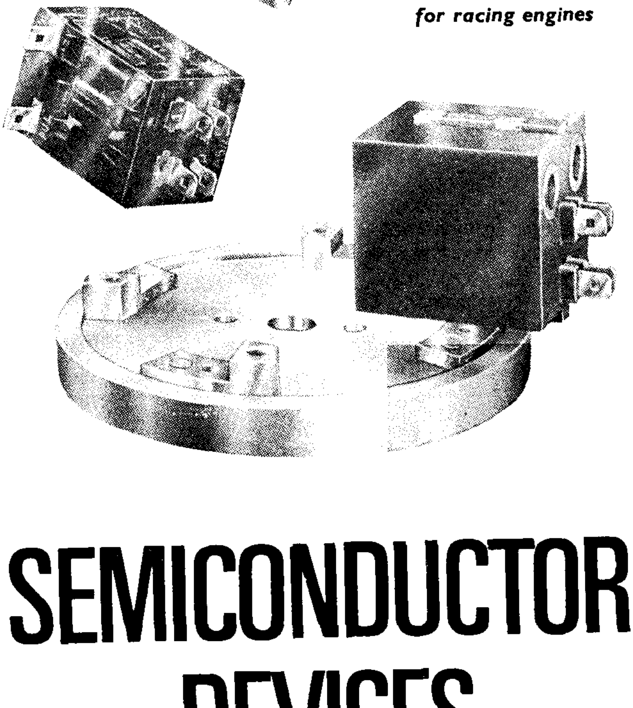
RADIO EXCHANGE Ltd.

61a, HIGH STREET, BEDFORD. Phone: 2367

Callers side entrance
Barratts Shoe Shop
Open 9—5 p.m.
Sats. 10—12.30 p.m.



Lucas electronic ignition system for racing engines



SEMICONDUCTOR DEVICES FOR AUTOMOBILES

Explains how electronics can help to improve performance and reliability in vehicle electrical systems. Some novel devices to aid the motorist are also described.

With the developments which were taking place in solid-state physics during the early 1950s, Lucas engineers quickly realised that significant technical advantages were to be obtained from the use of semiconductor devices in automobile electrical equipment. In particular, it would become possible to eliminate many moving parts, and to achieve switching by means of transistors instead of electrical contacts, thus offering potential advantages in performance and reliability. In 1955, an intensive investigation into possible applications was begun.

At that time, the semiconductor devices available were based on the use of germanium as the semiconducting material, and the development of silicon devices was as yet only in its infancy. This was important, since for unrestricted application in the automobile, semiconductor devices must withstand ambient temperatures in excess of 90°C, and this factor largely excludes the use of germanium whose operating temperature is limited to a maximum of 110°C. Silicon devices, on the other hand, are capable of satisfactory operation at temperatures up to 200°C, and must be used if the full advantages of semiconductors are to be obtained.

It was realised at the outset, therefore, that if progress was to be made, Lucas would have to undertake the fundamental development of silicon devices for automobile applications, and in 1956 a comprehensive study of the design, construction and production of silicon devices was commenced, having as its ultimate objective the manufacture of a range of silicon power devices to meet all the foreseeable demands of the automobile industry.

This programme involved a study of device technology from the growing of high-purity single crystals, through the techniques of device fabrication, to testing under operating conditions. Its successful outcome has culminated in the setting up of a new Lucas factory devoted to the production of silicon semiconductor devices—for both the automobile and electronics industries.

PRACTICAL APPLICATIONS

The first silicon semiconductor device to be used on a production scale was a full-wave bridge rectifier for the output of motor cycle alternators, replacing the selenium rectifier used hitherto, and this has been followed by a variety of diodes and transistors used in a number of other applications. It may be of interest to study some of these applications in greater detail.

ZENER DIODE CHARGE CONTROL

A Zener diode can be employed to provide an extremely simple method of regulating battery input current, according to its state of charge, for motor cycles equipped with 12 volt electrical systems. An appropriately rated Zener diode is connected in parallel with the battery, as illustrated in Fig. 1, and acts as a by-pass valve through which rectified current from the alternator is directed according to the state of charge of the battery.

As the battery becomes recharged, its terminal voltage rises. When it reaches approximately 14V, the Zener diode—which up to this point has opposed the passage of current—becomes partially conductive and thus provides an alternative path for part of the alternator output. Further small rises in battery voltage result in large increases in diode conductivity until, at approximately 15V (the on-charge voltage of a fully charged 12V battery) the bulk of the alternator output is by-

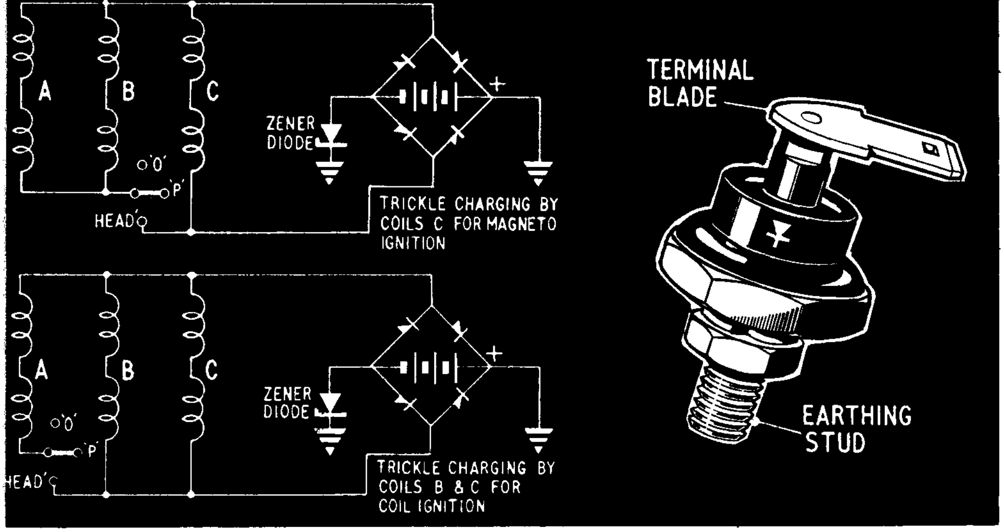


Fig. 1. Two simple motor-cycle battery charging control circuits for coil and magneto ignition utilising a zener diode for control. Also shown is a typical silicon diode rectifier

passed and the system off-load voltage is stabilised.

If an electrical load, such as the headlamp, is now switched on, the system voltage will fall below 15V and less current will flow through the diode, the balance being diverted to supply the load. If the latter is heavy enough to cause the system voltage to be depressed below 14V, the Zener diode will revert to its high resistance state of virtual non-conductivity, and all of the generated output will go to meeting the current demands of the battery and equipment in use.

CAR ALTERNATOR DEVELOPMENTS

It is well known that to meet the requirements of increasing electrical loading on the modern car, and to cater for city traffic density conditions by providing useful output even when the engine is idling, recent generating system developments have been directed towards the multi-pole three-phase alternator. This can be designed to meet both these requirements and at the same time be reduced in size and weight by comparison with the more conventional dynamo widely employed up to the present time.

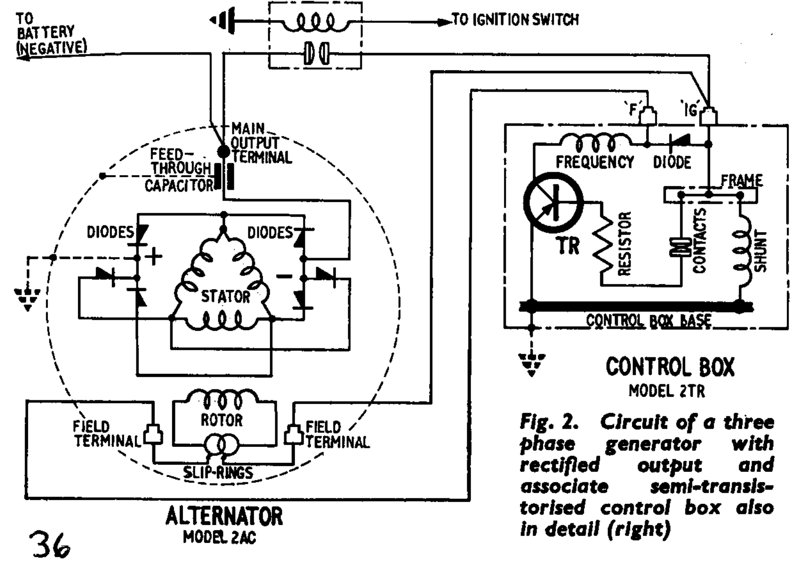
Hitherto, however, the problem of output rectification to direct current for battery charging had prevented much progress being made in this direction, so far as the private car was concerned; although alternators had in fact been used on certain passenger service vehicles for several years, in conjunction with copper-oxide or selenium rectifiers. These, while being devices of a semiconductor nature, are necessarily large and heavy, with limitations in operating temperature, and are subject to changing characteristics with age. Consequently, while such rectifiers could usually be accommodated and fairly adequately cooled on passenger service vehicles, their use on the private car was quite impracticable.

With the advent of silicon diodes, this state of affairs changes completely. By virtue of being so small and light in weight, six diodes can be readily accommodated in the end cover of the alternator to give "built-in" full-wave rectification of the three-phase output. Moreover, they can be cooled by the ventilating air stream provided for the alternator.

Thus it is to a great extent due to the development of the silicon diode that it has become possible to consider the use of an alternator on the private car as a practical proposition, and future generating system developments will undoubtedly be based on this type of machine.

ALTERNATOR OUTPUT CONTROLS

The only form of control of alternator output required is one which will maintain the terminal voltage at a substantially constant predetermined value, that is, a voltage regulator. Hitherto, a vibrating-contact electromagnetic device connected in the field circuit had been employed for this purpose, while a later development was the use of a transistor to interrupt the field current, the vibrating contacts being con-



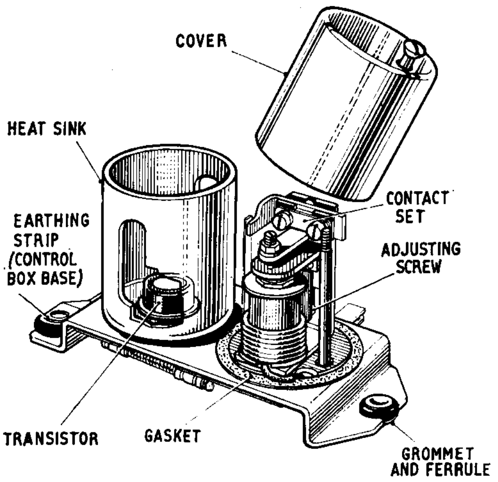
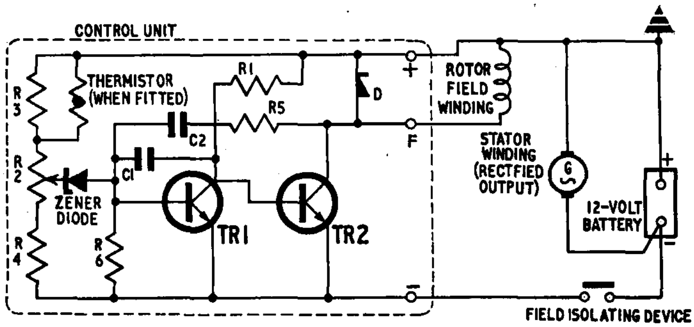


Fig. 2. Circuit of a three phase generator with rectified output and associate semi-transistorised control box also in detail (right)



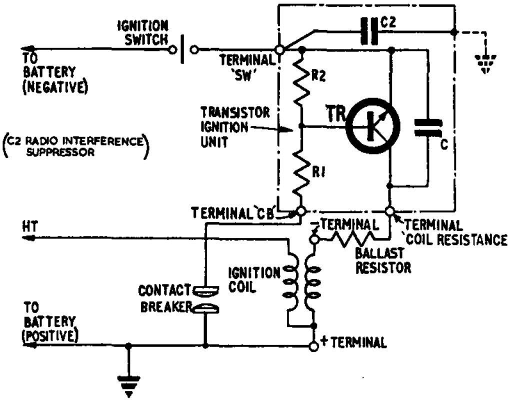


Fig. 3. Control circuit using semiconductors throughout

Fig. 4 (right). A grounded base transistor for switching ignition coil primary current

nected in the base circuit, so breaking only a small current (Fig. 2). In each of these instances, the voltage reference is provided by an armature tensioning spring.

A further development takes advantage of the availability of Lucas silicon semiconductor devices to provide an electronic control in which all moving parts are eliminated; thus the control has increased reliability, since there are no moving parts to wear or to require adjustment, and this results also in greater stability in output control. In addition, the electronic control unit is reduced in size and weight.

The circuit of this control is shown in Fig. 3, and it will be seen that it contains a Zener diode and two transistors TR1 and TR2. In effect, the action is similar to that of the electromagnetic regulator in that the current in the alternator field winding is varied to maintain the generated output voltage within close limits, but switching is achieved by the transistors instead of vibrating contacts, while a Zener diode and potentiometer provide the voltage reference in place of the voltage coil and tension spring system.

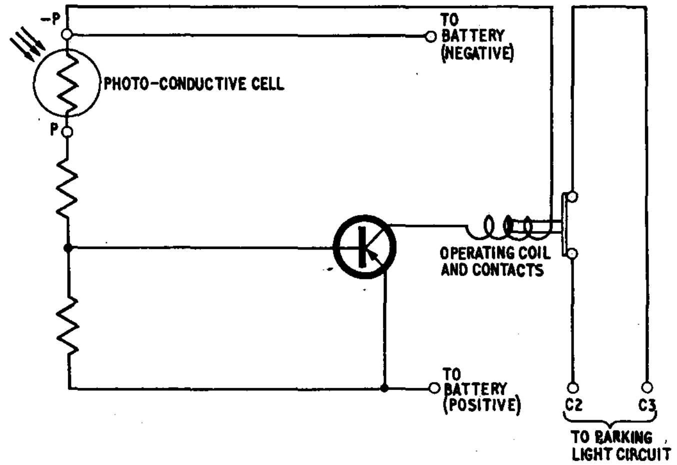
It is not proposed in this article to give a detailed description of how this control operates, but briefly at rest or very low speeds the field circuit is completed through TR2 which is held conducting by virtue of the connection through R1. As the alternator rotor is driven at increasing speed by the engine, the rising voltage generated in the stator winding is applied to the potential divider consisting of R3, R2 and R4, and according to the position of the tapping point on R2, a proportion of this potential is applied to the Zener diode.

When the value of this potential reaches the Zener diode breakdown voltage (corresponding to a known output terminal voltage) the diode conducts, and current flows in the base circuit of TR1. The latter becomes conducting, lowering the current in the base circuit of TR2 and, as a result, so also the alternator field excitation. Consequently, the alternator output voltage will tend to fall, and this in turn will reduce the base current in TR1, allowing increased field current to flow in TR2. By this means, the field current is continuously varied to keep the output voltage substantially constant at the value determined by the setting of R2. Basically, this is the principle of operation of the Lucas Model 4TR Control, but there are certain desirable additions which space does not permit to be described here.

TRANSISTOR-ASSISTED IGNITION

In the conventional coil ignition system, an engine-driven contact breaker controls the flow of battery current through the primary winding of an induction coil. Each time the contacts open, the resulting collapse of magnetic flux in the soft iron core of the coil induces a high voltage in the secondary winding. The contact breaker thus performs the function of a high speed switch in an inductive circuit, breaking a current of several amperes at a rate which may be of the order of 300–400 times per second—and at each contact separation arcing and sparking necessarily occur at the contacts, so that frequent adjustment becomes necessary in service.

In order to reduce this arduous contact duty, the Lucas T.A.C. Ignition System makes use of the switching characteristics of a transistor specially developed for this purpose. The circuit of this system is in Fig. 4, which shows that the contact breaker is connected in the transistor base circuit, while the ignition



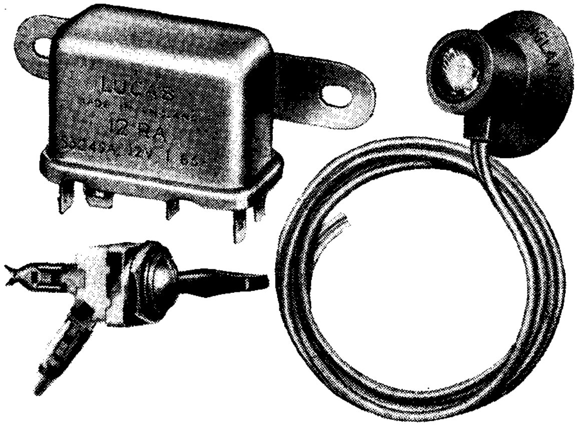


Fig. 5. Automatic parking light circuit and components

coil primary circuit is completed through the collector-emitter electrodes of the transistor.

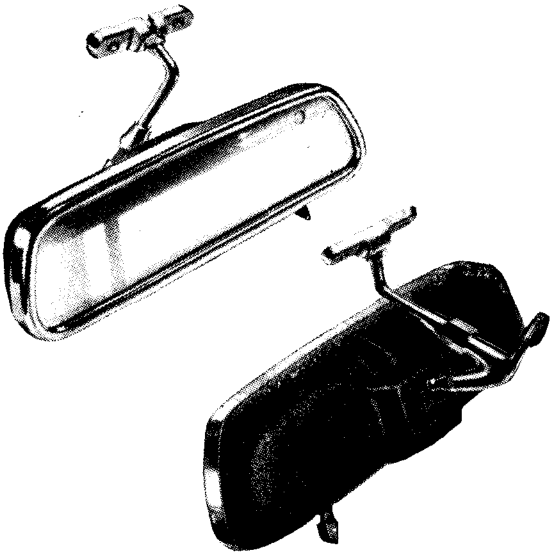
When the contacts are closed, a non-inductive current of about 1A flows in the base circuit, so switching on the transistor and allowing coil primary current to flow. When the contacts separate, the base current is switched off and the transistor immediately becomes non-conducting, so that a high voltage is developed in the coil secondary winding in the normal manner. However, because the contacts now only break a small, non-inductive current, the contact duty is greatly reduced, as is also the need for maintenance and continual readjustment in service. The primary self-induced voltage of some 300V appears across the transistor collector and base electrodes, and for this reason the transistor must be of special high voltage type.

In addition to lighter contact duty, the transistor-assisted ignition system has other advantages. Due to the absence of arcing, low speed performance is improved and this can be extremely beneficial on certain engines, particularly when starting at low temperatures. Also, since the transistor can handle a higher value of coil primary current, a coil of reduced primary inductance can be employed, giving better ignition performance at high speeds when the period during which the contacts are closed is of very short duration.

ELECTRONIC IGNITION FOR HIGH SPEED ENGINES

The rate of sparking in the conventional and the Lucas T.A.C. Ignition Systems is limited by electrical and mechanical considerations to about 400 sparks per second, and while this is adequate for the normal car engine, high speed racing engines (such as those used in Great Britain's successful Formula 1 cars) demand sparking rates of 700–800 per second. Here, again, the advent of semiconductor devices has facilitated the development of the Lucas Electronic Ignition System, in which the contact breaker and most other moving parts are eliminated, and a sparking rate of 1,000 per second becomes possible.

Briefly, the system comprises an electromagnetic pick-up associated with pole pieces attached to the engine flywheel, a transistor amplifier, a spark generator and a high tension distributor. As the engine rotates, a voltage impulse is produced at the pick-up each time one of the accurately positioned pole pieces passes within the pick-up field. This pulse, of relatively low value, is amplified by the transistor amplifier, which can be considered as a normally closed switch allowing battery current to flow through the primary of a trigger transformer situated in the spark generator. The amplified pulse has the effect of "opening" this switch, so that current flow in the transformer primary ceases.



Anti-dazzle mirror actuated by photo-cell controlled solenoid

The energy released by the resulting collapse of current induces a voltage in the trigger transformer secondary winding, and this in turn causes current to flow in the base circuit of a transistor in the spark generator. The transistor thereby becomes conducting, and battery current flows in the primary winding of a high voltage transformer, this circuit being arranged to initiate a regenerative effect. Consequently, primary current rises very rapidly, giving rise to an induced voltage in the transformer secondary of the order of 20 kilovolts. This is fed to a rotor arm and distributed to the plugs in the normal manner. Regeneration ceases when the transformer is saturated, and the transistor again becomes non-conducting. The complete cycle time is less than 200 microseconds. With the cessation of the voltage pulse at the pick-up, the trigger amplifier switch again closes, and conduction recommences in the trigger transformer primary in readiness for the cycle to be repeated at the next pick-up pulse.

AUTOMATIC ANTI-DAZZLE MIRROR

A newly developed device employs a sensitive electronic circuit to detect glare from the headlamps of a following vehicle at night, and to cause the prismatic rear view mirror to be deflected to an alternative position in which a secondary image of reduced intensity is visible to the driver.

A photo-conductive cell mounted behind an aperture in one corner of the mirror is connected to a circuit containing three transistors on a printed circuit base, controlling the action of a solenoid-and-plunger mechanism which effects mechanical movement of the mirror. When the cell is illuminated by the headlamps of a following vehicle, its resistance falls and this initiates a change in the electronic circuit which results in current flowing in the actuating solenoid, causing the mirror to be deflected.

A capacitor provides a time delay to prevent mirror "flapping" due to rapid light changes, as could occur for example on an undulating road, while a diode quenches the solenoid self-induced voltage on switching off.

AUTOMATIC PARKING LIGHT CONTROL

In similar vein, the Lucas Automatic Parking Light Control also employs a photo-conductive cell, in conjunction with a transistor-assisted relay, the circuit being shown in Fig. 5. This device automatically controls the switching of the side or parking lights of a vehicle according to the natural light conditions.

With the circuit set in daylight for automatic operation, the transistor conducts, energising the relay operating coil and so opening the "normally-closed" contacts. As the light fails, the resistance of the photo-conductive cell increases, reducing the transistor base potential, until a point is reached (corresponding to "lighting-up" time) when transistor current ceases. The relay now closes to complete the parking light circuit. ★

The only musical instrument devised by the Australian Aborigine is the didjeridoo, a hollowed pole seldom less than 6ft long, which produces a deep, organlike note when played with pursed lips. Rhythm is kept by the natives by clapping boomerangs or pieces of wood together. Shown above is a group of Aborigine children practising their music. Left is a photograph of Rolf Harris who first brought the instrument into the public eye

ELECTRONIC DIDJERIDOO

by A. J. BASSETT

THE Didjeridoo is a traditional Aboriginal musical instrument which was brought into the public eye by Rolf Harris in his popular "hit" record "Sun Arise".

The author was recently challenged to produce an electronic imitation of the unusual "voice" of this instrument, and so set out to beat the challenge. Results of this effort include a fairly simple electronic device, capable of most fascinating sound effects.

The Aboriginal instrument is in the form of a flute which produces a very peculiar sound accompanied by low-frequency modulation of the player's voice. In order to play this instrument, it appears, one must be capable of simultaneous nasal exhalation and oral inhalation (or vice versa?) The "electronic didjeridoo" renders unnecessary this unusual feat; the player simply croons into a microphone and strange sounds issue forth!

The heart of the instrument is the *ring modulator* shown in Fig. 1. Note that only six components are needed to build this simple circuit. Transistor driver transformers type LT44 are suitable for both T1 and T2. D1–D4 are germanium junction diodes. The gold bonded diodes type OA5 are suitable here, though almost any type of junction diode may be used provided its forward resistance is low.

If suitable diodes are not available, four transistors may be converted to the purpose by soldering the base lead of each to its own collector (use heat shunt). These two leads together form the cathode (red sleeving) while the emitter forms the anode. Check that the forward resistance of the diodes are roughly equal (within about 10 per cent).

Mount these six components together on a tagboard or on printed circuit board. Be sure to make good soldered joints, and use heat sinks to protect the diodes during the process.

Note that the circuit has two inputs (1) and (2), one output, and a common connection. Provide connecting points or wires to these.

Fig. 1. Basic circuit of the ring modulator

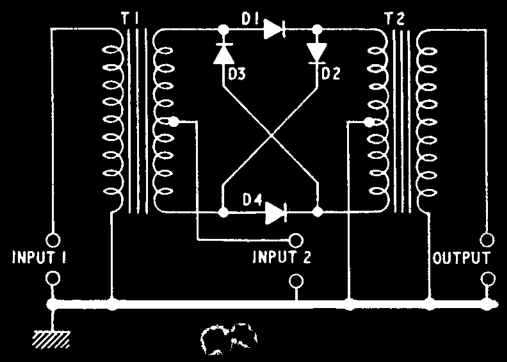
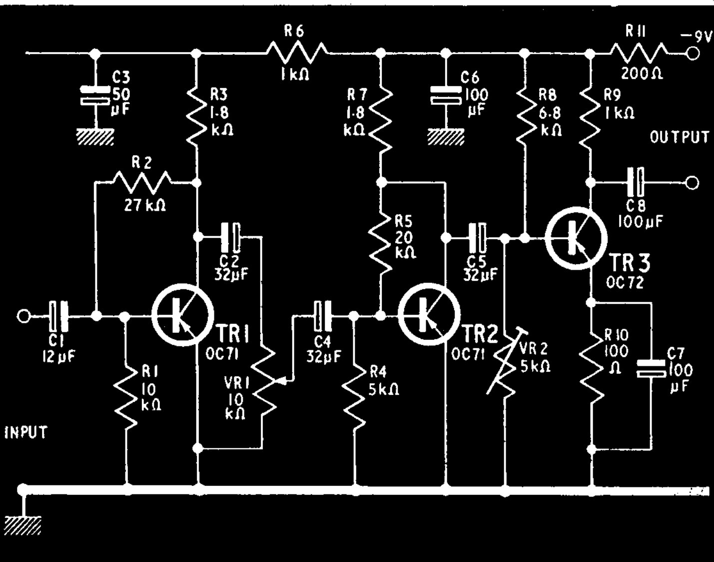


Fig. 2. A suitable drive amplifier



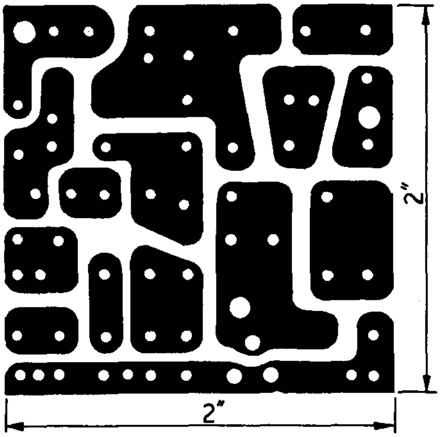
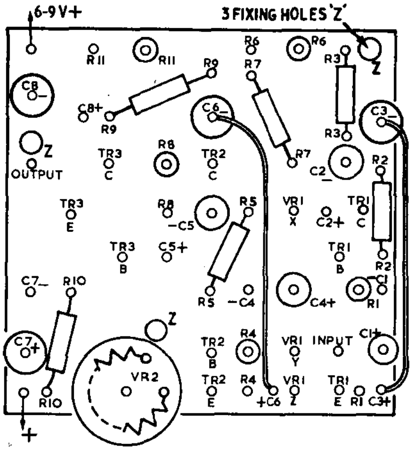


Fig. 3a (left). Printed wiring board for drive amplifier

Fig. 3b (right). Component layout on reverse side of board



MICROPHONE AMPLIFIER

Having constructed the basic circuit, we may proceed to add the drive necessary to make it function. A low power amplifier suitable for use with a microphone provides the input at the secondary centre tap (input 2) of T1. If you do not have a suitable valve or transistor amplifier already available, the circuit shown in Fig. 2 will meet the requirements admirably and can be used with most moving coil microphones.

This amplifier can be assembled on a piece of printed circuit board measuring 2in square. A full size layout diagram for the printed circuit is given in Fig. 3a. The reverse side of the board with all components indicated appears in Fig. 3b.

Using miniature components, this amplifier can quite easily be built on the specified board. VR2 is a miniature G type preset potentiometer. Resistors are standard ¼ or ⅛W types.

The amplifier is capacitor coupled to input (2) of the ring modulator to avoid d.c. flow in this winding; such current would produce undesirable working conditions for the diodes.

To test the amplifier, connect a crystal earpiece across its output, connect a microphone to the input, check the position of the volume control, and apply an audio signal to the microphone. The signal should come clearly through the earpiece.

A.C. DRIVE

The drive at input (1) on the ring modulator is provided by a simple low voltage a.c. source, such as a 6·3V heater transformer (T3) connected with a potentiometer and limiting resistors to prevent overloading. This is shown in Fig. 4.

If you wish to be independent of the mains supply, or to apply a frequency other than 50c/s, the oscillator shown in Fig. 5 is suitable. This is an RC phase shift oscillator supplying a low frequency sinewave via the amplifier transistor TR5. The phase shift oscillator is a versatile unit. It is, however, somewhat bulky, the various potentiometers necessitating a laminated plastic panel of approximately 7in × 2½in.

Fig. 7 shows the component layout and wiring.

SETTING UP THE V.F.O.

Set the preset potentiometers VR3, 4, 5 to 30 kilohms each, and VR6 to its maximum value.

Temporarily short out VR7 and connect a crystal earpiece from the collector of TR4 to its emitter, in order to monitor the oscillations by ear. If you have an oscilloscope, use this for monitoring purposes instead of the earpiece.

Connect the 9V battery. A low humming note should be apparent from the earpiece. Gradually adjust VR6 until this note reaches maximum volume. The frequency is controlled by potentiometers VR3, 4, 5, and mismatch of these may result in loss of volume or failure to oscillate. They should be adjusted around 30 kilohms for maximum volume.

Once matched, these potentiometers may be used to change the frequency of oscillation, but should be kept roughly "in step" with one another in order to maintain oscillation. Thus, each may be cautiously adjusted, in turn, until the desired frequency is reached.

Fig. 4. Sine wave input for ring modulator

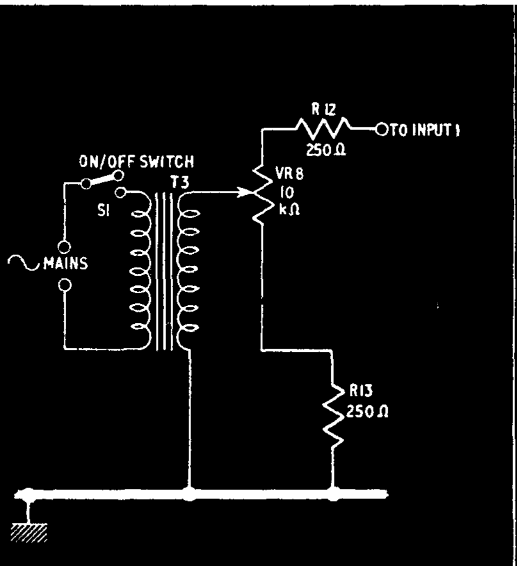
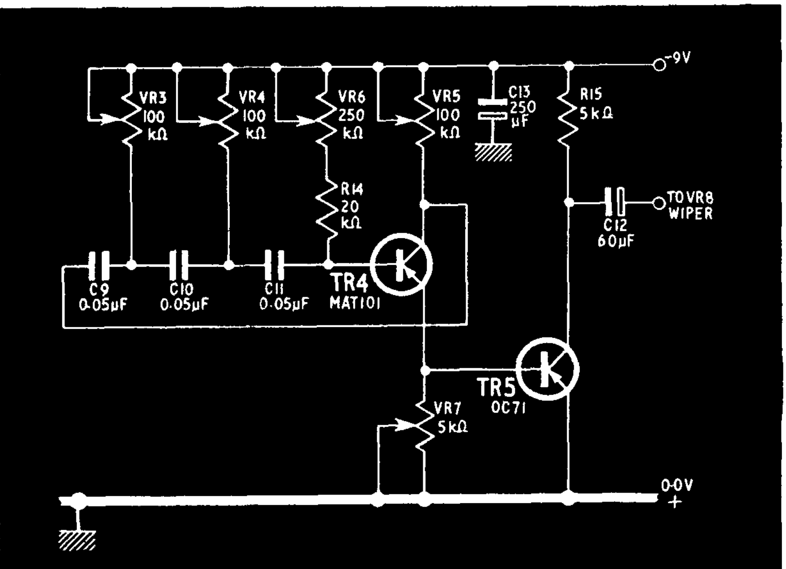


Fig. 5. Phase shift oscillator and amplifier



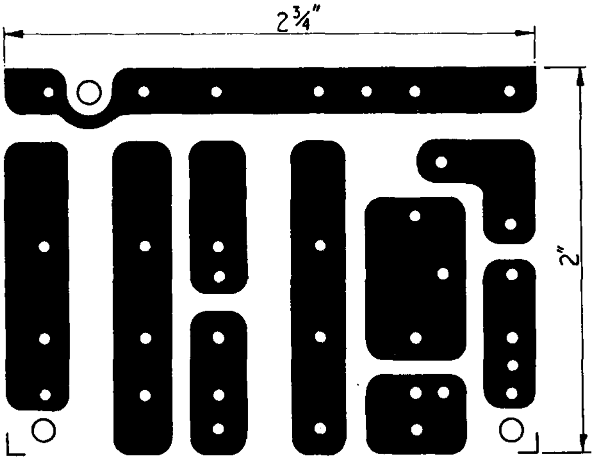


Fig. 6a. Printed wiring for simple version of the phase shift oscillator

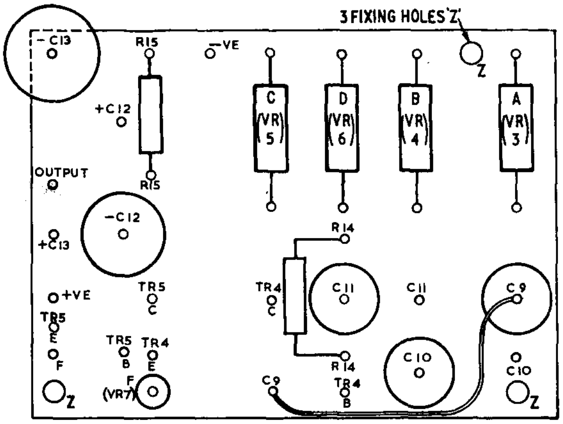


Fig. 6b. Component layout for the simple phase shift oscillator

The frequency range of this type of oscillator is fairly wide, but depends greatly upon the make and quality of the components used. A range from below 20c/s to above 400c/s is to be expected if care is taken.

Now bring TR5 into action by removing the short circuit across VR7. Monitor the output from C12 using an earpiece and adjust VR7 to achieve loudest output.

The question of waveform now arises. Slight mismatch of the tuning potentiometers VR3, 4, 5 will improve the waveform. Reduce the value of VR5 slightly, and raise the other two (but not enough to stop the oscillation). The output will sound a lot "smoother", and those who are using an oscilloscope will see the improvement in waveform most clearly. Adjust VR6, 7 in order to remove any remaining harsh overtones from the output.

Connect the output from C12 directly to the slider of VR8 in place of the 6·3V transformer secondary (Fig. 4).

SIMPLER PHASE SHIFT OSCILLATOR

If preferred, the phase shift oscillator of Fig. 5 may be replaced by a smaller, less versatile version shown in Fig. 6a, b.

In this alternative version, plenty of space has been allowed on the printed circuit board (Fig. 6a) in case the fixed tuning resistors have to be "built up" to particular values for oscillations at specific required frequencies. The layout given is therefore much more open than that of the amplifier illustrated in Fig. 3.

The components required are the same as for the phase shift oscillator of Fig. 5, except that the potentiometers VR3, 4, 5, and 6 are not used. Fixed resistors, their values arrived at by experimentation, replace these four potentiometers as indicated in Fig. 6b.

SETTING UP THE INSTRUMENT

Having built the ring modulator and prepared the drive amplifier and sinewave input, connect these units together as indicated in the text. The output from the ring modulator may be connected to a gramophone or guitar amplifier, to a tape recorder, or to a high impedance earpiece for monitoring.

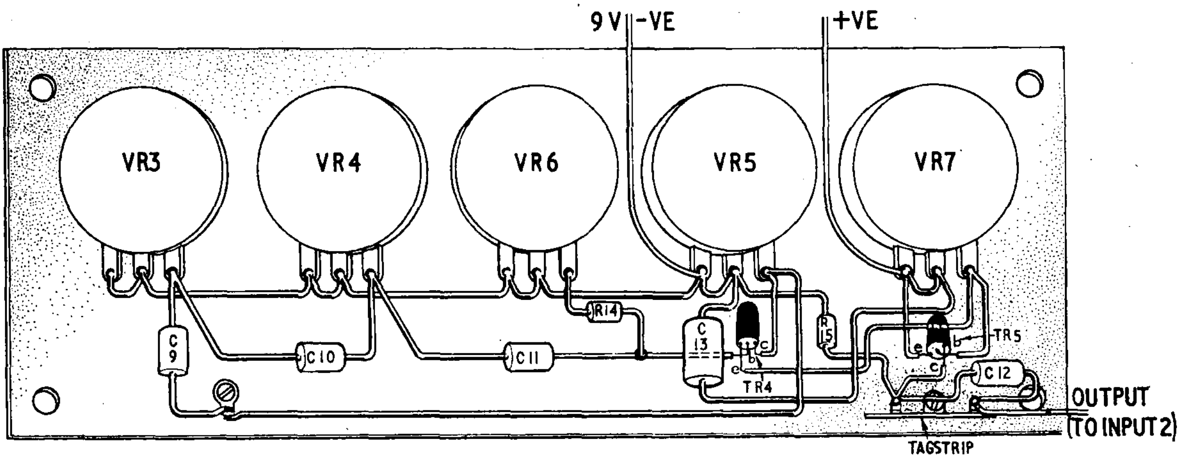
Turn the volume control of the drive amplifier VR1 and also VR8 on the sinewave unit, to minimum volume. Connect the battery. Adjust VR8 until the sinewave oscillator is only just audible (in theory the signal should never be heard, but in practice it usually is, because of slight unbalance between the components of the ring-modulator) at the output. Adjust the volume control of the drive amplifier until an input at the microphone gives adequate output. The device is now ready for use:

PRODUCING EFFECTS

USING A 50C/S SINEWAVE AT INPUT (1)

If you whistle into the microphone the output will have a strange "trilled" quality. This is useful to test the equipment, as it gives immediate indication of 50c/s modulation.

