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OCTOBER 1971

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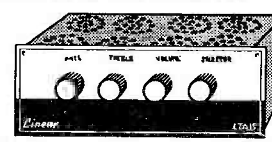

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Input Sensitivity 2 mv (max.) Output 30 watts.
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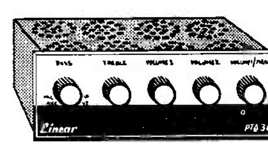

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If required an attractive wood cabinet with veneer finish can be supplied for any model. Prices from **£3.50**

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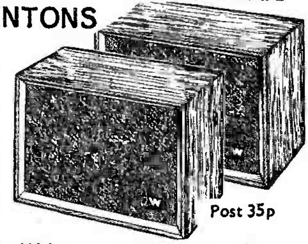
SUPER SPEAKER BARGAINS

WHARFEDALE DENTONS

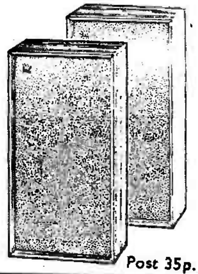


A compact system sold in matched pairs for a perfectly balanced stereo system. Each Denton contains an 8in. bass unit with 3in. pressure unit, coupled by a Wharfedale crossover network. Rated input: 15 watts maximum. Frequency response: 65–17,000Hz. Impedance: 4/8 ohms. Cabinet 9¾in. x 14in. x 8¾in. These most attractive units are available in oiled teak, white or matt walnut and are small enough to blend in with most surroundings.

Post 35p

LIST PRICE £39·00 **£28·00** Walnut White **£27·00** Teak

WHARFEDALE TRITONS



A new and exciting addition to the Wharfedale range, this three speaker system will satisfy the most ardent Hi-Fi enthusiast. Shelf or floor standing—hand finished in oiled teak or polished walnut. Frequency response 55–22,000Hz. C.A.B. Dome pressure unit. Bass unit 8in. Mid-range unit 5in. Treble unit 2in. Impedance 8 ohms. Size 21¾in. x 9¾in. x 9in.

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LASKY'S PRICE **£36·00** Teak **£38·00** Walnut White

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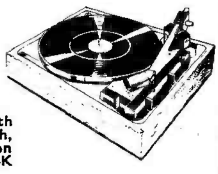
BSR McDONALD MP60

High precision low-mass counterbalanced pick-up arm, heavy balanced turntable, simple to operate controls, viscous cueing device, slide in cartridge carrier, 4 pole motor.

LASKY'S PRICE **£12·50** Post 35p



BSR McDONALD UNITS & PACKAGES

A. Chassis only. **B.** Complete with Lasky's plinth and cover. **C.** Complete with Lasky's plinth, cover and AD76K cartridge. **D.** Comp. wired on BSR plinth with cover. **E.** As D plus AD76K cartridge.

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510	£13·45	£16·95	£20·75	£22·00	£26·00
310	£9·95	£13·45	£17·25	£21·00	£23·50
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Garrard SP25 Mk. III with 9TA cart.	£13·95
Garrard SL40B	£9·95
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Type	Singles	5	10	20
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Post Each 5p. 5-20p. 10-25. 20-50p.

SONY 8FC 59W SCOOP

DIGITAL AM/FM CLOCK RADIO

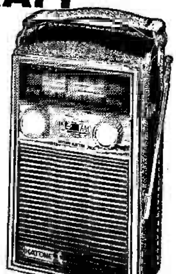
Digital Alarm Clock Radio. The digital clock shows you the time minute by minute with matchless accuracy and once set the Digimatic will wake you up at the same time every morning without having to be re-set. The radio section eatures Sony's unique sleep button, you fall gently to sleep lulled by the sweet tone of the radio, which switches itself off at a predetermined time. Available in either black, white or red (8FC-59W). Frequency range 530-1,605KHz (AM); 87-108MHz (FM). Uses 8 transistors and 8 semi-conductors, built-in ferrite aerial and 3¼in loudspeaker. Power requirements: 230V AC 50Hz. Dimensions: 12¾in x 3¾in. x 5¼in.

LIST PRICE £30·00

LASKY'S PRICE **£22·50** Post free in U.K.

KATONE AM/AIRCRAFT PORTABLE RADIO

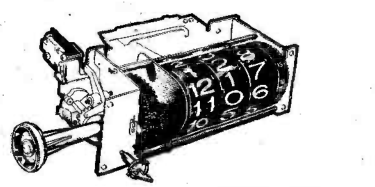
BATTERY/MAINS



A combined battery and mains portable of exceptionally attractive design. Housed in a leatherette covered case, size 8½in. x 5½in. x 3¼in., fitted with an 8-section external telescopic aerial for FM and internal ferrite rod for MW wave bands, and clear easy-to-read dial with logging scale. Wave band coverage is FM 88-108MHz, AM 535-1,600KHz. A highly selective circuit using 9 transistors and 9 semi-conductors operating from either 4 x 1·5 volt torch batteries or direct from 230 volts 50Hz AC house mains, from a built-in mains unit. A socket is fitted for a personal earphone. Easy-to-use silver colour knobs, with "woodgrain" panel enhances the appearance of this fine radio.

LASKY'S PRICE **£9·95** Post 15p

DIGITAL CLOCK SCOOP



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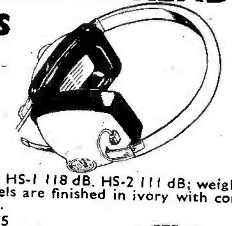
SPECIAL QUOTES FOR QUANTITES

for you to mount into any housing. The clock measures 4¾ W x 1¾ H x 3¾ D (overall from front of drum to back of switch). SPEC.: 210/240V a.c., 50Hz operation; switch rating 250V, 3A. Complete with instructions. **HUNDREDS OF APPLICATIONS. COMPLETE WITH KNOBS.**

LASKY'S PRICE **£6·95** Post 18p

TRIO HS.1 & HS.2 STEREO HEADPHONE BARGAINS



Models HS-1 and HS-2. Both these sets by TRIO offer really superb stereo reproduction in a lightweight, fully adjustable headset designed for optimum comfort. Listening fatigue is unknown with TRIO headphones. Brief spec. both models: Input imp. 8Ω nominal (matching 4 to 8Ω); max. input 0·5W; frequency response 20–19 kHz; output sensitivity at 1mW input; HS-1 118 dB. HS-2 111 dB; weight 0·66lbs. Identical in appearance—both models are finished in ivory with contrasting foam filled ear pads and head band.

LIST PRICE £8·40 HS.1 **£5·20p** LIST PRICE £6·75 HS.2 **£4·15p** Post 18p

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£2.98

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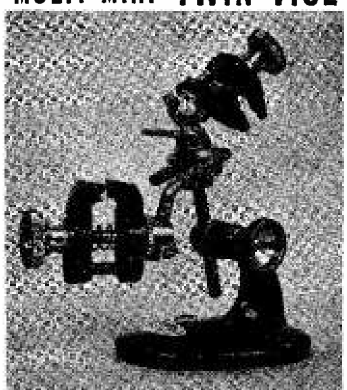
The Unique
MULTI-MINI TWIN-VICE



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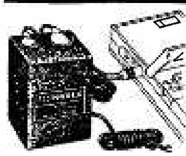

RUN YOUR TAPE RECORDER OFF A.C. MAINS
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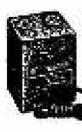
MAIN UNITS



For single outputs, 6v, 9v, 12v, 18v, £2.00. For two separate outputs, 4½v + 4½v, 6v + 6v., 9v + 9v, £2.50. P. & P. 15p. per unit. *(Please state outputs reqd).*

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BSY28	0·13	OC26	0·25
BSY29	0·13	OC28	0·30
BSY95A	0·15	OC35	0·25
OC41	0·13	OC36	0·37
OC44	0·13	AD149	0·30
OC45	0·13	AUY10	1·25
OC71	0·13	2S034	0·25
OC72	0·13	2N3055	0·63
OC73	0·17	**Diodes**	
OC81	0·13	AAY42	0·10
OC81D	0·13	OA95	0·19
OC83	0·20	OA79	0·09
OC139	0·13	OA81	0·09
OC140	0·17	IN9114	0·07

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H28	20	OC200/1/2/3 PNP Silicon uncoded TO-5 can	50p
H29	20	OA47 gold bonded diodes coded MCS2	50p

F.E.T. PRICE BREAKTHROUGH!!