Fig. 7. Component and wiring layout for phase shift oscillator



COMPONENTS . . .

RING MODULATOR (FIG. 1)

D1, 2, 3, 4 Germanium junction diodes Mullard OA5 or low resistance alternatives

T1, 2 Miniature push-pull driver transformer. Type LT44 (Henry's Radio Ltd.)

DRIVE AMPLIFIER (FIG. 2)

Resistors

R1 10kΩ
R2 27kΩ
R3 1·8kΩ
R4 5kΩ
R5 20kΩ
R6 1kΩ
R7 1·8kΩ
R8 6·8kΩ
R9 1kΩ
R10 100Ω
R11 200Ω
All 10%, ¼ or ⅛W carbon

Potentiometers

VR1 10kΩ linear, miniature
VR2 5kΩ linear, miniature

Capacitors

C1 12μF 2·5V
C2 32μF 6V
C3 50μF 12V
C4 32μF 2·5V
C5 32μF 6V
C6 100μF 12V
C7 100μF 2·5V
C8 100μF 12V
all electrolytic

Transistors

TR1 OC71
TR2 OC71
TR3 OC72

SINE WAVE UNIT (FIG. 4)

Resistors

R12 250Ω
R13 250Ω
All 10%, ¼W carbon

Potentiometer

VR8 10kΩ linear

Transformer

T3 Heater transformer. Secondary 6·3V

Switch

S1 Single pole, on/off

PHASE SHIFT OSCILLATOR (FIG. 5)

Resistors

R14 20kΩ
R15 5kΩ
All 10%, ¼W carbon

Potentiometers

VR3 100kΩ linear
VR4 100kΩ linear
VR5 100kΩ linear
VR6 250kΩ linear
VR7 5kΩ linear

Capacitors

C9 0·05μF paper or polyester
C10 0·05μF paper or polyester
C11 0·05μF paper or polyester
C12 60μF electrolytic 12V
C13 250μF electrolytic 12V

Transistors

TR4 MAT101 or high gain red spot
TR5 OC71

If you say "ah", "oo" etc. into the microphone, the resulting output may resemble anything from a ship's siren or factory hooter, or a racing car, to a didjeridoo or a "Mersey" scream! (Some "pop stars" do not need a ring-modulator, they modulate their voices by shaking their heads).

Effects similar to some of those in the television programme "Space Patrol" may be obtained by using an electronic organ to provide the input.

USING OTHER WAVEFORMS AND FREQUENCIES

The 50c/s sinewave is recommended by the author as a good basis to begin experiments with the *electronic didjeridoo*, for some startling effects are easily obtained. Moreover, many of these effects can sound quite pleasant!

There is nothing against the use of a square or sawtooth waveform (e.g. from a multivibrator), or white noise, though these tend to produce harsher sounds at the output.

If a 1,000c/s oscillator is used, the human voice becomes distorted in a most unusual manner, which may be useful for science-fiction effects, pop-record imitation, unusual forms of voice production, etc.

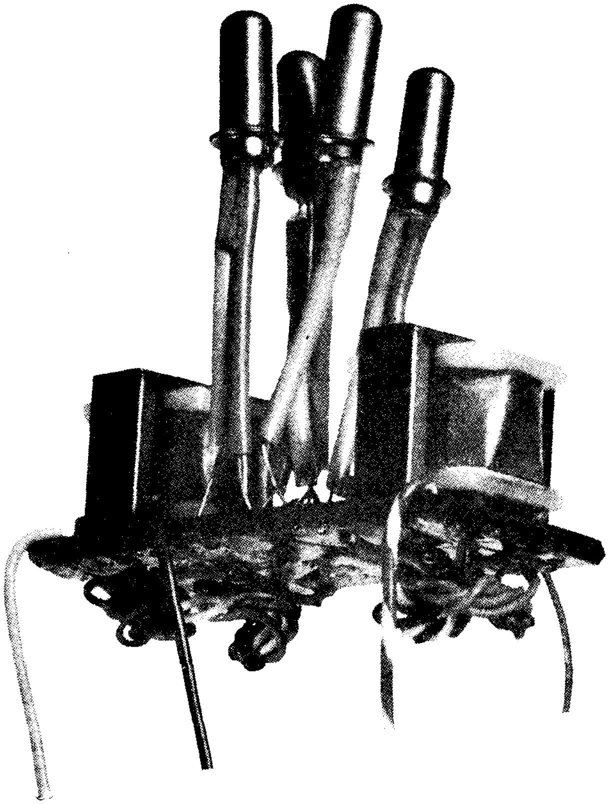
USING TWO OSCILLATORS

If an oscillator operating at about 600c/s is used at one input, and a variable oscillator with a range, say, 200c/s to 1,000c/s provides the other input, various "glissando" and mouth organ effects are readily produced upon variation of the frequency of one of the oscillators.

Many other sound effects, too numerous to mention here, may be produced with the aid of this device.

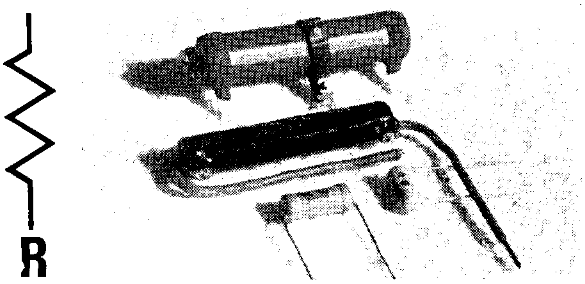
The more experienced, bold and imaginative experimenters will find much worthwhile potential for further development. Extra components may be added to the basic circuit. Several ring-modulators may be used together, or in combinations with other "gadgets" such as the echo chamber, tremolo unit, signal generator etc. to produce special effects. ★

This photograph shows the ring modulator unit. Four transistors have been employed here—their base and collector leads connected together as described in the text

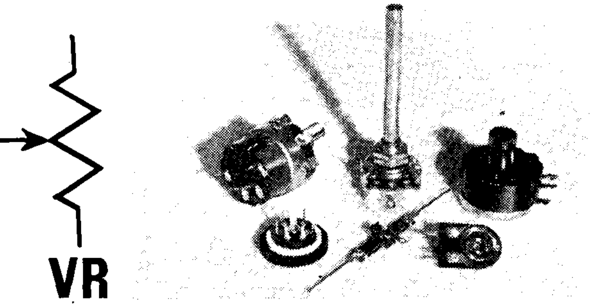


BEGINNERS start here... 1

An Instructional Series for the Newcomer to Electronics

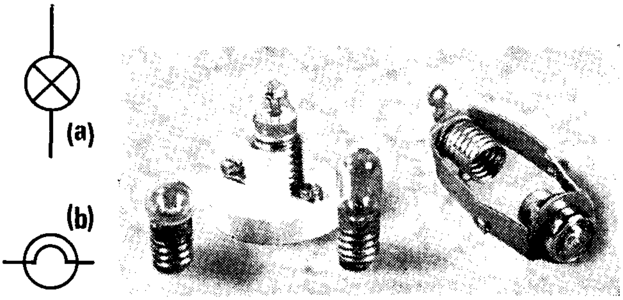


WIRE WOUND RESISTORS



VARIABLE RESISTORS (*Potentiometers*)

BATTERIES



LAMPS
(*a*) *Indicating*
(*b*) *Illuminating*

YOU ARE INTERESTED IN ELECTRONICS, but at present it is all rather mysterious. Well, at least we imagine that is so, otherwise it is hardly likely that you would be reading this.

Perhaps you have as yet a vague idea of the meaning of electronics, although it is possible that you have a certain basic knowledge of electricity.

But, more to the point, you are keen and desire to build interesting and useful gadgets or to carry out simple experiments to prove the theoretical principles you read about.

You are alive to the tremendous importance of electronics in our present age, and you wish to learn about the subject and to acquire some practical skill.

Yes—you've decided that electronics is going to be your hobby!

Well now, we have identified *you*, but what exactly are *we* proposing to do in this section of Practical Electronics? Fair enough. Let us now try to explain.

ELECTRONIC ESSENTIALS

Each month our space in this feature will be divided, more or less equally, between matters theoretical and matters practical. We shall start with quite elementary theory and progress a little each month. The clearly stated facts of electrical or electronic theory will be accompanied by simple practical projects intended to demonstrate just what has been explained in words.

These simple experiments and building projects will also serve to initiate you into the practical techniques involved. This is of course very important—since you intend to be a *practical* man.

Certain skills you must acquire in assembling components and wiring up come largely through repeated practice, but we shall explain and show how in words and pictures.

The materials and components used will be commonly available, and generally quite inexpensive.

A SERIOUS WARNING!

One final, but rather important, point before we really get down to business.

As you look through the other pages of Practical Electronics you will become interested in the various constructional projects we describe.

One or more of these gadgets or items of equipment may take your fancy. The urge to start right away may be irresistible. Oh yes, we realise this, quite well (we were beginners once, too!). So please accept this advice: moderate your enthusiasm with discretion. Unless you have a more experienced parent or friend to advise and assist, wait until you have read a few of the articles in this series before attempting to build any of the main projects.

What you can do is earmark those articles of special appeal, and keep your copies of Practical Electronics carefully for future reference.

In a surprisingly short time you will be suitably prepared to commence operations on your own!

COMPONENT SYMBOLS

Look at the left-hand column on the previous page. Here are depicted some symbols used in circuit diagrams. These (and others to follow) you must learn.

Against each symbol appears an illustration of samples of the actual component. There are, of course, many varieties of each kind of component, but the photographs do illustrate the general shape and appearance of those most usually met.

OUR FIRST EXPERIMENTS

The remainder of our space in this first issue is devoted to some experiments that require very few items and little preparation. They can in fact be carried out on the table without upsetting the household! Carry out carefully the instructions that follow and the apparatus you make can be used for quite a number of different experiments.

A special word to those of you who have some knowledge of elementary electricity. You will find that the earlier experiments in this series cover ground with which you are already well acquainted. However, not to worry. Before long we shall be dealing with subjects that are more or less exclusive to the specialised field of electronics.

The first piece of apparatus we describe will enable you to investigate for yourself the fundamental laws governing resistance. You should remember that *resistance* is the property of a material that impedes current flow and it is measured in *ohms*. The *resistor* is the component which is manufactured to give a required value of resistance.

Fig. 1.1 shows the apparatus connected up, and to make it you will require the items specified below. All the materials and parts used in this series will be simple and cheap and usually obtainable from radio shops or from multiple stores such as Woolworths.

ASSEMBLY OF COMPONENTS

Cut two pieces—each 1in long—from the piece of wood. Drill two holes in each (near the centre and about 1in apart) large enough for the knitting needles to push into them. These pieces of wood can then be glued to the main board or nailed on with panel pins in the position shown. They should be about 11in apart, though this distance need not be very accurately measured. Space should be left at one end of the board to mount the bulb holder.

The knitting needle is used to give support to the electric fire element which we use as our resistor. The needle is pushed through the element so that the turns of wire are fairly evenly spaced. If you have available or can easily obtain 26 gauge Eureka wire you can wind a coil yourself of about 400 turns and get similar results to those obtained with an electric fire element.

The ends of the element can be wound round ordinary wood screws fixed into the top of the end supports. The extra holes in the end supports will not be used until later experiments, but it is easier to drill them out before assembly.

SHOPPING LIST

One piece of soft wood approximately 16in × 3in × ⅞in.

One pair of 12in No. 8 *plastics* knitting needles (one of these will be used later).

Two yards of ordinary plastics covered flex.

About 12 crocodile or bulldog clips (these are always useful).

One Edison screw bulb holder.

One 3·5 volt 0·3 ampere bulb.

One 4½ volt battery (Ever Ready type 1289 or similar).

One 750 watt electric fire replacement element *or* length of about six yards of 26 gauge Eureka resistance wire.

CROCODILE LEADS

While doing this preliminary construction work you could make up a number of lengths of wire (each about 12in long) with a crocodile clip on each end. You will always find a use for such leads in any practical work connected with electronics.

Having made up the equipment you will be keen to start with the first experiment: this is to show the relationship between *resistance*, *voltage* and *current*.

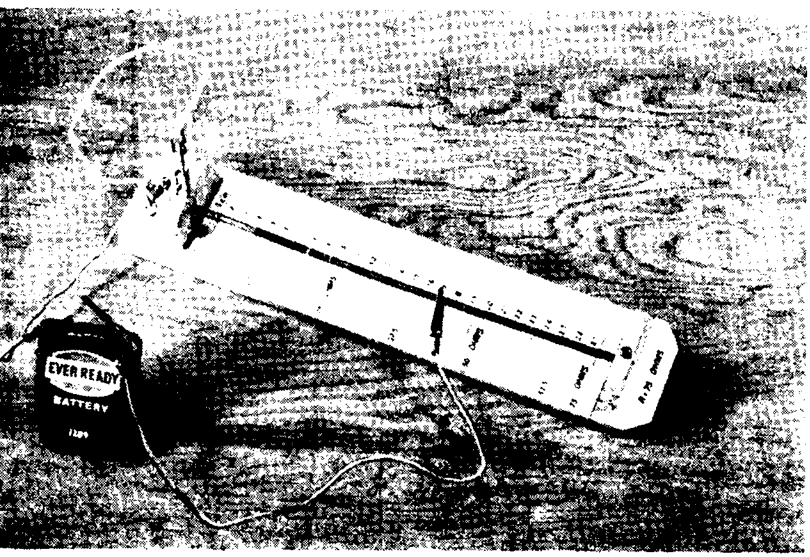
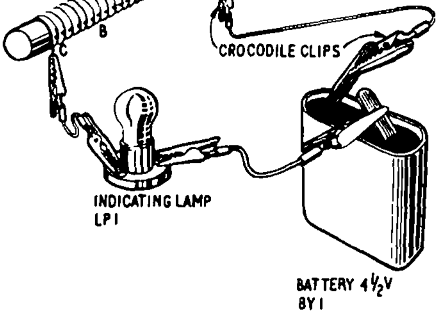


Fig. 1.1 (left). Simple apparatus for resistance experiments

Fig. 1.2. A pictorial representation of the set-up for the first experiment



You must remember that current is the movement of very tiny particles (known as *electrons*) round the circuit and it is measured in amperes, or fractions of an ampere; for example, milli-amperes (usually shown mA) which are thousanths of an ampere, and micro-amperes (usually abbreviated to μA) which are millionths of an ampere. The energy or force necessary to push the electrons round the circuit is supplied by the battery and measured in volts.

We have shown the completed apparatus in the photograph (Fig. 1.1) as a guide to the construction. In Fig. 1.2 we indicate the circuit diagram in pictorial form; while in Fig. 1.3 the electrical or "theoretical" circuit is shown. We want you to study the symbols used each month so that very soon you can make up the experiments without needing the pictorial diagram.

You will note by referring to the illustrations on the first page of this article that there are two symbols for a lamp. It is not very important which is used, but in some circuits it is of interest to know the function of a lamp. In our present series of experiments we are showing the lamp as an indicating device—precisely what it is in this case.

With the whole of the element being used as indicated, the resistance of the coiled wire is large enough to reduce the current flow so that the bulb will not light up. If you now slide the crocodile clip along the wire from point (A) you will reach a point (B) where the current is now enough to light the bulb. Continuing along the wire the bulb gets brighter still until it is brightest at point (C) where there is no element, that is no resistance, in circuit.

OHM'S LAW

There is a simple relationship between the resistance, voltage, and current and this is known as OHM'S LAW. It can be represented by the simple equation $V = I \times R$ where V is the voltage in volts, I is the current in amperes and R is the resistance in *ohms*.

By having a sliding contact with the resistor you have made a variable resistor—a type of component which is used frequently in electronic circuits. To save space the manufacturer bends the coil of wire into almost a circle, inserts it into an insulated container and connects a spindle to the sliding contact. A number of different types are shown in our photograph at the beginning of this article. These are similar to the volume controls of your radio and television set, of course.

The variable resistor or *potentiometer* that you have made has a value of about 75 ohms. To obtain higher values of resistance very fine wire must be used. Because of the cost and difficulty in making them, wire-wound resistors (fixed or variable) are not usually made greater than 100,000 ohms. For higher values the wire is replaced by carbon, and values can be obtained up to 20 million ohms.

ENGINEERS' SHORTHAND

To save writing out large numbers of noughts when high values of resistance are required a form of shorthand is adopted. This you will need to learn, to understand the talk of electronic engineers. If we have a resistance of 1,000 ohms (usually written 1,000Ω), we abbreviate this to 1kΩ or 1 kilohm, usually spoken of as "one kay". Similarly, with 1,000,000Ω we reduce this to 1MΩ (1 megohm), usually spoken of as "one meg".

You may have noticed that we have divided our baseboard into a number of equal segments. These are actually centimetre divisions, although ¼in divisions would suit equally well. We can make use of these divisions in our next experiment.

Repeat the first experiment, setting the slider so that the bulb just glows faintly and make a note of the length of resistance in use or "in circuit". This will be about 11cm.

Now connect your slider to the end A. Use a length of wire with crocodile clips to short out the centre portion of the resistor. If you make the two end portions of the resistor about 5½cm each, that is adding up to the length measured above, then the bulb should just glow as before.

You now have a circuit similar to Figs. 1.4a and 1.4b with effectively two resistors connected *in series*.

You have proved that the two resistors can be replaced by one single one which has the same value as the other two added together. This is usually shown by a simple formula thus:

$$R\ TOTAL = R1 + R2$$

Of course, if you have more than two resistors in series then you can keep adding them together to find the total resistance. You must always remember to get the correct number of noughts if you need to add together resistors with values expressed in ohms, *kil*ohms and *meg*ohms.

Next month we shall deal with resistors in parallel.

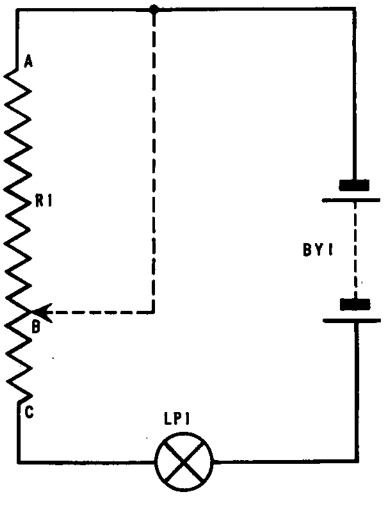
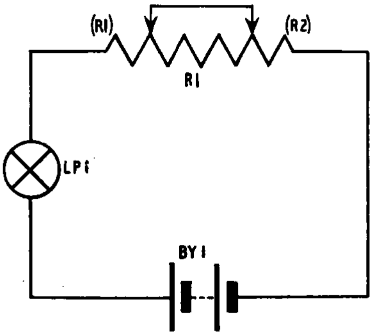
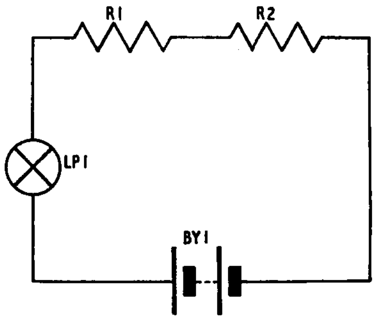


Fig. 1.3 (left). The arrangement of Fig. 1.2 shown in the conventional manner of a theoretical circuit diagram

Fig. 1.4a (centre). The resistance element is divided into two equal parts by means of the crocodile lead

Fig. 1.4b (right). The diagram of Fig. 1.4a is now redrawn to show two resistors in series





ELECTRONORAMA

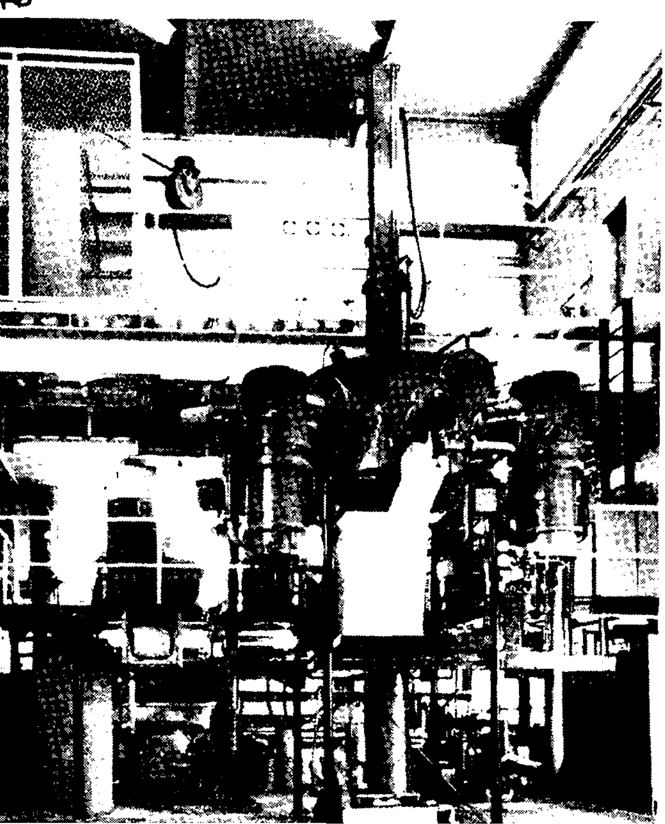
HIGHLIGHTS FROM THE CONTEMPORARY SCENE

Modern Electron Beam Furnace

One of the largest and most modern electron beam furnaces in the world has recently been put into operation by Murex Limited, Rainham, Essex, the leading British producer of refractory metals such as tantalum, niobium, molybdenum and tungsten. This furnace, which was supplied by Messrs. Degussa Wolfgang, A. G., of West Germany, has a rating of 250kW. With its transverse electron guns, automatic feed mechanisms, closed circuit television systems and the special refinements in its controls, it can be described as the most advanced furnace of its type at present in operation in any country in the world.

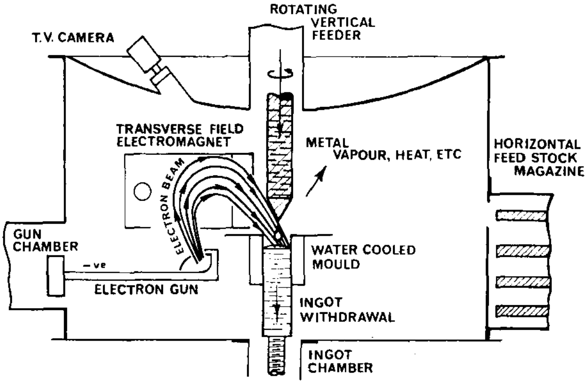
The furnace permits the production of ingots ranging from 3in diameter for tungsten, melting point 3,400°C., to 8in diameter ingots of metals and alloys whose melting points are lower. A melting rate of 60 kilos per hour has been achieved for a 2in diameter ingot of tantalum alloy, but slower rates are normally used where a high degree of purification is required.

The metal to be melted is fed into the furnace in the form of a bar pressed from powder, and it is bombarded by beams of electrons from three electron guns. On striking the metal feedstock, the energy of the electrons is converted into heat, causing the feedstock to melt and drip into the molten pool, from the bottom of which an ingot of pure metal is gradually withdrawn.



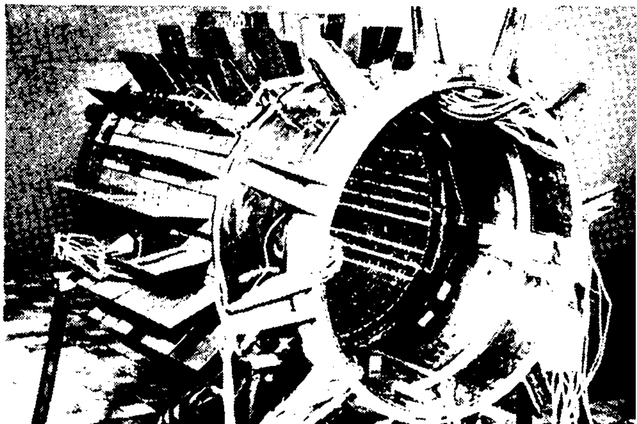
The electron guns are remote from and below the level of the molten pool of metal. The beam of electrons is turned through approximately 180° in a vertical circle by the horizontal field of an electromagnet immediately above each gun filament, so that the beam strikes down into the mould.

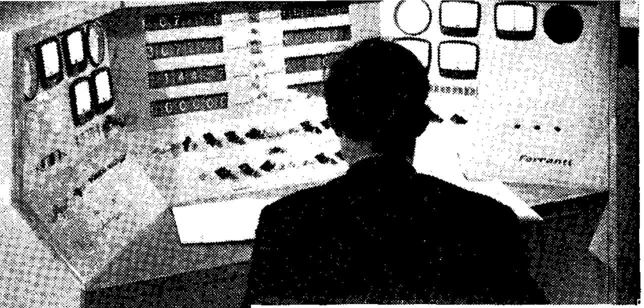
All the controls for the automatic operation of the furnace are grouped on a large console employing the latest push-button techniques. The melting operation can be viewed by both direct observation through a protected window or by a Pye closed circuit television system. Two cameras on top of the furnace are sighted on to the mould area through stroboscopic windows which reduce the light transmitted and, therefore, also the inevitable fogging of the glass by a factor of 1,000. Because of the ability to adjust the brightness and contrast, the use of the television monitors has advantages over direct observation as, for example, in the focusing of the electron beams.

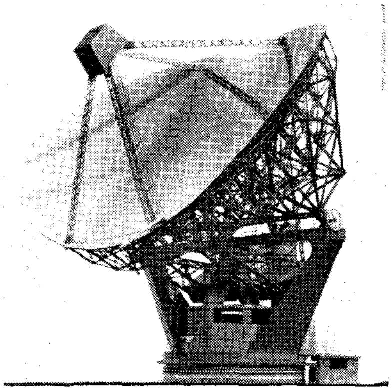


E-L Lighting Gets a Lift

Control panels on the flight deck of the B.A.C. One-Eleven Short Haul Jet airliner ordered by the American Airlines will be illuminated by Thorn *Plasteck*—a solid-state light source. This is the first time electroluminescent lighting has been used in British aircraft.







Argus Takes Control

The new Jodrell Bank Mk II telescope is now undergoing final commissioning tests prior to joining its big brother Mk I in space search programmes. Sophisticated electronic apparatus plays a significant part in this new "ear to space". A parametric amplifier with a low noise factor enables operation over the frequency range 2,000-10,000Mc/s (15-3cm), and so extends considerably that portion of the "radio window" to be explored.

The telescope is directly controlled by a Ferranti Argus 104 computer, the control desk of which is shown in the larger photograph above. This is the first time that a direct control system of this kind has been installed, and it is expected to provide considerable improvements over previous control methods in accuracy and flexibility.

Direct Current From "Daisy"

The idea of obtaining electricity directly from a heat source, so bypassing turbines and generators, has long attracted the attention of scientists and engineers.

Now, Russian scientists and engineers have developed the first experimental converting reactor *Romashka* ("Daisy"). *See picture on left.*

The thermal energy generated in the active section of the high-temperature nuclear reactor is conveyed by heat conductivity to a semiconducting thermo-electrical converter.

The thermo-electric converter is located on the external surface of the reactor, and contains elements of silicon-germanium alloy. One side of the thermo-elements receives the heat from the reactor, while the other is cooled, and an electric current is thus produced.

The power of the converting reactor is 500 watts. This is a small figure. But it should not be forgotten that this is the first operating installation of this kind and, while designing it, it was very important to provide the necessary conditions for further experimentation and research.

The start-up of the Russian high-temperature converting reactor *Romashka* heralds a new era in atomic power engineering and opens up a new chapter in the peaceful uses of the atom's forces.

An Improved Memory

An electronic memory device designed at the Institute of Electronics Automation and Telemechanics of the Georgian Academy of Sciences, U.S.S.R., is based on the optical memorising of information.

A fine film of calcium chloride covering a transparent screen records the signals of an electronic ray. "Travelling" over the screen in a preset direction, this ray records information in the form of dark and light dots.

It is stated that this new type of optical memory has great advantages over electronic-ray tubes or photosensitive materials now used in memory devices. With this method information can be repeatedly recorded on the same memory element.

The ray-recorded information can be retained for a virtually unlimited period of time, and is preserved even with the energising voltage switched off.

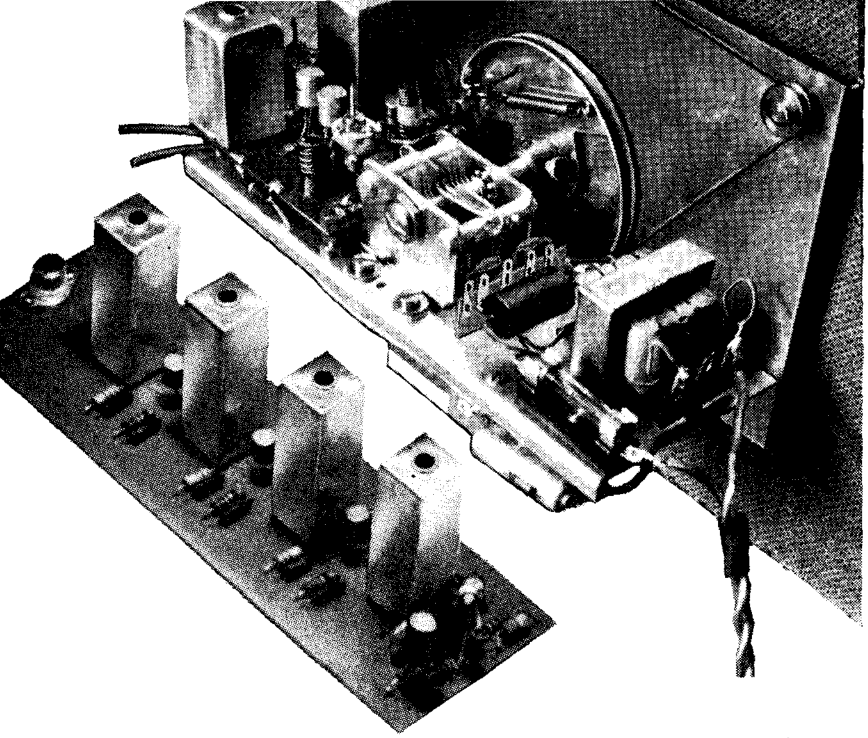
The receptive capacity of a screen covered with calcium chloride is very great. It can hold over 10,000 signs per square centimetre of surface. The time taken to record information is in the order of tens of milliseconds.

Micro-Welding by Light Beam

Laser welding is already well established in electronic research and production operations. Now comes a new addition to equipment in this field—the Model 450 Laser Welder pioneered and produced by the Sippican Corporation of U.S.A. This model is a revolutionary machine for joining wires and foils from approximately 0.075 diameter to extremely fine sizes.

The specially designed weld head contains a two-lamp elliptical geometry laser head, a ⅜in diameter by 7in long ruby laser crystal, and a water cooling jacket. The entire system is designed to operate over long periods of time at an energy of three joules per burst and at a repetition rate of up to 20 pulses per minute. The system can also be operated at one pulse per second with an output in the range of 1/10th of a joule per burst.

All work pieces are viewed by the operator through the same lenses used for beam focusing; a positive electrical and mechanical lockout feature prevents supply charging and discharge while viewing the parts to be welded.



Enjoy sound radio at its best with this up - to - the - minute design ★ An ideal companion for the quality amplifier described on other pages ★ An admirable adjunct indeed to any hi fi system

V.H.F. Broadcast Receiver

SPECIFICATION

Frequency coverage
Tunable over the range 85–105Mc/s.

R.F. stage
Common base configuration coupled to the aerial by a matching π section.

Oscillator
Separate local oscillator. Provision for subsequent addition of automatic frequency control.

I.F. amplifier
Three stages, excluding frequency changer; with detector, nine tuned circuits (though only eight are fully effective in determining selectivity).

Detector
Ratio detector, phase characteristic designed and adjusted for best linearity.

Audio stages
Pre-amplifier only; no output stages are included.

Sensitivity
Overall sensitivity for 1µV aerial input at 100Mc/s, frequency-modulated ± 25kc/s at 1,000c/s, is 110mV across 5,000 ohms.

Amplitude rejection
At 1µV aerial input, 42dB down; at 1mV aerial input, 39dB down.

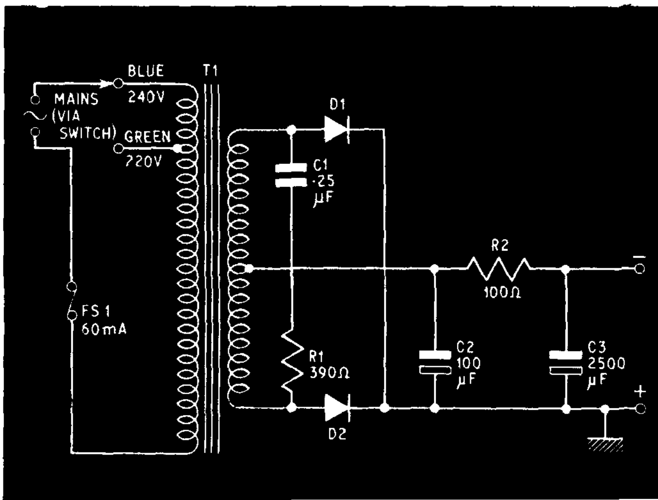
Non-linearity distortion
For pure sine wave, at 1,000c/s, r.f. signal 100Mc/s, non-linearity distortion is 2·2%.

Power supplies
Self-contained mains powered unit. 100c/s ripple less than 10µV.

THE V.H.F. TUNER here described is intended to afford the first stages of an equipment capable of high fidelity reproduction of records, as well as similarly good quality performance on the f.m. transmissions. Consequently no audio stages are provided in this receiver, except for a pre-amplifier which enables a reasonable signal to be passed into the input of an advance design of audio amplifier.

The receiver is in two parts; the first comprises the r.f. amplifier, oscillator and frequency changer, and the second the i.f. amplifier stages, detector and pre-amplifier. In addition, a miniature power pack is included so that the unit can be powered from the a.c. mains. Because the specified tuning dial is a fairly bulky item—it is necessarily so for appearance sake—it has been found possible to include both the mains unit and the r.f. stages on a small bracket attached thereto.

Fig. 1. The mains supply circuit



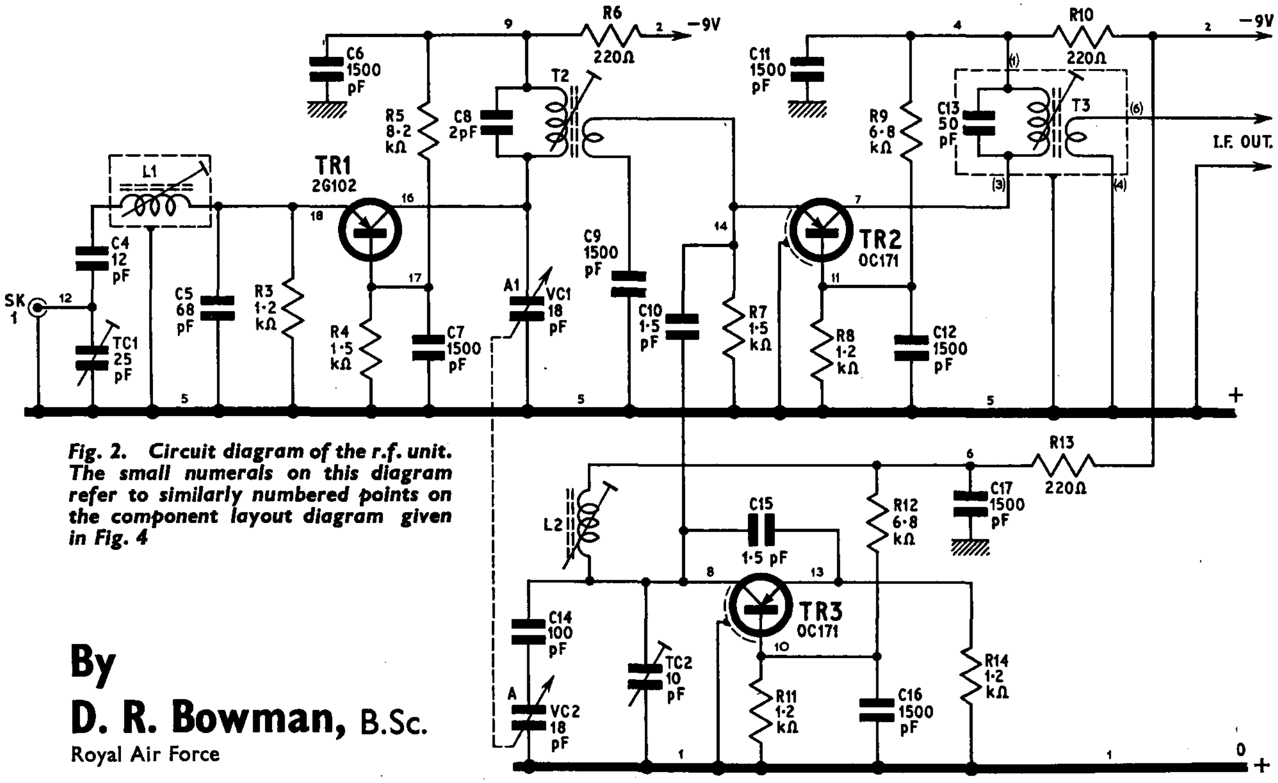


Fig. 2. Circuit diagram of the r.f. unit. The small numerals on this diagram refer to similarly numbered points on the component layout diagram given in Fig. 4

By

D. R. Bowman, B.Sc.

Royal Air Force

THE MAINS UNIT

The circuit diagram of the mains unit is given in Fig. 1. A pair of germanium rectifiers are used in conjunction with a centre tapped transformer. The ripple voltage on the d.c. output is very small, as it must be for good results. If appreciable hum voltage is present it modulates the signal generated by the oscillator, by varying the effective capacitance across the tuned circuit. The frequency modulation so impressed on the signal cannot afterwards be removed by any means.

THE R.F. UNIT

The circuit for the r.f. unit is given in Fig. 2, and it will be seen that three transistors in all are employed. It is possible to use a self-oscillating mixer in transistor circuits with good results, but the efficiency of conversion is not so high as compromises have to be made. Hence a separate oscillator is used in this design.

The aerial is coupled into the emitter of the r.f. transistor by means of a π coupling, which effects impedance matching between the aerial and the input impedance of the transistor. This coupling unit can be omitted with not very great loss, unless a 300 ohm aerial is to be used. Hence it has been assumed that an 80 ohm aerial will be connected by the usual coaxial cable.

All transistors in the r.f. unit are arranged in the common base configuration. This is strictly not essential, as transistors are now available which work well at these frequencies in the common emitter mode; but cost is saved at the expense of negligible decrease in gain, and, in addition, neutralisation bothers are avoided.

The r.f. input is not tuned, except in so far as the aerial and π coupling effect tuning. Because of the low input impedance of the r.f. transistor and the fact that a dipole aerial of reasonable dimensions has a very low "Q", gain will be of a few decibels less at the edges of the band than in the middle.

The collector circuit of the r.f. transistor is tuned by means of a variable capacitor VC1, ganged with that tuning the oscillator circuit. The tuned circuit forms also the primary of a closely coupled r.f. transformer T2, which matches the output impedance to the input impedance of the frequency changer TR2.

The transformer T3 in the collector circuit of TR2 is tuned to the intermediate frequency, 10·7Mc/s, and again the secondary is designed to effect a proper match with the first i.f. stage.

The oscillator, TR3, is a simple one, employing feedback from collector to emitter via a small capacitor.

Eventually, this capacitor (C15) can be removed and a variable capacitance diode substituted which, affected by a variable voltage from the ratio detector, will correct the tuning of the oscillator if it should drift off tune slightly.

As this variable capacitance diode is rather expensive it has been omitted in the prototype, but details will be given later for the conversion as an "optional extra". Perhaps it should be made clear that since batteries are not used, frequency drift is small and does not affect the working of the tuning unit within reasonable ranges of temperature.

A series capacitor C14 is used in conjunction with the oscillator section of the twin gang capacitor. This, together with the trimmer TC2 across the oscillator coil, gives good tracking over the tuning range. The oscillator operates at a frequency 10·7Mc/s higher than the r.f. input signal.

CONSTRUCTION

Printed (or rather "etched") circuit construction is specified, partly because of the possible reduction in size obtainable, and partly because of the improved ease of construction afforded by this method.

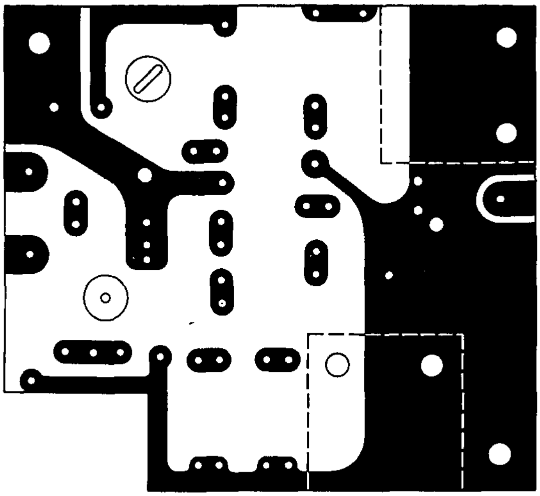


Fig. 3. The printed board. This measures $2\frac{3}{4}$ x $2\frac{1}{2}$in, with a $\frac{1}{2}$ x $\frac{3}{4}$in cut-out

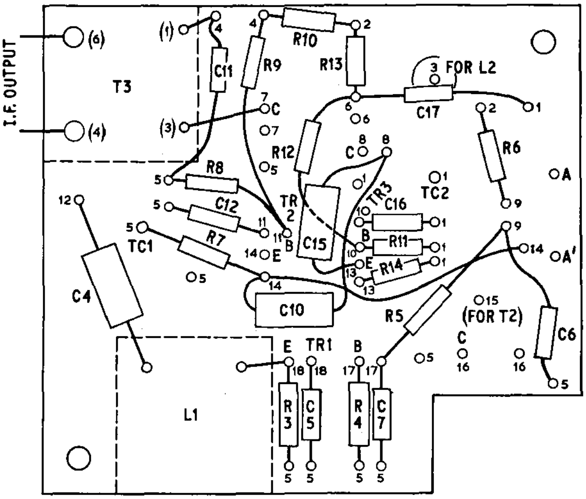


Fig. 4. The opposite side of the printed board. All components and connections are clearly indicated

Fig. 3 shows the actual printed board, while Fig. 4 shows the recommended arrangement of components. This is quite "tight", and care will have to be exercised in placing the components, but the compact layout does enable a small and reliable unit to be achieved. Components on the top side of the printed board are identified in Fig. 5.

When the tuning dial has been obtained the first step is to cut and bend an aluminium chassis to fit it. The plate of the dial is 7in in length, and so this is also the longer dimension of the chassis. A cut-out is made centrally $2\frac{3}{4}$in long and $1\frac{3}{8}$in deep on one long edge, and the remaining portion bent over at right angles. The back edge of the chassis is also bent over in order to stiffen it. Fig. 6 shows the arrangement, with all important dimensions.

Next the twin gang tuning capacitor is mounted centrally, its fixing lugs flush with the edge of the cut-out portion; and in this position the spindle can be engaged with the drum of the dial drive and the chassis can then be mounted on the plate of the tuning assembly with two 4B.A. screws and nuts.

Facing the rear of the drive, the r.f. unit is on the left and the mains pack on the right (refer to Fig. 5). No difficulty will be found in accommodating the latter, so long as the smoothing capacitors and the 100 ohm resistor R2 are mounted underneath the chassis, where they can be secured with a tag strip. The chassis itself will do very well as the heat sink for the rectifier diodes D1, D2.

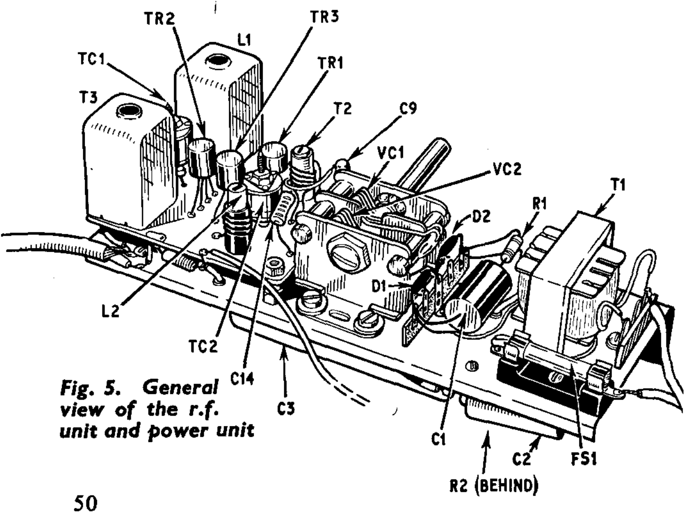


Fig. 5. General view of the r.f. unit and power unit

THE COPPER CLAD LAMINATE

Before marking out the copper clad laminate for etching, it is advisable to drill the two holes in the corners by which it will be mounted above the chassis. The board can then be put down on the chassis, its cut-out corner coinciding roughly with the cut-out in the chassis, but aligned so that the back and side edges lie flush with the corresponding edges of the chassis.

The holes for the mounting screws can then be marked out with a soft pencil on the aluminium, using the circuit board as a template. At the same time the connections A and A′ should be marked out on the copper surface so as to coincide with the connecting lugs of the ganged capacitor. If this is done, fitting will be facilitated. The recommended layout of Fig. 3 gives plenty of room for this manoeuvre. In fact, there is nothing specially critical about this diagram, and if a reasonable copy is made onto the laminate with the acid resist good results will be obtained.

It will be noted that the area surrounding the mounting holes is left covered with copper. This enables earthing to be effected by the mounting screws, which should be of brass. In order to confine r.f. currents to their own section of the circuit, the earthed areas mentioned are not connected together on the board, but are isolated by an area of insulation. Thus, if it is desired to test the unit before mounting, a temporary connection should be made by wire between the two—otherwise either the oscillator or the other two transistors will be without d.c. supplies.

ETCHING PROCEDURE

Etching is best done using 30 per cent ferric chloride solution, to which a little (1 per cent) concentrated hydrochloric acid has been added. The local chemist should be able to supply both these commodities cheaply in liquid form, but if the ferric chloride is bought as a solid, 4oz should be dissolved in 6oz water (this gives about 33 per cent solution, because of

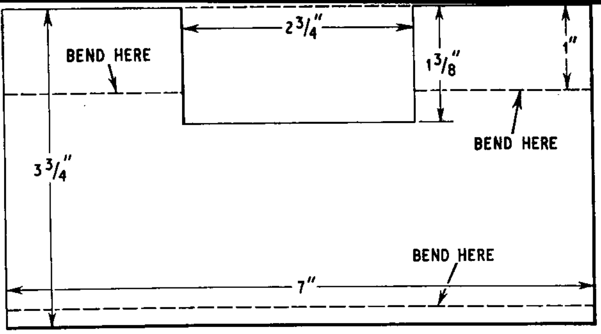


Fig. 6. Aluminium chassis details

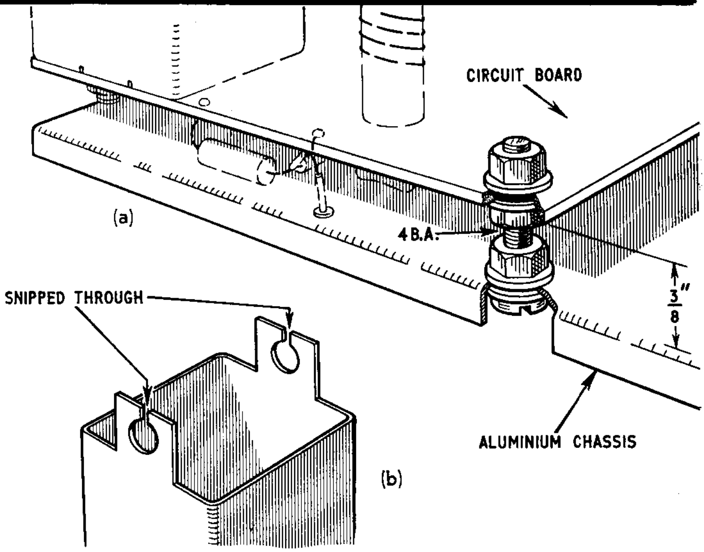


Fig. 7a (right). Method of mounting the circuit board onto the chassis

Fig. 7b. Lugs on coil cans snipped through prior to fitting over coils

the water of crystallisation present in the solid ferric chloride).

The black portions in Fig. 3 are those to be covered with "resist"—this may be french polish, cellulose paint, or similar material. Etching should be done at a temperature of about 50°C, and thorough stirring should be carried out, otherwise the process is likely to become exceedingly tedious.

MOUNTING THE COMPONENTS

When all the components are in place, the circuit board, completed except for the tuning capacitors, is mounted on the opposite side of the chassis to that occupied by the power pack, and the lugs of the tuning capacitors soldered to the points A and A′. Mounting is easily achieved by means of two 4B.A. brass screws, some washers and nuts, as shown in Fig. 7a. The nuts should be adjusted so that the distance between the board and chassis is ⅜in.

TESTING THE UNIT

The unit may be tested in the following way. First check all connections to ensure, for example, that no transistor has been mounted the wrong way round. It should be noted that if transistors type OC171 are used throughout, all these have an additional lead to earth the casing. The 2G102, a low-noise v.h.f. transistor made by Texas Instruments, has no such lead and hence the earth point 5 between points 16 and 17 on the diagram (Fig. 4) will not be used at all.

Next check the current taken by the unit, using a 9 volt battery. It is important not to use the mains pack until the i.f. amplifier is in circuit, or the rise in voltage on low load may cause the transistors to overheat. The current taken should be 5mA, plus or minus 2mA at most.

Next tune a v.h.f. receiver to 95Mc/s, with the unit switched on. With the tuning gang at maximum, and the oscillator beehive capacitor TC2 fully meshed, rotate the core of the oscillator coil L2 until a "plop" is heard in the v.h.f. receiver. This indicates that the oscillator is working, and also gives the approximate position that the core will need to take for preliminary tuning. No other tests are feasible until the i.f. amplifier has been constructed.

COIL CONSTRUCTION

Details for the coil winding are given below. These will enable the constructor to go ahead and have a good deal in readiness to proceed with the construction of the i.f. amplifier unit; this will be dealt with next month.

MOUNTING THE CANS

The popular and readily obtained cans and formers do not lend themselves well to mounting on printed circuit board. However, the following procedure has been found very successful in securing the cans, and good earth contacts are obtained between the can and the copper surface of the circuit board.

Before beginning the winding operation, ¾in 6B.A. brass bolts are fitted through the fixing holes, from the "inside". When the coils have been wound and fixed in place (contact adhesive is recommended for this) the can can be slipped over the unit. However, before doing this, each lug is snipped through with scissors or

continued on page 67

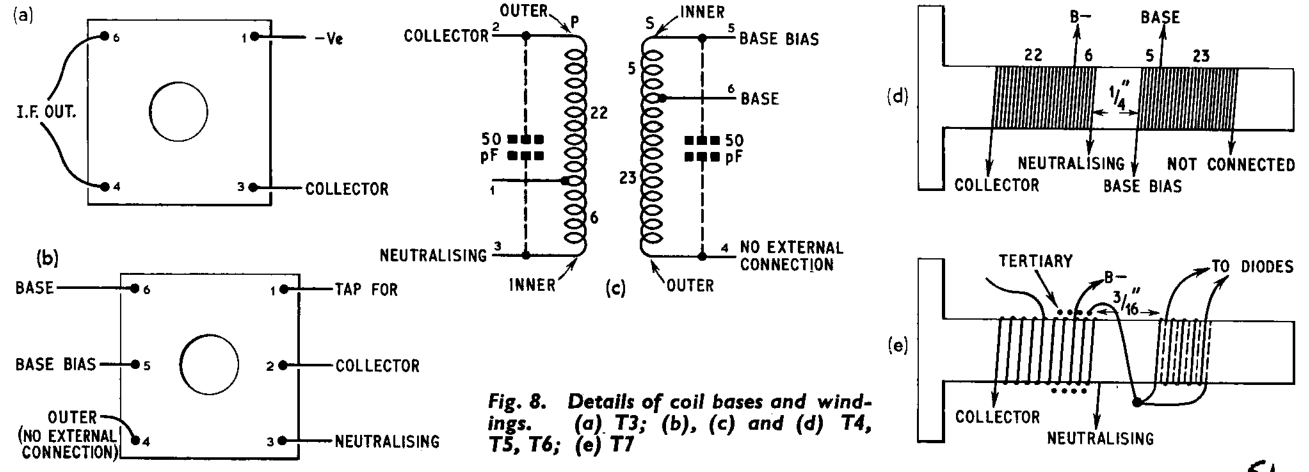
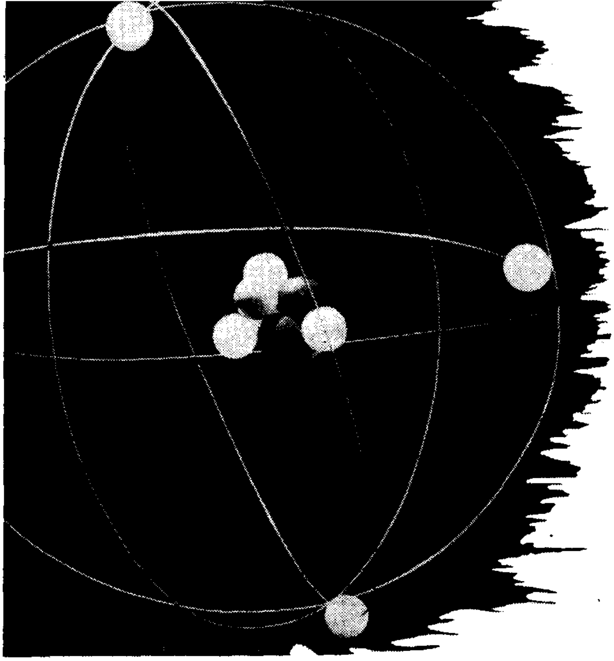


Fig. 8. Details of coil bases and windings. (a) T3; (b), (c) and (d) T4, T5, T6; (e) T7

A NEW LOOK AT THE ELECTRON

by G. D. HOWAT



Why is an electric spark blue? What is an electric spark? For that matter what is an electric current itself? Well, everyone knows the answer to the last question at least—an electric current, so we have been told, is a flow of electrons. This is fair enough, but consider a piece of wire, a rigid solid object which looks exactly the same whether it is passing an electric current or not. How can anything be "flowing" in such a motionless object? Perhaps we had better examine things a bit more closely.

According to the classical atomic theory any atom is built up of a number of smaller units called sub-atomic particles. All atoms of any given element are identical, and atoms of different elements differ only in the number and arrangement of the sub-atomic particles which they contain.

THE CLASSICAL MODEL

Without going into great detail it is sufficient to say that an atom consists of a nucleus, made up of positive sub-atomic particles, called protons, and (except for hydrogen) some neutral ones, neutrons; and a number of negative electrons arranged outside the nucleus. The electrons are frequently drawn as in Fig. 1, which shows them revolving around the nucleus in much the same way that planets revolve around the sun. Modern theories represent atoms rather differently but the type of idea depicted in Fig. 1 is easier to understand.

One important point should be noted: the number of electrons in any (uncharged) atom is always equal to the number of protons. As the proton has an exactly equal, but opposite, charge to the electron, an atom as a whole has no electrical charge at all. The electrons are not arranged at random but in a regular, though somewhat complex, sequence. Some vital statistics of the electron are given opposite.

METALLIC CONDUCTION

In most elements the electrons in each atom are held firmly in place by the equal and opposite charge on the nucleus. However, in some cases a phenomenon known as metallic conduction occurs.

A metal in the crystalline state has atoms lined up in neat rows with adjacent atoms close together, although they never actually touch. Metals have their electrons so arranged that the outermost ones are partially screened from the positive attraction of the nucleus and are not bound so closely to it. In the crystal lattice, therefore, the outermost electron can be pulled out of the atom quite easily and wander about. This occurs when an electric field is applied to the metal, and a diagrammatic scheme is shown in Fig. 2.

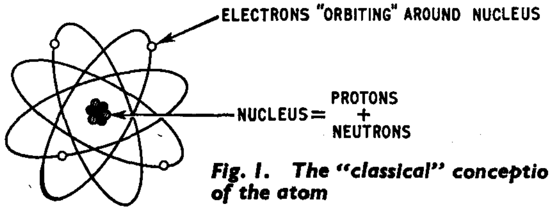


Fig. 1. The "classical" conception of the atom

In Fig. 2a a pair of electrodes (plates) is placed along a "wire" of several atoms. The plate on the left is given a positive charge and this attracts an electron from the nearest atom. As a result of this the atom is left with a positive charge as there is now one more proton in the nucleus than there are electrons around it. Such a charged atom is called an ion.

In Fig. 2b this ion removes an outermost electron from the next atom and so becomes a normal uncharged system again, although the second atom is now an ion.

ELECTRON STATISTICS

Weight of electron (m)	9×10^{-28} gramme
Charge on electron (e)	$1{\cdot}6\times10^{-19}$ coulomb
Charge to mass ratio $\left(\frac{e}{m}\right)$	$1{\cdot}759\times10^{8}$ coulomb/gramme
Radius of electron	$1{\cdot}87\times10^{-13}$ centimetre
Number of electrons in one gramme of hydrogen gas	6×10^{-23}
Atomic volume occupied by sub-atomic particles	10^{-12} to 10^{-15} per cent
Distance from electron orbit to nucleus in hydrogen	$0{\cdot}53\times10^{-8}$ centimetre

This process continues right along the line until the right-hand atom becomes an ion.

In Fig. 2c the process is completed by the last ion accepting an electron from the negative electrode and becoming an uncharged atom again.

This is a crude analogy and several points need clarification.

First, it is doubtful whether free ions are actually formed during conduction, probably as soon as one electron leaves an atom another jumps straight in, so the positively charged (metal) entity is really only a hypothetical being.

Second, it may be asked why an ion, even if it does exist, should always take an electron from the adjacent atom on the right-hand side of Fig. 2. Why should it not take back the electron from the atom that stole it? The answer is simply that the electrons travel much more easily in the direction of the field—right to left as in Fig. 2—than in the opposite direction. To push an electron against the field is possible but requires more energy than the ions have.

Third, it is seen from this that an electric current in fact travels from negative to positive which is the reverse of the so-called "conventional current". Certainly this is true insofar as the actual carriers of current, the electrons, are moving in this direction. It is equally true, however, that "positive holes", i.e. partially ionised atoms, are moving from positive to negative which is in accordance with traditional ideas.

Finally, and rather obviously, it goes without saying that the actual number of atoms and electrons in a conductor is far greater than that shown in Fig. 2. Figures in the order of 10^{20} are representative of the number of atoms in a short length of wire.

MOVABLE NEGATIVE CHARGE

The foregoing passage can be briefly summarised as follows: a metal contains certain electrons which are only loosely bonded to the atoms and which form a pool of movable negative charge. The application of an electric field causes this charge to migrate slowly, always at right angles to the field, the negative particles being attracted towards the positive end of the field, and "positive holes" moving in the opposite direction. Each electron jumps from one position to the next quite rapidly, but the time between jumps is long compared to this transit time. Therefore, the average velocity of the electrons, the "electron drift velocity" is small, probably about a walking pace, but an electrical impulse is transmitted from one point in a conductor to another very rapidly.

It might be asked how an electrode, such as the one used in Fig. 2, can be given an electric charge. If some of the electrons are removed from a body it exhibits a nett positive charge although this does not mean that certain selected atoms have become ions. Rather, all the atoms contributing to the "pool" each lose a small fraction of their charge. Similarly, if excess electrons are added to the pool these spread their charge over the entire conductor, giving it a negative charge.

TEMPERATURE EFFECTS

In practice, the atoms making up a metallic (or any other) lattice are not stationary but vibrate about a mean position, the amplitude of the vibrations being a function of the temperature of the lattice. As the temperature increases the oscillations increase in extent until at one definite point the lattice breaks up into individual atoms or groups of atoms; this is, of course, when the metal reaches its melting point.

Because of this internal motion, a certain force is needed to persuade the free electrons to move. This results in an absorption of energy to a small extent by the conductor, with a slight drop in the energy gradient along it. It is this which causes all conductors to have some degree of electrical resistance.

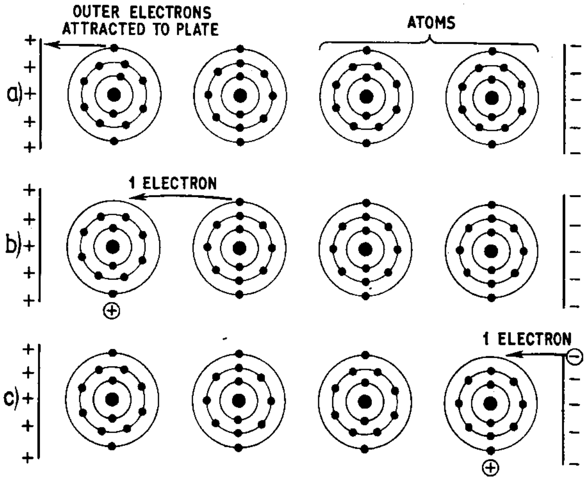


Fig. 2. Illustrating how an electronic current (flow of electrons) is produced in a metal when the latter is in an electric field

As the temperature of a conductor increases, and the motion of the atoms—called thermal motion—increases also, the resistance would be expected to rise proportionally. This is in practice observed to happen.

If we extrapolate backwards the resistance falls as temperature decreases, the relation being almost a linear one down to a very low value. However, at one specific, very low, temperature, usually only a degree or two above absolute zero, all resistance suddenly vanishes giving a conductor with absolutely no measurable resistance at all! This is known *as super-conductivity* but its nature will not be discussed here.

CONDUCTION IN LIQUIDS

In the liquid state there is no large-scale repeating structure analogous to the crystal lattice of a metal or other solid. Thus, there can be no corresponding electron "pool" in a liquid and metallic conduction cannot occur. Conduction in liquids relies on the presence of real ions in solution as the current carriers. Very pure (distilled) water is practically un-ionised and has a very low conductivity.

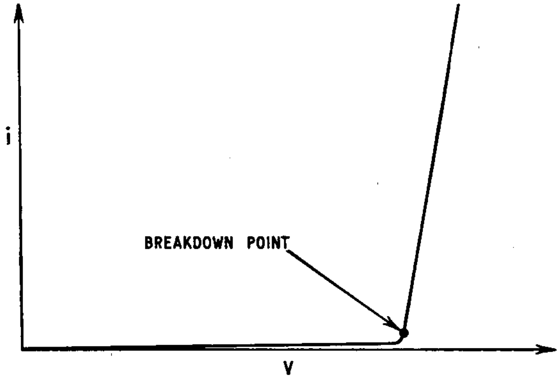


Fig. 3. Gases, which are normally very good insulators, become conductive when subjected to a high potentiaj. This curve indicates the critical potential or "breakdown point"

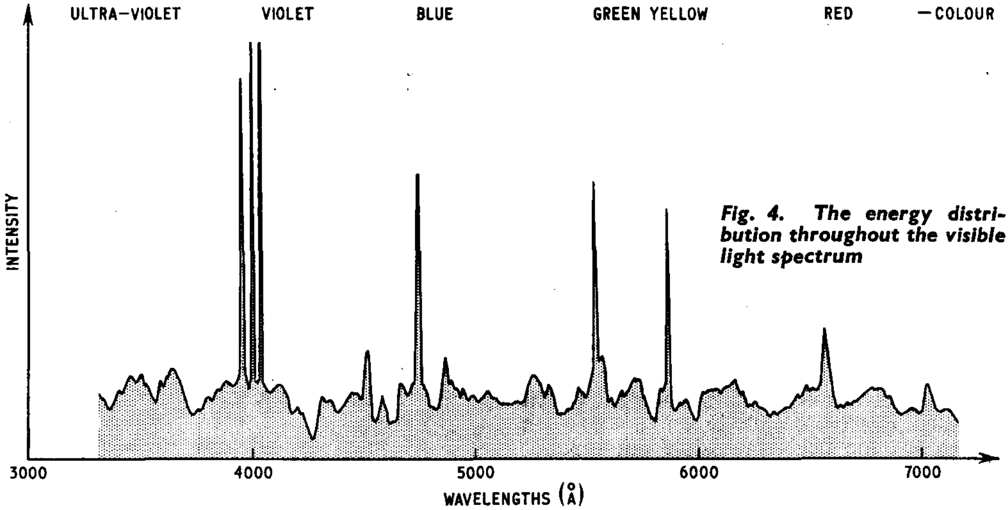


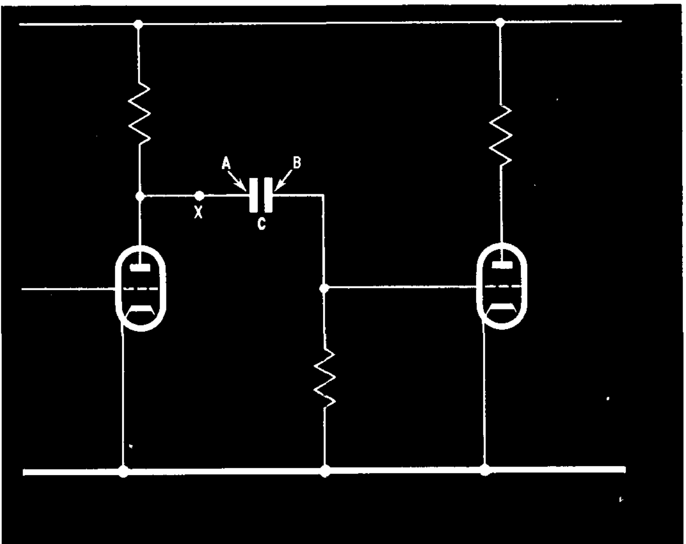
Fig. 4. The energy distribution throughout the visible light spectrum

It is not difficult to appreciate that an insulator in the electrical sense is merely any substance which does not have the properties outlined above; that is, anything which does not possess electrons or ions capable of movement through it. Gases are very efficient insulators: air containing 20 per cent oxygen, 79 per cent nitrogen and 1 per cent other assorted gases is particularly good in this respect. If this were not so, then it would be impossible to run any kind of electric power cable through the air. Ordinary air does allow a certain leakage from overhead power lines but this is mainly due to the presence of water vapour which, in this country, is always present to a greater or lesser extent.

IONISATION IN GASES

If the potential gradient across a volume of gas is increased to a high enough level, the resistance suddenly falls to a low value as shown in Fig. 3. For dry air the voltage needed to do this is around 30,000V/in. At this point the field passing through the gas molecules or atoms is sufficient to pull electrons out of the gas and ionise it. The presence of charged particles forms the low resistance path which suddenly appears in Fig. 3, and allows a flow of current through the gas. This current forms the actual spark discharge itself. As it passes, further ionisation of the gas occurs and in addition some other atoms become not ionised but activated.

Fig. 5. The capacitor has an infinite resistance to d.c., but by allowing the transfer of electrostatic charges, it has very low resistance to changing potentials or a.c.



An activated atom is one where the electrons are still retained within the atomic structure but have been displaced further from the nucleus than their normal fixed positions. In this activated state various chemical reactions occur—oxygen reacts to form ozone 0_3 which is responsible for the characteristic smell, rather like chlorine, that is often noticed around sparking equipment. In addition, a very small amount of nitrogen reacts with oxygen to form nitrogen oxides.

LIGHT EMISSION

Neither activated oxygen nor activated nitrogen can exist for long, and as soon as the spark passes they revert to the stable forms of the gases. Since energy must be used to activate them, this energy must be released when they de-activate and it appears as an emission of light at certain frequencies or wavelengths. The ionised atoms similarly de-ionise after the passage of the spark and this also produces light. The most powerful emission lines are at the following wavelengths: nitrogen, 3,995 and 4,630Å (Angstrom units) with smaller peaks at 5,769 and 5,940Å; oxygen, several close peaks at about 4,700Å. A rough idea of the spark spectrum for air is given in Fig. 4.

These figures now provide the answer to the question which began this article: why is a spark blue? From Fig. 4 it is seen that the most powerful emission lines are roughly in the range 4,000–4,700Å. These wavelengths fall at the blue end of the spectrum so the light from them would be a vivid dark blue. Fig. 4 also shows that light of all wavelengths is produced to a certain degree and this has the effect of watering down the colours to a paler blue.

It might well be asked how far this theory of electrons and electricity can go towards explaining known properties of electrical components and circuits. Actually it goes very well—as may be illustrated by considering some specific examples.

A well-known rule in magnetism is that like poles repel and unlike poles attract. A similar rule exists in electrostatics and states that like charges repel and unlike charges attract. This rule applies whatever the charged body is and thus is fully applicable to an electron.

LEARN ELECTRONICS — *AS YOU BUILD*

over 20 CIRCUITS, WORKING MODELS and TEST EQUIPMENT — including:

- Properties of the Valve
- Properties of the Transistor
- Basic Amplifier
- Basic Oscillator
- Basic Rectifier
- Signal Tracer
- Simple Counter
- Cathode Ray Oscilloscope
- Square Wave generator
- Morse Code Oscillator
- Simple Transmitter
- Simple remote control by radio
- Photo-electric circuit
- Basic Computer Circuit
- Basic transistorised radio receiver using *printed circuit*
- A.C. Experiments

The full equipment supplied comprises: valves, transistors, photo-tube, relay, modern type chassis board; printed circuit board; full range resistors, capacitors and conductors; transformers; potentiometers; switches; all hardware, wiring and every detail required for all practical work *plus* CATHODE RAY OSCILLOSCOPE for demonstrating results of all experiments carried out. All practical work fully described in comprehensive PRACTICAL MANUALS. Tutor service and advice if needed

This complete practical course will teach you all the basic principles of electronics by carrying out experiments and building operational apparatus. You will learn how to recognise and handle all types of modern components; their symbols and how to read a completed circuit or schematic diagram. The course then shows how all the basic electronic circuits are constructed and used, and how they actually work by using the oscilloscope provided. An application is given in all the main fields of electronics, i. e. Radio; Television; remote control; computers and automation; photoelectrics; counters, etc., and rules and procedure for fault finding and servicing of all electronic equipment including radio receivers

- **NO PREVIOUS KNOWLEDGE NEEDED**
- **SENT IN ATTRACTIVE BOX**
- **NO MATHS USED OR NEEDED**
- **COMPLETE ADVICE SERVICE**
- **NO EXTRAS REQUIRED**
- **EVERYTHING REMAINS STUDENT'S PROPERTY**

A completely NEW up-to-date home study practical course by BRITISH NATIONAL RADIO SCHOOL — Britain's Leading Electronic Training Organisation.

POST NOW FOR FREE BROCHURE

To: BRITISH NATIONAL RADIO SCHOOL, READING, BERKSHIRE. Please send free Brochure, without obligation, to:

NAME..

ADDRESS ....

....

Block Capitals Please

PE 11.64.

If a conducting body is given a negative charge it can easily be shown that all the charge migrates to the outside, if the body is a metal sphere the outside will be charged negatively but if the sphere is hollow it will be found that the inside has no charge at all. The explanation of this is quite simple and is a direct result of the above law.

Electrons all carry the same charge, negative, and will mutually repel one another. If a number of mobile electrons are free to wander about in a material they will, by virtue of this repulsive force, move around until they are all at the maximum distance from each other. In the case of a sphere this condition is best satisfied by arranging them in a regular pattern around the outer edge. It is this principle, incidentally, which makes possible the Van-de-Graf generator, one of the earliest efficient machines for producing very high voltages.

ELECTROSTATIC SCREENING

This phenomenon is made use of in electrostatic screening. Suppose that a wire is surrounded by a metal shield, then any charge on the wire is electrostatically bound to induce charges in the surrounding shield which will migrate to the outside. If the shield is earthed these induced charges will be removed as fast as they form and as a result no charges in the wire can have any effect outside the screen; by a reversal of these arguments such a wire can be passed through areas of high magnetic field intensity without inducing any voltage in the inner conductor. It is this principle upon which depends the working of coaxial cable and all other forms of screened cable.

CAPACITOR ACTION

The action of a capacitor can also be used to demonstrate how the foregoing theories can be applied. Capacitors are used in electronics for a variety of purposes—smoothing power supplies, in oscillatory circuits, to provide phase-shift of a waveform and, perhaps most commonly, as coupling and decoupling components.

Probably the simplest and most common coupling circuit is that shown in Fig. 5 and which represents two electronic valves connected by resistance-capacity coupling using the capacitor C. It is the action of this capacitor that we are going to investigate.

The capacitor is assumed to consist of two metal plates separated by a perfect insulator; Fig. 6 shows the capacitor alone and the voltages present on each plate. On side A there is a steady d.c. voltage of 200 which has 5V a.c. impressed on it, i.e. it is swinging from 195V to 205V and back again in a regular pattern. On plate B there is no d.c. component and this plate swings from +5V to −5V and back. The capacitor is seen to have an infinite resistance to d.c. but a very low resistance to a.c. How is this accomplished?

Suppose that, at a given instant, point X in Fig. 5 is becoming less positive, i.e. negative; electrons will therefore flow onto plate A and although the space between the plates is a non-conductor, the presence of a decreasing positive charge on A is transmitted through it onto plate B. By electrostatic induction a negative-going charge will be induced in B, i.e. electrons will flow onto the plate to give it a negative charge.

As long as the charge on A is changing, the charge on B will change in proportion. In other words, the charge on B is determined only by the *change* of charge on A and not by the absolute voltage. No electrons cross the space between the plates so d.c. is completely blocked, but by a process of electrostatic induction varying charges on A are transmitted to B, the apparent effect being that the capacitor is passing a.c.

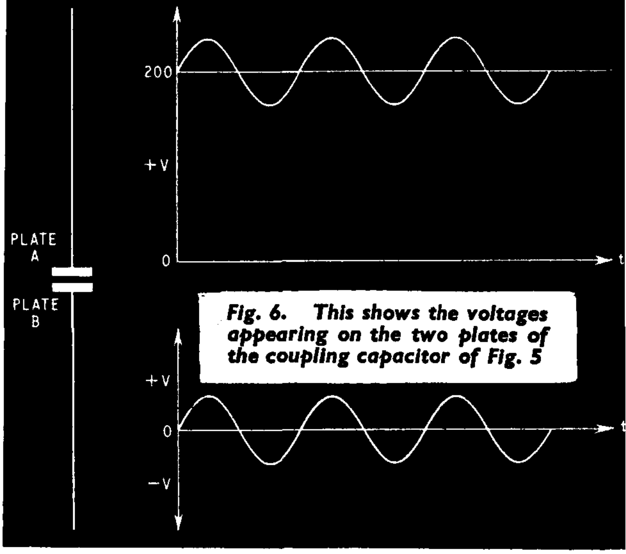


Fig. 6. This shows the voltages appearing on the two plates of the coupling capacitor of Fig. 5

Possibly a better analogy is presented by considering the action of a source of a.c. connected to a capacitor as in Fig. 7. During the first half-cycle the capacitor is charged as in Fig. 7a. During the opposite half-cycle the capacitor discharges and then recharges in the opposite direction as in Fig. 7b. Clearly, in order to do this electrons must have been transferred from one plate through the a.c. source to the other plate.