This field effect transistor is the 2N3823 in a plastic encapsulation, coded as 3823E. It is also an excellent replacement for the 2N3819.

Data sheet supplied with device.

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FULLY TESTED & GUARANTEED

TYPE "A" PNP Silicon alloy, metal TO-5 can. 2S300 type, direct replacement for the OC200/203 range.

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Make a Rev. Counter for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car. **£1 each**

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NPN/PNP Silicon Planar Transistors TO-18 mixed untested similar to 2N706-6A-8, BSY26-7A9-95A and BCY70 etc. **£4·25** per 500. **£8** per 1000.

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OC44, OC45 transistors fully marked and tested 500 to 999, **8p** each, 1000+ **6p** each.

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NEW UNMARKED UNTESTED PAKS

B66	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1, 2N706A, BSY95A, etc.	50p
B60	10	7 Watt Zener Diodes Mixed Voltages	50p
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	50p
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Separate tone and volume controls for each channel, inputs for turntable (ceramic cartridge), tuner and tape. Attractive black crackle finish with brushed aluminium front. Frequency response: 70-20,000 Hz ±3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 80mV; tuner/aux 80mV.

Normal retail price: £14·70

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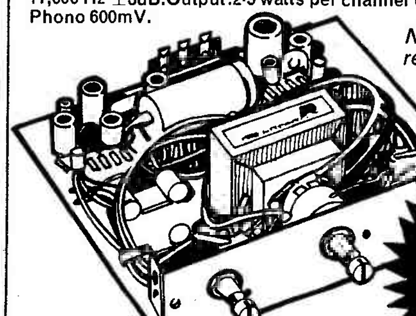
5-Watt Transistor Stereo Amplifier Chassis R.123

Completely self-contained, fully transistorised, mains-powered (240vAC) amplifier, needing only cabinet and knobs. Ideal for adapting mono players to stereo. Frequency response: 40-17,000 Hz ±3dB. Output: 2·5 watts per channel @ 8 ohms. Input: Phono 600mV.

Normal retail price: £7·30



ROC price £4.95

SOUNDS SENSATIONAL

AM/FM/MPX Stereo Tuner Amplifier R.124

A top quality amplifier with facility for receiving stereo broadcasts. Separate bass and treble controls, automatic frequency response, stereo headphone socket, output power: 8 watts. FM frequency range 88-108 M Hz; AM frequency range 535-1605 K Hz. Inputs for turntable (ceramic cartridge) and tape. Frequency response: 50-10,000 Hz ±3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 200mV, tape 100mV. FM: Sensitivity 20µV, stereo separation 26dB, image rejection 55dB. AM: Sensitivity 300µV.

Normal retail price: £42·00 **ROC price: £29.95**

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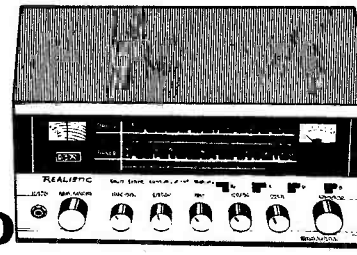
Professional Solid-state, Four-band Communications Receiver R.135

Fully transistorised with continuous coverage from 555K Hz to 30 M Hz in four bands (with illuminated bandspread for 160-10 metres). Incorporates internal speaker, automatic noise limiter, SSB/AM/CW switch, AVC switch, S Meter, Receive and Standby switch, external socket for headphone or speaker, bandspread control, BFO control, on/off/AF gain, band selector, antenna trimmer and RF gain. Runs off 240 v AC, batteries or any 12 v DC negative ground source. Frequency ranges (in mHz): Band A, 535-1·6; B, 1·55-4·5; C, 4·5-13; D, 13-30. Sensitivity: 0·5µV @ 30mHz. Bandspread: 10-160 metres.

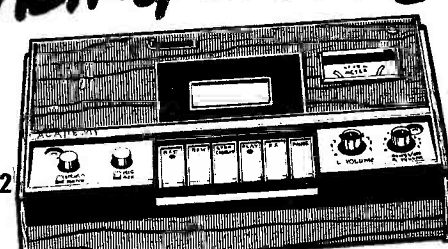
Normal retail price: £65·00



ROC price: £45.00

AMAZING OFFER!

Stereo Cassette Tape Unit R.142



Complete stereo record and playback unit with line and microphone inputs. Fitted with tape counter, separate pause control, recording level metres for each channel, pop-up cassette ejection. Supplied complete with two pencil microphones. Wow & flutter better than 0·3%, frequency response 100-10,000 Hz. Tape speed: 1⅞ IPS, 4·75 CMS. Rewind time: Better than 60 sec (C.60 cassette).

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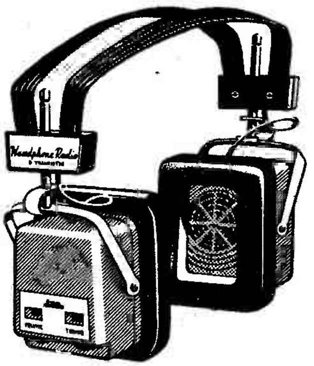

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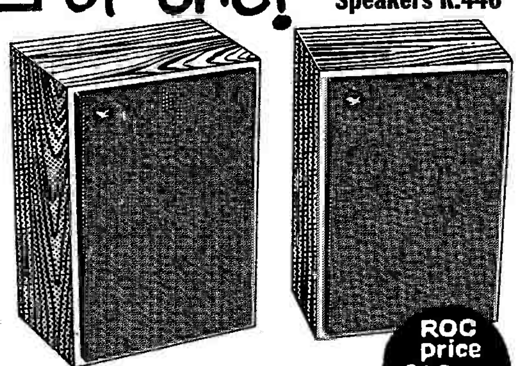

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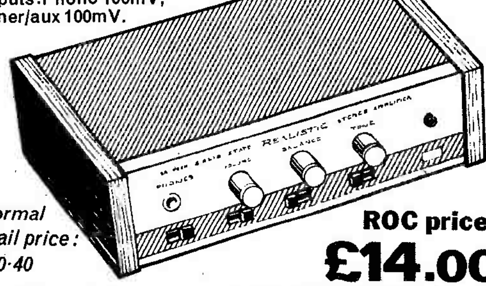
Heavily lagged teak finish cabinets each with large dual cone base unit and separate tweeter. Power handling: 10 watts peak; frequency range: 40-18,000 Hz, impedance: 8 ohms. Size: 14 x 8¾ x 6¼.
Normal retail price: £19·60

Don't read this!

10-watt Transistor Stereo Amplifier R.136
Ganged volume, balance and tone controls. Inputs for turntable (ceramic cartridge), tuner (see R.134) or tape. Oiled walnut case with satin finish aluminium front panel. Frequency response, 50-10,000 Hz ±3dB. Output: 5 watts per channel @ 8 ohms. Inputs: Phono 100mV, tuner/aux 100mV.



Normal retail price: £20·40

ROC price: £14.00

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AM/FM/MPX Stereo Tuner R.134

Matching unit to the R.136 amplifier. Covers AM and FM tuning bands with automatic stereo signal light. FM frequency range: 88-108mHz; AM frequency range: 535-1605kHz. FM: Sensitivity 5µV, stereo separation 25dB@1kHz, image rejection 50dB. AM: Sensitivity 250µV.
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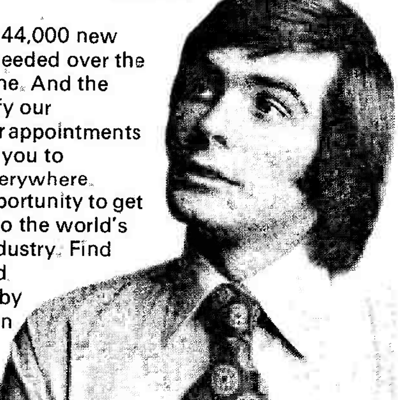

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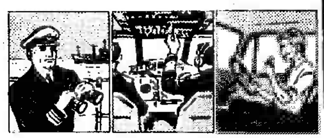

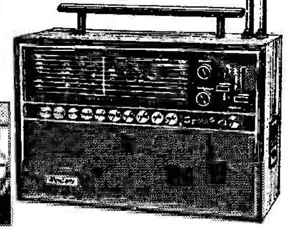

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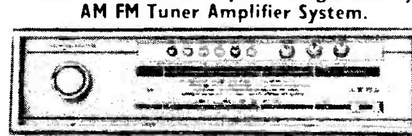
Transistorised Stereophonic High Fidelity AM FM Tuner Amplifier System.



This system includes this elegantly styled solid state Teak finished cabinet tuner/amplifier. Covering VHF/FM, Medium and long wavebands. The latest 4 Speed B.S.R. Mono/Stereo record changer with 2-10in. x 6in matching elliptical speakers. **A complete Hi-Fi Stereo Radiogram at less than half normal price.**

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P. & P. 88

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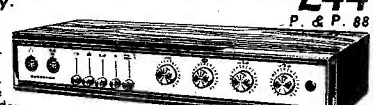

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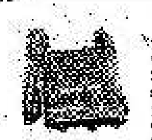

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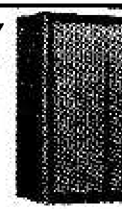

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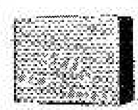

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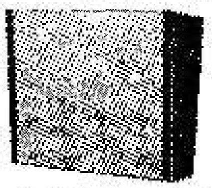

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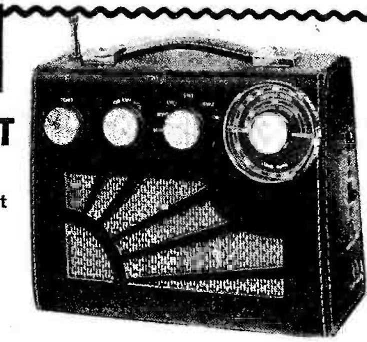
20F2	·67	DL35	·40	EL41	·54	PCF802	·44	U251	·66	OC81D	·12
20P3	·80	DL92	·26	EL84	·23	PCF805	·63	U301	·45	OC82	·12
20P4	·92	DL94	·37	EL90	·26	PCF806	·58	U329	·66	OC82D	·12
25L6GT	·20	DL96	·38	EL95	·33	PCF808	·70	U801	·98	OC170	·22

READERS RADIO

85 TORQUAY GARDENS, REDBRIDGE, ILFORD, ESSEX. Tel. 01-550 7441.

Postage on 1 valve 5p, on 2 or more valves 3p per valve extra.
Any parcel insured against damage in transit 3p extra.

Build yourself a TRANSISTOR RADIO



NEW! ROAMER 10 WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER, BAND, VHF AND AIRCRAFT BAND

Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mw Transistors. Car Aerial and Tape Record Sockets. Switched Earpiece Socket complete with Earpiece. 10 Transistors plus 3 Diodes. 7in × 4in Speaker. Air Spaced ganged Tuning Condenser with VHF section. Volume on/off, Wave Change and Tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts).

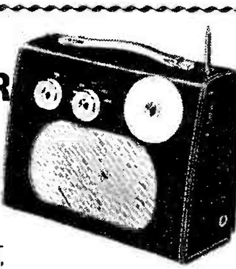
Total building cost £8·50
P. P. & Ins. 50p
(Overseas P. & P. £1)

ROAMER EIGHT Mk I

NOW WITH SWITCHED TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. Switched earpiece socket complete with earpiece. 8 transistors plus 3 diodes. 7in. × 4in. Speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts Price List and Easy Build Plans 25p (FREE with parts).

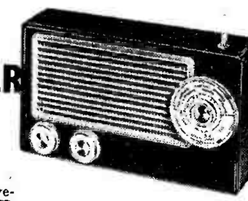
Total building cost £6·98 P. P. & Ins. 41p.
(Overseas P. & P. £1)



ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes, including Micro-Alloy R.F. Transistors. 7 × 4in. P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening, 30p extra.

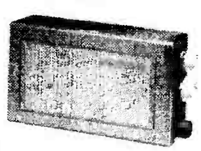
Total building costs £5·98 P. P. & Ins. 41p.
(Overseas P. & P. £1)



ROAMER SIX

6 Tunable Wavebands: MW, LW, SW1, SW2, Trawler band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

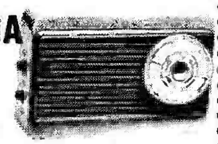
Total building costs £3·98 P. P. & Ins. 26p
(Overseas P. & P. £1)



POCKET FIVE

3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1½ × 3½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £2·23 P. P. & Ins. 21p
(Overseas P. & P. 63p)

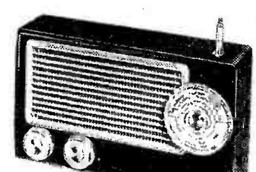


TRANSONA FIVE

NOW WITH 3in SPEAKER

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser volume control, fine tone 3in. moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

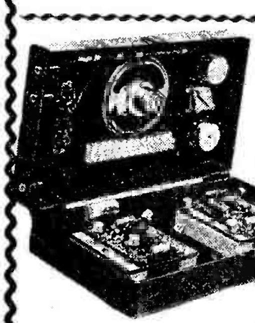
Total building costs £2·50 P. P. & Ins. 22p
(Overseas P. & P. 63p)



TRANS EIGHT

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £4·48 P. P. & Ins. 31p
(Overseas P. & P. £1)



NEW! "EDU-KIT"

BUILD RADIOS, AMPLIFIERS, ETC., FROM EASY STAGE DIAGRAMS. FIVE UNITS INCLUDING MASTER UNIT TO CONSTRUCT.

COMPONENTS INCLUDE: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: 4"×2½" Speaker: Terminal Strip: Ferrite Rod Aerial: 3 Plugs and Sockets: Battery Clips: 4 Tag Boards: Balanced Armature Unit: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ¼" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction.

All parts including Case and Plans £5·50 P. P. & Ins. 31p
(Overseas P. & P. £1)

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RADIO EXCHANGE CO

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I enclose £............ please send items marked

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ROAMER EIGHT	☐	TRANS EIGHT	☐
TRANSONA FIVE	☐	ROAMER SIX	☐
POCKET FIVE	☐	EDU-KIT	☐

Parts price list and plans for ....

Name ....

Address ....

.... PW.34

DISCOTHEQUE EQUIPMENT PACKAGE OFFERS

F.A.L. PHASE 50 MK.II AMPLIFIER £33.50
PR. FANE POP 25/2 25W L/SPEAKERS £13.50
Terms: Deposit £5.50 and 9 monthly payments of £4.72 (Total £47.98) £47.00
PACKAGE PRICE **£44** carr. £1

F.A.L. PHASE 50 MK.II AMPLIFIER £33.50
PR. FANE POP 50 L/SPEAKERS £21
Terms: Deposit £10.50 and 9 monthly payments of £5 (Total £55.50) £54.50
PACKAGE PRICE **£49·50** carr. £1

F.A.L. PHASE 100 AMPLIFIER £61.95
PR. L125 50W L/S in cabinets £59.80
Terms: Deposit £22 and 9 monthly payments of £11 (Total £121) £121.75
PACKAGE PRICE **£110** carr. £1.50

F.A.L. PHASE 100 AMPLIFIER £61.95
4 FANE POP 50 L/SPEAKERS £42
Terms: Deposit £14 and 9 monthly payments of £10 (Total £104) £103.95
PACKAGE PRICE **£94** carr. £1.50

F.A.L. DISCOTHEQUE CONSOLE

Incorporating twin Garrard SP25 Mk.III turntables and Goldring CS90 Ceramic Cartridges with diamond stylii. Separate Vol. Bass and Treble controls for each turntable plus MONITORING FACILITIES. Black Rexine covered Cabinet with lid.
£65 Carr. £1·25
Terms: Deposit £11 and 9 monthly payments of £6·70 (Total £71·30)

AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£5·75** Carr. 30p
OR SENIOR 15 WATT INC. **£6·75**
HF126 15,000 LINE SPEAKER carr. 35p

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 8–15 ohms. Please state choice. Exceptional performance at low cost.