During a number of cycles then, the electrons are pushed back and forth between one plate of the capacitor and the other. An a.c. ammeter connected in the circuit would show a current flowing, although no electrons in fact ever pass right round the circuit as they cannot pass across the capacitor plates.

CATHODE RAYS

The most characteristic manner in which electrons behave is in the thermionic valve. Here we have a stream of electrons passing from cathode to anode modulated by the varying negative field from the control grid. This is another example of like charges repelling.

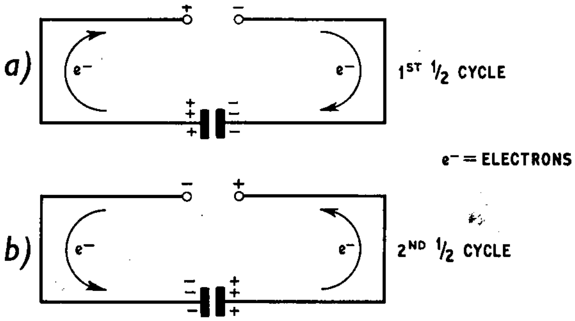


Fig. 7. A further illustration of the charging and discharging action which takes place when a capacitor is connected to an a.c. source

The entire science of electronics is based on the peculiar properties of electrons, stationary and in motion, in various forms of apparatus. Considering this, it is perhaps somewhat ironical that no-one has ever succeeded in discovering exactly what an electron really is! ★


Castle


MARTIN
TAPE
LP
78
MIC
SELECTOR
BASS
TREBLE
VOLUME
BALANCE

Z & I AERO SERVICES LTD.

Retail Shop:
85 TOTTENHAM COURT ROAD, LONDON, W.1.
Tel.: LANgham 8403

Head Office and Warehouse: **44A WESTBOURNE GROVE, LONDON, W.2.** *Tel.: PARK 5641/2/3*

OA2	6/-	5U4GB	6/6	6BR8	5/-	6SN7GT	4/6	12J5GT	3/-	35Z4GT	6/6	DAC32	7/-	EBC33	7/-	EF80	5/-	EY81	8/-	PL36	8/6	U281	13/-
OB2	6/-	5V4G	8/-	6BS7	16/-	6U4GT	10/6	12J7GT	7/6	35Z5GT	6/-	DAF91	4/6	EBC41	7/-	EF83	10/-	EY83	9/6	PL38	16/-	U282	14/-
OB3	6/-	5Y3GT	5/-	6BW6	9/-	6U8	7/6	12K7GT	7/-	42	5/-	DAF92	6/-	EBC81	6/6	EF85	6/-	EY86	6/-	PL81	7/-	U301	12/-
OC3	6/-	5X4G	8/-	6BW7	9/-	6V6	9/-	12K8	10/-	50B5	7/-	DAF96	6/-	EBF80	6/6	EF86	6/-	EZ35	5/6	PL82	5/6	U403	7/-
OD3	5/-	5Z3	6/-	6C4	2/6	6V6G	5/-	12Q7GT	5/-	50C5	6/6	DC70	8/-	EBF83	7/6	EF89	4/6	EZ40	5/6	PL83	6/-	U801	18/-
1A5GT	5/-	5Z4GT	8/-	6C5G	5/-	6V6GT	7/6	12SA7	7/-	50CD6G	25/-	DCC90	7/-	EBF89	6/9	EF91	4/-	EZ41	6/6	PL84	6/6	U4020	7/6
1A7GT	8/-	6/30L2	10/-	6C8G	7/-	6X4	4/-	12SG7	4/-	50L6GT	6/6	DET12	40/-	EBL1	14/-	EF93	4/9	EZ80	5/6	PL500	15/-	UABC80	5/6
1AD4	7/-	6A3	8/-	6CB6	5/-	6X5GT	5/6	12SJ7	4/-	80	6/-	DF33	8/-	EBL21	11/-	EF94	6/-	EZ81	4/6	PY33	9/-	UAF42	8/-
1B3GT	7/-	6A6	4/-	6CD6G	6/-	6Y6G	6/-	12SK7	5/-	83	8/-	DF66	6/-	EC80	8/-	EF95	5/6	GZ30	8/6	PY81	5/6	UBC41	6/6
1G6GT	7/-	6A8	8/-	6CL6	9/-	7R7	12/-	12SN7GT		85A1	25/-	DF72	7/-	EC88	12/-	EF98	10/-	GZ32	10/-	PY82	5/-	UBC81	7/-
1H4GT	6/-	6AB4	6/6	6CW4	12/-	9BW6	7/-		7/6	85A2	8/6	DF73	7/-	EC90	2/6	EF183	8/-	GZ34	10/-	PY83	6/-	UBF80	6/6
1H5GT	7/-	6AB7	4/-	6CY5	10/-	10C1	10/-	12SY7	6/-	85A3	5/6	DF91	3/-	EC91	5/-	EF184	8/-	GZ37	9/-	PY88	8/6	UBF89	7/-
1L4	2/6	6AC7	3/-	6D3	7/6	10C2	12/-	13D3	6/-	150B2	12/-	DF92	2/6	EC92	6/6	EFP60	10/-	KT66	15/-	PY800	8/6	UBL21	11/-
1L6	17/-	6AF4	11/-	6D4	15/-	10D1	7/-	19AQ5	5/-	150B3	8/-	DF96	6/-	ECC31	5/-	EL33	12/6	KT88	20/-	PX25	10/-	UCC84	9/-
1N5GT	8/-	6AG7	6/-	6DK6	6/-	10F1	14/-	19BG6G	7/-	807	9/-	DH63	6/-	ECC32	4/-	EL34	10/-	MU12/14	8/-	QQVO3/10		UCC85	6/6
1Q5GT	8/-	6AH6	10/-	6DS4	15/-	10F9	10/-	19G3	25/-	829B	60/-	DK32	8/-	ECC40	9/-	EL35	5/-	N78	15/-		35/-	UCF80	9/6
1R4	6/-	6AJ5	9/-	6E5	7/-	10F18	9/-	19G6	15/-	832	20/-	DK40	11/-	ECC81	4/-	EL36	9/-	NSP1	25/-	R2	8/-	UCH21	8/6
1R5	5/-	6AK5	5/6	6EV5	12/-	10L1	7/6	20F2	15/-	954	5/-	DK91	5/-	ECC82	5/-	EL37	17/6	NSP2	22/-	R10	15/-	UCH42	7/6
1S4	5/-	6AK6	7/-	6F6	8/-	10LD11	10/-	20L1	14/-	955	3/-	DK92	9/-	ECC83	6/-	EL38	17/6	OCP71	24/-	R17	8/-	UCH81	7/-
1S5	4/6	6AM5	2/6	6F7	5/-	10P13	12/6	20P1	14/-	956	2/-	DK96	7/6	ECC84	6/6	EL41	7/6	ORP12	12/-	R19	7/-	UCL82	8/-
1T4	3/-	6AM6	4/-	6F8G	5/-	10P14	12/-	20P3	12/-	957	5/-	DL66	12/-	ECC85	6/6	EL42	8/-	ORP60	10/-	RL18	12/6	UCL83	10/-
1T5GT	6/-	6AN5	10/-	6F13	6/-	11D3	7/-	20P4	14/-	958	4/-	DL68	10/-	ECC88	10/-	EL81	8/6	PC86	12/-	S130	12/6	UF41	7/6
1U4	5/-	6AQ5	6/-	6F23	9/6	11D5	7/-	20P5	12/-	959A	8/-	DL69	12/6	ECF80	7/6	EL83	7/-	PC88	12/-	SU2150A		UF42	7/6
1U5	6/-	6AQ6	8/-	6F24	11/-	12AC6	8/-	25A6G	5/-	2050	12/6	DL70	7/-	ECF82	7/6	EL84	5/-	PC97	9/-		10/-	UF80	6/6
1X2A	7/-	6AR5	6/-	6F28	10/-	12AH7GT		25L6GT	8/-	2051	6/-	DL73	12/-	ECF86	11/-	EL85	8/-	PCC84	5/6	TH41	10/-	UF85	7/-
1X2B	7/-	6AR6	6/-	6F33	6/-		5/-	25Z4G	7/-	5763	12/-	DL75	10/-	ECH21	10/-	EL86	7/6	PCC85	7/-	TH233	6/-	UF86	10/-
2CW4	12/-	6AS6	5/-	6J4	9/-	12AH8	11/-	25Z5	7/6	6080	25/-	DL92	5/-	ECH35	10/-	EL90	6/-	PCC88	10/6	TH2321	7/-	UF89	6/-
2D21	6/-	6AS7G	22/6	6J5G	4/-	12AQ5	7/-	25Z6GT	8/6	6146	27/6	DL93	4/-	ECH42	8/-	EL91	2/6	PCC89	10/-	TP22	5/-	UL41	7/6
3A4	4/-	6AT6	4/-	6J6	3/6	12AT6	5/-	27M1	60/-	9001	4/-	DL94	5/6	ECH81	6/-	EL821	6/-	PCC189	10/-	TP25	5/-	UL84	6/-
3A5	7/-	6AU6	6/-	6J7G	5/-	12AT7	4/-	28D7	7/-	9002	5/6	DL95	6/6	ECH83	7/6	EL822	8/-	PCF80	6/-	TP2620	7/6	UM80	7/-
3B7	5/-	6AV6	6/-	6J7GT	7/6	12AU6	6/-	29C1	20/-	9003	9/-	DL96	6/-	ECL80	6/6	EM4	10/-	PCF82	7/-	TT15	35/-	UU5	8/-
3D6	4/-	6B7	5/-	6K7	5/-	12AU7	5/-	30C15	10/-	9004	2/6	DM70	5/-	ECL82	7/6	EM31	5/-	PCF84	8/-	TT21	32/-	UU10	8/-
3E29	60/-	6B8	5/-	GK7GT	5/-	12AV6	6/-	30C17	12/-	9006	2/6	DY86	8/-	ECL83	9/-	EM34	9/6	PCF86	8/-	TT22	32/-	UY21	8/-
3Q4	6/6	6BA6	4/9	6K8	8/-	12AV7	8/-	30F5	9/-	A2293	15/6	E88CC	14/-	ECL86	9/-	EM80	6/6	PCF801	10/-	TZ40	40/-	UY41	5/6
3Q5GT	6/6	6BE6	5/-	6K8GT	8/-	12AX7	6/-	30L17	13/-	AZ1	9/-	E90CC	12/-	EF36	4/6	EM81	7/6	PCF802	10/-	U12/14	8/-	UY85	5/-
3S4	5/-	6BF6	6/-	6L6G	6/-	12AY7	10/-	30P12	10/-	AZ12	9/-	E91H	67/-	EF37A	8/-	EM84	8/-	PCF806	13/-	U22	6/-	W81M	6/-
3V4	5/6	6BH6	7/-	6L7	5/-	12B4A	9/-	30P19	14/-	AZ31	8/-	E92CC	7/-	EF39	5/-	EM85	9/-	PCL81	9/-	U25	11/-	X65	5/6
4D1	4/-	6BJ6	8/-	6L18	8/-	12BA6	6/-	30PL14	12/6	AZ41	6/6	E180CC	8/-	EF40	9/-	EM87	7/-	PCL82	6/6	U26	11/-	X66	8/-
4THA	14/-	6BK7A	8/-	6N7	8/-	12BE6	5/-	35L6GT	7/-	C1C	5/-	E180F	15/-	EF41	7/6	EN31	10/-	PCL83	8/3	U50	5/-	X79	18/-
5RAGY	9/-	6BN6	7/-	6P1	11/-	12BH7	8/-	35W4	5/-	CBL1	15/-	EABC80	6/-	EF42	6/-	EN32	10/-	PCL84	7/-	U76	4/-	Z66	10/-
5T4	8/-	6BQ7A	8/-	6Q7G	6/-	12BY7	10/-	35Z3	10/-	CL33	9/-	EAF42	8/6	EF54	6/-	EY51	7/-	PCL85	8/-	U191	11/-	Z319	17/6
5U4G	5/-	6BR7	11/6	6SL7GT	5/-	12F5GT	8/-	35Z4G	4/-	CY31	6/6	EB41	5/-	EF55	8/-	EY70	12/6	PCL86	9/-	U251	12/6		

Mullard Transistors

OC26	8/-	OC44	6/-	OC72	8/-	OC139	12/-	Set of 2
OC28	17/6	OC45	6/-	OC75	6/-	OC170	8/-	matched
OC35	15/-	OC70	5/-	OC76	6/-	OC171	9/-	OC81 and 1
OC42	8/-	OC71	5/-	OC77	8/-	OC204	10/6	OC81D 12/6

R.C.A. TRANSISTORS: 2N410 (OC45), 3/6; 2N412 (OC44), 3/6.

G.E.C. TRANSISTORS: GET115, 7/-; GET573, 20/-, 35/- matched pair.

MICRO-ALLOY TRANSISTORS: MAT101 (60 Mc/s) 8/6; MAT121 (120 Mc/s) 8/6; T1166 (60 Mc/s) 6/-.

All our valves carry three months guarantee.
Any faulty item replaced free of charge.

Please add 2/6 in £ for postage. Minimum charge 1/6.
Please address all correspondence to the Head Office.

JOY'FUL NEWS No. I

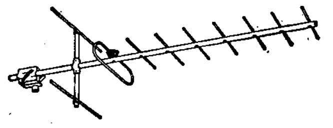
The WORLD FAMOUS, sensational, unique **"JOYSTICK"** all band aerial—short waves, medium waves, amateur and broadcast, transmit and receive, just 7ft. 6in. long. The flat dweller's dream aerial. World patents pending. £3 10s. 0d. carr. paid. MONEY BACK GUARANTEE. Testimonials galore.

Equally unique, **"JOYMATCH"** tuners greatly improve ANY AERIAL, but best results with the **"JOYSTICK"**. Type I (general purpose) 11s. 6d. post free; Type 2 (Medium waves) 47s. post free; Type 3 (Super short wave tuner—uses the famous Pi circuit) 41s. post free; Type 6, D.I.Y. tuner—your own circuit choice in seconds—an infinite range of uses, comprising tapped inductance with shorting lead and two variable capacitors in one unit. 42s. post free. MONEY BACK GUARANTEE.

The **"JOYMAST"** puts the **"JOYSTICK"** 31ft. 6in. in the clear. Radio amateur G3MWZ reports from the Welsh mountains "Every night it blew a gale, which at 1,000ft. A.S.L. on a mountain really IS a test". G3MWZ goes on to say that the **"JOYMAST"** stood firm against this terrific attack. Radio amateur G4HZ/M writes "I think this is FABULOUS, and quality of materials ABSOLUTELY FIRST CLASS—the whole thing MOST BEAUTIFULLY MADE". The **"JOYMAST"** comes complete with **"JOYSTICK"** for £9 19s. 0d., £6 9s. 0d. less **"JOYSTICK"** or 12s. each for separate interlocking mast sections: ALL carr. paid. MONEY BACK GUARANTEE.

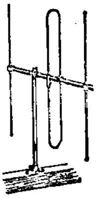
PARTRIDGE ELECTRONICS LTD.
7 SOWELL ST., BROADSTAIRS
KENT, ENGLAND

BBC2 (625 LINE) TV AERIALS



MAST MOUNTING ARRAYS, 9 element 45/-; wide spaced high gain, 11 element 55/-; 14 element 62/6. **WALL MOUNTING WITH CRANKED ARM,** 9 element 60/-; wide spaced high gain, 11 element 67/6; 14 element 75/-. **CHIMNEY ARRAYS COMPLETE,** 9 element 72/-; wide spaced high gain, 11 element 80/-; 14 element 87/6. **LOFT ARRAYS,** 7 element 32/6; wide spaced high gain, 11 element, **WITH TILTING ARM** 62/6; 14 element 70/-. **ALL HIGH GAIN UNITS HAVE SPECIAL MULTI-ROD REFLECTOR. LOW LOSS CO-AXIAL CABLE** 1/6 yd.

BBC ✦ ITV ✦ F.M. AERIALS



B.B.C. (BAND I). Telescopic loft 21/-. External S/D 30/-.

I.T.V. (BAND 3). 3 Element loft array 25/-. 5 element 35/-. Wall mounting, 3 element 35/-. 5 element 45/-.

COMBINED B.B.C./I.T.V. Loft 1+3, 41/3; 1+5, 48/9. Wall mounting 1+3, 56/3; 1+5, 63/9. Chimney 1+3, 63/9: 1+5, 71/3.

F.M. (BAND 2). Loft S/D, 12/6. "H", 30/-. 3 element, 52/6. External units available. Co-ax. cable 8d. yd. Co-ax. plugs, 1/3. Outlet boxes, 4/6. Diplexer Crossover Boxes 12/6. C.W.O. or C.O.D. P.P. 3/-. Send 6d. stamps for illustrated lists.

K.V.A. ELECTRONICS (Dept. 2)
3b, Godstone Road, Kenley, Surrey.
CRO 2527

BEGINNER'S GUIDE TO ELECTRONICS

by T. L. Squires

This book provides a "short-cut" for those wishing to obtain a quick acquaintance with modern electronics.

15/-. Postage 9d.

A PROGRAMMED COURSE IN BASIC ELECTRONICS. NYIT: 38/-. Postage 1/-.

A B C's OF ELECTRONICS by F. J. Waters. 16/-. Postage 9d.

ELECTRONICS POCKET BOOK, by J. P. Hawker & J. A. Reddihough. 21/-. Postage 9d.

ELECTRONICS DATA HANDBOOK, by M. Clifford. 21/-. Postage 1/-.

BASIC ELECTRONICS, Van Valkenburgh Nooger & Neville Inc. 1 vol. complete. 82/-. Postage 2/-.

RADIO ELECTRONICS, by S. Seely. 37/6. Postage 1/3.

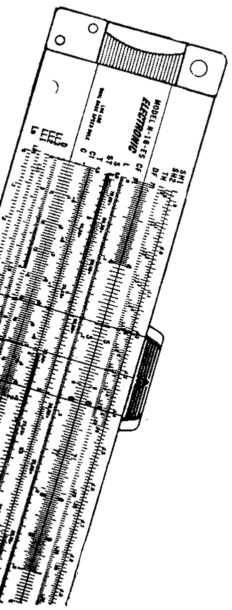
PROBLEMS IN ELECTRONICS, by J. C. Higgins. 24/-. Postage 1/-.

COMPLETE CATALOGUE. 1/-.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKISTS
of British and American Technical Books
19-21 PRAED STREET
LONDON, W.2
Phone: PADdington 4185
Open 6 days 9-6 p.m.

NEW PRODUCTS



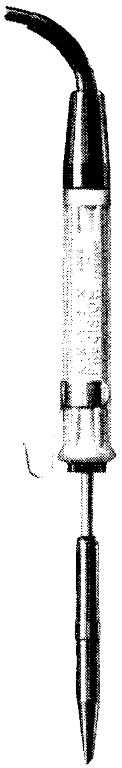
Designer's Slide Rule

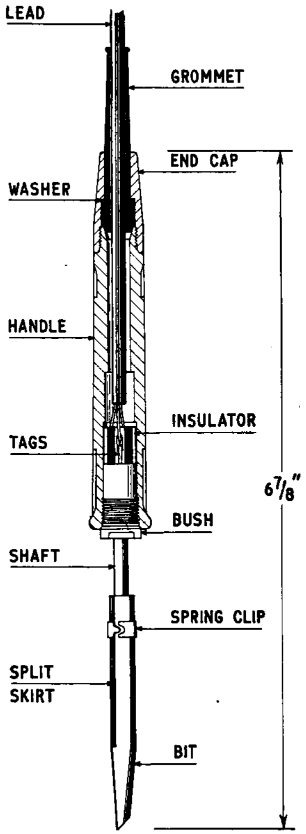
British Pens Ltd., Bearwood Road, Smethwick 41, Staffs.

The Pickett Model N16ES electronic slide rule incorporates many features not found on any other: it includes special scales enabling ready calculation of most electronic problems, such as reactance, impedance, frequency, phase shift.

The more conventional scales feature an Ln scale (exclusive to this rule) of equal parts zero to 2·3 (decimal exponents of e) which when used with the LogLog scales simplify the calculations involving the exponential e which occurs frequently in electronic work.

Construction is of metal, giving a hard wearing accuracy under extreme conditions and is available in white or yellow-green which prevents eyestrain. There are 34 ten-inch scale sections.





Lightweight Iron

Antex Ltd., Grosvenor House, Croydon, Surrey.

Details are shown above of a new precision-built soldering iron which weighs less than *3 ounces*, but has the same versatility as irons weighing ten times as much.

Known as the Antex Model C240N, this iron is fitted with readily interchangeable bits which last five times as long as ordinary nickel plated bits. This instrument is capable of undertaking the same jobs as the larger irons and is priced at 32s 6d.

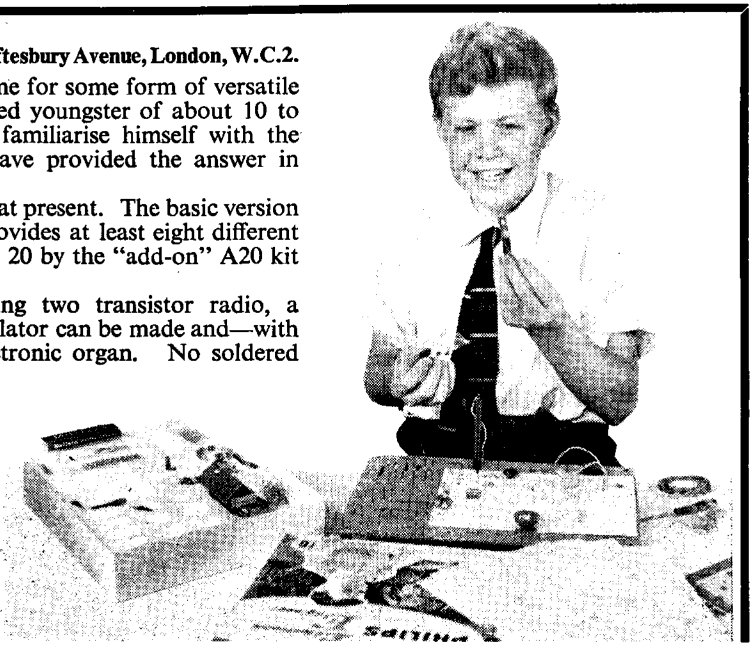
Electronic Toy Kit

Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

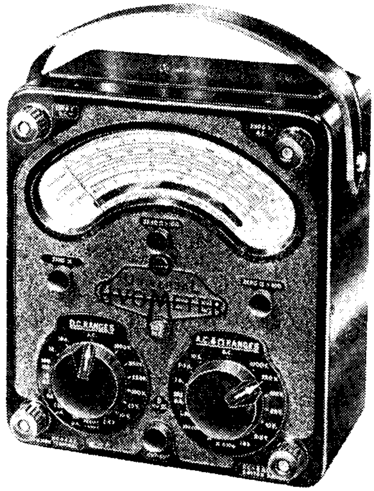
There has been a need for a long time for some form of versatile electronics toy with which an interested youngster of about 10 to 16 years of age can experiment to familiarise himself with the subject, and Philips Electrical Ltd. have provided the answer in their new electronic kits.

Two related types are manufactured at present. The basic version type EE8 retails at £4 19s 11d, and provides at least eight different applications; these can be extended to 20 by the "add-on" A20 kit which is priced at £3 9s 6d.

Circuits such as a direction finding two transistor radio, a gramophone amplifier and morse oscillator can be made and—with the additional kit—a one octave electronic organ. No soldered joints are used.



Model 8 Mk III



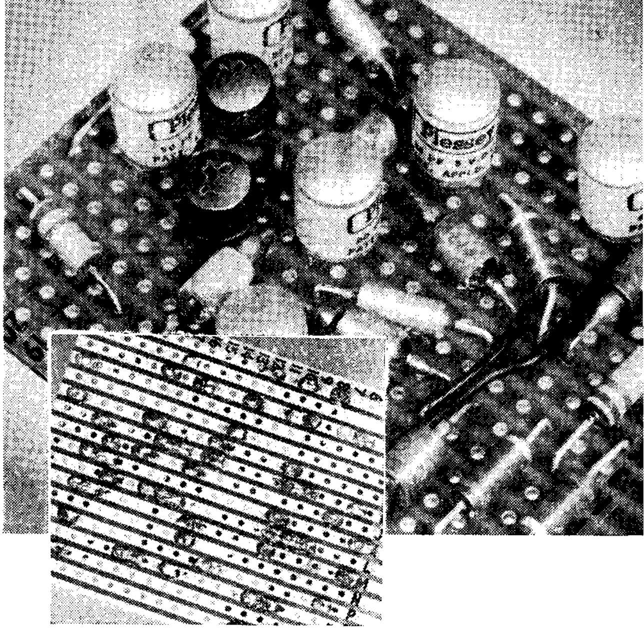
AVO Ltd., 92-96 Vauxhall Bridge Road, London, S.W.1.

A new version of the well known AVO Model 8 multimeter has been announced.

This new meter has greatly improved sensitivity in the lower a.c. voltage ranges requiring 10mA for full-scale deflection on the 2·5V a.c. range, and only 1mA on the 10V a.c. and 25V a.c. ranges. The ohms circuit has a 1A fuse to protect against overload and a spare is provided.

Temperature compensation is also improved by means of a thermistor in the meter circuit which enables current measurements of up to 400A to be made using shunts for the meter. The percentage deviation in scale indication over the frequency range 15c/s to 15kc/s has been improved by not exceeding 4 per cent on the 2·5V a.c. range and 2 per cent between 10V and 250V.

Other specifications are as previous marks.



Wiring Boards

Vero Electronics Ltd., South Mill Road, Regent's Park, Southampton.

A typical example of how developments in industry are finally passed on to the amateur experimenter is the case of "Veroboard" and "Vero Plain Board".

Veroboard is made from conventional s.r.b.p. board clad with strips of copper and a regular hole matrix is pierced in the copper.

Circuit layouts are then designed by "bridging" the strips with components and "breaking" the copper where necessary by using a special tool or an ordinary twist drill Extremely low cost printed circuit layouts can be designed by this method, without any messy chemicals or photography being involved.

Vero Plain Board is plain s.r.b.p. with regular holes drilled in the board. The board is for those who prefer using more conventional wiring systems. Pins are available for insertion in the holes.

High Fidelity P.W.M. Power Amplifier

A new integrated amplifier type X-10 using techniques hitherto unknown in ordinary commercial audio work has been produced by Sinclair Radionics Ltd.

The amplifier utilises the pulse width modulation (p.w.m.) principle which ensures better transient response and better efficiency.

Eleven transistors are mounted on a printed board, and four of these are used in the transformerless output stage.

The amplifier uses a 12 to 15V d.c. supply and for a 1mV input gives a claimed output of 10 watts into a 15 ohm speaker with less than 0·1 per cent distortion and a frequency response of 5c/s to 20,000c/s at 1dB down.

Technical Suppliers Ltd., 63 Goldhawk Road, London, W.12.

LASKY'S RADIO

For the Finest Value and Service to the HOME CONSTRUCTOR AND THE ELECTRONICS ENTHUSIAST

We consider our construction parcels to be the finest value on the home constructor market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded less postage.

TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE

★ LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER and SKYROVER DE LUXE. A simple additional circuit provides coverage of the 1100/1950M band (including 1500 M. Light programme). This is in addition to all existing Medium and Short wavebands.
All necessary components with construction data. Only **10/- extra Post Free.**
This conversion is suitable for Skyrover and Skyrover De Luxe receivers that have already been constructed.

GENERAL SPECIFICATION
7 transistor plus 2 diode superhet, 6 waveband portable receiver.
The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-94M, and also 4 separate switched band-spread ranges, 13M, 16M, 19M and 25M, with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.

SPECIFICATION:
Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4-U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. Band Spread Tuning. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

WAVEBAND COVERAGE: 180-567M; 31-94M and Band Spread on 13, 16, 19 and 25 metre Bands.

The SKYROVER

Controls: Waveband Selector, Volume Control with on/off Switch, Tuning Control. In plastic cabinet, size 10 × 6¼ × 3½in. with metal trim and carrying handle.
Can now be built for £8.19.6 P. & P. 5/- extra.

H.P. Terms: £1 deposit and 11 monthly payments of 16/6.

The SKYROVER De Luxe

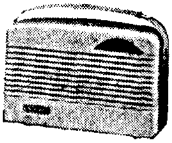
Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11¼ × 6½ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.
Can now be built for £10.19.6 P. & P. 5/- extra.

H.P. Terms: 25/- deposit and 11 monthly payments of 20/-.

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. **Four U2** batteries 3/4 extra. All components available separately.

REALISTIC SEVEN

Fully tunable long and medium bands. Uses 7 Mullard Transistors; plus Diode OA70.
STAR features:
● 7 Transistor Superhet. ● 350 Milliwatt output 4in. high flux speaker. ● All components mounted on a single printed circuit board, size 5¼in. × 5½in. in one complete assembly. ● Plastic cabinet, with carrying handle, size 7in. × 10in. × 3½in., in blue/grey. ● Easy to read dial. ● External socket for car aerial. ● I.F.-frequency 470 Kc/s. ● Ferrite rod internal aerial. ● Operates from PP9 or similar batt. ● Full comprehensive data supplied with each Receiver. ● All coils and I.F.s etc., fully wound ready for immediate assembly. An outstanding Receiver.

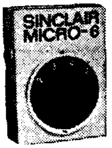


Can be built for
£5 . 19 . 6
P. & P. 4/6.

REALISTIC SEVEN De Luxe

By popular request a De Luxe version of the well-known Realistic Seven now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING covered in attractive washable material, with super-chrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. **ONLY £1 EXTRA**

Both models: Battery 3/9 extra. (All components available separately.) Data and instructions separately 2/6, refunded if you purchase parcel.



NEW SINCLAIR SUPER MINIATURES

THE MICRO-6 Self-contained pocket radio. Size only 1 4/5 × 1 3/10 × ½in. A marvel of modern miniaturisation—truly amazing performance. Without a doubt the most advanced transistor circuit ever offered to home constructors—yet may be built in an evening. Complete with earphone and detailed construction data. **Can be built for only 59/6** Mercury cell 1/11 extra (2 required). All parts sold separately.

THE SLIMLINE The new amazing performance 2-transistor pocket radio size only 2⅞in. × 1⅝ × 1⅝in. Micro alloy transistorised and printed circuit. Easy to assemble. **CAN BE BUILT FOR 49/6** All components available separately.

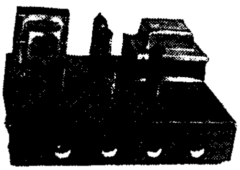
TRANSFILTERS By BRUSH CRYSTAL CO. Available from stock.

TO—01B 465 kc/s. ± 2 kc/s.	TO—02D 470 kc/s. ± 1 kc/s.
TO—01D 470 kc/s. ± 2 kc/s.	TF—01B 465 kc/s. ± 2 kc/s.
TO—02B. 465 kc/s. ± 1 kc/s.	TF—01D 470 kc/s. ± 2 kc/s.

6/6 EACH P. & P. 6d.

CONSTRUCTORS BARGAINS

THE BH-14 HI-FI MONO AMPLIFIER KIT



High quality 14 watt power amplifier with bass and treble controls and separate volume controls on each input. Inputs: 1-5 m/v.; 2-40 m/v. Output impedance 3 or 15 ohms. 5 valves—line-up: 2 × EL84, 1 × EF86, ECC83 and EZ81. Frequency response 15 c/s.—20 Kc/s. Ideal for the discerning Hi-Fi enthusiast or as guitar amp. Gold hammer finish with distinctive Perspex front panel. Complete kit of parts with detailed construction data.

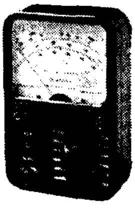
MAY BE BUILT FOR 9 GNS. POST FREE. Instruction book available sep. 1/6.
AVAILABLE READY BUILT AND TESTED. 11 GNS. POST FREE.

The "Sixteen" Multirange METER KIT

This outstanding meter was featured by *Practical Wireless*, in the Jan. '64 issue. Lusky's are now able to offer the complete kit of parts as specified by the designer.

RANGE SPECIFICATION:
D.C. volts: 0-2.5-25-50-250-500 at 20,000 Ω/V.
A.C. volts: 0-25-50-250-500 at 1,000Ω/V.
D.C. current: 0-50μA, 0-2.5-50-250 mA.
Resistance: 0-2000Ω, 0-200kΩ, 0-20 MΩ.
Basic movement: 40μA f.s.d. moving coil. With universal shunt full scale deflection current is 50μA.
Size/finish: Black plastic case—3⅞ × 5⅞ × 1⅞in.
Controls: 12 position range switch: separate slide switch for A.C. volts—D.C. ohms; ohms zero adjustment pot. meter; meter zero. External connections: Two 4 mm. sockets for test lead plugs.

Power requirements: One 15v. and one 1.5v. batts. Complete with all parts and full construction details.



H.P. Terms: 21/- deposit and 5 monthly payments of 21/-.
Data and circuit available separately, 2/6; refunded if all parts bought. Pair of batteries 2/- extra.

LASKY'S PRICE £5.19.6 P. & P. 5/-.

BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers 2- or 4-track models.

COLLARO STUDIO TAPE DECK.
Latest model 3 speed, 3 motors. Take 7in. reels. Fitted with half-track heads. **LASKY'S PRICE £10/10/-.** New and Unused. Carr. & Pack. 7/6.

COLLARO STUDIO TAPE DECK. As above but fitted with the latest quarter-track heads. **LASKY'S PRICE £13/19/6.** Carr. & Pack. 7/6.

MARTIN TAPE RECORDER AMPS. Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3-ohm output, speed equalising, etc. For 200-250 v. A.C. mains.

PRICES ½-track Model **£11/11/-.** ¼-track Model **£12/12/-.** P. & P. 2/6. Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9 × 5in. speaker. Price complete with speaker **£5/5/-.** P. & P. 5/-.

SPECIAL INTEREST ITEMS!

DEAC RECHARGEABLE NICKEL CADMIUM CELLS

Rating 1.22 v. 3.5 A.H. at 10 hour rate. 1,001 uses for model makers, miniature electronic equipment, portable radios, transistor radios, T.V's, tape recs., transceivers, photo flash, etc. Hermetically sealed. Size 3½ × 1¼ × 1⅜in. Listed at 35/- each.
LASKY'S PRICE 15/- each. POST FREE. BANK of 9, **79/6.**

THE HARROW POWER PACK

Battery eliminator for portable radios, etc. Converts your battery radio to A.C. mains. Replaces 4½ v., 6 v. and 9 v. batts. Size only 3in. × 2in. × 2½in. State voltage required when ordering.
LASKY'S PRICE 29/6 P. & P.

TRANSISTORS

ALL BRANDS NEW AND GUARANTEED

GET 81, GET 85, GET 86 **2/6**; 837A, 874P **3/6**; OC45, OC71, OC81D **4/6**; OC 44, OC 70, OC 76, OC 81 (match pair **10/6**) **5/6**; AF 117, OC 75, OC 170, OC 200 **6/6**; OC 23, OC 42, OC 43, OC 73, OC 82D **7/6**; OCP 71 **9/6**; OC 201, OC 204 **15/-**; OC 205, OC 206 **19/6**; OC 28 **24/6**.

---

207 EDGWARE ROAD, LONDON, W.2.
Near Praed St. PADDINGTON 3271/2

33 TOTTENHAM COURT ROAD, W.1.
Nearest Stn., Goodge St. MUSEUM 2605

BOTH OPEN ALL DAY SAT. Early Closing Thurs.

Mail Orders to Dept. P.W., 207 *Edgware Rd., W.2.*

152/3 FLEET STREET, LONDON, E.C.4.
Telephone: Fleet Street 2833
OPEN ALL DAY THURSDAY. Early Closing Sat.

LASKY'S FOR SPEEDY MAIL ORDER SERVICE

NOW *ANYONE* CAN AFFORD TO TRAIN TO BE AN EXPERT IN RADIO, TV, AND ELECTRONICS

Anyone can afford these amazing courses—anyone can understand this practical training—No complicated mathematics to hold you back—No old fashioned, obscure explanations to frustrate you!

The lessons are **CRYSTAL CLEAR, PRACTICAL, EASY TO MASTER AND USE**—Early lessons make fundamentals clear even to the beginner, while other lessons will give you the practical " know-how " of an expert!

Compares favourably with some courses costing very much more! By creating a mass market through large volume sales and eliminating individual letter writing we are able to pass on these savings directly to you!

Each course is printed on extra large quarto size sheets and bound into one manual to simplify handling and distribution.