HF801D	8"	8W	£2.71	HF120D	12"	15W	£4.75
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HF120	12"	15W	£4.25	HF126D	12"	15W	£5.90

FANE 807 HIGH FIDELITY LOUDSPEAKER

A full range 8in. 10 watt unit for excellent sound quality, in suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25 Hz to 16 KHz. Impedance 3 or 8–15 Ω. Gauss 10,000. Remarkable value. **£3·50**

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Modern design. Teak veneer finish. Acoustically lined. All sizes approx. Carr. 30p. per enclosure
JE8 Size 16 x 11 x 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi 'speaker. **£5·35**
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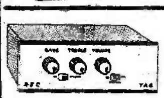
SE12 For exclnt prfmnce with 12in. Hi-Fi speaker and Tweeter. Size 25 x 16 x 10½in. **£7·87**

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1·5v and 90v, where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram **£3** Assembled ready for use **£3·50**

R.S.C. TA6 6 Watt HI-FI SOLID STATE AMPLIFIER



200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9½ x 2¼ x 5½in. Attractive brushed silver finish facia plate 10½ x 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£7·50** Carr. 40p
OR FACTORY BUILT WITH 12 MONTHS' GUARANTEE **£9·75**

R.S.C. A11 HI-FI 12-14 WATT AMPLIFIER

PUSH-PULL OUTPUT. Two input sockets with sep. vol. controls for mixing. High sensitivity, 5 valves. Bass and treble controls. Response ± 3dB 30-20,000 c/s. Hum level −60dB. Sensitivity 40 millivolts. For Crystal or Ceramic PUs. High Impedance "mikes". For Musical Instruments etc.
Std. AC mains. For 3 & 15 ohm spkrs. Complete kit. Full instructions and point-to-point wiring diagrams. Carr. 60p SAE for leaflet. Twin handled metal cover £1.75 **£10·50**
Factory built £14.75 or Dep. £3 and 9 mthly pymnts of £1.60 (Total £17.40.)

R.S.C. COLUMN SPEAKERS

R·S·C HI-FI CENTRES LTD.

IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

All types 15 Ohms covered in Rexine Vynair
TYPE C4100 IS ALSO SUITABLE FOR BASS GUITAR OR ELECTRONIC ORGAN

TYPE C48S 25-30 WATTS Fitted four 8" high flux 8 watt speakers. Overall size approx 48 x 10 x 5 in. Carr 50p
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Terms: Dep. £4 and 9 monthly payments £3 (Total £31) **£27·50**

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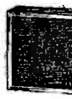
30 WATT HI-FI AMPLIFIER FOR GUITAR, VOCAL OR INSTRUMENTAL GROUP.

A 2 or 4 input, 2 vol. control Hi-Fi unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/gold P.V.C. facia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet.
Terms: Deposit £3.70 and 9 monthly payments of £2.10 (Total £22.60) **£19·95** Carr. 65p

HIGH QUALITY LOUDSPEAKER UNITS

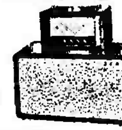
IN TEAK VENEERED CABINETS



L13 13" × 8" 10 Watt 10,000 lines 3 or 15 ohms. State impedance required. **£5·25** carr. 40p
L12 12" 25 WATT 10,000 lines 15 ohms. Also supplied Rexine covered **£10·50** carr. 45p

L125 50 WATT Two tone Rexine and vynair finish. Fitted pair of 12" 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Or deposit £4 and 9 monthly payments of £3·85. Total £34·15 **£31** Carr. 75p

R.S.C. BASS REGENT 50 WATT AMPLIFIER



A powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape, Peak Output rating. Loudspeaker unit optional horizontal or vertical mounting. **£60** Carr. £1.50
★ Two extra heavy duty 12in. Loudspeakers.
★ Four Jack inputs and two Volume Controls for simultaneous use of up to four pick-ups or "mikes".
Bass and Treble controls. Send S.A.E. for leaflet.
Credit Terms Deposit £16 and 9 monthly payments of £5.75 (Total £67.75)

FAL PHASE 50 MkII AMPLIFIER 50W

Solid state 4 Separately controlled inputs. Plus master vol. control. Ind. Bass and Treble Controls. Protective circuit to guard against damage from accidental shorts. Output for Speaker/s 3·30 ohms. Size 17" × 7" × 7½" 200-250v. A.C. mains. Output 60 watts music rating Or deposit £6 & 9 monthly payments £3·50. Total £37·50. **£33·50** Carr. 65p

FAL PHASE 100 AMPLIFIER 100W

Solid State. 4 Separately controlled inputs Plus master volume control. Ind. Bass and Treble Controls. Output for speaker/s 3·30 ohms. Protective circuit to guard against damage from accidental shorts. I.H.F.M. Output rating. Or deposit £12 & 9 monthly payments £6·25. Total £68·25. **£61·95** Carr. 75p
Send S.A.E. for leaflets.

FANE ULTRA HIGH POWER LOUDSPEAKERS

All power ratings are R.M.S. continuous. 2 YEARS' GUARANTEE High flux ceramic magnets. Heavy cast chassis. All carr. free.

'POP' 100 18" 100 Watt 14,000 gauss 8/15Ω **£22·05** Dep: £6 and 9 monthly payments £2·10 (Total £24·90)

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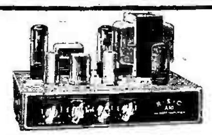
'POP' 50 12" 50 Watt 13,000 gauss 15Ω **£10·50** Dep £2 and 9 monthly payments £1.15 (Total £12.85) Pair suitable all purposes

FOR BASS GUITAR, ELECT. ORGAN. ETC.

FANE LOUDSPEAKERS 'POP' 25/2

12in. 25 WATT
Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). **£6·75** Carr. free
or Dep. £1 and 9 mthly payments 75p (Total £7.75).

R.S.C A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



Highly sensitive. Push-Pull high output, Hum level—70dB. Response ±3dB 30-20,000 c/s. All high grade components. Valves EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 millivolts. For High Impedance microphones. For Clubs, Schools, Theatres. Dance Halls Outdoor Functions, etc. For Electronic Organ, Guitar, String Bass, etc. Gram, Radio or Tape. Two separate inputs with vol. controls permit such as "mike" and Pick-up etc. to be used for mixing purposes, 200-250 v. 50 c/s A.C mains. For 3 and 15 ohm speakers. Complete Kit of parts with wiring diagram and instructions. Twin-handled perforated cover £1.75 Or factory built with EL34 output valves and 12 months' guarantee for £19.75 **£15·75** Carr. 65p
TERMS: Deposit £4 and 9 monthly payments of £2·10 (Total £22·90). Send S.A.E. for leaflet.

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250-0-250v. 100mA, 6.3v. 2a., 6.3v. 1a. .. £1.60
350-0-350v. 80mA, 6.3v. 2a., 0-5-6.3v. 2a. £1.65
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[illegible] mA, 6.3v. 4a., 0-5-6.3v. 3a. £2.60

FILAMENT or TRANSISTOR POWER PACK
Types 6.3v. 1.5a. 49p; 6.3v. 2a. 54p; 6.3v. 3a. 76p; 6.3v. 6a. £1.30; 12v. 1a. 55p; 12v. 3a. or 24v. 1.5a £1.35; 0.9-18v. 1½a. £1.10; 0-12-25-42v. 2a. £1.76
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OUTPUT TRANSFORMERS
Standard Pentode 5,000 Ω or 7,000 Ω to 3 Ω 50p
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SMOOTHING CHOKES 150mA, 7-10H, 250 Ω 70p; 100mA, 10H, 200 Ω 60p; 80mA, 10H, 350 Ω 50p; 60mA, 10H, 400 Ω 25p.

SELENIUM RECTIFIERS F. W. (Bridged)
All 6/12v. D.C. output. Max. A.C. input 18v. 1a. 25p. 2a. 35p. 3a. 50p. 4a. 65p. 6a. 80p.

BC221 MAINS POWER UNITS
200/250v I/P, O/Ps 135v at 20 mA from electronic stabiliser also 6·3v AC for heaters. Uses 4 valves made to fit in battery compartment of unit with small control box with swt and fuses. Supplied new with circ and mains lead.
Price **£6·00** plus 60p carr.
Spares for above, set of 4 new valves **£1·00**
New mains trans **£1·50** both post paid.

R.F. 26 TUNING UNITS
These tune 50 to 65 Mc/s use 3 valves I.F. O/P 7 Mc/s will mod up to 100 Mc/s fitted slow motion dial etc. Supplied in good cond. with circ. Price **£2.10** plus 40p post.
Rx unit 3645 for use with above **£2·25** carr. paid

METER UNITS
Radio altimeter units 6·5 mA F.S.D. 270° scale size front 3¼" sq. fitted on/off and range swt ideal for use as rev. counters; good condition.
Price **80p** plus 15p post

AMPLIFIER UNIT 115v 50c/s I/P
These are a small self contained unit, uses 3 valves 6X4 Rect, 6AK6 O/P and 12AX7 Amp; these are low impedance I/P & 500 ohm O/P, fully enclosed size 10 x 3½ x 3½". Supplied with circ. & mods. for 3 ohm O/P, ideal unit for beginner, Ex USAF surplus good cond. Price **£2·50** plus 25p post. Small 230/110 trans for above 75p post paid.

HEAVY DUTY MAINS TRANS.
Pria 200/220/240v 50c/s Sec 500-0-500 at 400 mA or can be connected to give 1 kV at 200 mA; varnish finish tag connections; size overall 5½ x 5½ x 4¼; supplied in new condition ex service.
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POWER UNITS
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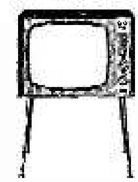

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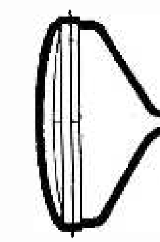

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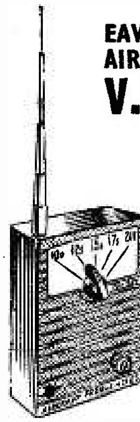

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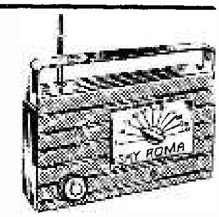

Can be built in one evening

At last! After trying countless circuits searching for easy build, work first-time short wave. Giving advanced world-wide performance, we chose this 'Sky Roma'. Anyone from 9 years up can follow the step-by-step, easy-as-ABC, fully illustrated instructions. (We built ten prototypes and everyone worked first time) no soldering necessary. 76 stations logged on rod aerial in 30 mins.—**Russia, Africa, USA, Switzerland, etc.** Experience thrills of world wide news, sport, music. etc. **Eavesdrop on unusual broadcasts.** Uses PP3 battery. Transistorised (no valves!). Size only 3" x 4¾" x 1¼". As tremendous demand anticipated price held to only **£2·25** (45/-) + 17p (3/6) p. & p. for all parts incl. Cabinet, screws, instructions etc. (Parts available separately).

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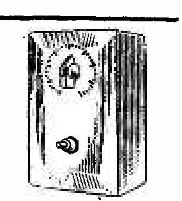

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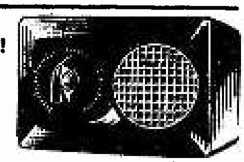

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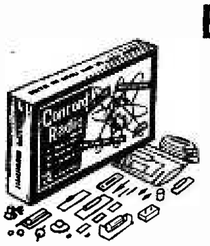

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2N1613	22p	BC148	12p	MPF104	37p
2N1711	25p	BC149	20p	MPF105	40p
2N2147	75p	BC154	37p	NKT217	40p
2N2160	60p	BC157	20p	NKT277	20p
2N2218	20p	BC158	17p	NKT403	75p
2N2219	20p	BC159	20p	NKT404	62p
2N2222	20p	BC169C	15p	OA5	20p
2N2222A	25p	BC177	25p	OA9	10p
2N2369	20p	BC178	25p	OA10	25p
2N2484	35p	BC179	27p	OA47	10p
2N2646	50p	BC182L	12p	OA70	10p
2N2904	20p	BC183L	12p	OA73	10p
2N2904A	25p	BC184L	15p	OA79	10p
2N2905	25p	BC212	12p	OA81	10p
2N2906	20p	BCY30	25p	OA85	12p
2N2906A	25p	BCY31	30p	OA90	10p
2N2907	23p	BCY32	50p	OA91	7p
2N2926	10p	BCY33	25p	OA95	7p
2N3011	25p	BCY34	30p	OA200	7p
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2N3054	50p	BCY39	85p	OC16	50p
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2N3705	15p	BCY78	30p	OC28	60p
2N3707	15p	BCY79	30p	OC29	60p
2N3709	10p	BCZ10	35p	OC35	50p
2N3710	10p	BCZ11	45p	OC36	60p
2N3819	35p	BD112	50p	OC41	25p
2N3820	60p	BD121	65p	OC42	30p
2N4058	15p	BD123	80p	OC43	40p
2N4061	15p	BD124	75p	OC44	17p
2N5457	35p	BD125	50p	OC45	15p
2N5458	37p	BD131	75p	OC70	12p
2N5459	50p	BD132	85p	OC71	15p
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2S304	75p	BDY11	£1·62	OC75	25p
40250	50p	BDY17	£1·50	OC76	25p
40361	50p	BDY18	£1·75	OC77	40p
40362	55p	BDY19	£1·87	OC81	25p
AAY30	10p	BDY61	£1·25	OC82	25p
AAY42	15p	BDY62	£1·00	OC83	25p
AAZ13	12p	BF115	25p	OC84	25p
AAZ17	10p	BF152	30p	OC139	25p
AC107	37p	BF154	40p	OC140	37p
AC126	25p	BF158	30p	OC141	62p
AC127	25p	BF159	60p	OC170	25p
AC128	25p	BF167	25p	OC171	30p
AC176	25p	BF170	35p	OC200	40p
AC187	30p	BF173	30p	OC201	70p
AC188	30p	BF177	40p	OC202	80p
ACY17	30p	BF178	25p	OC203	40p
ACY18	25p	BF179	40p	OC204	40p
ACY19	25p	BF180	35p	OC205	75p
ACY20	20p	BF181	35p	OC206	90p
ACY21	20p	BF182	30p	OC207	90p
ACY22	10p	BF184	20p	OCP71	97p
ACY39	50p	BF185	20p	ORP12	50p
ACY40	15p	BF194	17p	ORP60	40p
AD140	50p	BF195	15p	ORP61	42p
AD149	50p	BF196	15p	TIP29A	50p
AD161	37p	BF197	15p	TIP30A	60p
AD162	37p	BF200	37p	TIP31A	62p
AF114	25p	BF274	37p	TIP32A	75p
AF115	25p	BFX13	25p	TIP33A	
AF116	25p	BFX29	25p		£1·00
AF117	25p	BFX30	25p	TIP34A	
AF118	62p	BFX37	32p		£2·00
AF124	25p	BFX84	25p	TIS43	40p
AF125	20p	BFX85	35p	TIS60	22p
AF126	17p	BFX86	25p	TIS61	25p
AF127	17p	BFX87	25p	TIS62	27p
AF139	30p	BFX88	20p	ZTX107	15p
AF178	47p	BFY18	30p	ZTX108	15p
AF179	65p	BFY50	22p	ZTX300	12p
AF180	52p	BFY51	20p	ZTX301	15p
AF181	42p	BFY52	22p	ZTX302	20p
AF186	40p	BFY53	17p	ZTX303	20p
AF239	40p	BFY90	65p	ZTX304	25p
ASY26	25p	BSX20	17p	ZTX500	20p
ASY27	32p	BSX21	20p	ZTX501	25p
ASY28	25p	BSX76	15p	ZTX502	25p
ASY29	30p	BSY95	15p	ZTX503	20p
ASY67	47p	BSY95A	15p	ZTX504	40p
ASZ21	42p	BY100	15p	ZTX531	30p
BA115	7p	BY126	15p		
BA164	10p	BY127	20p	DISCOUNTS	
BAX13	5p	BY182	85p	10%	12+
BAX16	7p	BYZ10	40p	15%	25+
BAY31	7p	BYZ11	35p	20%	100+
BAY38	17p	BYZ12	30p	Any one type	

HENRY'S LOW COST INTEGRATED CIRCUITS

WE OFFER FROM STOCK AN EXCLUSIVE RANGE OF BRAND NEW CERAMIC FULL SPECIFICATION LOW COST TTL 7400 RANGE BY I.T.T, TEXAS, FAIRCHILD