Please select the course most suitable for your requirements from the following:
No. 1. RADIO COURSE. Fundamental facts—Electrons—Conductors and Insulators—Radio Batteries—Circuits—Magnetism—Ohm's Law—Resistor Colour Code—Chart—What resistor to use—Electro-Magnetism—Electromagnetic Induction—Self Induction—Radio Frequency Inductances—Capacity Coupling—I.F. Transformers—Radio Coils—Radio Capacitors—The Farad—Dielectric—Capacitor Colour Code—Alternating Current Theory & Filters—Reactance and Resistance—Charts to calculate Capacity Frequency and Inductance—Handy Radio Formulae—Practical Aspects of Radio Servicing—Radio Valves—Transistor Theory—N Type Germanium—P Type Germanium—Diode Action—Transistor Action—D.C. Stabilization—Transistor Bias Adjustment—R.F. Amplification—Superheterodyne Principles—A.V.C. Power Supplies—Meters—Multitesters and Valve Testers—Point to Point Servicing—Signal Generators and Signal Tracers—Using an Oscilloscope for Servicing—Alignment—Amplifiers and P.A. Equipment—High Fidelity—Advantages of Inverse Feedback—Speakers—Frequency Modulation—How to Obtain Radio Jobs. **Price for the complete course. ONLY 36/-. Plus postage 1/6.**

No. 2. ELECTRONICS COURSE. Includes most of the above lessons plus L.C. and R. Combined Circuits—Resonance Phenomenon—Behaviour at Resonance—How Meters Work—Making a Voltmeter—Ohm meter Connections—Valves—Electron Behaviour—Triode—Characteristic Curves—Power Supplies—Audio Amplifiers—Microphones—Resistance Coupling—Obtaining Grid Bias—Push Pull and Parallel—Phase Inverter Circuit—Radio Frequency Voltage Amplifiers—I.F. and Multiband Coils—Detection—Receiver Circuits—Results of Frequency Mixing—A.V.C.—Electronic Oscillators—Quartz Crystals—Radio Transmitter Circuits—Modulation and Tuning—Lines, Antennas and Radiation—Test Equipment Using Meters—Electronic Test Equipment—Thyratrons—Photo-Cell Equipment—Radio Compass—H.F. Heating—Electronic Shaping Circuits—Electron Microscope—Electric Strain Gauges—Inter-Communicators—Radio Servicing Techniques—Servicing Printed Circuits.

Price for the complete course. ONLY 39/6. Plus postage 1/6.
Graduates of the Electronics Course can qualify for a certificate—details sent with each order.
No. 3. TELEVISION COURSE. Effect of Mis-adjusted controls—Pictures of various faults—Service adjustments—Circuit Faults Indicated by a Poor Pattern—Finding Bad Valves by observing Picture Faults—Separate Channel I.F. System—Intercarrier I.F. System—Negative Picture—Interference—Antenna Principles and Practices—U.H.F. Transmission Lines—Facts About the T.V. Signal to Help you in Service Work—Synchronizing Separators—T.V. Interference Aids—All about Cathode Ray Tubes—Explanation of T.V. Circuits—Video Detector—Video Amplifier—D.C. Restorer Circuit—Automatic Gain Control Circuits—Oscillators—Deflection Coils—Automatic Frequency Control Circuits—Analysis of Stagger Tuned I.F. Receiver—Analysis of Three Inter-Carrier Type Receivers—The Vertical Deflection Circuit—The Horizontal Deflection Circuit—Waveforms—Schematics of various sections of a T.V.—U.H.F. Converters and Tuners—T.V. Test Equipment and Alignment—Analysis of Various Problems.

Price for the complete course. ONLY 36/-. Plus postage 1/6.

UNCONDITIONALLY GUARANTEED TO GIVE COMPLETE SATISFACTION
You must be convinced that this is the best value you have ever seen in Electronic, Radio or T.V. Training, otherwise you can return the course (or have your money refunded if sent with order) after you have examined it in your own home for a full seven days.

IF YOU SEND CASH WITH ORDER WE WILL INCLUDE A FREE 70-PAGE BOOK.
Tick on the coupon one book for each course ordered with full cash.

RADIO SERVICING FAULT FINDING BOOK. TELEVISION FAULT BOOK. OSCILLOSCOPE BOOK.

These free books are authoritative, and loaded with information. Would cost at least 5/- each if bought separately—by sending cash you reduce book-keeping and other costs, which savings we pass back to you!

▬ ▬ ▬ ▬FREE TRIAL OFFER▬ ▬ ▬ ▬ ▬

Pay only 5/- per week if you wish. Clip coupon right now for this special offer
To: Sim-Tech Book Company, Dept. ELI., Gater's Mill, West End, Southampton, Hants.

Please send the following courses for a full seven days' trial.

☐ **No. 1. RADIO COURSE.** **37/6, incl. postage.**

☐ **No. 2. ELECTRONICS COURSE.** **41/-, incl. postage.**

☐ **No. 3. TELEVISION COURSE.** **37/6, incl. postage.**

(Free trial customers tick one only please).

If not delighted, I may return the course post-paid without further obligation on my part. Otherwise I will pay cash price **OR** 5/- weekly until purchase price plus 2/6 service charge has been paid.

☐ Tick here if enclosing fully purchase price.
Please send me ☐ **FREE. RADIO FAULT FINDING BOOK.**
☐ **FREE T.V. FAULT FINDING BOOK.** ☐ **FREE OSCILLOSCOPE BOOK.**
Amount enclosed £.................

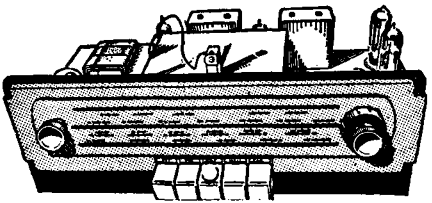
I understand that you will refund this money in full if I am not 100% satisfied. Overseas customers please send full amount (including Ireland).

NAME ....

ADDRESS ....

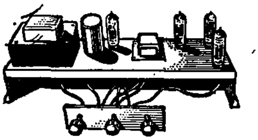
....

City.. County..



BRAND NEW AM/FM (V.H.F.) RADIO GRAM CHASSIS AT £13.13.0 (Carriage Paid)

Chassis size 15 × 6¾ × 5½in. high. New manufacture. Dial. 14½ × 4in. in 2 colours, predominantly gold. 200-250v. A.C. only.
Pick-up, Ext. Speaker, Ae., E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1000-1900 M.; 200-550 M.; 88-98 Mc's. Valves EZ80 rect.; ECH81, EF89, EABC80, EL84, ECC85. Speaker 8 × 5in. and Cabinet to fit chassis (table model), **47/6** (post 5/-).
10 × 6in. ELLIPTICAL SPEAKER **25/-** to purchaser of this chassis. **TERMS:** (Chassis) **£3.10.0** down and 5 monthly payments of £2.4.0. Cheap Room Dipole for V.H.F., **12/6.** Feeder **6d.** per yard. Circuit diagram **2/6 ALTERNATIVE DESIGN.** L.W. 1000-1900 M.; S.W. (9-15 Mc/s); M.W. 190-475 M.; V.H.F. 87-100 Mc's; Gram position. Otherwise similar to above chassis. Price **£15.15.0** (carr. paid). **TERMS: £3.10.0** down and 6 monthly payments of £2.4.0.



PUSH-PULL O.P. AMPLIFIER

£5.5.0 (6/- Carr.)

Brand new 200-240 A.C. mains Bass, treble and vol. controls, with valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 × 3¼ × 3½in. With o.p. trans for 2-3 ohm speaker. Front panel normally screwed to chassis) may be removed and used as "flying panel".

LAFAYETTE BRAND TAPE

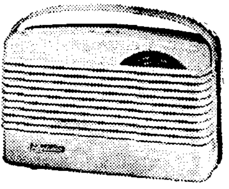
FULLY GUARANTEED AT RECORD LOW PRICES

MYLAR BASE	
5in. Double play, 1,200ft.	15/–
5¾in. Double play, 1,800ft.	22/6
7in. Stand play, 1,200ft.	12/6
7in. Long play, 1,800ft.	19/6
7in. Double play, 2,400ft.	25/–
TRIPLE PLAY	
3in. 450ft.	12/6
4in. 900ft.	22/6
5in. 1,800ft.	42/6
5¾in. 2,400ft.	55/–
7in. 3,600ft.	75/–
P.V.C. BASE	
5in. Standard play 600ft.	8/6
5¾in. Standard play, 850ft.	11/6
ACETATE BASE	
5in. Long play, 900ft.	10/–
5¾in. Long play, 1,200ft.	12/6
7in. Long play, 1,800ft.	15/–
MESSAGE TAPES	
3in. 150ft.	3/6
3in.—225ft.	4/11
3in. —300ft.	7/6

P. & P. 1/- extra per reel; 4 reels and over Post Free.

"REALISTIC" 'SEVEN'

Transistor Superhet. 350 Milliwatt output, 4-inch speaker. All components mounted on a single printed circuit board size 5½ × 5½in. in one complete assembly. Plastic cabinet with carrying handle, size 7 × 10 × 3½in. External socket for car aerial. Ferrite rod aerial. Price for the complete parcel including Transistors, Cabinet, Speaker, etc. and full Construction Data: **£5.19.6.** P. & P. 4/6.
PP9 Battery **3/9.** Data and instructions separately **2/6.** Refunded if you purchase the parcel.
Any parts supplied separately.

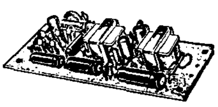


SINGLE RECORD PLAYER USING EMI DECK AND PICK-UP

4 speed, 200/240 v A.C. Valves, rectifier and ECL82. Cab. size 12 × 11½ × 5½in. attrac. coloured imitation leather finish. Takes 10in. records. **£7.19.6** carr. paid.
ALTERNATIVE TYPE OF SINGLE RECORD PLAYER available, using BSR GU 7 motor and pick-up on one plate. Valves UY85 and UCL82. Cab. size 13¾ × 13 × 5½in., red or blue rexine. Takes 12in. records. Price **£8.9.6** carr. paid.

4-TRANSISTOR MINIATURE PUSH-PULL AUDIO AMPLIFIER HIGH IMPEDANCE

PRINTED CIRCUIT. 4in. × 2¾in. 1½in. over transformers. Output for 3-ohm speaker. Suitable for microphone, record player, guitar and intercom. 9 volt battery required. Frequency range 100 cps. to 25 Kcps. Push-pull output class B. Instruction sheet provided. Fully wired ready for use. Two types. 200 mw. **29/6;** 1 watt, **41/-.** P. & P. 2/6.



4-SPEED AUTOCHANGERS

Carr. 5/- each

BSR-UA14	£5.19.6
GARRARD AUTOSLIM	£6.10.0
STEREO	£7.5 0
AUTOSLIM DE LUXE AT6	£10.19.6
STEREO	£11.10.0

2½-WATT AMPLIFIER

Our price ONLY **56/-** (post 5/-); a few hundred only; valves EF91 and ECL82 with metal rectifier: 6 × 4 × 1¾in. high (5in. over ECL82). Mains trans. and o.p. with vol. and tone controls; on-off; co-ax. input.

TAPE RECORDER AMPLIFIER

Fully built. Front panel 12¼ × 3in. Chassis size 10½ × 5 × 4in. Valves EF86, ECC83 and 2EL84. Controls (1) MIC. Vol. (2) Tuner/P.U. Vol. (3) Play back or monitor. (4) Tone, 2 jack sockets for Tuner/P.U. and MIC-switch for superimpose. Separate power pack containing transf. & rectifier. For Collaro studio deck only. Price **£8.14.0** (6/- P. & P.).

ALL ITEMS ARE NEW AND FULLY BUILT UNLESS OTHERWISE STATED. TESTED BEFORE DESPATCH.
Terms available on Items over £5. Send 6d. (stamps will do) for 20-page illustrated catalogue. Delivery by return, C.O.D. 2/- extra
ALL ITEMS GUARANTEED 12 MONTHS. **VALVES 3 MONTHS**
Regret overseas orders cannot be executed.

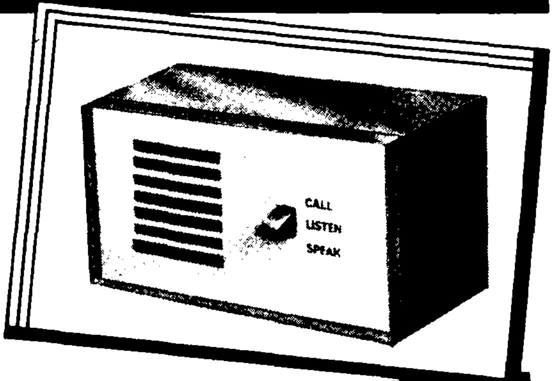
GLADSTONE RADIO

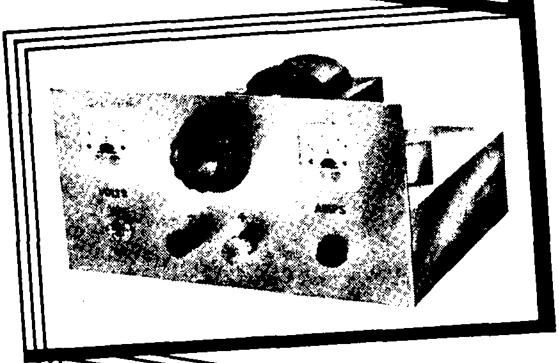
66 ELMS ROAD, ALDERSHOT, Hants.
(2 mins. from Station and Buses).

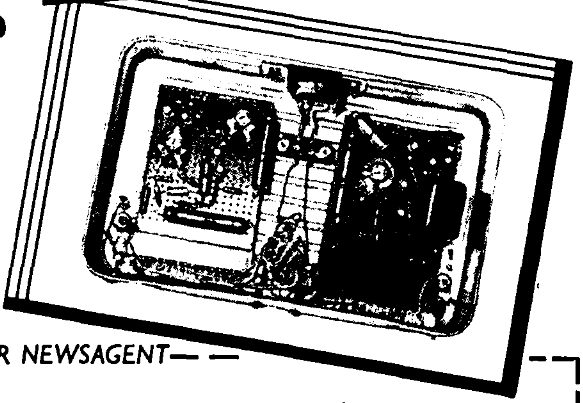
(CLOSED WED.)
Aldershot 22240

FREE INSIDE NEXT MONTH'S Practical Electronics

2 DOUBLE SIDED BLUEPRINTS







TO BUILD

1. TRANSISTOR INTERCOM

2. VARIABLE LOW VOLTAGE D.C. SUPPLY UNIT

3. TRANSISTORISED DECIMAL STEP PRE-AMPLIFIER

PLUS

4 MORE PAGES FOR YOUR ELECTRONIC DATA BOOK

Other Outstanding Features Including

An Ultrasonic Remote Control Device

— — —FILL IN AND HAND TO YOUR NEWSAGENT— —

ORDER YOUR COPY NOW!

TO..(Name of Newsagent)

Please send/reserve* PRACTICAL ELECTRONICS (2/6) every month, commencing with the December issue, on sale November 12th.

NAME ....

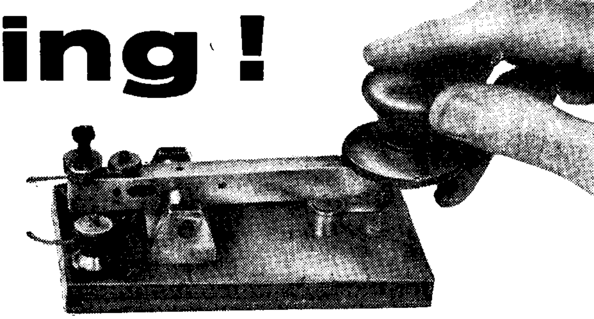
ADDRESS..

....

Get Tapping !

A SIMPLE MORSE PRACTICE OSCILLATOR

BY JACQUES HENRY DU BOIS



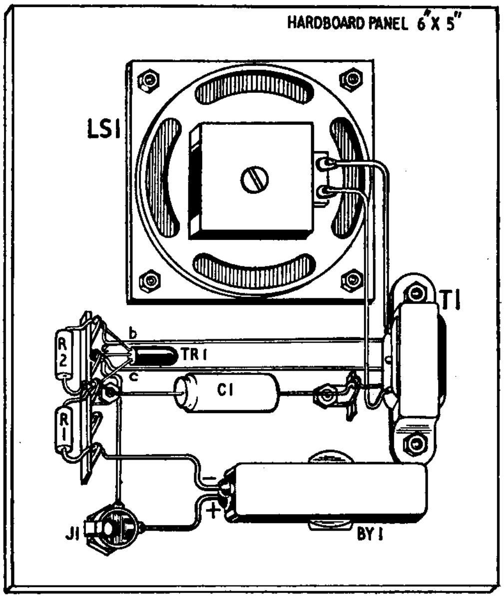
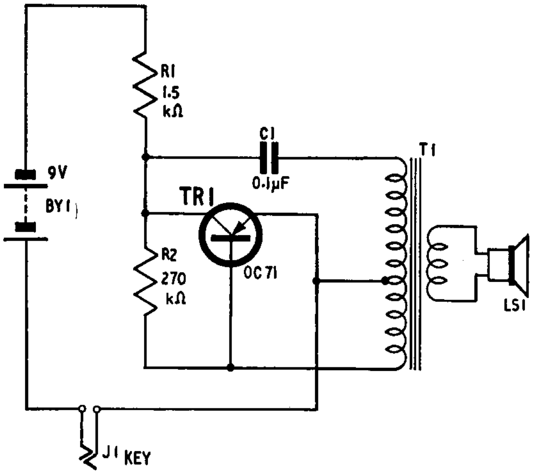


Fig. 1 (above). Component layout details

Fig. 2 (below). Theoretical circuit



It will be seen from the diagrams that the number of components required has been kept to a minimum, and the oscillator is therefore cheap to build. Although an OC71 is shown in the circuit diagram, Fig. 2, any red spot transistor can be used.

The pitch of the note can be varied by changing the values of R1, R2 and C1. It was found that a small change in value of R1 altered the current consumption quite considerably, therefore it is suggested that the current be measured each time the values are altered, to avoid excessive consumption from the battery.

CONSTRUCTION

The oscillator should be built on a piece of ordinary hardboard, measuring approximately 6in. × 5in., with a suitable size circular piece cut out to suit the loudspeaker.

To help with the wiring, a five-way (one earthed) tag strip and a single "earthed" tag should be mounted on the board. All the component connections are made on or between these tags and the necessary details are given in Fig. 1. By following the layout diagram it should be a simple job to wire all the components correctly, but particular care should be taken to make sure that the transistor is not wired the wrong way round, as damage can so easily be done by faulty wiring.

When the wiring has been completed it is a simple matter to cover the front surface of the component board (which is also the baffle), with a suitable material and screw by the four front edges to a suitable small wooden case.

Once the unit is completed you will be eager to start practising. Plug in a morse key at J1 and all is set to go. ★

COMPONENTS . . .

Resistors

R1 1·5kΩ } ¼W carbon
R2 270kΩ }

Capacitor

C1 0·25μF paper

Transistor

TR1 OC71 (or any red spot)

Miscellaneous

T1	Transistor output transformer; ratio at least 10:1 (Repanco TT5)
LS1	Loudspeaker unit 3in, 3 ohm
J1	Miniature jack socket and plug
BY1	9 volt battery (Ever Ready PP3 or equivalent)

Also required: Spring clip for battery, one 5-way and one 1-way tag strip, wire, 4B.A. nuts and bolts, and a piece of hardboard 6in by 5in


GOODMANS
HIGH FIDELITY LOUDSPEAKER MANUAL

L. K. ELECTRONICS

The Cheapest — The Best
The Quickest Service

● **SCOOP! B.S.R. U.A. 25 Autochangers.** T.C. 8 Mono P.U. Brand new and boxed. Wired for stereo. Note **OUR** price **£5.7.6.** P.P. 5/-. The very, very latest model.

● **SCOOP! B.S.R. U.A. 14 Autochangers.** T.C. 8 Mono P.U. Brand new and boxed. Wired for stereo. Note **OUR** price **£5.7.6.** P.P. 5/-. Latest model.

● **SCOOP! Garrard Autoslim.** Mono P.U. Brand new and boxed. Wired for stereo. Latest model. Note **OUR** price **£6.0.0** only. P.P. 5/-.

● **SCOOP! Garrard A.T.5.** Wired for stereo, inclusive of head and mono cartridge (A.T.5 is an auto transcriptor). The finest changer of them all. **OUR** price, brand new and boxed, **£7.10.0** only P.P. 5/-.

AUTOCHANGERS

Single Players		
E.M.I. Autostop, Mono	**£5.7.6**	P.P. 4/6
Garrard S.R.P. 10, Mono	**£5.5.0**	P.P. 4/6
E.M.I. Separate Pick-up	**£3.0.0**	P.P. 3/6
Transcription Units—Stereo Head—Mono		
Garrard 4 H.F. Stereo	**£14.10.0**	P.P. 5/-
Philips A.G. 10/16. Stereo	**£12.0.0**	P.P. 5/-
Garrard A.T.6, Stereo	**£9.19.6**	P.P. 5/-
Garrard 301	**£16.10.0**	P.P. 5/-

● **SCOOP! Record Player Cabinets.** Two-tone, de-luxe finish with cut-out board. These are brand new and product of very famous national manufacturer. **OUR** price **£2.15.0** only. P.P. 3/6.

● **SCOOP! 3-watt Gramophone Amplifier.** Complete with 5in. Speaker, **49/6.** P.P. 5/-.
The amplifier is complete, on a fabric-covered baffle board. Output transformer included. Tone and volume controls and on/off switch. Ready to switch on and play. Terrific volume. Size 12½in. × 6in. × 3½in. back to front. For 200-250 v. A.C. Output 3 watts.

● **SCOOP!** Diodes—over 1,000,000 in stock—ideal substitute O.A.81 vision detector.
Note **OUR** price **£1.0.0** per 500. P.P. 2/-. (In 500 lots only).

● **SCOOP! Transistor Tape Recorder.** The best obtainable by very famous manufacturer. Brand new, boxed, guaranteed. Reduced from 12 gns. **OUR** price **£7.10.0.** P.P. 3/6. Complete with microphone, tape, batteries and operational booklet. Features push-pull amplifier, two motors, single switch operation, pause, speed, wind, rewind, record, play back. Can be used in any position, indoor or outdoor.

● **SCOOP! Hi-Fidelity Speakers,** 15-watt. Very famous national manufacturer—we cannot mention name. 45-13,000 c.p.s., 3 or 15 ohm voice coils, response 45-13,000 c.p.s. Magnet 15,000 lines. In carton—unopened and unused. **OUR** price **£4.4.0** only.

● **SCOOP! A Stereophonic Amplifier** with the following features. A twin gauged tone control in a special negative feedback circuit, giving a wide range of tone correction. A balance control enabling the amplifiers to be equalized in output to compensate for pick-up, lead, speakers, recording differences. A speaker switch. M1, single amplifier. M2, dual amplifiers for increased Monaural output. S.3, two speakers at 5 watts per channel. Twin gauged vo lume controls and all four controls placed equidistant along the front of the chassis. Designed, made and guaranteed by Brittamer Ltd.. Brand new and at a fraction of original cost. **OUR** price **£7.10.0** only.

● **SCOOP! Monaural 15 watt Amplifiers.** A limited number only. A.C. only. Dual inputs. To clear at half price. Brand new and boxed. Guaranteed. While stocks last, **£13.0.0** only.

● **SCOOP! 1964 Radiogram Chassis. Stereo** 3-wave bands, long, medium, short. 5 watts per channel. 6 valves. Latest Mullard A.C. 200/250 v. Ferrite aerial. Glass dial. Horizontal wording. Size 13in. × 4in. Aligned and calibrated. Concentric controls. Isolated chassis. Size 13½in. × 9in. high × 5in. deep. Product of famous national manufacturer. Brand new and boxed. Maker's guarantee.
OUR price **£13.10.0.** List price £19.8.0. P.P. 5/6. Our Chassis List quotes prices—the keenest in the Trade. We are Main Agents for the complete range of Brittamer Chassis and Amplifiers. "Brittamer"—makers of Radiogram Chassis to the Top Names in Radio.

● **SCOOP!** For **£25.0.0** only. A fabulous offer. **Garrard A.T.5 Transcriptor,** plus 2 12in. 15 watt Hi-Fidelity speakers, plus the very latest Continental push-button chassis by Brittamer. Stereo, 3-wave band, 6 valves, 5 watts per channel. The finest chassis of its type in the world. You will be amazed at performance and quality. We unhesitatingly recommend this chassis.

● **SCOOP!** Limited number only. **Miniature Superhet 4-valve Portable Radios.** Ferrite rod aerial. Hide leather case. Complete with valves, speaker and circuit. To clear **OUR** price **50/-** only. Cannot be repeated.
Speakers ex Equipment. 5in. **5/-**, 7in. × 4in. **6/-**, 6in. **6/6**, 8in. **7/-**. P.P. 1/6 each.

● **SCOOP! Microphones.** Complete Lead Coax. Plug, Brand New. **OUR** price **5/-** only. P.P. 1/6.

TRANSISTOR SECTION

● **SCOOP! A first-class 2 wave-band 6 transistor superhet chassis** by world famous manufacturer. Fully built, aligned, tested, guaranteed. Full coverage long and medium waves. Note **OUR** price **£4.4.0** only. Suitable speaker **10/6.** A few cabinets can be supplied at **22/6** each. **OUR** price for the package deal **£5.5.0** only.

● **SCOOP! As above, 8 transistor.**
OUR price **£5.4.0** only. Suitable speaker **10/6.** Cabinet (very attractive two-tone), **22/6.**
OUR price for the package deal **£6.10.0** only.

● **SCOOP!** A Limited Number Only. **Tape Decks by B.S.R.** Latest model. A.C./200/240 v. Brand new and boxed.
OUR price **£6.10.0** only. P.P. 4/6.

● **SCOOP! Tape Recorder Amplifiers.** Suitable for B.S.R. or Collaro Decks. Price: **£6.10.0** for B.S.R. Deck; **£6.12.0** for Collaro Deck. P.P. 6/-.
Mk. III. Fully built, high gain, low noise, printed circuit. The amplifier is supplied complete with the switch wafer fully wired for B.S.R. deck. For Collaro deck, a completely wired separate switch with spindle is supplied. Magic Eye.
S.A.E. enquiries please. Our Complete Lists 1/- only—credited against your order

● **IF NOT ADVERTISED IT IS STILL IN STOCK**

L.K. ELECTRONICS (Victoria) LTD.

★ **17 GILLINGHAM ROW, WILTON ROAD, LONDON, S.W.1.** ★

V.H.F. BROADCAST RECEIVER

continued from page 51

tin-snips (see Fig. 7b) so that, on bending over, the halves can be worked round the brass bolts and pressed flat on the underside of the base plate of the former.

A brass washer and nut holds them firm, leaving nearly ½in of bolt standing proud for insertion through the fixing holes. When these in turn are screwed up with a further washer and nut a good earth contact is assured, together with a firm assembly.

COMPONENTS . . .

Resistors

R1	390Ω	R6	220Ω	R11	1·2kΩ
R2	100Ω ½W	R7	1·5kΩ	R12	6·8kΩ
R3	1·2kΩ	R8	1·2kΩ	R13	220Ω
R4	1·5kΩ	R9	6·8kΩ	R14	1·2kΩ
R5	8·2kΩ	R10	220Ω		

All ¼W carbon, unless otherwise indicated.

Capacitors

C1	0·25μF paper	C10	1·5pF
C2	100μF elect. 12V	C11	1,500pF
C3	2,500μF elect. 12V	C12	1,500pF
C4	12pF	C13	50pF ceramic. Neg. temp. coefficient
C5	68pF	C14	100pF
C6	1,500pF	C15	1·5pF
C7	1,500pF	C16	1,500pF
C8	2pF	C17	1,500pF
C9	1,500pF		

All silver mica or high quality ceramic, unless otherwise indicated.

TC1 25pF max. concentric trimmer
TC2 10pF max. concentric trimmer
VC1 18pF max } Twin gang variable (Jackson Bros.
VC2 18pF max } type U)

Inductors

L1 Aerial coil } see text
L2 Oscillator coil }

Transformers

T1 Mains transformer. Secondary 9–0–9V 80 mA (Osmor type MT9)
T2 Inter-stage r.f. transformer } see text
T3 First i.f. transformer }

Transistors

TR1 2G102 TR2 OC171 TR3 OC171

Diodes

D1 OA6 D2 OA6

Miscellaneous

FS1 60mA fuse cartridge and holder
SK1 coaxial socket
Dial and drive unit (Jackson Bros. type SL16)
Multicore Solder

COIL WINDING DATA

The oscillator coil L2 and the r.f. inter-stage transformer T2 are wound on two pieces of plastics cut from a former 0·27in diameter—such as are sold with a "long" type can.

OSCILLATOR COIL L2

Four turns 18 s.w.g. enamelled wire, spaced 0·25in in length.

R.F. INTER-STAGE TRANSFORMER T2

Primary: Five turns 18 s.w.g. enamelled wire, spaced 0·35in in length.
Secondary: Two turns 28 s.w.g. enamelled wire, interwound with "earthy" end of primary.

The direction of connection of the secondary winding is unimportant, but it is technically best to keep the two earthy ends of the coils together. Both of these coils have v.h.f. dust cores (purple coded).

AERIAL COIL L1

"Short" can with former 0·27in diameter approximately. V.H.F. iron-dust core. Five turns 28 s.w.g. enamelled wire, spaced 0·5in

FIRST I.F. TRANSFORMER T3

"Short" can with former 0·27in diameter approximately. Iron-dust core.

Primary: 28 turns 32 s.w.g. gauge enamelled wire, close wound.
Secondary: Six turns 32 s.w.g. enamelled wire, wound centrally *over primary*, one layer of Sellotape as insulation.

I.F. TRANSFORMERS T4, T5 & T6

"Long" can with former and iron-dust cores.

Primary: 28 turns 32 s.w.g. enamelled wire, closewound. Tapped six turns from "inner" end.
Secondary: Same, but tapped five turns from "inner" end. Spacing between ends of windings 0·25in *precisely*.

DETECTOR TRANSFORMER T7

"Long" can with former and iron-dust cores.

Primary: 32 turns 34 s.w.g. enamelled wire, closewound, tapped eight turns from "inner" end.
Secondary: Bifilar-wound 16 + 16 turns 32 s.w.g. wire, closewound.
Tertiary: 10 turns 34 s.w.g. wire, wound five each side of the primary tap directly on top.
Spacing between ends of windings $\frac{1}{16}$in *precisely*.

Since more has to go in the detector can than the coils and associated capacitors, the connections are not given here but will be provided next month.

PRACTICAL ELECTRONICS COLOUR CODE CALCULATOR

The colour Code Calculator, presented with this first number of Practical Electronics, has been devised in order to enable the experimenter to readily assess the value of the more common type of five or six colour capacitors and various resistors.

There are tubular, "dog bone", encapsulated mica, and many other types of capacitors which, although bearing colour identification, are not physically the same. However, providing the correct sequence of colours (temperature coefficient first) can be identified, the calculator can be used to obtain the values.

The instructions on the back illustrate how to use the calculator and also give examples, which show the reader the method of operation. Due to the difference in multiplier values between capacitors and resistors, the right and left hand sides of scale C are used separately for resistors and capacitors, respectively.

The calculator will be an invaluable aid in the workshop of many amateurs, and also in technical schools and laboratories.

NEWS BRIEFS

SCHOOLS' SCIENCE FAIR

The British Association for the Advancement of Science Annual Conference was held at the end of August at Southampton. The School's Science Fair of 1964 under the auspices of the Association was opened by Lord Brain, F.R.S., in the magnificent new building of the Southampton College of Technology at East Park Terrace.

The fair, probably the most ambitious ever to be staged by the Southern Area Committee under the Chairmanship of Professor G. J. Hills, was supported by some sixty schools and three training colleges who provided 138 carefully prepared and admirably displayed exhibits covering a very wide range of science education.

Several of the electronics exhibits were of extremely high standard and on a parallel with projects undertaken by university degree final year students. Special mention must be made of an electron accelerator exhibit and flying spot transparency scanner exhibit, together with the following outstanding exhibits: derivation of a value for g; transistor Geiger-Muller counter; digital computer; wave motion machine; van der Graaf generator; light and sound device; and a transistor metronome.

Attendance at the Schools' Science Fair numbered many thousands. The Southern Area Committee must have felt well rewarded for all their hard work in organising such a highly successful exhibition.

HE'S THE CHAMP!

Harry Secombe presents a Philips battery tape recorder to thirteen-year-old Clifford Hones of Harlow, Essex. Clifford had just won the grand final in the Philips Electronic Engineer Kit competition at the TV and Radio Show, held recently at Earls Court, London. The competition was open throughout the Show for all children between 11 and 14 years of age.

BRITISH AMATEUR TELEVISION CLUB

The 1964 Convention of the British Amateur Television Club was held in the conference suite of the Independent Television Authority headquarters, London, on Saturday, 12 September.

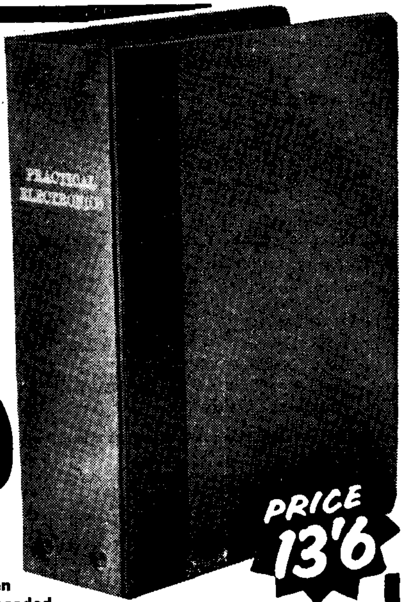
In the afternoon, following the general meeting, a number of papers were read, including one lecture on semiconductors delivered over the air from amateur television station G3OUO/T located at Wembley, Middlesex. Unfortunately, on this of all days, conditions were rather poor, and the picture quality was much below that normally obtained over such a distance (8 miles) with 70cm ham equipment. The sound also was marred at times by interference from radio altimeters. Despite this the lecture held the attention of most of those present.

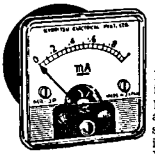
Steadily increasing interest in amateur television is evidenced by the fact that the membership of BATC has risen by 300 in the last two years. The 1k mark is likely to be reached any day now.

INTERNATIONAL RADIO COMMUNICATIONS EXHIBITION

Licensed hams and other radio and electronics enthusiasts will be flocking to the Seymour Hall, London, between 28 and 31 October: the occasion—the annual exhibition organised by the Radio Society of Great Britain.

The Society will be operating its own stations—with call signs GB3RS and GB2VHF—on the various amateur bands throughout the period of the exhibition. Amateur station equipment belonging to individual members will be on view, and the Royal Navy, the Army and the G.P.O. will provide educational displays.





CLEAR PLASTIC PANEL METERS

First grade quality, Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows:

Type MR. 38P. 1 21/32in. square fronts.

50μA	32/6	1A D.C.	22/6
100μA	29/6	5A D.C.	22/6
200μA	27/6	3V D.C.	22/6
500μA	25/-	10V D.C.	22/6
50-0-50μA	29/6	20V D.C.	22/6
100-0-100μA	27/6	50V D.C.	22/6
500-0-500μA	22/6	100V D.C.	22/6
1-0-1mA	22/6	150V D.C.	22/6
1mA	22/6	300V D.C.	22/6
5mA	22/6	500V D.C.	22/6
10mA	22/6	750V D.C.	22/6
50mA	22/6	15V A.C.	22/6
100mA	22/6	50V A.C.	22/6
150mA	22/6	150V A.C.	22/6
200mA	22/6	300V A.C.	22/6
300mA	22/6	500V A.C.	22/6
500mA	22/6	"S" Meter	
750mA	22/6	1mA	29/6

Type MR.52P. 2½in. square fronts.

50μA	57/6	100mA	32/6
100μA	47/6	1A D.C.	32/6
500μA	37/6	300V D.C.	32/6
50-0-50μA	57/6	300V A.C.	32/6
100-0-100μA	47/6	"S" Meter	
1mA	32/6	1mA	39/6
10mA	32/6		

Type MR.65P 3½ × 3¼in. fronts

50μA	59/6	1mA	35/-
100μA	49/6	10mA	35/-
500μA	39/6	100mA	35/-
50-0-50μA	59/6	1A D.C.	35/-
100-0-100μA	49/6	300V D.C.	35/-
VU meter	59/6	300V A.C.	35/-

Type MR-85P 4in. × 4in. sq. FRONTS

50μA	69/6	1mA	45/-
100μA	59/6	10mA	45/-
200μA	55/-	50mA	45/-
500μA	49/6	100mA	45/-
50-0-50μA	69/6	1 amp D.C.	45/-
100-0-100μA	59/6	5 amp D.C.	45/-
500-0-500μA	49/6	300 V A.C.	45/-
1-0-1mA	45/-	300V D.C.	45/-

POST EXTRA

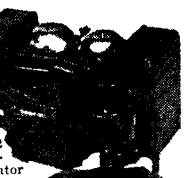
ILLUMINATED "S" METERS

Cal. in "S" units. 1mA basic. 1 21/32in. sq. front **29/6**. P. & P. 1/-. Ditto, 2 3/16in. sq. front, **39/6**. P. & P. 1/-.

MINIFLUX ½-TRACK TAPE HEADS

Set of three, record, playback, erase. Only **29/6** set. P. P. 9d.

FIELD TELEPHONES



Type "L" 2 line connection, generator bell ringing. Complete telephone intercom. Supplied in excellent condition, fully tested and complete with batteries, only **69/6** per pair. Carr. 5/-.

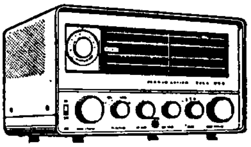
Type "F" As above but moulded bakelite case (as illustrated). Supplied complete with wooden transit case for field use. **£4/19/6** per pair. Carr. 5/-.

ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPE

Time base 2 c/s-750 kc/s. Calibrators at 100 kc/s and 1 Mc/s. Separate Y1 and Y2 amplifiers up to 5.5 Mc/s. Operation 110/230 volt A.C. Supplied in perfect working order. **£27/10/-**. Carriage 20/-.

BEST BUY!

Send 1/- P.O. for full Catalogue and Lists. Open 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.



NEW LAFAYETTE COMMUNICATION RECEIVER

MODEL HA-63. only **£27.10.0.** Carr. 10/-.

● 7 valves plus metal rectifiers ● 4 bands covering 550 kc/s.-31 mc/s. ● Illuminated "S" Meter ● 1.5 Microvolt Sensitivity ● Electrical bandspread ● Aerial trimmer ● Noise limiter ● B.F.O. ● R.F. stage ● Big slide rule dial ● Output or headphones or 4/8Ω speaker ● Modern steel cabinet size 13in. × 7 4/5in. × 10in. ● Operation 220/240 volt A.C. S.A.E. For Full Details. Matching Speaker in Cabinet 55/-.

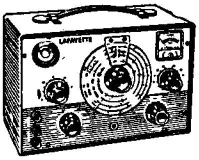
FULL RANGE OF OTHER LAFAYETTE RECEIVERS IN STOCK

MODEL HE-40. 4 Bands, 550 kc/s to 30 Mc/s. **£19.19.0.** Carr. 10/-

MODEL HE-30. 9 Valves, 4 Bands, 550 kc/s to 30 Mc/s. **£35. 0.0.** Carr. 10/-

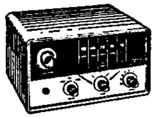
Each receiver supplied brand new and fully guaranteed complete with manual. All models for operation on 220/240 volt A.C. S.A.E. for illustrated leaflet. Generous part exchange allowances.

LAYFAYETTE PRECISION TEST EQUIPMENT



Modern range of precision test equipment for the service man. Supplied brand new and guaranteed with manual. For operation on 220/240 v. A.C. **TE-20A Signal Generator.** 120 kc/s-360 Mc/s on 6 bands directly calibrated. Variable R.F. Attenuator. Variable audio output. **£12/19/6.** Carr. 5/-. **TE-46 Capacity Resistance Analyser.** Ranges 2 PF-2,000 Mfd.; 2 ohms-200 Megohm. Also checks impedance, turns ratio, insulation. **£15.** Carr. 5/-. S.A.E. for full details.

LAYFAYETTE "PRECON" AMATEUR PRESELECTOR CONVERTOR



★ Crystal controlled. ★ For 80-40-20-15-10 Metre Bands ★ As a convertor—converts your receiver to dual conversion ★ Improves selectivity ★ Widens bandspread ★ High signal to noise ratio ★ Improved image reflection ★ Self powered ★ Modern styling. SPECIFICATIONS. 80, 40 Metres preselector only. 20, 15 and 10 metres preselector and convertor. GAIN: Preselector, 36db at 80 metres; convertor, 22db at 20 metres. OUTPUT FREQUENCY: 3.5-3.85 Mc/s on 20M. Band. 3.5-3.95 Mc/s on 15M Band, 3.5-5.2 Mc/s on 10M. Band. VALVES: 2—6BA6, 1—6BL8. CONTROLS: Aerial trimmer, function, bandswitch, gain. Two stages of RF.AMP. Sensitivity and stability excellent. 3 crystals are included for 20, 15 and 10M Bands. SIZE: 10in. × 6in. × 8in. Operation 220/240 v. A.C. **19 gns.** Carriage 7/6. S.A.E. for full details.

LAFAYETTE BRAND RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in.	200ft. L.P. mylar	4/-
3¼in.	600ft. T.P. mylar	10/-
5in.	600ft. std. plastic	8/6
5in.	900ft. L.P. acetate	10/-
5in.	1,200ft. D.P. mylar	15/-
5¾in.	1,200ft L.P. acetate	12/6
5¾in.	1,800ft. D.P. mylar	22/6
7in.	1,200ft. std. mylar	12/6
7in.	1,800ft. L.P. acetate	15/-
7in.	1,800ft. L.P. mylar	20/-
7in.	2,400ft. D.P. mylar	25/-

Postage 2/-. Over £3 post paid.

CHASSIS PUNCH SET

Set of 5 popular size hole cutters, ⅝in., ⅞in., ¾in., 1in., 1⅛in. Supplied complete with punches, dies, T drive handle, tapered reamer, fitted leather case and instructions. **49/6.** P.P. 2/-.

BRAND NEW DOUBLE BEAM C.R.T.s.

Cossor 89D. **59/6.** P.P. 4/6. Dumont K1051P1. **59/6.** P.P. 4/6.

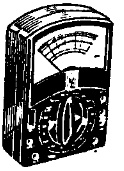
MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Complete with instructions. **39/6.** Carr. 10/-. Battery **8/6.** extra.

MAINS ISOLATION TRANSFORMER

230V. to 230V. 50W. **16/6.** P.P. 3/-; 100W. **29/6.** P.P. 3/6; 1,000W. £5. Carr. 10/-.

MULTI-METERS



Brand New—Fully Guaranteed—Lowest ever prices

Supplied with leads, batteries, instructions

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/1/100/500 MA. D.C. 0/100 kΩ. **39/6.** P. & P. 1/6.

MODEL 500. 30,000 o.p.v. 0/.5/1/2.5/10/25/100/250/500/1,000V D.C. 0/2.5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA 12 amp. D.C. 0/60K/6 Meg/60 MegΩ. **£8/17/6** Post Paid.

MODEL NH-400 10,000 O.P.V. 0/.3/3/30/120/300/600/1,200 v. D.C. 0/12/60/120/300/1,200 v. A.C. 0/120 μA/30/300 MA. D.C. 0/2K/200K/2 Meg.Ω. 100 PF.—.2 MFD **79/3.** P. & P. 2/6.

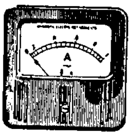
MODEL AR-620 20,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/500μA/10/250 MA. 0/10K /100k/1 Meg.Ω. 250 PF—.02 MFD. 0.500 Henrys **92/6.** P. & P. 2/6.

MODEL NH-201 30,000 O.P.V. 0/.25/1/10/50/250/500/1,000 v. D.C. 0/10/50/250/500 v. A.C. 0/50μA/10/250 MA. 0/5K/500K/5 MegΩ. **99/6.** P. & P. 2/6.

MODEL ITI-2. 20,000 O.P.V. 0/5/25/250/500/2,500 v. D.C. 0/10/50/500/1,000 V. A.C. 0/50μA/25/250 mA. D.C. 0/60K/6 Meg. Ω. .01-3 MFD. **82/6.** P. & P. 2/6.

MODEL TE-12 20,000 O.P.V. 0/.06/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 MA. 0/6K/600K/6 Meg./60 Meg. Ω. P.F.-2 MFD. **£5/19/6.** P. & P. 2/6.

MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 V.D.C. 0/10/50/500/2,500 V.A.C. 0/2 MegΩ. 0/250 mA. — 20 to + 36 db. **94/6.** P.P. 2/6.



BAKELITE PANEL METERS

First grade quality 3½in. square fronts.

		5mA	29/6
		10mA	29/6
		50mA	29/6
		100mA	29/6
		1A D.C.	29/6
		5A D.C.	29/6
25μA	65/-	*1A A.C.	29/6
50μA	42/6	*5A A.C.	29/6
100μA	39/6	*10A A.C.	29/6
500μA	35/-	*30A A.C.	29/6
50-0-50μA	42/6	*50A A.C.	29/6
100-0-100μA	39/6	300V D.C.	29/6
50mv.	39/6	*300V A.C.	29/6
100mv.	39/6	300V A.C.	35/-
1mA	29/6	VU Meter	49/6

*Moving iron, all others moving coil

POST EXTRA.

VARIABLE VOLTAGE TRANSFORMERS

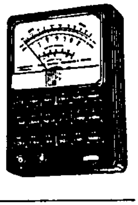
Pri. 230V. Sec. 0-260V. 1 amp. **£4/10/-**; 2½amp. **£5/17/6**; 5 amp. **£9**; 8 amp. **£14/10/-**; 10 amp. **£16/10/-**; 12 amp. **£18/15/-**; 20 amp. **£32/10/-**. All fully shrouded.

SILICON RECTIFIERS

400 v. P.I.V. 4.7 amp. (SCR)	7/6
400 v. P.I.V. 3 amp.	7/6
200 v. P.I.V. 6 amp.	5/6
1,000 v. P.I.V. 650 mA	7/6
800 v. P.I.V. 500mA.	5/6
400 v. P.I.V. 500mA.	3/6
200 v. P.I.V. 200 mA.	3/-
95 v. P.I.V. 3 amp.	5/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165mA.	1/-

Discounts for quantities. Post extra.

TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER



Large clear plastic scale, simple operation, D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA. Decibels — 20 to + 36 db. Size 6in. × 4 3/16in. × 2¼in. Complete with leads, batteries and instructions. **£5/19/6.** P. & P. 2/-.

MARCONI TF 144G/4 STANDARD SIGNAL GENERATORS

First release of this late mark. 85 kc/s to 25 Mc/s. ±1%. Output variable from 1μV. to 1 volt. Internal sine wave, modulation 400 c/s up to 75% depth. Operation 200/250 volt A.C. Offered in really excellent condition, like new, fully tested and guaranteed, **£25.** Carr. 30/-.

TRIPLETT SIGNAL GENERATOR 1632

10 RANGES: 100 kc/s-120 Mc/s. on fundamentals. Six valves, stabilised. H.T. FULLY ATTENUATED OUTPUT, 100μamp. carrier level meter. 1 Mc/s. xtal check. Operation 115 V.A.C. Supplied in perfect working order. **£12.** Carr. 10/-. (230/115V. Transformer **12/6** extra.)

OSCILLOSCOPE OS-57/USM-38

Brand new high quality American oscilloscopes incorporating 3in. tube, printed circuit and miniature valves. Time base 1, 10, 100 1K and 10KμS/in. Calibration markers, 1, 10, & 100μS. Calibrated Y input volts, X expansion, sweep stability. Operation 115 V.A.C. Supplied brand new, fully tested with test leads, probe and circuit diagram. **£29/10/-** each. Carr. 10/-. (230/115V. Transformer **18/6** extra.)

2 WAY RADIOS

New Improved Models. **TYPE 1.** 3 transistor. Range up to 1 MILE **£8/17/6 per pair.**

TYPE 2 9 transistor. Range up to 5 miles. **£21. per pair.**

Postage extra. S.A.E. for full details.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

EVERYTHING YOU NEED...

TRANSDUCERS

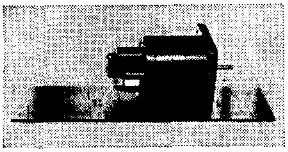
For remote ultrasonic control systems

Gulton Transducers can be used for simple remote control without cables or electronic links, two units only being required. The Transducers are suitable for both transmitting and receiving. Ideally suited for the experimenter and designer for remote control systems of all kinds. Free TX/RX circuit with each order.

55/- **each** ***or two for £5***

Components for use with the Transducers:

QHF9 Transformer	**4/- each**
Set of 3 transistors	**15/-**
Low current reed relay .. .. .. (7v.9A)	**24/- each**



MICRO-MOTORS

This new Sleyride Motor is precision made and prototype tested by RAE Farnborough. Only 1 in. dia., 2 in. long and weighs only 1.3 oz. Rated 1/1000 h.p., normal running speed 5,000 r.p.m. Spindle dia. 3/32 in., length 11/32 in. For 1½, 6 or 12 v. Reversible.

25/- each
plus 1/6 p. & p.

TRANSISTOR TESTER

The Unique

D.909

Tests Alpha Gain (A.C. Gain) and Beta Gain (D.C. Gain) with transistors in place. Facilities also provided for testing leakage between Collector and Emitter and Collector Base. Exclusive Variable Voltage Smoothed D.C. Power Supply, continuously variable from 0/25 v. up to 25mA. Output voltage can be used as centre-tapped voltage supply enabling modern transistorised receivers to be tested. **£10 each**

Send S.A.E. for detailed leaflet

from direct TV Replacements LTD

The DTV Group hold the largest stocks of the widest range of rectifiers, valves, test equipment, transformers, components and accessories off all kinds.
Send s.a.e. for free lists. Terms of Business: C.W.O. or C.O.D.

Dept. P.E., 126 Hamilton Road, West Norwood, London, S.E.27
Telephone: GIPsy Hill 6166 (PBX)

SOLDER WITH
PRIMAX and PRIMAXA
SUPER EFFICIENT SPOTLIGHT
SOLDERING GUNS

PRIMAX
60W SPOTLIGHT
86/8 ea.

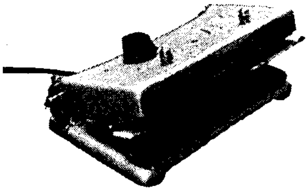
PRIMAXA
100W SPOTLIGHT
112/8 ea.

Distributors: S. KEMPNER LTD., LONDON, W.1
29 PADDINGTON STREET, Tel.: HUNter 0755

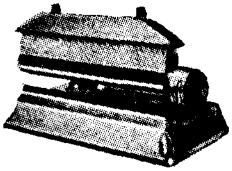
ZEVA

BRAND

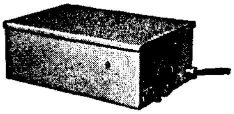
HAND AND FOOT-OPERATED SEALING TOOLS
FOR ALL KINDS OF PLASTICS



The "PACKFIX" for cellophane and polythene bags. Hand or foot-operated, all voltages. From £10.

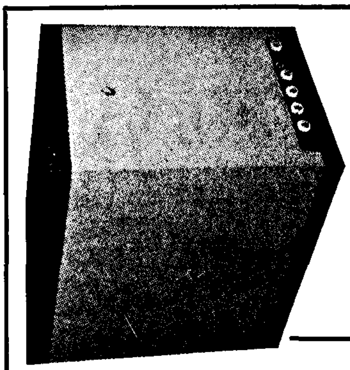


FLT cellophane and polythene bag sealer. Foot operated or magneto electrically driven. Seals bags up to 15¼" width. From £42.



Hot plates thermostatically controlled. Small and large sizes for cellophane, polythene and shrinking foils. From £12.

LET US SOLVE YOUR SEALING PROBLEMS.
WRITE FOR COMPLETE ILLUSTRATED LISTS
TO DISTRIBUTORS:
S. KEMPNER LTD., 29 PADDINGTON ST., LONDON, W.1
TEL.: HUNTER 0755



BASS-MAJOR 30 WATT GUITAR AMPLIFIER

A MULTI-PURPOSE HIGH FIDELITY, HIGH OUTPUT UNIT FOR VOCAL AND INSTRUMENTALIST GROUPS

Eminently suitable for bass, lead or rhythm guitar and all other musical instruments

- ★ **Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter speech coils. Designed for efficiently handling full output of amplifier at frequencies down to 25 c.p.s.**
- ★ **Dual Cone in second speaker reproduces frequencies up to 17,000 c.p.s.**
- ★ **Heavily made cabinet of convenient size 24 x 21 x 14in. has an exceptionally attractive covering in two contrasting tones of Vynair.**
- ★ **For 200-250 v., 50 c.p.s., A.C. mains operation.**
- ★ **Four jack socket inputs and two independent volume controls for simultaneous connection of up to four instrument pick-ups or microphones.**
- ★ **Separate bass and treble controls providing more than adequate "Boost" or "Cut".**
- ★ **LEVEL frequency response throughout the audible range.**
- ★ **SUPERIOR TO UNITS AT TWICE THE COST.**

39½ Gns.

Send S.A.E. for leaflet OR DEPOSIT of £4.3.0 and 12 monthly payments of £3.9.11. Carr. 17/6.

R.S.C. G5 GUITAR AMPLIFIER

5-watt high quality output. Incorporating high flux 12in. 10 watt 12,000 line loudspeaker. Sensitivity 50 m.v. High impedance jack input. Handsome strongly made cabinet (size 14 × 14 × 7in. approx.) finished in complementary shades of Rexine/Tygan. 200-250 A.C. mains.

£9.19.6 Or DEPOSIT **22/3** and 9 monthly payments of **22/3.** Carr. 7/6.

LINEAR TREMOLO/PRE AMP. UNIT

Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. L.T. This applies to practically all amplifiers of our manufacture, and to those of several other manufacturers. The unit plugs into power supply point and any input socket or amplifier. Controls are Speed (frequency of interruptions), Depth (for heavy or light effect), Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY **4 Gns.**

R.S.C. 30-WATT ULTRA LINEAR

HIGH FIDELITY AMPLIFIER A10

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 dB down. Frequency response ±3 dB 30-20,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS,** etc. For use with Electronic **ORGAN, GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for **19/9.** The amplifier can be supplied, factory built with EL34 output valves and 12 months' guarantee, for **14 gns.** Send S.A.E. for leaflet.

11 Gns.
Carr. 10/-

TERMS: DEPOSIT 33/9 and 9 monthly payments of 33/9. Suitable mikes & spkrs. available at competitive prices.

FANE HEAVY DUTY HI-FI SPEAKERS

12in. 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.

122/10 20 watt, **5** gns.	122/10A 20 watt, **6** gns.
122/12 20 watt, **7** gns.	122/12A 20 watt, **8** gns.
122/14 22 watt, **9** gns.	122/14A 22 watt, **10** gns.
122/17 25 watt, **£11.17.6**	122/17A 25 watt, **£12.17.6**

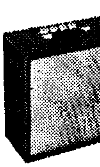
15in. 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.

152/12 20 watt, **12** gns.	152/12A 20 watt, **13** gns.
152/14 27 watt, **14** gns.	152/14A 27 watt, **15** gns.
152/17 35 watt, **16** gns.	152/17A 35 watt, **17** gns.

"A" indicates dual cone type. 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

FANE EXTRA HEAVY DUTY LOUDSPEAKER 15in. TYPE 153. 40 watts. Total flux 375,000 lines. Extremely high sensitivity. 15 ohm voice coil. Only **18 gns.** or Deposit **37/6** and 12 monthly payments of **31/6.**

R.S.C. SENIOR 15 WATT LEAD or RHYTHM GUITAR AMPLIFIER



High-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-ups can be used at the same time. Loudspeaker is a heavy duty high flux 12in. 20 watt model with cast chassis. Cabinet is well made and finished as Junior Model. Size approx. 18 × 18 × 8in.

Only **19 Gns.** Carr. 10/-

Send S.A.E. for leaflet. Or DEPOSIT **39/11** and twelve monthly payments of **33/4.**

R.S.C. B20 BASS GUITAR AMPLIFIER

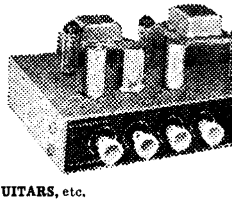
A highly efficient unit incorporating a massive 15in. high flux loudspeaker specially constructed to withstand heaviest load conditions. Rating 25 watts. Individual bass and treble controls give ample "boost" and "cut". Two high impedance jack socket inputs are separately controlled. All controls are conveniently positioned in a recess on top of the cabinet. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair. Size approx. 24 × 21 × 13in. Operation from 200-250 v. 50 c.p.s. A.C. mains.

Send S.A.E. for leaflet.

29½ Gns. Or Deposit **£3.2.0** and 12 monthly payments of **51/8.** Carr. 17/6.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram., as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response—3 dB 30-30,000 c/s. Six negative feedback loops. Hum level 60 dB down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs for **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, LEAD OR RHYTHM GUITARS,** etc.

OUTPUT SOCKET with plug provides 300 v. 30 mA, and 6.3 v. 1.5 a. for supply of a **RADIO FEEDER UNIT.** Size approx. 12 × 9 × 7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speaker. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-. (Or factory built **51/-** extra.)

If required louvred metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9** and 9 monthly payments of **24/9.** Send S.A.E. for illustrated leaflet detailing Cabinets, Speakers, Microphones, etc., with cash and credit terms.

R.S.C. CORNER CONSOLE CABINETS

Polished walnut veneer finish. Pleasing design.

JUNIOR MODEL. Size 20 × 11 × 8in. for 8 × 5in. or 10 × 6in. speakers, **£2.9.9.**

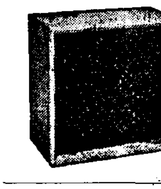
STANDARD MODEL. Size 27 × 18 × 12in. for 8 or 10in. speakers, **£4.11.9.**

SENIOR MODEL. Size 30 × 20 × 15in. for 12in. Speaker. Suitable Speaker systems below. Only **7 gns.**

R.S.C. BASS REFLEX CABINETS, JUNIOR MODEL. Specially designed for W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 × 12 × 10in. Handsome appearance. Ensures superb reproduction for only **£3.19.6.**

STANDARD MODEL. As above but for 12in. speakers. Size 20 × 15 × 13in. For vertical or horizontal use. **£5.19.6.** Set of legs with brass ferrules, **19/6.**

12in. 10-WATT HIGH QUALITY LOUDSPEAKER. In walnut veneered cabinet. Gauss12,000lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6.** Carr. **5/-.** Terms: Deposit **11/3** and 9 monthly payments of **11/3. 12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS.** Size 18 × 13 × 10in. Finish as above. Terms: Deposit **17/9** and 9 monthly payments of **17/9.** Only **£7.19.6.** Carr. 8/6.



AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker, crossover unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating **£4.19.9.** Carr. 5/-. Or Senior 15 watt, **£6.19.9.** Carr. 7/6.

HEAVY DUTY LOUDSPEAKERS IN SUBSTANTIAL REXINE COVERED CABINETS. Type BG1. Suitable for Bass Guitar. Speaker Unit 15in., High Flux, 15 ohms, 30 watts. Cabinet size approx. 24 × 21 × 13in. Only **19½ gns.** Or Deposit **43/-** and 12 monthly payments of **34/-.**

R.S.C. (MANCHESTER) LTD.

MAIL ORDERS TO: ROOM 5, 54 WELLINGTON STREET, LEEDS 1.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries, please. Personal shoppers welcomed at any of the branches below. Open all day Saturday. **BRADFORD,** 54 Morley Street. Nr. Alhambra Theatre (Half-day Wednesday). **BRISTOL,** 14 Lower Castle Street, Open 5th October. **BIRMINGHAM,** 6 Gt. Western Arcade, opp. Snow Hill Station (No half-day). **DERBY,** 26 Osmaston Rd., The Spot (Half-day Wednesday). **DARLINGTON,** 13 Post House Wynd (Half-day Wednesday). **EDINBURGH,** 133 Leith Street (Half-day Wed.). **GLASGOW,** 326 Argyle Street (Half-day Tuesday). **HULL,** 51 Savile Street (Half-day Thursday). **LEICESTER,** 32 High Street (Half-day Thursday). **LEEDS,** 5-7 County (Mecca) Arcade (No half-day closing). **LIVERPOOL,** 73 Dale Street (No half-day closing). **LONDON,** 238 Edgware Road (Half-day Thursday). **MANCHESTER** 8-10 Brown St. (Market St.) (No half-day). **MIDDLESBROUGH,** 106 Newport Rd. (Half-day Wednesday). **SHEFFIELD,** 13 Exchange Street, Castle Market Bldgs. (Half-day Thursday).

TRANSISTORS

AC113	5/6	OA79	3/-	OC74	8/-
AC115	4/-	OA81	2/-	OC75	5/6
AC155	4/-	OA85	3/-	OC76	8/6
AC156	5/6	OA86	4/-	OC78	8/-
AC154	5/6	OA90	3/-	OC79	8/-
AC157	7/-	OA91	3/-	OC81	5/6
AD140	25/-	OA95	3/6	OC82	10/-
AF102	27/6	OC16W	35/-	OC83	4/-
AF114	11/-	OC19	25/-	OC84	8/-
AF115	10/6	OC26	25/-	OC139	8/-
AF116	5/-	OC35	12/-	OC140	19/-
AF117	9/6	OC36	21/6	OC141	31/-
AF118	20/-	OC41	8/-	OC169	10/-
AF124	11/-	OC42	6/-	OC170	8/6
AF125	10/6	OC43	12/6	OC171	6/-
AF126	10/-	OC44	5/-	OC200	10/6
AF127	9/6	OC45	5/-	OC201	29/-
BY100	7/6	OC70	6/6	OC202	24/6
BY114	6/-	OC71	4/3	OC203	13/-
GET113	6/9	OC72	5/6	OC204	19/-
GET114	6/6	OC82	8/-	MAT100	7/9
GET115	9/6	2xOC72 ..		MAT101	8/6
GET116	17/-	matched		MAT120	7/9
OA70	3/-	pair	16/-	MAT121	8/6
OA73	3/-	OC73	16/-	ADT140	15/-

SETS OF TRANSISTORS

Set No. 1: comprising OC44, 2 × OC45, OC81, matched pair OC81 **20/-.**

Set No. 2: comprising OC81, matched pair OC81 **10/-.**

CATALOGUE

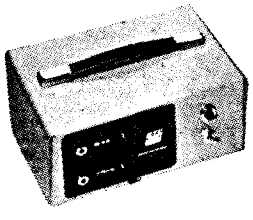
Our latest 1964/65 Catalogue is now available. Copies have been sent to many of our regular customers. If you have not received your copy please drop us a card. Please send 1/- in stamps.

TERMS: Cash with Order or C.O.D. Postage and Packing Charges extra. Single valves 9d., Minimum Parcel Post charges 2/-. Please include sufficient postage with your order. Minimum C.O.D. fees and postage 3/6. These Postal Rates apply to U.K. only. For full terms of business see inside cover of catalogue. Personal shoppers 9 a.m. to 5 p.m. Mon. to Friday, Saturday 10 a.m. to 1 p.m.

ALPHA

RADIO SUPPLY CO.

103 LEEDS TERRACE
WINTOUN STREET
LEEDS 7



T615, 15 WATT TRANSISTOR AMPLIFIER

For use on
12 volt supply

FULLY ILLUSTRATED LEAFLET AVAILABLE

GOODMANS HIGH QUALITY FIDELITY LOUDSPEAKER UNITS

AXIETTE 8. Frequency range 40-15,000 c/s, rated 6 watts, resonance 65 c/s, impedance 15/16 ohms, **£5.5.7.**

AXIOM 10. Frequency range 40-15,000 c/s, rated 10 watts, resonance 45 c/s, impedance 15/16 ohms, **£6.5.11.**

AXIOM 201. Twin diaphragm 12″ unit. Frequency range 30-16,000 c/s, rated 15 watts, resonance 35 c/s, impedance 15/16 ohms, **£10.17.4.**

AXIOM 301. 12″ Twin diaphragm loudspeaker. Frequency range 30-16,000 c/s, rated 20 watts, resonance 35 c/s, impedance 15/16 ohms, **£15.4.6.**

AUDIOM 81. 15″ 25 watt, 15 ohm, available in two versions. Audiom 81 Bass — Audiom 81 Standard, **£25.0.0 each.**

AUDIOM 51. 12″ rigid die-cast chassis. Bass unit rated 15 watt, **£9.2.8.**

AUDIOM 61B. 12″, 20 watts, **£14.7.8.**

ELEGANZIA HIGH FIDELITY LOUDSPEAKER SYSTEM. Dimensions 27″ high × 20″ wide × 6¼″ deep. Frequency range 35 c/s to 15,000 c/s. Power handling capacity 15 watts. Impedance 15/16 ohms, **£27.10.0.**

LATEST GOODMAN MAXIUM LOUDSPEAKER SYSTEM. Available in walnut or teak, **£17.10.6.**

HORN LOADED PRESSURE UNITS. High Frequency TREBAX 100-25 watts, **£6.10.2.** High Frequency TREBAX/20XL, **£7.7.0.** Mid-Frequency MIDAX 650-25 watts, **£9.19.6.**

COMPONENTS. Crossover XO/5000 **£2.0.11.** Crossover XO/960, **£5.10.11.** Crossover XO/950/5000, **£7.7.6.**

MULTI-RANGE TESTMETERS

Eagle TK20A, **£2.9.6.** Eagle EP10K, **£4.9.6.** Eagle EP20K, **£4.19.6.** Eagle EP30K, **£6.19.6.** Leather Case for above, **19.6.** Eagle EP50K, **£9.19.6.** Leather Case for above, **£1.9.6.** Caby M1, **£2.14.0.** Caby A10, **£4.17.6.** Caby B40, **£6.2.6.** Altham 200H, **£5.5.0.** Taylor 127A, **£10.10.0** Leather Case for above, **£2.5.0.**

RECORD PLAYER AND TAPE DECK UNITS

B.S.R. Monarch UA14, **£6.6.0.** Stereo Version, **£6.17.6.** B.S.R. Monarch UA15, **£6.19.6.** Stereo Version, **£7.15.0.** B.S.R. Monarch TU12, **£3.10.0.** Battery version of above, **£3.17.6.** B.S.R. Monarch GU7, **£3.17.6.** Battery version of above, **£4.4.0.** B.S.R. Monarch TD2 Tapedeck, 2 track, **£8.8.0.** 4 track version of above, **£9.9.0.** Garrard Autoslim, **£6.19.6.** B.S.R. Monarch TD10 Tapedeck, 2 track, **£9.9.0.** 4 track version of above, **£10.10.0.** Garrard Autoslim De Luxe Model AT6, **£11.5.0.**

THE COMMON CORE SERIES

COMMON-CORE

BASIC ELECTRICITY (5 parts) BASIC ELECTRONICS (6 parts)

BASIC SYNCHROS & SERVOMECHANISMS (2 parts)

BASIC ELECTRONIC CIRCUITS (2 parts)

WHAT READERS HAVE SAID ABOUT THEM—

"*. . . Thank you for sending BASIC ELECTRONICS. I read the first part last night and was more amazed as I read further. After reading the section on Filter Circuits once, I understood more about them than I have been able to find out in a whole year from the obscurities of other text books and manuals. Thank you for a really first class work . . .*"

"*. . . I think the Basic Books are the best I have ever read, and I've read a hell of a lot . . .*"

"*. . . A truly excellent publication, not in the least complicated by endless mathematics . . .*"

"*. . . The books are excellent and contain the information I have been seeking for years . . .*"

"*. . . Your books seem to explain things much more easily. I wish they were on sale when I had to learn radio . . .*"

COUPON - SEND NOW! **OR ASK YOUR BOOKSELLER**

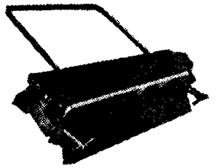
To **THE TECHNICAL PRESS LTD.**
112 Westbourne Grove, London, W.2.

Please send me your FREE prospectus describing
THE COMMON-CORE SERIES

Name ....
Address ....
.... PE

PARKER'S SHEET METAL FOLDING MACHINES

NEW BENCH MODEL



Capacity 36in. wide x 18-gauge mild steel. Forms channels and angles down to 45 deg., which can be flattened to give safe edge. Depth of fold according to height of bench. Will form flanges.

Weight approx. 2 cwt.

Price £23/0/0, carr. free. Also the well-known vice models of:

36in. x 18-gauge capacity ...	£11 10 0	Carriage free
24in. x 18-gauge capacity ...	£6 15 0	
18in. x 16-gauge capacity ...	£6 15 0	

One year's guarantee: money refunded without question if not satisfied. Send for details:

A. B. PARKER, Wheatcroft Works

WELLINGTON STREET, BATLEY, YORKS. Tel. 426

KITS

Top Band Receiver (also Medium wave BC)
£10 0s. 0d.

Top Band Transmitter (8 watts)
£14 0s. 0d. ready soon

NOMAD Car Radio (1 watt output) **£6 19s. 6d.**

Also Transistors (AF from 3/6; RF from 6/-)
components SAE list

Transistor power supplies from 35/-

Enquiries welcome about all types of kits, write in to:

NORCOL LTD., 147 London Road
Yorktown, Camberley, Surrey
Tel.: Camberley 3743

HEAVY DUTY SHROUDED AUTO TRANSFORMERS, 240-110 V. Fitted with 2 pin American sockets or terminal blocks. State which type. Brand new and Guaranteed. 1,000 watts, **£4.15.0**, carr. 5/-; 500 watts, **£3.10.0**, carr. 4/-; 300 watts, **£2.7.6**, carr. 3/6; 150 watts, **£1.17.6**, carr. 3/-.

2 KV. In metal case, with handle, 2 American socket outputs, **£9.10.0.** Carr. 7/6.

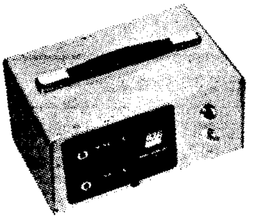
EX-MINISTRY INDUSTRIAL TYPES. Tapped 250, 240, 230, 220, 120, 115, 110, 105 volts 10 KVA, **£29.10.0**; 5 KVA **£19.10.0.** Ex warehouse. Both types enclosed in heavy metal case.

We have London's largest selection of Low Tension Transformers, Variable Voltage Transformers, Smoothing Chokes, Capacitors, Sliding Resistors, Low Tension D.C. Supply Units. Send for lists now, or visit our walk round dept., where we have thousands of genuine electronic bargains.

L.T. TRANSFORMERS

Pri. tapped 200-260 v. Sec. tapped 28, 29, 30, 31 v. 25 amps, conservatively rated, **£6.19.6.** carr. 10/-; Pri. 200-250 v. Sec. 25-0-25 v. 7 amps, pri. earth shielded, **£5.17.6**, carr. 7/6; Pri. tapped 200, 225, 240 v. Sec. tapped 12, 18, 24, 30, 36 v. 10 amps, **£5.15.0**, carr. 7/6; Pri. 240 v. Sec. tapped 4, 6, 11 v. 200 amps, **£10.19.6**, carr. 10/-; Pri. 240 v. Sec. tapped 53.5, 55.2 v. 6 amps, **£3.17.6**, carr. 7/6: Pri. 220-240 v. Sec. tapped 6-12 v. 20 amps, **£3.12.6**, carr. 6/-. Pri. 230 v. Sec. 70 v. 5 amp. "C" core sealed, **£4.5.0**, c. 7/6. Hundreds more available. Send for list now.

SAMSON'S ELECTRONICS LTD.
9-10 CHAPEL STREET
LONDON, N.W.1.
Tel. PAD 7851 Tel. AMB 5125



T615 PORTABLE
12v. TRANSISTOR
AMPLIFIER
15wt. OUTPUT
INBUILT MICROPHONE
PRE-AMPLIFIER

Details and Nearest Stockist from:

Messrs. E. K. ELECTRONICS (I.A.) LTD.
BROTHERTON HALL, BROTHERTON
KNOTTINGLEY, YORKSHIRE

RETURN-OF-POST SERVICE

We offer a really efficient Mail Order Service on all items stocked. All cash orders are dealt with on the day of receipt.
● Hire purchase orders are subject to slight delay but this is kept to the absolute minimum.

● SPECIAL OFFER!! STEREO CARTRIDGES
RONNETTE 105 Stereo/Mono Cartridge. Complete with fixing bracket and styli. List 59/4. OUR PRICE **23/6.** Post Free.

● ILLUSTRATED LISTS
Illustrated lists are available on LOUDSPEAKERS, TAPE DECKS, TEST GEAR, GRAMOPHONE EQUIPMENT, AMPLIFIERS. Any will be sent free upon request.

● AMPLIFIER KITS
We have full stocks of all components for the Mullard 510, Mullard 3-3, Mullard 2 and 3 Valve Pre-amp, Mullard Stereo, Mullard Mixer.
Fully detailed list on any of these sent upon request.
Instruction Manual: All Mullard Audio Circuits in "Circuits for Audio Amplifiers", **9/5.** Post free.

VERSATILE HI-FI PRE-AMPLIFIER
ALL PARTS STOCKED FOR THIS DESIGN. Full details and list free on request.

● LATEST TEST METERS

	Cash Price	Hire Purchase Deposit	Mthly/Pmts.
AVO Model 8 Mark III	**£24. 0.0**	**£4.16.0**	12 of **£1.15.2**
AVO Model 7 Mark II	**£21. 0.0**	**£4. 4.0**	12 of **£1.10.10**
AVO Multiminor Mark 4	**£9.10.0**	**£1.18.8**	12 of **14/4**
T.M.K. TP10	**£3.19.6**	**£1. 3.6**	3 of **£1.2.0**
T.M.K. TP5S	**£5.19.6**	**£1.15.6**	3 of **£1.11.4**
T.M.K. Model 500	**£8.19.6**	**£1.15.6**	12 of **13/8**
TAYLOR MODEL 127A	**£10.10.0**	**£2. 2.0**	12 of **15/8**

Full details of any of the above supplied free on request.
The AVO models 7 and 8 are both latest models from current production—not to be confused with Government Surplus.

● TAPE RECORDING EQUIPMENT

TAPE DECKS

ALL CARRIAGE FREE	Cash Price	Hire Purchase Deposit	Mthly/Pmts.
COLLARO STUDIO, latest model,			
Two track, Bradmatic Heads	**£10.19.6**	**£2. 3.6**	12 of **16/4**
Four Track, Marriott Heads	**£17.17.0**	**£3.12.0**	12 of **26/2**

MARTIN TAPE AMPLIFIER KITS

Tape Amplifiers
For Collaro 8311-V 2-Track **£11.11.0.** 8311-4-V 4-Track **£12.12.0.**
Tape Pre-amplifiers
For Collaro 8319-CP 2-Track **£8.8.0.** 8319-4-CP 4-Track **£9.9.0.**
Drop through assembly for mounting 8319 Pre-Amp under Collaro Deck, **£1.11.6.**
Carrying Cases with speaker. For Collaro Deck and 8311 Amplifier, **£5.5.0.**
H.P. TERMS available on decks, amp. and cases. Ask for quote.

MULLARD TAPE PRE-AMPLIFIER KIT

We stock complete kits and all separate components for the Mullard Tape Pre-Amplifier. Fully detailed list available.