Part No.	Description	Price and Qty. 1–24	25–99	100	250+
7400	Quadruple 2-input NAND Gate	20p	18p	15p	13p
7401	Quadruple 2-input Positive NAND Gate (with open collector output)	20p	18p	15p	18p
7402	Quadruple 2-input Positive NOR Gates	20p	18p	15p	13p
7403	Quadruple 2-input Positive NAND Gates (with open collector output)	20p	18p	15p	13p
7404	Hex Inverters	20p	18p	15p	13p
7405	Hex Inverter with open collector	20p	18p	15p	13p
7410	Triple 3-input Positive NAND Gates	20p	18p	15p	13p
7413	Dual 4-input Schmitt Trigger	35p	32p	29p	25p
7420	Dual 4-input Positive NAND Gates	20p	18p	15p	13p
7430	8-input Positive NAND Gates	20p	18p	15p	13p
7440	Dual 4-input Positive NAND Buffers	20p	18p	15p	13p
7441	BCD to decimal nixie driver	87p	77p	66p	60p
7442	BCD to decimal decoder (4-10 lines, 1 of 10)	87p	77p	67p	60p
7447	BCD-Seven-Segment Decoder/Drivers (15-V Outputs)	£1·40	£1·30	£1·20	£1·05
7450	Expandable dual 2-input AND-OR-INVERT	20p	18p	15p	13p
7451	Dual 2-wide 2-input AND-OR-INVERT GATES	20p	18p	15p	13p
7453	Quad 2-input Expandable AND-OR-INVERT	20p	18p	15p	13p
7454	4-wide 2-input AND-OR-INVERT Gates	20p	18p	15p	12p
7460	Dual 4-input Expander	20p	18p	15p	13p
7470	Single-phase J-K Flip-Flop	35p	32p	29p	25p
7472	Master-slave J-K Flip-Flop	35p	32p	29p	25p
7473	Dual Master slave J-K Flip-Flop	43p	40p	37p	33p
7474	Dual O type Flip-Flop	43p	40p	37p	33p
7475	Quad latch	47p	45p	43p	40p
7476	Dual J-K with pre-set and clear	47p	45p	43p	40p
7480	Gated Full Adders	87p	77p	67p	60p
7481	16-bit read/write memory	£1·35	£1·25	£1·15	£1·00
7482	2-bit Binary Full Adders	£1·30	£1·20	£1·00	85p
7483	Quad Full Adder	87p	77p	67p	60p
7486	Quad 2 input Exclusive OR Gates	80p	70p	60p	50p
7490	BCD decade counter	87p	77p	67p	60p
7491	8-bit Shift Registers	£1·21	£1·00	87p	75p
7492	Divide-by-Twelve Counters	87p	77p	67p	60p
7493	4-bit Binary Counters	87p	77p	67p	60p
7494	Dual entry 4-bit shift register	87p	77p	67p	60p
7495	4-bit up-down shift register	87p	77p	67p	60p
7496	5-bit Parallel in parallel out Shift Register	87p	77p	67p	60p
74100	8-bit Bistable Latches	£1·75	£1·65	£1·65	£1·35
74118	Hex Set-Reset Latches	£1·30	£1·20	£1·00	85p
74121	Monostable Multivibrators	87p	77p	67p	60p
74141	BCD-to-Decimal Decoder/Driver	87p	77p	67p	60p
74145	BCD-to-Decimal Decoder/Drivers	£1·80	£1·70	£1·60	£1·50
74151	8-bit Data Selectors (with Strobe)	£1·40	£1·30	£1·20	£1·05
74153	Dual 4-Line-to-1-Line Data Selectors/Multiplexers	£1·40	£1·30	£1·20	£1·05
74191	Binary Counter reversible	£2·50	£2·25	£2·00	£1·50

Devices may be mixed to qualify for quantity price.
Data available for above series in booklet form, price **10p.** *(Ref No. 30).*
Larger quantity prices Extn. 4. Dual Inline 14 Pin Socket 30p each 16 Pin 35p each.

SILICON RECTIFIERS

1 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS

Type	P.I.V.	1–49	50+	100+	500+	1000+
IN4001	50	8p	7p	6p	5p	4p
IN4002	100	9p	8p	7p	5½p	4½p
IN4003	200	10p	9p	7½p	6p	5p
IN4004	400	10p	9p	8p	7p	6p
IN4005	600	12p	10p	9p	7p	7p
IN4006	800	15p	14p	12p	11p	9p
IN4007	1000	20p	16p	13p	12p	10p

1.5 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS

Type	P.I.V.	1–49	50+	100+	500+	1000+
PL4001	50	10p	9p	8p	7p	6p
PL4002	100	11p	10p	9p	8p	7p
PL4003	200	12p	11p	10p	9p	8p
PL4004	400	12p	11p	10p	9p	8p
PL4005	600	15p	13p	11p	10p	9p
PL4006	800	17p	15p	13p	12p	10p
PL4007	1000	20p	17p	15p	13p	11p

3 AMP PLASTIC WIRE ENDED RECTIFIERS

Type	P.I.V.	1–49	50+	100+	500+	1000+
PL7001	50	20p	18p	17p	16p	14p
PL7002	100	20p	19p	18p	17p	15p
PL7003	200	22p	20p	19p	18p	16p
PL7004	400	25p	23p	21p	20p	18p
PL7005	600	26p	24p	23p	22p	20p
PL7006	800	27p	25p	24p	23p	21p
PL7007	1000	30p	28p	26p	24p	22p

POTTED BRIDGE RECTIFIERS (SILICON) SIZE ½ x ½ x ⅜ins.

Type	P.I.V.	Cur-rent	1–49	50+	100+	500+
1002	100	2 amps	60p	55p	50p	45p
2002	200	2 amps	70p	65p	60p	55p
4002	400	2 amps	80p	75p	70p	65p
1004	100	4 amps	70p	60p	55p	50p
2004	200	4 amps	75p	70p	65p	60p
4004	400	4 amps	80p	75p	70p	65p
6002	600	2 amps	90p	80p	75p	70p
6004	600	4 amps	90p	80p	75p	70p
1006	100	6 amps	75p	70p	65p	60p
2006	200	6 amps	80p	75p	70p	65p
4006	400	6 amps	£1·10	80p	90p	80p
6006	600	6 amps	£1·25	£1·10	£1·00	90p

INTEGRATED CIRCUITS

MCFC4000P	£1·12	LA709C	65p
I.C. 12	£2·75	MC1304	£2·75
PA246	£2·45	MC724P	60p
TAA263	75p	741c (T05)	85p
TAD100	£1·97	741c (DIL)	85p
TAD110	£1·97	709c (T05)	65p
MC1303	£2·60	709c (DIL)	65p
UL900	40p	Toshiba 20 watt Amp	£4·47
UL914	40p	Toshiba	
UL923	40p	PreAmp	£1·50

ZENER DIODES

400 M/W 5% Miniature
BZY 88 Range. All voltages 3·3–33 Volt. 15p each.
25+ 12p; 100+ 10p; 500+ 8p; 1000+ 6p. Any one type.
1½ Watt 5% Metal case. Wire Ends. 6·8V. all voltages to 100V. 25p each.
25+ 22p; 100+ 19p; 500+ 17p; 1000+ 15p. Any one type.
3 Watt Plastic Wire Ends 5%
All voltages 6·8–100V. 30p each.
25+ 27p; 100+ 25p; 500+ 23p; 1000+ 21p. Any one type.
10 Watt Stud Mounting 5%
All voltages 5·1–100V. 40p each.
25+ 37p; 100+ 35p. Any one type.

TRIACS

(All stud mounting)

Type	P.I. Volts	Cur-rent	1–49	50+	100+
SC35A	100	3 amps	90p	75p	65p
SC35B	200	3 amps	95p	80p	70p
SC35D	400	3 amps	£1·00	85p	75p
SC40A	100	6 amps	£1·00	85p	75p
SC40B	200	6 amps	£1·20	£1·00	85p
SC40D	400	6 amps	£1·25	£1·10	£1·00
SC45A	100	10 amps	£1·25	£1·10	£1·00
SC45B	200	10 amps	£1·35	£1·20	£1·10
SC45D	400	10 amps	£1·50	£1·35	£1·20
SC50A	100	15 amps	£1·65	£1·50	£1·35
SC50B	200	15 amps	£1·75	£1·60	£1·45
SC50D	400	15 amps	£2·00	£1·75	£1·60
SC40E	500	6 amps	£1·50	£1·25	£1·10
SC45E	500	10 amps	£1·75	£1·50	£1·35
SC50E	500	15 amps	£2·25	£2·00	£1·75