● GRAMOPHONE EQUIPMENT

ALL LATEST MODELS ALL POST FREE	Cash Price	Hire Purchase Deposit	Mthly/Pmts.
RECORD CHANGERS			
GARRARD AUTOSLIM (Mono PU) ..	**£6.17.6**	**£1.12.6**	6 of **£1**
GARRARD AUTOSLIM De-luxe AT6 (Mono PU)	**£11. 9.0**	**£2. 6.0**	12 of **16/11**
GARRARD AUTOSLIM AT6 (Stereo/Mono PU)	**£12. 5.4**	**£2. 9.4**	12 of **18/-**
B.S.R. UA14 (TC8 Mono PU)	**£6.15.0**	**£1.10.0**	6 of **£1**
B.S.R. UA14 Monarch (TC8 Stereo/LP/78)	**£7.15.0**	**£1.18.0**	6 of **£1.2.0**
B.S.R. UA15 (TC8 Mono PU)	**£7.15.0**	**£1.18.0**	6 of **£1.2.0**
B.S.R. UA15 (TC8S Stereo/LP/78) ..	**£8.15.0**	**£2. 6.0**	6 of **£1.4.0**

Many of the above can be supplied for stereo working. See our Gramophone Equipment List for details.

● JASON F.M. TUNERS
We stock all parts needed for the construction of these excellent tuners. All parts can be supplied separately but we can offer attractive reductions in price if all items are purchased at same time as follows:

FMT2 (less power), £7.15.0.; FMT2 (with power), £9.12.6.
FMT3 (less power), £9.9.6.; FMT3 (with power), £11.7.6.
FMT1, £6.12.6.; Mercury 2, £10.14.6.; JTV/2, £14.12.6.
Hire Purchase Terms available. Ask for list.

● HI-FI LOUDSPEAKERS
GOODMANS: Axiette 8in., **£5.5.7**; Axiom 10in., **£6.5.11**; 12in. Axiom 201, **£10.17.4**; 12in. **Axiom 301, £15.4.6**; 12in. **Audiom 51 Bass, £9.2.8**; 12in. **Audiom 61 Bass, £14.7.8; Trebax Tweeter, £6.10.2;** XO5000 **Crossover unit, £2.0.11.**
WHITELEY: HF1016 10in., **£7.7.0; HF1012** 10in., **£4.12.0; HF816** 8in., **£6.6.0; T816** 8in., **£5.19.6; T10 Tweeter, £4.12.0; T359 Tweeter, £1.12.3; CX3000 Crossover unit, £1.1.3; CX1500 Crossover unit, £2.2.0.** H.P. Terms available on all speakers.

● OUTPUT TRANSFORMERS
GILSON: W0696A, W0696B, **60/6**, post 2/6. W0892, **75/-**, post 2/9. W0767, **32/6**, post 1/6. W01796, **66/-**, post 2/6. W1796A, **66/-**, post 2/6. W01932, **92/6**, post 3/-.
PARTRIDGE: P3667, **75/-**, post 2/9. P4131, **75/-**, post 2/9.
PARMEKO: P2629, **49/9**; P2642, **47/3**; P2643, **49/9.** All plus post 2/9. P2641 **30/9**, post 2/-; P2929, **16/9**, post 2/-; P2932, **43/-**, post 2/6.

● MAINS TRANSFORMERS
GILSON: W0741A, **75/-**, post 4/-; W0839, **58/6**, post 2/9; W01228, **69/6**, post 3/6; W01288, **69/6**, post 3/6; W01566, **96/-**, post 4/6; W01341, Choke, **43/-**, post 2/-.
PARMEKO: P2631, **37/-**, post 2/9; P2630, **57/3**, post 3/3; P2644, **80/-**, post 4/-; P2930, **43/-**, post 3/-; P2931, **59/6**, post 3/3.

WATTS RADIO (Mail Order) LTD
54 CHURCH STREET, WEYBRIDGE, SURREY
Telephone Weybridge 47556
Please note: Postal business only. Callers welcome by appointment.

★ TERMS OF BUSINESS
Cash with order or C.O.D. We charge C.O.D. orders as follows: Up to £5 minimum of 4/2. Over £5 and under £10, 2/8. Over £10, no charge. **Postage extra on CASH order under £5 except where stated. Postage extra on overseas orders irrespective of price.**
★ HIRE PURCHASE TERMS AVAILABLE

Practical Electronics Classified Advertisements

The pre-paid rate for classified advertisements is 1/- per word (minimum order 12/-), box number 1/6 extra. Semi-displayed setting £3.5.0 per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL ELECTRONICS and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post.* Advertisements, together with remittance, should be sent to the Advertisement Manager, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, WC2, for insertion in the next available issue.

TAPE RECORDERS, TAPES, ETC.

TAPE TO DISC RECORDING. 10in LP, **42/-**; 12in LP, **48/-**; 7in EP, **21/-**. S.A.E., Leaflet, DEROY SOUND SERVICE, 52, Hest Bank Lane, Hest Bank, Lancaster. Tel.: HB.2444.

SPEAK . . . LISTEN . . . to the World through "Worldwide Tapetalk". S.A.E. for particulars: THE GARDENS, Harrow, Middlesex.

AMERICAN LAFAYETTE High Quality Recording Tape, 7in Spools, Extra Play, 1,800ft **15/-** Reel (sent to any Address). MAZEL RADIO, 134, London Road, Manchester 1, Lancs.

FOR QUALITY consult our sixty-page (photographically illustrated) latest Hi-Fi equipment catalogue (**4/6d.**). Unbiased advice, preferential terms to members, LP-s from your precious tapes. AUDIO SUPPLY, 10 Clifford Street, London W.1.

MUSICAL INSTRUMENTS

SOLID RHYTHM ELECTRIC GUITAR (Far Eastern Import) with Lead, etc., and 15 watt Shaftesbury 'Mazeltoff' Guitar Amplifier with 10in H.D. Speaker. **£25** pair. MAZEL RADIO/MUSICALS, 124-138, London Road, Manchester, Lancs. Phone: Manchester, Ardwick 3505.

METAL WORK

CABINETS • CASES
CHASSIS

Anything in metal. **"One-offs"** a pleasure
Send your drawing for quote
Stove enamelled in any professional finish

MOSS, WATSON

40 Mount Pleasant Street, Oldham, Lancs. *MAIN* 9400

MISCELLANEOUS

CONVERT ANY TV SET into an Oscilloscope. Diagrams and Instructions, **12/6**. REDMOND, 26, St. Johns Road, Hove, Sussex.

HAMMER FINISH PAINT. The modern finish for electronics. Can be brushed or sprayed. Blue or silver, 2½oz tins **3/6**, ½ pint **7/6**, 1 pint **15/-**. Post 6d. on any order. Trade supplied. FINNIGAN SPECIALITY PAINTS, (PE), Mickley Square, Stocksfield, Northumberland.

SERVICE SHEETS

GENUINE SERVICE SHEETS, Radio/TV/T Recorders. S.A.E. with enquiries: REDWATT ELECTRICAL, 41, Denmark Street, Wakefield, Yorks.

SERVICE SHEETS, Radio, TV, etc.; List 1/-. S.A.E. Enquiries: TELRAY, Maudland Bank, Preston.

STATE MODEL NO. Radio **2/-**. TV **2/6**. S.A.E. DARWIN, 19, George Street, St. Helens, Lancs.

SERVICE SHEETS for all makes of Radio and TV 1925-1964. Prices from **1/-** with free fault-finding guide. S.A.E. inquiries. Catalogue of 6,000 models, **1/6**, Valves, modern and obsolete. Radio/TV Books. S.E.A. lists, HAMILTON RADIO, Western Road, St. Leonards, Sussex.

SERVICE SHEETS

4/- each, plus postage.

We have the largest display of Service Sheets for all makes and types of Radios, Televisions, Tape Recorders, etc. in the country, and can supply by return of post.

To obtain the Service Sheet you require, please complete the attached coupon:

From:
Name: ....
Address: ....
....
....

To: **S.P. DISTRIBUTORS**
44 Old Bond St., London, W.1

Please supply Service Sheets for the following:

Make: ....
Model No.: .... Radio/TV
Make: ....
Model No.: .... Radio/TV
Make: ....
Model No. ....

I also require list of Service Sheets at 1/6.

I also require list of Manuals at 1/-

(please delete items not applicable)

I enclose remittance of ....

MAIL ORDERS ONLY

SITUATIONS VACANT

RADIO TECHNICIAN

A number of suitably qualified candidates will be required for training, leading to permanent and pensionable employment. (Normally at Cheltenham but with opportunities for service abroad or appointment to other U.K. stations).

Applicants must be 19 or over and be familiar with the use of Test Gear and have had Radio/Electronic workshop experience. They must offer at least "O" level GCE passes in English Language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g. at 19 £722, at 25 £929 (highest pay on entry) rising by four increments to £1,067.

Prospects of promotion to grades in salary range £997–£1,634.

Annual Leave allowance of 3 weeks 3 days, rising to 4 weeks 2 days.

Normal Civil Service sick leave regulations apply.

Apply
Recruitment Officer (RT/)
Government Communication Headquarters
Oakley
Priors Road
Cheltenham

EDUCATIONAL

STUDY RADIO, TELEVISION AND ELECTRONICS with the world's largest home study organisation. I.E.R.E., City & Guilds, R.T.E.B., etc. Also Practical Courses with equipment. All books supplied. Write for FREE Prospectus stating subject to I.C.S. (Dept. 577), Intertext House, Parkgate Road, London, S.W.11.

A.M.I.MECH.E., A.M.I.E.R.E., City & Guilds, G.C.E., etc., bring high pay and security. "NO PASS—NO FEE" terms. Over 95% successes. For details of Exams and courses in all branches of Engineering, Building, Electronics, etc., write for 156-page Handbook—FREE. B.I.E.T., (Dept. 152), London, W.8.

Practical Electronics Classified Advertisements

CONTINUED

EDUCATIONAL

(continued)

HOME STUDY COURSES in Practical Electronics. Free Brochure without obligation from: BRITISH NATIONAL RADIO SCHOOL, Reading, Berks.

B.Sc.(ENG.), A.M.I.MECH.E., A.M.I.E.R.E., City & Guilds, etc., on "NO PASS—NO FEE" terms. Wide range of guaranteed Home Study Courses in Electronics, Computers, Radio, T.V., etc. 156-page Guide—FREE. Please state subject of interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, 151 College House, Wright's Lane, London, W.8.

FOR SALE

TRANSISTORS UNMARKED UNTESTED. 40 for **10/-**, P. & P. 1/-. 4 packets post free. Relays, thousands of types, special catalogue free. General Catalogue of Mechanical & Electrical Gear, Tools, etc., 5,000 items, free. K. R. WHISTON (Dept. PET), New Mills, Stockport.

625
Band
4.

T.V. AERIALS

B.B.C.
I.T.A.
F.M.

Complete to install. Money back guarantee **625. 8.El. 30/- 14 El. 40/- B.B.C.** H.Type **33/-** Fringe **68/- I.T.A. 5.El. 27/-** Double **5. 70/-** P. & P. 4/- C.W.O. Send S.A.E. for FREE fitting instructions and price list of all types of aerials.

ELECTRONIC INSTALLATIONS
81 Garstang Road, Preston, Lancs.

RELAYS, EX-GOVERNMENT. **£3** for 12, our selection, post paid. WALTONS WIRELESS STORES, 15 Church Street, Wolverhampton.

ELECTRIC SOLDERING IRON

FANTASTIC BARGAIN OFFER

ONLY 9/6
P. & P. 1/-

Lightweight Pistol Grip handle. 40 watt, 240 - 250v. A.C. Solid copper bit, detachable handle forms cover for iron when not in use. With 4½ft. Safety 3-core flex. Indispensable for every home handyman. *A boon to model makers and a necessity for every electronics enthusiast. Offered to you at this new amazing price.*

C. H. SERVICE (Dept. P.E.1)
Lusted Hall Lane, Tatsfield, Kent.

VENNER TIME SWITCHES reconditioned, 14-day clock, once on, once off every 24 hours, jewelled movement, fully guaranteed, 5 amp., **32/6**; 1 amp, **25/-**, P. & P. 2/6. A. R. BATCHELOR (P.E. Dept.), 4 Park Road, Bromley, Kent.

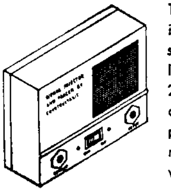
FOR SALE

(continued)

ARMATURE REWINDS. Hoover Junior Exchange Service. Models 375/119/1224, **32/6** inc. post. Fields **15/-**. Send for lists. JERVIS & TONGE LTD., Ringwood Road, Brimington, Chesterfield, Derbys. Tel. Chest. 75267.

5-TON FACTORY CLEARANCE, Radio, TV Electrical Components, in mixed parcels. Example: 28lb. mixed parcel **£1**, pp 7/6d. Speakers, grilles, valves, bases, i.f.s. covers condensers, etc. Hundred other items. S.A.E. List and Postal Orders to P. NEWTON, 16 Shalcross Crescent, Hatfield, Herts.

2 for price of ONE



The first combined transistorised signal injector plus signal tracer in same case. Injector covers 2 K/c to 2 M/c. Tracer has R.F. detector. Separate flexible probes. Small battery lasts months. Easy to assemble with all diagrams provided.

ONLY **47/6** in Kit Form
OR **60/-** Built and Tested } P. & P. 1/-

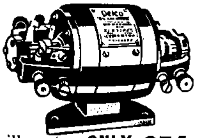
Send now, while stocks last, to—

CONSTRUCTAKIT
61 CEMETERY ROAD, GATESHEAD 8
Co. Durham.

CONDENSER BARGAIN! Miniature paper condensers, ½in × ⅜in. Ideal for transistor sets, .0001, .001, .002, .005, .02, .04μf. Your choice, **7/6d.** per 100 or **£3** per 1,000. G. F. MILWARD, 17 Peel Close, Drayton Bassett, Staffs.

TRANSFORMERS

ROTARY TRANSFORMERS



TV from your OWN Car Battery

Famous **DELCO** transforms 12 or 24v. supply to mains Power for TV, ¼" drills, etc. **ONLY 85/-** C.O.D. 2/6 extra. Carr. Paid.

SMALLER MODEL. 12/24v. input, 110/250v. output **22/6**

HOOVER ROTARY TRANSFORMERS. 6v. input, 250v. output. 12v. input, 490v. output. 32 watts. **Brand New** **25/-**
New but Store Soiled **21/-**

REMOTE CONTROL RELAY. 12 volts 40 amp. contacts. **Each 12/6**

INDOOR T.V. AERIALS. Single Dipole extending to 5ft. **Each 15/-**

VIBRATOR POWER-PAK. Step 12v. up to MAINS output. For Universal AC/DC razors, small fluorescent fittings, radios, etc. .... **Only 32/6**

LARGE ROTARY TRANSFORMER. 12v. input, over 1,200v. output. New. For experimental purposes **£5**

Send NOW—Delivery by Return

JAMES WALKER
ELECTRONICS DIVISION
36 Alexandra Street
Thurmaston, Leicester

WANTED

NEW VALVES WANTED
Any type, or quantity
CASH PAID
R.S.T. Valve Mail Order Co.
211A Streatham Road
Mitcham, Surrey
Telephone: MITCHAM 6202

RECEIVERS AND COMPONENTS

TRANSISTORS! Give-away price. NKT124/5 Power Type. 6 for **10/-**. 2SO17 4W, up to 60mc/s, **5/-** each. Post free, G. F. MILWARD, 17 Peel Close, Drayton Bassett, Staffs.

RESISTORS! You can't resist this! ½W, 1W, 2W Polythene wrapped on cards of 10. Mixed values and wattages. **£2/10/-** per 1,000. G. F. MILWARD, 17 Peel Close, Drayton Bassett, Staffs.

TESTED TRANSISTORS

All new, few equivalent.

OA202
1/- each, Red or White Spots.

2/- each, XA101, XA102, XB103, OA90, OC430, XA112, XA111.

3/- each, OC44, OC45, OC70, OC71, OC81, OC81D, OC200, GET16.

4/- each, AF114, AF115, AF117, OC170, OC171, SX658, XU611.

5/- each, OC72, OC139, OC140, OC204, ORP60, BY100, GET8.

10/- each, OC35, OC26, OC28, GET57, 2SO13. All new, few equivalent.

ZENER DIODES 4.7 v. to 33 volt ¼ watt, 3/6 each. 1.5 watt, 5/- each, 7 watt, 6/- each.

Send 3d. stamp for Full Price List and Free Equivalent Chart.

B. W. CURSONS
78 BROAD STREET
CANTERBURY, KENT

CONTINUED OVERLEAF

RECEIVERS AND COMPONENTS

(continued)

R. & R. RADIO & TV SERVICE

44 Market Street, BACUP. Tel. 465

SALVAGE VALVES

6F13	4/6	10P14	5/–	PL82	3/6	20P4	6/6
6L18	4/6	20P5	6/6	U801	7/6	30P16	5/–
EF80	1/6	30P4	7/–	10F1	1/6	PCC84	4/–
ECC82	3/–	6F15	5/–	20F2	5/6	PCL83	5/–
ECL80	3/–	EB91	1/–	30FL1	5/–	PY81	3/6
30F5	5/–	EF85	5/–	PY32	6/–	U301	6/–
PL38	6/–	EF37	6/–	6U4GT	5/–	10P13	5/6
PCF80	4/–	20P3	6/–	6F1	1/6	20D1	1/6
PL81	5/–	30PL1	6/–	ECC81	3/–	30P12	6/–
PZ30	5/–	PL36	6/–	EY86	4/–	PY82	4/–
U329	5/–	PCL82	5/–				

Post 6d. per valve, 3 or more post free.
Speakers ex T.V. 5 inch round 3/6, 6 by 4 inch 3/6, 8 inch round, 6/–, post 2/–.
Ex T.V. printed circuit panels, containing valve holders, resistors, condensers, etc., 5/6, post 2/–.
Assorted mains droppers ex T.V. 2/6 each, 10 £1.
Pre-set controls £1 per doz. assorted values, post 1/–, Resistors, New: ½ watt 3½d., 1 watt 5d., 2 watt 9d., all 10%. Silver mica, paper and electrolytics in stock. New Mullard transistors and condensers also in stock. S.A.E. with all enquiries. All goods subject to satisfaction or money refunded.

A.1 POST FREE BARGAINS. Guaranteed reclaimed valves. Send for full list to: Dept. MO/E, A.1 RADIO COMPONENTS, 14, The Borough, Canterbury, Kent.

TELEVISION TUBE SHOP

FOR

Unused, Guaranteed Tubes

OVER 2,000 IN STOCK

All prices from 50% to 75% of List Price

All tubes tested before despatch and Guaranteed for 12 months

CARRIAGE 10/- via B.R.S. or 15/- via passenger train

TERMS £2 down (plus carriage) and £1 per month

See our advertisement in PRACTICAL TELEVISION for exact prices, or write for details

TELEVISION TUBE SHOP

48 BATTERSEA BRIDGE ROAD
LONDON, S.W.11. BAT 6859
OPEN ALL WEEK AND SATS. UNTIL 4 p.m.

(Continued Facing Page)

Key Switch, 3 position, centre off, 3 c/o + 4 c/o, **6/-**

Ferox Cubes LA12, wound, **5/-**

Panel Lamps, Min. Liliput screw, White Bezel, **3/-**

DLR5 Headphones, with plug and socket, **12/6**

Min. Liliput screw bulbs, 12 volt, **1/6**

High Speed Relay, c/o 1,000 + 1,000 ohm, **6/6**

400 ohm P.O. Relay, 1B, **5/-**; 1B 1M, **6/-**

2,000 ohm P.O. Relay, 1M, **5/-**; 1M IB, **6/-**

G.P.O. Hand Sets, with Press to Talk in handle, **15/-**

G.P.O. Jack Plug, with lead, **3/-**

Isolated Jack Socket, **2/6**

Breast Set Mike, with fittings, **6/-**

500 Micro Amp Meter and Meter Switch, **15/-**

Toggle Switch, SP on/off, **2/6**

Push Button Switch, DP on/off, on when press only, **2/6**

Power Supply and LF Amplifier, N/O 1, **15/-** for N/O 38 set

6 core min. Cable, 3 amp screened PVC outer, **3/-** yard; 12 core ditto, both fitted with Plessey plugs and sockets, in 10 yard lengths only

New range of High Stability Resistors, 5% to 1%, ¼ to 5 watt, send for full lists.

Telescopic Drawer Slides, 17½in. to 29in., **12/6 pair**

Copper Laminate Board, single or double sided, **5/-** sq. ft., or 3ft. by 4ft. panels, **33/-**

Jones Plugs and Sockets, 4-12-18-24-32 way, **5/-** pair

Plessey Plugs and Sockets, 2-4-6-12-25 way, **5/-** pair

31 way P.O. Cable, **2/-** yard. Minimum 5 yards.

Ever Ready Batteries, 90V + 7½V, **4/6** or 12 for **30/-**

Mallory Mercury Cells, 6·75V, **3/6**

8 Tag Panels, with 150 Resistors, Condensers, Diodes, **10/-**

2ft. 9in. Mobile Aerials, **6/6**

30 meg. Oscillator Unit, 3 valve tunable to 27 meg., **12/6**

Parcel of ex-Government valves, 20 for **10/-**

Small Component Boxes, 7 divisions, 60 for **12/6**

Printed Circuit Preset Pots, 10K, **2/-**

115 volt Western Electric Magslips, **50/-** each

230 volt BTH Magslips, **90/-** each

Electro Magnetic Counters, P.O. 4 digit, **4/6**

Mu Metal Screen for 5UP7 tubes, **6/6**

30 + 30 pF Variable Condensers, **4/-**

¼ amp Fuses, **5/-** per 100, 1¼in. × ¼in.

Mic. Jacks, 3 for **3/-**

Small Instrument Cases, 5in. × 5in. front, 4¼in. deep, with grey plastic front, **6/-** each. Rack to house two of these, side by side, **7/6**

Transformer PL1101, output 7 volt at 4 amp, three times plus 7 volt at 125 mA, **18/-**

H.T. Transformers, 1,800 volt plus 1,800 volt at 500 mA, and 600 volt plus 600 volt at 500 mA, **60/-**

PARMEKO NEPTUNE TRANSFORMERS
115 volt or mains input. Output 450-0-450 at 260 mA; 275-0-275 at 45 mA; 132 volt at 20 mA; 30 volt at 30 mA; 6·4 volt at 16 amp; 6·4 volt at 4·5 amp; 6·3 volt at 1·2 amp; 5 volt at 6 amp. These are oil filled, packed in own drum, **70/-** each

PARMEKO NEPTUNE CHOKES OIL FILLED
10 henry at 260 mA, **22/-**; 15 henry at 45 mA, **12/6**; 5 henry at 20 mA, **6/6**

PAPER BLOCK CONDENSERS

MFD	Volts wkg	Price
1	350	**1/3**
1	500	**1/6**
1	600	**2/-**
1	800	**2/6**
1	1,200	**4/-**
1	3,400	**5/-**
2	350	**1/9**
2	700	**3/-**
2	1,000	**4/-**
4	400	**4/-**
4	600	**4/6**
4	800	**5/-**
4	1,200	**7/6**
4	2,000	**8/-**
8	400	**5/6**
8	600	**6/-**
10	250	**4/-**
10	700	**7/-**
0·5	5,000	**9/-**
2	2,000	**14/6**

ON ALL ORDERS UNDER 20/- PLEASE ADD 2/- POST AND PACKING

SUPER BREAKDOWN UNIT

Remote Control Unit Type F. New in sealed cartons, containing P.O. Relay 2,000 ohms Resistance, 100 volt Plessey Hand Generator, Telephone Ringing Bell A.C. 8 amp, Morse Key on base, 2 D.P. D.T. Key Switches, Double Phone Jack, moulded, 5 position 6 pole Yaxley Switch, Induction Coil tapped 1-17-33 ohms, 7 Brass Screw Terminals on panels, plus Resistors, Condensers, Pointer Knobs. All in a handy metal box with hinged lid and side fasteners. Also web carry strap. Size 10½in. × 10in. × 7in., **25/-**, post free. Or items may be purchased separately. Relay **5/-**, Hand Generator **7/6**, Bell **5/-**, Morse Key **4/6**, Key Switches **5/-** pair, Double Phone Jack **2/6**, Yaxley Switch **2/-**, Ind Coil 2/-, Terminals 7 for **2/-**, all post free.

Also available Key Switches. 4 pole 2 throw **3/6** each or 3 position D.P. plus D.P. centre off **5/-** or rotary switch 6 pole 3 way **3/-**.

Speakers, 3 ohm P.M. 5in. **5/-**, 6in. **6/-**, 7 × 4in. **7/-**, 8in. **8/-**, 10in. **12/6**.

U.K. ONLY

E. R. NICHOLLS

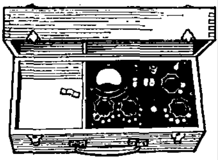
Mail Order and Retail Shop:

46 LOWFIELD ROAD off SHAW HEATH
STOCKPORT, CHESHIRE

RECEIVERS AND COMPONENTS

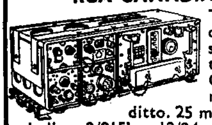
(continued)

WHEATSTONE BRIDGE



Centre Zero Galvanometer Scaled 20-0-20 2½in. movement. 2·5 mA. full scale deflection, 3 stud switch controls 0-10, 0-100 ohms, 0-Inf. Complete in carrying case with instructions, **45/-**. Post 5/-. Spare meters for above, **10/-**. P. 1/6.

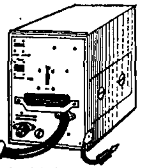
RCA CANADIAN No. 29



Transmitter/Receiver 2-8 Mc/s., separate Manual tuning R.F. and Osc., also preset motor operated ditto. 25 miniature valves including 2/815's. 12/24 v. d.c. operation. Unused condition. Outside case store soiled, **£12/10/-**. Carr. £2.

English version. Manual tuning only. Complete station, £8/10/-. Carr. £2.

CONVERTOR



Runs your mains shaver, radio, record player, etc., from car battery. New type vibrator converts 12 v. D.C. to 240 v. D.C. at 100 mA. Low drain. Brand new complete with spare fuses, battery clips, etc. 25/-. Carr. 7/6.

TRANSMITTER. 1·75-16 Mc/s., 3 waveband tuneable, grid modulation using 813. Used complete with all valves, circuit, **£7/10/-**. Carriage 10/-.

MOVING COIL HEADPHONES. BRAND NEW. Chamois padded, complete with jack plug, **15/6**. Post 2/-.

R.C.A. AR88D RECEIVERS. Brand new. **£75. Carriage 30/-. (Many other bargains.)**

A. J. THOMPSON,
"Eiling Lodge" Codicote, Hitchin, Herts.
Phone: Codicote: 242

---

2 METRES 4

The thrills of VHF Amateur Radio can now be yours for as low as 42/6 complete kit (by post, carriage and packing, 2/6 extra). Tuning range 70-150 Mc/s. Stamped addressed envelope for free copy of literature and full details. Newcomers to Short-Wave Radio ask for details of the famous "Globe-King" kits and receivers. Home and Overseas Sales.

JOHNSONS (Radio)
St. Martins Gate, Worcester

FOOTBALL POOL COMPUTER

Novel low-cost circuit for forecasting

Analogue Computer. Multiplication and division by electrical analogue. Simple demonstration of computer principles. Both above circuits for **3/6** post free.

Noughts and Crosses Machine. Full circuit and instructions for our fabulous design **3/6**. Cannot be beaten!

Multimeter Kit. 18,000 o.p.v. 25 range kit with Weston 50 μA meter, only **65/-**. (2.5A range 4/- extra). Stamp for details.

Multimeters. Illus. leaflet on request. TK20A, 1,000 o.p.v. **33/-**, post 1/6; EP10K, 10,000 o.p.v. **69/6**, post 1/6; EP30K, 30,000 o.p.v. **95/6**, post 2/-; EP50K, 50,000 o.p.v. **130/-**, post 2/6.

High Stab, Resistors, ½W, 1%, **2/-**.

PLANET INSTRUMENT CO.
25 DOMINION AVENUE, LEEDS 7

INSULATION TESTERS (New)

500 volt, 500 megohms. Price **£22**, carriage paid.
1,000 volts, 1,000 megohms, **£28**, carriage paid.

SOLENOID. Overall length 3¼in., stroke ⅛in. to ¼in. Maximum push 8 oz. 12-24V. D.C. operation. D.C. resistance 35 ohm. Price **8/6.** P. & P. 1/6.

TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230V. A.C. or Battery operated. Incorporates built-in monitor Oscillator, Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price **£16/10/-** Plus 4/6 P. & P.

SPECIAL REVERSING 24 VOLT D.C. QUADRANT MOTOR 2 AMPERE.
Quadrant moves 90 degrees with limit switches. Ideal for opening doors, etc. Price **32/6.** P. & P. 3/-.

EX P.O. MAGNETIC COUNTER (old type), either 500 ohms for 24 volt operation or 3 ohms for 6 volt D.C. operation. 4 figures to 9,999. Price, either type **8/6.** P. & P. 1/6.

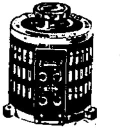
LATEST HIGH SPEED MAGNETIC COUNTERS, 4 figure, 10 impulses per second. Type 100D, 4.1 ohm coil, 3-6V. D.C. operation. Type 100A, 500 ohm coil, 18-24V. D.C. operation. Type 100B, 2,300 ohm coil, 36-48V. D.C. operation. Any type **15/-** each, plus 1/6 P. & P.

RESETTABLE HIGH SPEED COUNTER. 3 figure, 1,500 ohm coil, 40-50v. D.C. operation. Brand new. **50/-** each, plus 1/6 P. & P.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY 37.6

The ideal instrument for workshop, lab. or factory. This wonderful device enables you to freeze" motion and examine moving parts as stationary. We supply a simple circuit diagram and all electrical parts including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New modified circuits bring price down to **37/6** plus 3.- P. & P.

NSP2 CV2296 STROBOTRON FLASH-TUBE made by Ferranti, brand new. I.O. base. Price **15/-**. P. & P. 1/-.



VARIABLE VOLTAGE TRANSFORMER £4.10.0 *Post Paid*

Input 230v. A.C. Output 0-260v. at 1 amp., fully shrouded, new. Also available 2.5, 5, 8, 10, 12, 20, 37.5 and 50 amp. Write for details.

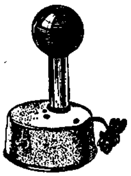
SEALS SIEMENED HIGH SPEED RELAYS

H96A, 2.2 ohm ± 2.2	ohm, new	... ...	**12/6**
H96B, 50 ohm ± 50	ohm, new	... ...	**12/6**
H96C, 145 ohm ± 145	ohm, new	... ...	**12/6**
H96D, 500 ohm ± 500	ohm, new ,	... ...	**12/6**
H96E, 1700 ohm ± 1700	ohm, ex-equip.	...	**16/6**

... A.C. AMMETERS

0- 1 amp. F.R. 2½" Dia. 0-15 amp. F.R. 2½" Dia.
0- 5 " " 0-20 " "
0-10 " " **All at 21/- each**

VAN DE GRAAFF ELECTRO-STATIC GENERATOR, fitted with Motor drive for 230v. A C. giving a potential of approx. 5,0000 volts, Supplied absolutely complete including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price **£6.6.0,** plus 4/- P. & P.



LIGHT SENSITIVE SWITCH

Kit of parts, including ORP .12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., price **25/-** plus 2/6 P. & P. ORP .12 including circuit, **10/6** each, plus 1/- P. & P.

ULTRA VIOLET BULBS

Easy to use source of UV for dozens of practical and experimental uses.
12 volt 36 watt AC/DC SBC **6/6**, P. & P. 1/-.
12 volt 60 watt AC/DC SBC **8/6.** P. & P. 1/-.
Transformer to suit the above: Input 200-240 A.C. Output 12 Volt A.C. 36 watt, **16/6.** P. & P. 2/6. Input 200-240 A.C. 12 volt A.C. 60 watt, **22/6.** P. & P. 3/6.
Set of four colours **FLUORESCENT Paint.** Orange, Yellow, Green and Red, in ½oz. tins. Ideal for use with the above Ultra Violet Bulbs, **9/6.** P. & P. 1/6.

SERVICE TRADING CO.
All Mail Orders also callers
47-49 High Street, Kingston on Thames
Tel: KINgston 9450
Personal callers only
9 Little Newport Street, London, WC2
(off Leicester Square) Tel: GERrard 0576

HAVE YOU EVER SEEN T.V. TROUBLES?

That is "Pin-Point T.V. Troubles in 10 minutes" we mean! Thousands of ***Practical Television*** readers already own and use "T.V. Troubles" every day. Designed for use by amateur or expert, this amazingly practical manual shows you how to find the trouble in any T.V. circuit FAST!

A simple cross-index tells you where you'll find cause of trouble, handy check charts then help you accurately locate the EXACT trouble spot! You will eliminate hours of aggravation, cut out waste time because this new Coyne system will help you get right down to the heart of the trouble in minutes.

Over 700 trouble spots are covered in the 340 cross-index pages. Included are 50 time saving check charts as well as 290 diagrams and photos together with explanations of circuits and designs.

YOU CAN USE THIS BOOK RIGHT ON THE JOB—NO NEED TO MEMORISE!

This Pin-Point Book was designed especially for on-the-job trouble shooting. You simply turn to the indexed section, locate the circuit description and check-charts, and in minutes you have the trouble spot located and ready for repair.

NO COMPLICATED THEORY OR MATHEMATICS. Just practical circuit description, service methods and trouble shooting techniques to help you make faster T.V. repairs.

EVEN AN EXPERT CAN SAVE TIME BY USING "T.V. TROUBLES"

Here is a way to reduce "thinking time."

All the logical reasons for each problem are stated in black and white—you use your skill to take it from there!

Don't miss out any longer. Time wasted now locating T.V. faults could be saved by quick reference to this lightning fast T.V. problem answer book. Send for your trial copy now, then when you decide to keep it (as we are sure you will), pay only 5/- per week until completed.

The price? Only **39/6** plus postage.

FREE ELECTRONIC DATA HANDBOOK WITH EVERY ORDER

IRONCLAD GUARANTEE

This book must be able to earn you more than its cost within two weeks or your money refunded!
Free 88 page oscilloscope book will be included if you send cash with order.

FREE TRIAL OFFER!

TERMS ONLY 5/- PER WEEK

To SIM-TECH TECHNICAL BOOKS
Dept. ETV1
West End, Southampton, Hants.

☐ Please send "T.V. Troubles" for a full seven days' free trial. If not delighted I may return the manual, post paid without further obligation on my part. Otherwise I will pay cash of 5/- weekly until paid.

☐ Tick here if enclosing full price of 41/- (which includes 1/6 postage). You get free Oscilloscope Book. Same 7-day money back guarantee. Overseas customers please send full amount (including Ireland).

Name ....

Address ....

....

City .... County ....

TYGAN FRET (Contem. pat.), 12 × 12in. **2/-**; 12 × 18in. **3/-**; 12 × 24in. **4/-**, etc.
EXPANDED ANODISED METAL—Attractive gilt finish ¾ in. × ⅓ in. diamond mesh **4/6** sq. ft. Multiples of 6 in. cut. Max. size 4ft. × 3ft., **47/6**, plus carr.
ENAMELLED COPPER WIRE—¼lb. reels 14g-20g, **2/6**; 22g-28g, **3/-**; 30g-34g, **3/9**; 36g-38g, **4/3**; 39g-40g, **4/6**, etc.

Volume Controls—5K-2 Meg. ohms, 3in. Spindles. Morganite Midget Type 1⅛in. diam. Guar. 1 year. LOG or LIN ratios less Sw. **3/-**. DP. Sw. **4/6**. Twin Stereo less Sw. **6/6**. DP. Sw. **8/-**. **Specials to order.**

SPECIAL BARGAIN

½ Meg. VOL. Controls DP. Sw. ½" flatted spindle. Famous Mfrs. **4 for 10/-**, post free.

BONDACOUST Speaker Cabinet Acoustic Wadding (1in. thick approx.) 12in. wide, any length cut, **1/6** ft., **4/-** yd. **TINNED COPPER WIRE.** 16-22g. **2/6** ¼lb. **ERSIN MULTICORE SOLDER.** 60/40 4d. per yard. Cartons **2/6**, etc.

New Boxed VALVES Reduced Bargain Prices

1T4	**3/6**	ECC83	**7/-**	PCC84	**8/-**
1R5	**6/-**	ECL82	**10/-**	PCF80	**8/-**
1S5	**6/-**	ECL80	**9/-**	PCL83	**10/6**
3S4	**7/-**	EF80	**7/6**	PCL84	**10/-**
3V4	**7/-**	EF86	**8/6**	PL81	**9/6**
DAF96	**8/-**	EL84	**7/-**	PL82	**9/-**
DF96	**8/-**	EY51	**9/-**	PL83	**8/-**
DK96	**8/-**	EY86	**9/-**	PY32	**10/6**
DL96	**8/-**	EZ81	**7/-**	PY81	**8/-**
ECC81	**7/-**	GZ32	**9/6**	PY82	**7/-**
ECC82	**7/-**	EM84	**8/6**	U25	**10/6**

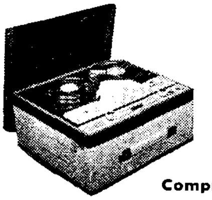
CO-AX 80 ohm CABLE

High grade low loss Cellular Air Spaced Polythene—¼in. diam. Stranded Cond.

Now only 6d. yard

BARGAIN PRICES—SPECIAL LENGTHS 20 yds. **9/-**; P. & P. 1/6. Coax. Plugs **1/-**; 40 yds. **17/6**; P. & P. 2/-. Sockets **1/-**; 60 yds. **25/-**; P. & P. 3/-. Couplers **1/3**.

THE KEENEST TAPE RECORDER BARGAIN OF THE YEAR



A 24 gns. Tape Recorder offered at the bargain price of only 15 gns. plus 10/- carr. Supplied in 3 Units already wired and tested. A modern Circuit for quality recording from Mike, 'Gram or Radio, using latest B.S.R. Twin Track Monardeck Type TD2.
Valve line up EF86, ECL82, EM84, EZ80 and Silicon Diode.

COMPLETE KIT

Comprising items below

Leaflet, circuits, instructions, 2/- post free.

BARGAIN PRICE	**15 gns.**	+ 10/- carr.
2-tone Cabinet and 8" × 5" Speaker. Size 14" × 10½" × 7½"	**£3.10.0**	+ 5/- carr.
Wired Amplifier complete with 4-valves, front Panel, Knobs	**£5.12.6**	+ 3/6 carr.
B.S.R. Monardeck Type T.D.2	**£7. 7.0**	+ 4/6 carr.
Accessories — Mike, Tape, Screened Lead Plugs, etc.	**£1. 0.0**	+ 2/- carr.

NEW BRITISH RECORDING TAPE

Famous Manufacturer. Bulk purchase, genuine recommended. Tape Bargain. Unconditional Guarantee. Fitted Leader & Stop Foils (except 3in.).

	Standard (PVC base)		**Long Play** (PVC base)		**D'be Play** (Mylar base)	
3in.	150ft.	**3/9**	225ft.	**4/9**	300ft.	**6/6**
5in.	600ft.	**11/6**	900ft.	**15/-**	1200ft.	**25/-**
5¾in.	850ft.	**14/6**	1200ft.	**17/6**	1800ft.	**32/6**
7in.	1200ft.	**17/6**	1800ft.	**22/6**	2400ft.	**42/6**

Post and Packing—3in. Reels, 6d. Each additional Reel, 3d. 4in. to 7in. Reels **1/-**. *Each additional Reel, 6d.*

EMPTY TAPE REELS (Plastic): 3in. **1/3**, 4in. **2/-**, 5in. **2/-**, 5¾in. **2/-**, 7in. **2/3**.
PLASTIC REEL CONTAINERS (Casettes): 3in. **1/3**, 5in. **1/9**, 5¾in. **2/-**, 7in. **2/3**.

Speakers P.M.—3 ohms 2½" E.M.I. **15/6**. Goodmans 3½" **16/6**. 5" Rola **15/6**. 6" Elac **16/6**. 7" × 4" Goodmans **15/6**. 8" Rola **19/6**. 10" R. × A. **25/-**. 9" × 6" Goodmans **22/6**. E.M.I. Tweeter **22/6**. **Jack Plugs.** Standard 2½" Igranic Type, **2/6**. Screened ditto, **3/3**. Miniature scr. 1½", **2/3**. Sub-min. **1/3**.

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s 9/16 in. diam. **5/3**
Osc. Coil M. & L.W. **5/9**
Midget Driver Trans. 3.5:1 .... **6/9**
Midget Output Trans. Push-Pull—3 ohms **6/9**

Elect. Condensers—Midget Type 1 mfd.-50 mfd. ea. **1/9**, 100 mfd. **2/-**, 12V.
Condensers 150 v. working: .01 mfd., .02 mfd., .03 mfd., .04 mfd. **9d.**; .05 mfd., .1 mfd., **1/-**; .25 mfd., **1/3**; .5 mfd., **1/6**, etc.
Midget Tuning Condensers. J.B. "OO" 208 pF and 176pF, **8/6**; ditto with trimmers, **9/6**. J.B. 220pF and 105pF conc. slow motion **10/6**. 365pF single **7/6**.

Condensers—Silver Mica. All values 2pF to 1,000pF, **6d**. each. Dittos Ceramics **9d**. Tub. 450V T.C.C. etc. 0.001 mFd to 0.01 and 0.1/350V. **9d**. 0.02-0.1/500V., **1/-**. 0.25 Hunt, **1/6**. 0.5 T.C.C. **1/9**, etc., etc. **Close Tol. S/Micas**—10% 5pF-500pF, **8d**. 600-5,000pF, **1/-**. 1% 2pF-100pF, **9d**. 100pF-500pF, **11d**. 575pF-5,000pF, **1/6**. **Resistors**—Full Range 10 ohms-10 meg. ohms 20% ¼ and ½W, **3d**., ¾W, **5d**. (Midget type modern rating) 1W, **6d**., 2W, **9d**. **Hi-Stab.** 5% ¼W, ½W, **6d**. (100 ohms-1 meg). Other values **9d**. 1%, ½W, **1/6**, etc., etc.

TRIMMERS, Ceramic (Compression Type)—30pF, 50pF, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, **1/9**.
PHILIPS. Bee Hive Type (conc. air spaced)—2-8pF, **1/-**; 3-30pF, **1/-**.
KNOBS—Modern Continental types. Brown or Ivory with Gold Ring; 1" dia., **9d**. each; 1⅜", **1/-** each; Brown or Ivory with Gold Centre, 1" dia., **10d**. each; 1⅜", **1/3** each. LARGE SELECTION AVAILABLE.

METAL RECTIFIERS. STC Types—RMI, **4/9**; RM2, **5/6**; RM3, **7/6**; RM4, **16/-**; RM5, **21/-**; RM4B, **17/6**.

TUB-ELECTROLYTICS-CAN

25/25v. 50/12v. 1/9; 8 + 8/450v. 4/6; 50/50v. 100/125v. 2/-; 32 + 32/275v. 4/6; 8/450v. 4/350v. 2/3; 50/50/350v. 6/6; 16 + 16/450v. 5/6; 60/250/275v. 12/6; 32 + 32/450v. 6/6. 100 + 200/275v. 12/6.

TRS RADIO COMPONENT SPECIALISTS

Est. 1949

70 Brigstock Rd., Thornton Heath, Surrey. *Hours: 9 a.m.-6 p.m., 1 p.m. Wed.*
THO 2188. *Terms C.W.O. or C.O.D. Post and Packing up to ½ lb. 9d.; 1 lb. 1/3; 3 lb. 2/3; 5 lb. 2/9; 8 lb. 3/6.*

PADGETTS RADIO STORES

OLD TOWN HALL, KNOWLER HILL, LIVERSEDGE, YORKS.

Telephone: Cleckheaton 2866

Single Phase 230 V. 1400 r.p.m. ¼ h.p. motor with pulley, **26/-**. Less pulley, **24/-**. Fully guaranteed ex-washing machine. Carr. 8/6.
One Sixth H.P. Motor 15/-. Post 6/9.
New Indicator Unit. C.R.T. 100. Complete with two tubes, type VCRX393 and VCRX298 plus 21 small valves. Relays removed, **57/-** or less valves **32/-**. carr. 10/-. Sorry no details on the unit.
New Boxed Test Set. 100 only. Type 350, complete with meter and case. No details. **37/6**. Post 6/9.
New Condenser Parcel. Mixed. Send **6/-**. Post paid.
New 12in. Speaker with built in tweeter. 15 or 3 ohms. **28/6**. Post paid.
P.M. Speakers, all 3 ohm, ex-TV Sets. 6in. round, 6 × 4in. and 5in., **3/-**. Post **2/-**, 6 for **20/-**. Post paid. 8in. round, **6/-**. Post 2/-. 7 × 4in. **5/-**. Post 2/-.

VALVE LIST

Ex equipment. 3 months guarantee.
All Post Paid

EL91	**1/6**	20L1	**5/-**	PL38	**8/-**
ECL80	**2/-**	20P3	**4/-**	PY80	**3/-**
ECC82	**3/-**	20P4	**8/6**	PL82	**3/-**
EY51	**2/6**	20P1	**4/-**	PL83	**3/-**
EBF80	**4/6**	U801	**8/6**	PL33	**3/-**
EB91	**9d.**	U281	**5/-**	PY81	**3/-**
EL38	**5/-**	U232	**5/-**	PY82	**3/-**
EF91	**9d.**	U329	**5/-**	PCF80	**4/-**
6F1	**1/-**	KT36	**5/-**	PCC84	**4/-**
6F14	**5/-**	KT66	**8/-**	VR150/30	**3/-**
6F15	**5/-**	6V6GT	**4/-**	IT4	**1/9**
6LD20	**5/-**	6B8	**1/6**	12AT7	**3/-**
10C2	**5/-**	6K25	**5/-**	6CH6	**1/6**
10F1	**1/-**	6P25	**3/6**	6X4	**3/-**
10P13	**5/-**	6U4	**5/-**	R18	**3/6**
10P14	**5/-**	PY33	**6/-**	ARP12	**1/6**
20D1	**2/-**	PL81	**4/-**	807	**5/6**

EF50 **1/-**, doz. **6/-**; 6K7 **1/3**, doz. **10/-**; 6V6 **1/9**, doz. **18/-**; 6K8 **1/9**, doz. **18/-**.
Send S.A.E. for rare valve enquiry.

Breaking up Mark III Type 19 Sets. Meter, 500 microamp., **5/-**. Post 1/9. Jack Socket **1/-**. Post 6d. Doz. **10/-**. Post paid. Jack **1/5**. Post 6d. Toggle Switch Metal **6d**. Post 6d. Doz. **10/-**. Post paid. Relay Type 3000 **1/9**. Post 1/9. Doz. **20/-**. Post paid. Any other spare send 2/- plus post to cover.

TV Sets. 13 channels. Untested but complete. 14in. **30/-** 17in. **50/-**. Carr. 10/-. Well packed but sent at owner's risk.

Reclaimed Tubes Six months guarantee. 14in. Mullard and Mazda **17/-**. Carr. 7/6. 17in. **30/-**. Carr. 7/6.

TRAINING

Full-time courses in RADAR and RADIO-TELEGRAPHY for prospective marine Radio Officers. Govt. approved exam. centre.
Also courses in RADIO SERVICE and in basic ELECTRONICS, RADIO and TELEVISION.
Apply: Director, British School of Telegraphy, 20 Penywern Road, Earls Court, London, S.W.5.

BLANK CHASSIS

Precision made in our own works from commercial quality half-hard Aluminium. Two, three or four sided. SAME DAY SERVICE of over 20 different forms made up to YOUR SIZE.

Or EXACT size you require to nearest 1/16" (maximum length 35", depth 4"). *Specials dealt with promptly.* SEND FOR ILLUSTRATED LEAFLETS or order straight away, working out total area of material required and referring to table below, which is for four-sided chassis in 18 s.w.g. (for 16 s.w.g. add ⅙th)

48 sq. in.	**4/-**	176 sq. in.	**8/-**	304 sq. in.	**12/-**
80 sq. in.	**5/-**	208 sq. in.	**9/-**	336 sq. in.	**13/-**
112 sq. in.	**6/-**	240 sq. in.	**10/-**	368 sq. in.	**14/-**
144 sq. in.	**7/-**	272 sq. in.	**11/-**	and pro rata	
P. & P. 2/6		P. & P. 2/9		P. & P. 3/-	

FLANGES (¼", ⅜" or ½") 6d. per bend.

STRENGTHENED CORNERS 1/- each corner.

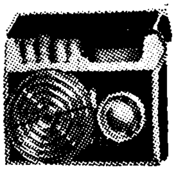
PANELS. The same material can be supplied for panels, screens, etc., at 4/6 sq. ft. (16 s.w.g., 5/3) plus P. & P. (over £2 post free)

H. L. SMITH & CO. LTD.

287-289 EDGWARE ROAD, LONDON, W.1
PAD 5298/7595

CLEARANCE SALE

ASTONISHING CIGARETTE RADIO only 18/6



Yes, a perfectly ordinary packet of cigarettes!—but watch your friends astonishment on hearing it fetch in station after station, loud and clear! Still holds 10 Cigarettes—yet cleverly conceals highly sensitive, fully transistorised circuit (including tiny battery). Even a young boy can assemble it in under 2 hours. No soldering. **No experience necessary.** Only 16 connections to make. Ideal for taking to work with you. From our bulging testimonial file, Mr. D.B. of Huddersfield writes:—"... *I have fitted the parts in and it is working wonderfully* ..." ALL PARTS including Semi-Conductors, A.B.C. Plans, etc. **ONLY 18/6d. plus 1/6d. post, etc. (C.O.D. 2/6d. ex.)**

MAKE 5 DIFFERENT TRANSISTOR RADIOS for 35/-

Amazing Radio Construction Set! Become a radio expert for 35/-. A complete Home Radio Course. No experience needed. Parts include Radio book instructions for each design, Step-by-Step plan, all Transistors, loudspeaker, personal phone, knobs, screws, etc., all you need. Box size 14" × 10" × 2" (parts avail. sep.). Originally £6. **NOW 35/- + 2/6 P. & P.**

CONCORD ELECTRONICS LTD

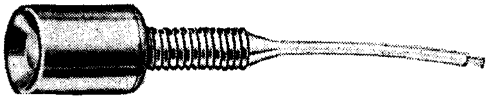
9 Western Road, Hove

(P.E.11)

RADIATION DETECTORS 20TH CENTURY

HC4 GEIGER COUNTER

Low-priced miniature geiger counter robustly constructed for gamma detection. Halogen quenched—low voltage.



SSN/03K Solid State Detector

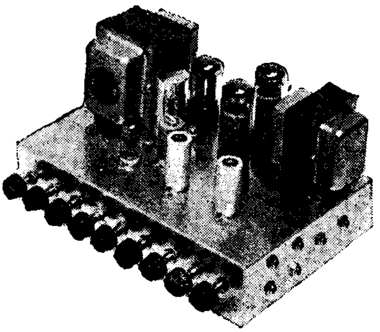
Miniature silicon solid state detector for α, β and γ radiation. With simple transistor amplifier, can be used with standard scalers. Circuit of economy transistor amplifier available on request.

Write for further information to:—

20th CENTURY ELECTRONICS LTD.

KING HENRY'S DRIVE, NEW ADDINGTON
CROYDON, SURREY, ENGLAND
TELEPHONE: LODGE HILL 2121-6

GUITAR AMPLIFIERS WITH· TREMOLO



Five jack socket inputs, four with separate mixing volume controls, and one input "straight through". All inputs are of very high sensitivity only 10 millivolts input is required for full output, making them suitable for all types of guitars and microphones. Separate Bass and Treble controls, giving a wide range of lift and cut. Separate master gain control. Tremolo speed and depth controls. Jack socket for remote tremolo switching. Outputs for 3 and 15 ohms speakers. Valves used in the 30 watt and 50 watt amplifier ECC83, ECC83, EL34, EL34, GZ34. In the 15 watt amplifier ECC83, ECC83, EL84, EL84, EZ81. An extra valve ECC83 is used in the tremolo circuit. The chassis is complete with baseplate and is solidly made of 18 gauge steel, finished silver grey hammer.
Size 12 × 8 × 6½ inches high.

PRICES—

50 watt with tremolo	**£20.10.0**
50 watt less tremolo	**£19.10.0**
30 watt with tremolo	**£15.10.0**
30 watt less tremolo	**£14.10.0**
15 watt with tremolo	**£12.10.0**
15 watt less tremolo	**£11.10.0**

Add carriage 10/- any amplifier. Send for free descriptive leaflet.

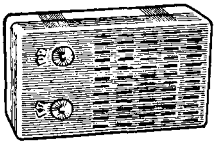
STROUD AUDIO

PAGANHILL LANE, STROUD, GLOS. Stroud 783

MAINS POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6 v.—9 to 12 volts for up to 500 mA. (class B working). Takes the place of any of the following batteries. PP1-PP3-PP4-PP6-PP7-PP9 and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only 14/6, plus 2/6 post.

OUR BARGAIN OF THE YEAR

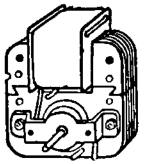


Complete kit of parts to build this 6-transistor 2 wave superhet receiver at only 39/6 plus 2/6 post and ins.

"CORONET" Mk. III

It fully covers the medium-wave band and that part of the long-wave band to bring in B.B.C. Light. The circuit includes a highly efficient slab aerial and 2½" P.M. speaker. Overall size approximately 4½ × 2½ × 1½in. Supplied complete with carrying case.

MOTOR BARGAIN



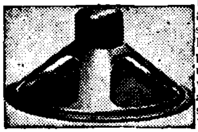
Silent running mains motor by very famous maker. Ideal for gramophone, tape recorder, fan, etc. etc. 200-250 volts. A.C. shaded pole start. Size approximately 2¾ × 2½ × 1¾in., 2,750 r.p.m. Spindle diameter 5/32in. Spindle length ¾in. Brand new guarantee. Price **12/6** plus 1/- post.

YAXLEY SWITCHES

POLES	2 WAY	3 WAY	4 WAY	6 WAY	8 WAY	10 WAY	11 WAY	12 WAY
1	2/8	2/10	3/1	3/6	4/-	4/6	4/6	4/8
2	3/3	3/8	4/1	4/11	6/-	7/-	7/-	7/6
3	3/11	4/6	5/2		8/-	9/6	9/6	10/3
4	4/6	5/4	6/2	7/10	10/-	12/-	12/-	13/-
6	5/9	7/-	8/3	10/9	15/-	17/-	17/-	18/6
8	8/-	8/8	10/4	13/8	18/-	22/-	22/-	25/-
10	10/-	10/6	12/5	16/9	22/6	27/-	27/-	30/-
12	12/-	12/6	14/6	19/8	27/6	32/-	32/-	36/-
14	14/-	14/6	17/-	22/6				
16	16/-	16/6	19/6	25/6				

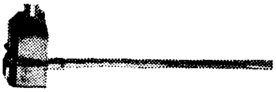
5 WAY 1 pole 3/6 2 pole 4/9 **24 WAY** 1 pole 15/- 2 pole 22/6

Speaker Bargain



12in. High fidelity loudspeaker. High flux permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new, by famous maker. Price **27/6,** plus 3/6 post and insurance.

Adjustable Thermostat



Suitable for Industrial or domestic purposes such as controlling furnace oven, immersion heater, etc. Can also be used as a flamestat or fire alarm. Made by Sunvic these are approximately 17in. long and adjustable over a range 0 to 550°F. The contacts are rated at 15 amps. 230 volts, and the adjustment spindle, which comes to the top, can be fitted with a flexible drive for remote control or just a pointer knob for local control. Listed at **£3** or **£4** each, these are offered at only **8/6,** plus 2/6 postage and insurance.

Timer Kit

Special offer of all components except metal box to make mains operated interval timer for photography, etc., **12/6** plus 2/6 post.

Waterproof Heater Wire

16 yd. length. 70 watts. Self regulating temperature control, **10/-** post free.

Building a Scope ?

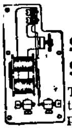
3in. oscilloscope tube. American made type No. 3FP7, base 6.3 v. 6 amp. heater electrostatic deflection, brand new and guaranteed, with circuit diagram of scope, **15/-** each plus 2/6 post and insurance.

Ice-Stat

This is a small thermostat which cuts on and off at round freezing point. Has many uses, one of which could be an ice warning device to be fitted under your motor car. Price **7/6.** Post 1/-.

Simmerstat Heater Regulator

Suitable to control elements, heaters, soldering irons and boiling rings up to 2,500 watts. Complete adjustable, normal price 55/- each, special snip price **12/6,** plus 1/6 postage and insurance.



Siemens High Speed Relay

Twin 250 ohm coils adjustable tension change over contacts—platinum points **7/6.** Post 1/-.

BARGAINS

Air Spaced Trimmers, good length ¼in. spindle 0-50pf. but easily converted down to 0-5 pf. **2/6** ea., post 1/-. Ditto but 2 gang for F.M. Tuners etc., **4/6** ea. Post 1-.

High Voltage Condensers. 2 mfd. 1.2 kv. **4/6,** 4 mfd. 1.5 kv. **6/6,** 0.5 mfd. 4 kv. **6/6,** .01 mfd. 5 kv. **3/6.**

Trimmer Assortment. 3 doz. various sizes and types including doubles and ceramic air spaced. Retail list value over £4, all new and unused **10/-** for 36. Post 2/-.

Motor Generator, 6 v. input gives 12 v. output, suitable to run 12 v. car battery radio off 6 v. battery **17/6,** post and insurance 3/6.

Midget 3in. P.M. Loudspeaker 3 ohm, **12/6,** 8 ohm, **13/6. Midget** 208 pF+176 pF two-gang Tuning Condenser with trimmers tor transistor set. **Price 9/-.**

Post Office Type Key Switch. 3 position 10 change over contacts **7/6,** post 1/-.

Rectifier Valves. 4 pin 4 v. 120 ma. full waves replace MU12 etc. **4/6.** P. & P. 1/-. **40**/- per doz. Post free.

Double Trimmers. Ideal for making preset station receiver 100 pf. plus 100 pf. **6**/- per doz. Post 1/-.

Mica Condenser. 100 pf. 200 pf. 300 pf. 500 pf. 1,000 pf. 3 doz. assorted list value £2. 36 for **5/-.** Post 2/-.

Litz Wire for coil winding. Normally over 40/- per lb. from makers, 1lb. reels **20/-**ea. Post and packing 2/-.

Hours Elapsed Meter. Fine American make unused but ex-equipment **35/-** ea., post 2/-. **12 v. 10 amp. Rectifier.** 8¾in. sq. plates **19/6,** post 2/-.

ELECTRONICS (CROYDON) LTD.

266 LONDON ROAD, WEST CROYDON, SURREY
Post orders to :
43 SILVERDALE ROAD, EASTBOURNE, SUSSEX

LINEAR

FOR AUDIO EQUIPMENT

HIGH SENSITIVITY **HIGHEST FIDELITY**

MAXIMUM RELIABILITY **REASONABLE COST**

We regret to announce that after maintaining our prices for seven years (with the exception of one unit) we are reluctantly announcing a revised price list.

L.50. 50 watt Amplifier approximately 14 x 10 x 8 in. Sensitivity 25 m.v. output for 3 and 15 ohm Speakers. *Retail price* **22 guineas.**

CONCHORD. 30 watt Hi-Fi Amplifier with two separately controlled inputs. *Retail price* **17 guineas.**

L.10. 10 watt Hi-Fi Amplifier with separate pre-amp. *Retail price* **16 guineas.**

L.1/10. 10 watt Hi-Fi amplifier with integral pre-amp. *Retail price* **13½ guineas.**

DIATONIC. 10/14 watt Hi-Fi Amplifier with integral pre-amp *Retail price* **12½ guineas.**

L.5/5. Stereophonic Amplifier. Output 5 watts each channel. *Retail price* **12½ guineas.**

L.T.45X. Tape Amplifier with equalisation adjustment for 1⅞, 3¾ and 7½in. per second. Suitable for Collaro Studio Tape Transcriptor. Complete with integral power pack. *Retail price* **12½ guineas.**

LP.1 Tape Pre-Amplifier. As above but less power pack facilities. *Retail price* **9½ guineas.**

L.45A. 4/5 watt Amplifier. *Retail price* **6 guineas.**

L.G. 34. 3/4 watt Amplifier. Shelf mounting type for gram use. *Retail price* **£5.10.0.**

TREMOLO UNIT. For Guitar purposes to plug into mains Amplifier. *Retail price* **4 guineas.**

Trade and Export Enquiries invited—

LINEAR PRODUCTS LTD. ELECTRON WORKS
ARMLEY, LEEDS.
Tel. Leeds 63-0126 (3 lines).
S.A.E. for catalogue.

BATTERY ELIMINATORS

The ideal way of running your TRANSISTOR RADIO, RECORD PLAYER, TAPE RECORDER, AMPLIFIER, etc. Types available: 9v; 6v: 4½v (single output) 39/6 each. P. & P. 2/9.
9v + 9v; 6v + 6v; or 4½v + 4½v (two separate outputs) 42/6 each. P. & P. 2/9. Please state output required. All the above units are completely isolated from mains by double wound transformer ensuring 100% safety.

R.C.S. PRODUCTS (RADIO) LTD.
11 Oliver Road, London, E.17

"PRACTICAL ELECTRONICS" CONSTRUCTIONAL DESIGNS

All specified 1st grade Components, complete Metalwork, full range of Materials, engraved Panel Plates, Ancillary Equipment and Assembled Units. *Comprehensive lists available for each "P.E." Constructional Article.*

Please send 6d in stamps for each design

MALVYN ENGINEERING WORKS
Engineers to the Radio and Electronic Industries
7 CURRIE STREET, HERTFORD, HERTS
TELEPHONE : HERTFORD 2264

AN EXTRA ROOM IN YOUR LOFT

Make your loft usable. Fit a Benson disappearing loft ladder. Rigidly constructed. Folds out of sight. Closes trap automatically.

ONLY **£12-19-6** carr. paid

Handrails 25/- each extra
ALL TYPES OF LADDERS SOLD

Write now for illustrated brochure, floor strengthening details and terms—all post free

BENSON (LOFT) LADDERS
(Dept. P.E.), Pontefract Ave., Pontefract Lane, York Road, Leeds 9
Tel. 34918 (2 lines)

T.V. TUBES

17in. – 35/- 14in. – 15/-

Most makes and types available. Set Tested. Guaranteed good picture. Ex Rental Service Depts. Stock. Carriage 5/- extra.

SEND FOR LATEST FREE LIST

DUKE & CO. (LONDON) LTD.
621/3 Romford Rd., Manor Park E.12 ILFord 6001·2·3

RES/CAP. BRIDGE 39/6

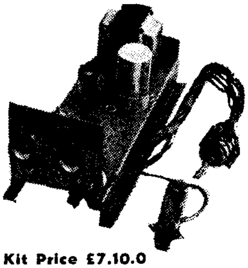
p. & p. 2/6

Checks all types of resistors,, condensers
6 RANGES
Built in 1 hour. Direct reading
READY CALIBRATED
Stamp for details of this and other kits

RADIO MAIL (Dept. CA)
Raleigh Mews, Raleigh St., Nottingham

HIGH QUALITY TAPE AMPLIFIER KIT

Suitable for use with tape decks having a high impedance record head and a low impedance erase head. Magic eye recording level. 3 ohm 4 watt output. 2 inputs with tone control. Provision for monitoring. Simple point to point wiring instructions. This tape amplifier is also available completely built and tested. Ideal for use with Collaro and B.S.R. decks.



Kit Price £7.10.0
Ready Built £9.17.6
p & p 3/6

ELECTROSURE LTD., Fore Street, Exeter

In BIRMINGHAM...

call on us for . . .

THOUSANDS of COMPONENTS and VALVES

Hi-Fi Equipment Swop Shop
Short Wave Receivers – Aligned
Mullard High Speed Valve Testing

NORMAN H. FIELD 68 Hurst Street
ELECTRONICS (Opposite the Hippodrome)

VALUABLE NEW HANDBOOK FREE TO AMBITIOUS ENGINEERS

Have you had *your* copy of "Engineering Opportunities"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

We definitely Guarantee
"NO PASS—NO FEE"

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

WHICH OF THESE IS YOUR PET SUBJECT?

MECH. ENGINEERING
Gen. Mech. Eng.—Maintenance Eng. — Diesel Eng. — Press Tool Design — Sheet Metal Work — Welding — Eng. Pattern Making — Inspection - Draughtsmanship — Metallurgy — Production Eng.

RADIO ENGINEERING
General Radio — Radio & TV Servicing — TV Eng. — Telecommunications — Electronics—Sound Recording—Automation—Practical Radio —Radio Amateurs' Exam.

CIVIL ENGINEERING
General Civil Eng. — Municipal Eng. — Structural Eng. Sanitary Eng. — Road Eng. Hydraulics—Mining—Water Supply—Petrol Tech.

ELEC. ENGINEERING
General Electrical Eng. — Installations— Draughtsmanship — Illuminating Eng. — Refrigeration — Elem. Elec. Science — Elec. Supply — Mining Elec. Eng.

AUTO ENGINEERING
General Auto Eng. — Auto. Maintenance — Repair — Auto. Diesel Maintenance — Auto. Electrical Equipment—Garage Management.

BUILDING
General Building — Heating & Ventilation — Plumbing — Architecture — Carpentry — Painting — Decorating — Specifications & Quantities — Surveying — Architectural Draughtsmanship.

WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT INSTRUMENT TECHNOLOGY WORKS STUDY, MATHEMATICS, ETC.

Which qualification would increase your earning power?
A.M.I.Mech.E., A.M.S.E., A.M.I.C.E., A.M.I.E.R.E., B.Sc., A.M.I.P.E., A.M.I.M.I., A.R.I.B.A., A.I.O.B., A.M.I.Chem.E., A.R.I.C.S. M.R.S.H., A.M.I.E.D., A.M.Mun.E., CITY & GUILDS, GEN. CERT. OF EDUCATION, ETC.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
155 COLLEGE HOUSE, 29-31 WRIGHT'S LANE, W.8

THIS BOOK TELLS YOU

- ★ *HOW to get a better paid, more interesting job.*
- ★ *HOW to qualify for rapid promotion.*
- ★ *HOW to put some letters after your name and become a key man . . . quickly and easily.*
- ★ *HOW to benefit from our free Advisory and Appointments Depts.*
- ★ *HOW you can take advantage of the chances you are now missing.*
- ★ *HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.*

156 PAGES OF EXPERT CAREER - GUIDANCE

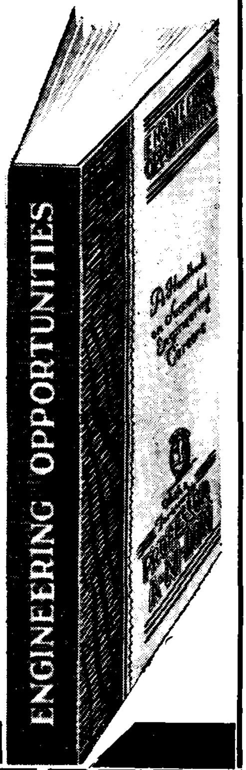
PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Radio, T.V., Electronics, Etc., A.M.I.E.R.E. City & Guilds Radio Amateurs' Exam.
R.T.E.B. Certificate
P.M.G. Certificate
Practical Radio
Radio & Television Servicing
Practical Electronics
Electronics Engineering
Automation

INCLUDING TOOLS

The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.

B.I.E.T.



You are bound to benefit from reading "ENGINEERING OPPORTUNITIES", and if you are earning less than £25 a week you should send for your copy *now*—FREE and without obligation.

POST NOW!

TO B.I.E.T., 155 COLLEGE HOUSE,
29-31 WRIGHT'S LANE, W.8.

2½d. stamp if posted in an unsealed envelope.

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).

....

NAME ....

ADDRESS ....

....

....

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD

Published about the 15th of the month by GEORGE NEWNES LIMITED, Tower House, Southampton Street, London, W.C.2. Printed in England by THE CHAPEL RIVER PRESS LIMITED, Andover, Hants. Sole Agents for Australia and New Zealand: GORDON & GOTCH (A/sia) Ltd.: South Africa and Rhodesia: CENTRAL NEWS AGENCY LTD.: East Africa: STATIONERY & OFFICE SUPPLIES LTD. Subscription rate including postage for one year: To any part of the World £1 15. 0.

TRANSISTORS, CRYSTALS, VALVES, COMPONENTS AND EQUIPMENT

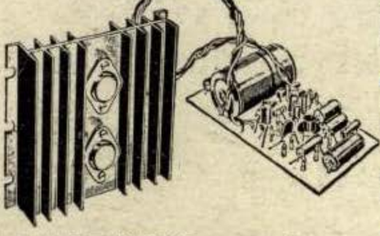
FOR THE AMATEUR AND PROFESSIONAL — ALL TYPES FOR EVERY PURPOSE

THE ELECTRONIC COMPONENT SPECIALISTS FOR MORE THAN 20 YEARS

COMPLETE CATALOGUES 2/6d POST PAID

TRANSISTOR HIGH FIDELITY EQUIPMENT

MONO or STEREO | **10 WATTS and 20 WATTS**



★ **15/16 ohm 10 watt Power Amplifier**

BUILT £5.19.6 P.P. 2/6

(KIT **£5.10.0** P.P. 2/6)

★ **3/4 ohm 10 watt**

BUILT £5.10.0 P.P. 2/6

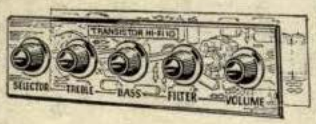
(KIT **99/6** P.P. 2/6)

★ MAINS UNITS **59/6** for one amplifier. or **69/6** to power 2 amplifiers.

PREAMPLIFIERS

● Mono full function preamplifier with 8 input positions. Low noise, high quality and sensitivity. Gives 10 watts with one power amplifier or 20 watts with two amplifiers.

Size: 9 × 2½ × 2in.



BUILT £5.10.0 P.P. 2/-

(KIT **99/6** P.P. 2/-)

★ Brown and Gold detailed front panel plate **8/6**.

● **STEREO PREAMPLIFIER**

For use with two power amplifiers.

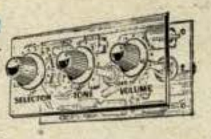
Size: 9 × 3½ × 1⅝in.

PRICE BUILT £10.19.6 P.P. 3/6

★ Dark Brown with Gold Front Panel **12/6**.

● MULTI-INPUT PREAMPLIFIER

Simplified preamplifier for use with one or two power amplifiers, 8 inputs.



PRICE BUILT 65/- P.P. 1/6

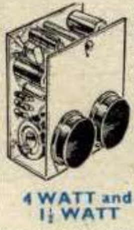
★ Front Panel Plate **6/6**.

All the above preamplifiers can be used with any valve or transistor power amplifier requiring 250mV plate for full output. They can be operated with two 9 volt batteries in series or from the power amplifiers.

CIRCUITS AND DETAILS ON REQUEST

Demonstrations of above equipment and VHF FM Tuner can be heard during normal shop hours.

NEW! TWO NEW PACKAGED TRANSISTOR QUALITY AMPLIFIERS



4 WATT and 1½ WATT

● 6-Transistor printed circuit designs. Push-pull output for 3 to 5 ohm speakers. Can be battery operated. 6mV into 1 Kohm sensitivity. Response 40 c/s to 12 kc/s.

Can be used with above preamplifiers for mono or stereo in any application requiring a low distortion low cost amplifier.

OVERALL SIZES 2½ × 2 × 1¼ inches.

- ● 4 watt version operates from 12 to 18 volts. **PRICE BUILT 79/6** P.P. 1/6
- ● 1½ watt version from 9 to 12 volts. **PRICE BUILT 65/-** P.P. 1/6

★ CIRCUITS AND DETAILS ON REQUEST ★

VHF TRANSISTOR FM TUNER

● HIGH STABILITY — HIGH SENSITIVITY ●

Features 5-Mullard transistors with 4 diodes, compact printed circuit, high gain, low distortion, superhet design. Full tuning from 87/105 Mc/s with geared tuning. AVC and AFC. 9 volt 9 mA operation. 50 dB S/N. Output up to 1 volt audio. Easy to build and align. Overall size in cabinet 3½ × 2¼ × 4in. All parts sold separately and guaranteed.

★ CIRCUIT AND DETAILS ON REQUEST ★

● TOTAL COST WITH FRONT PANEL **£7.19.6** P.P. 2/6

(Cabinet Assembly **20/-** extra)

PUSH-BUTTON PORTABLE/CAR RADIO

● UNBEATABLE FOR PERFORMANCE AND DESIGN ●

Printed circuit 6-Transistor 2-Diode superhet radio with full tuning on medium and long wave bands. Push-pull output up to 1 watt. Attractive portable cabinet, size 10 × 7 × 3½in. with horizontal slow motion tuning dial and push button wave change. Easy to build with superb performance. All parts sold separately and fully guaranteed.

★CIRCUIT AND DETAILS ON REQUEST★

● TOTAL COST OF ALL PARTS **£7.19.6** P.P. 3/6

(Batteries 6/- extra)

MULTIMETERS

BRAND NEW. FULLY GUARANTEED

PT34	1 Kohm/volt sensitivity	**39/6**	
CABYMI	2 Kohm/volt sensitivity	**49/6**	
THL33	2 Kohm/volt sensitivity (Illustrated)	**75/-**	POST AND PACKING 2/- ANY MODEL
EP10K	10 Kohm/volt sensitivity	**79/6**	
IT12	20 Kohm/volt sensitivity	**82/6**	
TP5S	20 Kohm/volt sensitivity	**£5.19.6**	
500	30 Kohm/volt sensitivity	**£8.19.6**	
EP30K	30 Kohm/volt sensitivity	**£5.10.0**	
EP50K	50 Kohm/volt sensitivity	**£8.10.0**	
EP100K	100 Kohm/volt sensitivity	**£9.19.6**	

BUILD A QUALITY TAPE RECORDER

● 6-valve printed circuit designs with Magic Eye — Collaro Studio 2-track or 4-track decks. Portable cabinets with 8 × 5in. speakers. Complete in every detail.

TWO TRACK £26 P.P. 8/6 **FOUR TRACK £30** P.P. 8/6

★ DETAIL LEAFLET ON REQUEST ★

We can supply from stock most of the components and items specified on circuits published in this and other magazines. Quality parts at realistic prices. Let us quote for your circuit.

300 TRANSISTOR TYPES, DIODES AND RECTIFIERS

800 VALVES AND TUBES

500 QUARTZ CRYSTALS

NEW 8 PAGE LIST ON REQUEST

HENRY'S RADIO LTD.

303 EDGWARE RD.
LONDON W.2

PADdington 1008/9

Shop hours: Monday to Saturday, open all day 9 a.m. to 6 p.m. Thursday 1 p.m.

● TRADE AND EXPORT ENQUIRIES INVITED ●