DIAC ST2 20p

Larger quantity prices Extn. 4

SEMI-CONDUCTORS

LOOK AT THESE PRICES FOR QUANTITIES FROM STOCK

AF114 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

AF115 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

AF116 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

AF117 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

2N3055 **75p** — Mullard 115watt Silicon Power — 25 + 65p; 100 + 50p

2N3819 Texas **35p** — 25 + 30p; 100 + 25p; 500 + 20p; 1000 + 18p

BFY90 **65p** — 1000 MC/S — 25 + 60p; 100 + 55p; 500 + 50p

2N2646 **40p** — Motorola Unijunction — 25 + 35p; 100 + 30p; 500 + 25p

AF139 **30p** — Siemens V.H.F. — 25 + 25p; 100 + 22p; 500 + 19p

AF186 **40p** — Mullard V.H.F. — 25 + 35p; 100 + 30p; 500 + 25p

OC170 Mullard **25p** — 25 + 21p; 100 + 17p; 500 + 15p

BYZ13 **25p** — Mullard 6a 200v — 25 + 20p; 100 + 17p; 500 + 15p

OC171 Mullard **30p** — 25 + 27p; 100 + 22p

BC107, BC108, BC109 **12p** each — I.T.T. Planars — 25 + 11p; 100 + 10p; 500 + 8p

BY127 Mullard **20p** — 1000v 1 amp Plastic — 25 + 17p; 100 + 15p; 500 + 13p

OCP71 **97p** — Mullard Photo — 25 + 85p; 100 + 80p; 500 + 75p

BC113 SGS **15p** — 25 + 13p; 100 + 11p; 500 + 9p

OA202 **10p** — SILICON Diodes — 25 + 8p; 100 + 6p; 500 + 5p; 1000 + 4p

OC28 **62p** — Mullard Power — 25 + 55p; 100 + 50p; 500 + 42p

OC42 Mullard **30p** — 25 + 25p; 100 + 23p; 500 + 21p; 1000 + 18p

OC71 Mullard **15p** — 25 + 12p; 100 + 10p; 500 + 8p

ORP12 Mullard **50p** — 25 + 45p; 100 + 42p; 500 + 40p

OC45 Mullard **15p** — 25 + 13p; 100 + 12p; 500 + 10p; 1000 + 8p

2N930 **25p** — 25 + 23p; 100 + 20p; 500 + 17p; 1000 + 15p

OC75 Mullard **25p** — 25 + 21p; 100 + 17p; 500 + 15p; 1000 + 13p

OC72 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p; 1000 + 13p

OC20 **97p** — Mullard 100v — 25 + 85p; 100 + 80p; 500 + 75p

OC83 **25p** — 25 + 20p; 100 + 17p; 500 + 15p; 1000 + 13p

OC44 Mullard **17p** — 25 + 15p; 100 + 13p; 500 + 11p; 1000 + 10p

OC84 **25p** — 25 + 20p; 100 + 17p; 500 + 15p; 1000 + 13p

OC139 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

AF239 **42p** — 25 + 35p; 100 + 30p; 500 + 25p; 1000 + 20p

OC81 Mullard **25p** — 25 + 20p; 100 + 17p; 500 + 15p

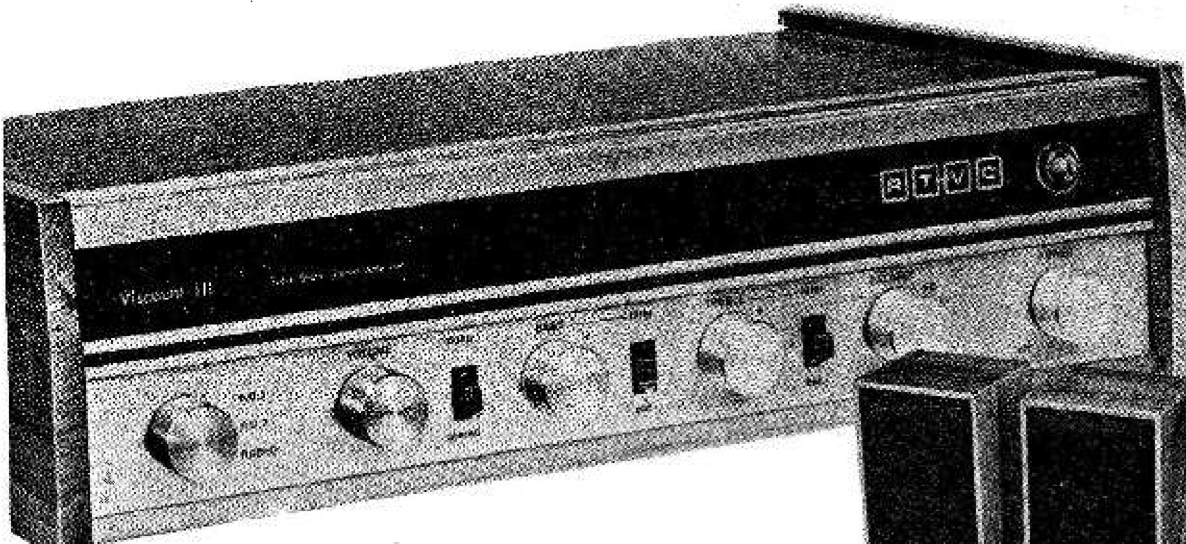
HENRY'S RADIO LTD. SEMI-CONDUCTOR DEPARTMENT
303 EDGWARE RD., LONDON, W2. TEL: 01-723 1008/9
CALLERS 356 EDGWARE ROAD W2.

NEW LIST - NEW PRICES 1971 TRANSISTOR LIST 1500+ SEND FOR YOUR FREE COPY TODAY...

DISCOUNTS 10% 12+ 15% 25+ 20% 100+ ANY ONE TYPE
POSTAGE 7p. ALL ORDERS

We respectfully ask customers to include a minimum £1.00 per order, it helps to plan ahead & saves postage as well.

28watts, r.m.s. 40Hz to 40kHz ± 3dB



Viscount III Audio Suite complete £49

There are two stereo amplifiers—the R100 for ceramic cartridges, the R101 for magnetic. Both incorporate FETs (FIELD EFFECT TRANSISTORS), just like top-priced units. FETs give you more of the signal you want, and almost none of the background hiss you don't. Both units have a jack socket to plug in headphones and there's a separate output for tape recorder. Filters (an unusual feature in this price range) and tone controls give a wide range of bass and treble adjustment which compensate for input deficiencies and domestic acoustic conditions.

PRICES SYSTEM 1

Viscount III R101 amplifier	£22·00	+90p p&p
2 x Duo Type II speakers,	£14·00	+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00	+£1·50 p&p
Total	£59·00	

Available complete for only £52·00+£3·50 p&p

SYSTEM 2

Viscount R101 amplifier	£22·00	+90p p&p
2 x Duo Type III speakers	£32·00	+ £3 p&p
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23·00	+£1·50 p&p
Total	£77·00	

Available complete for £69+£4 p&p

SYSTEM 3

Viscount III Amplifier R100	£17·00	+90p p&p
2 x Duo Type II speakers, pair	£14·00	+£2 p&p
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21·00	+£1·50 p&p
Total	£52·00	

Available complete for only £49·00+£3·50 p&p

SPEAKERS Duo Type II Size 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts. 3 ohms. Simulated Teak cabinet. **£14 pair**+£2 p&p.

Duo Type III Size 23½" x 11½" x 9½". Drive unit 13½" x 8¼" with H.F. speaker. Max. power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair**+£3 p&p.

SPECIFICATION R100/101

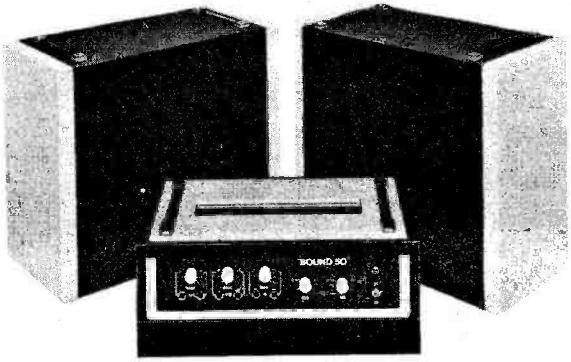
14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities; headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2. −58dB. **R100** same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size 13¾" x 9" x 3¾".

R+TV

Radio and TV Components (Acton) Ltd. 21c High Street, Acton, London W3 6NG
323 Edgware Road, London, W.2. Mail orders to Acton. Terms C.W.O. *All enquiries S.A.E.*
Goods not despatched outside U.K.

SOUND 50

50 WATT AMPLIFIER & SPEAKER SYSTEM



The Sound Fifty valve amplifier and speakers are sturdily constructed with smart housings and thoroughly tested electronics. They are designed to last—to withstand the knocks and bumps of life on the road. Built for the small and medium sized gig, they are easy to handle and quick to set up and can be relied upon to come over with all the quality and power you need.

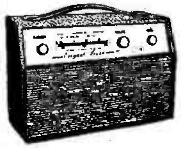
Output Power: 45 watts R.M.S. (Sine wave drive). **Frequency response:** −3dB points 30Hz at 18KHz. **Total distortion:** less than 2% at rated output. **Signal to noise ratio:** better than 60dB.
Speaker Impedance: 3, 8 or 15 ohms. **Bass Control Range:** ± 13dB at 60Hz. **Treble Control Range:** ± 12dB at 10 KHz. **Inputs:** 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K.
To protect the output valves, the incorporated fail safe circuit will enable the amplifier to be used at half power.
SPEAKERS! Size 20″ × 20″ × 10″ incorporating 12″ heavy duty 25 watt high flux, quality loudspeaker with cast frame. Cabinets attractively finished in two tone colour scheme—Black and grey.

COMPLETE SYSTEM £50 Plus £6 P. & P.
Sound 50 amp and 2 speakers

or available separately. Amplifier £28.50 plus £1.50 P. & P.
Speakers £12.50 each plus £2.25 P. & P.

THE ELEGANT SEVEN Mk. III

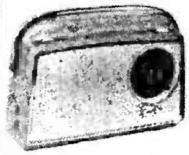
(350mW Output)



7 transistor fully-tunable M.W.—L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.
MAINS POWER PACK KIT: 75p extra.

Price **£5.25** plus 50p. P. & P.
Circuit 13p FREE WITH PARTS.

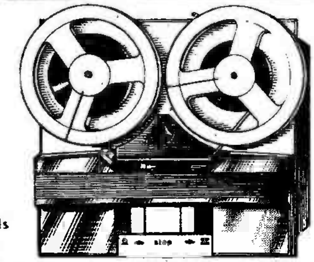
THE DORSET (600mW Output)



7-transistor fully tunable M.W.—L.W. superhet portable. Set of parts. The latest modulised and pre-alignment techniques make this simple to build. Sizes: 12 x 8 x 3in.

Price **£5.25** plus 50p P. & P.
Circuit 13p FREE WITH PARTS

CONTINENTAL 4 TRACK, 3 SPEED TAPE DECK

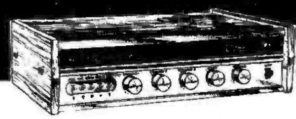


with high impedance heads

R.C. 74 tape deck. Three speeds—7½, 3¾ and 1⅞ ips.
4-track record/playback head. Plus 4-track erase head. Positive pressure pad system. Takes any tape spool up to and including 7″. The R.C. 74 is driven by a powerful 200/250V 50-cycle A.C. motor. A heavy, accurately balanced, flywheel brings wow and flutter levels down to approx. 0.3% total at 3¾ and 7½ ips. Fast rewind in both directions.
Controls couldn't be simpler! Just five push buttons that interlock to cut out accidental tape damage. Efficient servo-action type braking. Easy drop-in tape loading.
The R.C. 74 comes with an attractive moulded deck cover, which has positions for tone and volume controls. The unit is built into a rigid die-cast frame, and overall size of the whole unit is 12¾ × 11⅛ × 6 inches. Every single deck fully tested before dispatch. Spools not supplied.

Price complete **£15·00.** Plus 75p P. & P.

RELIANT mk. IV



The Reliant Mk. IV
provides a high standard of sound reproduction, with full mixing facilities. It's versatility makes it suitable for: Discotheque, P.A., Home Entertainment Applications, etc.

- ★ **Five Electronically Mixed Inputs**
- ★ **Three Individual Mixing Controls**
- ★ **Separate bass and treble controls common to all five inputs**
- ★ **Mixer employing F.E.T. (Field Effect Transistor)**
- ★ **Solid State Circuitry**
- ★ **Attractive Styling**

£9.50 PRICE plus P. & P. 60p.

SPECIFICATIONS

INPUTS:—1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.) All 250mV sensitivity.

CONTROLS:—3 Volume controls. Bass control range ±13db @ 60 Hz. Treble control range ±12db @ 15KHz. Separate ON/OFF Switch, Neon Indicator.

POWER OUTPUT:—12 Watts R.M.S. into 3 to 4 ohms speaker.

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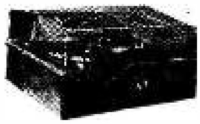

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100	0·25	0·33	0·53	0·58	0·63	1·40
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200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
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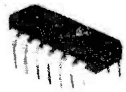

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BP03 = 7403	Quad 2-input pos. NAND gates (with open collector output)	0·15	0·14	0·12
BP04 = 7404	Hex Inverters	0·15	0·14	0·12
BP05 = 7405	Hex Inverter (with open-collector output)	0·15	0·14	0·12
BP10 = 7410	Triple 3-input pos. NAND gates	0·15	0·14	0·12
BP13 = 7413	Dual 4-input Schmitt trigger	0·29	0·26	0·24
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BP30 = 7430	8-input pos. NAND gates	0·15	0·14	0·12
BP40 = 7440	Dual 4-input pos. NAND buffers	0·15	0·14	0·12
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BP48 = 7448	BCD-to-seven-segment decoder/driver	0·97	0·94	0·88
BP50 = 7450	Expandable dual 2-input and-or-invert	0·15	0·14	0·12
BP51 = 7451	Dual 2-wide 2-input and-or-invert gates	0·15	0·14	0·12
BP53 = 7453	Quad 2-input expandable and-or-invert	0·15	0·14	0·12
BP54 = 7454	4-wide 2-input and-or-invert gates	0·15	0·14	0·12
BP60 = 7460	Dual 4-input expander	0·15	0·14	0·12
BP70 = 7470	Single-phase J-K flip-flop	0·29	0·26	0·24
BP72 = 7472	Master slave J-K flip-flop	0·29	0·26	0·24
BP73 = 7473	Dual Master slave J-K flip-flop	0·37	0·35	0·32
BP74 = 7474	Dual D type flip-flop	0·37	0·35	0·32
BP75 = 7475	Quad latch	0·47	0·45	0·42
BP76 = 7476	Dual J-K with pre-set and clear	0·43	0·40	0·38
BP80 = 7480	Gated full adders	0·67	0·64	0·58
BP81 = 7481	16-bit read/write memory	0·97	0·94	0·88
BP82 = 7482	2-bit binary full adders	0·97	0·94	0·88
BP83 = 7483	Quad full adder	1·10	1·05	0·95
BP86 = 7486	Quad 2-input exclusive NOR gates	0·32	0·30	0·28
BP90 = 7490	BCD decade counter	0·67	0·64	0·58
BP91 = 7491	8-bit shift registers	0·87	0·84	0·78
BP92 = 7492	Divide-by-twelve counters	0·67	0·64	0·58
BP93 = 7493	4-bit binary counters	0·67	0·64	0·58
BP94 = 7494	Dual entry 4-bit shift register	0·77	0·74	0·68
BP95 = 7495	4-bit up-down shift register	0·77	0·74	0·68
BP96 = 7496	5-bit parallel in parallel out shift-register	0·77	0·74	0·68
BP100 = 74100	8-bit bistable latches	1·75	1·65	1·55
BP104 = 74104	Single J-K flip-flop equivalent 9000 series	0·97	9·94	0·88
BP105 = 74105	Single J-K flip flop equivalent 9001 series	0·97	0·94	0·88
BP107 = 74107	Dual Master slave flip-flops	0·40	0·38	0·36
BP110 = 74110	Gates master-slave flip-flops	0·55	0·53	0·50
BP111 = 74111	Dual data lock-out flip-flop	1·25	1·15	1·00
BP118 = 74118	Hex set-reset latches	1·00	0·95	0·90
BP119 = 74119	Hex set-reset latches. 24-pin	1·35	1·25	1·10
BP121 = 74121	Monostable multivibrators	0·67	0·64	0·58
BP141 = 74141	BCD-to-decimal decoder/driver	0·67	0·64	0·58
BP145 = 74145	BCD-to-decimal decoder/driver O/C	1·50	1·40	1·30
BP150 = 74150	16-bit data selector	1·80	1·70	1·60
BP151 = 74151	8-bit data selectors (with strobe)	1·00	0·95	0·90
BP153 = 74153	Dual 4-line-to-1-line data	1·20	1·10	0·95
BP154 = 74154	4- to 16-line decoder	1·80	1·70	1·60
BP155 = 74155	Dual 2- to 4-line decoder	1·40	1·30	1·20
BP156 = 74156	Dual 2- to 4-line decoder O/C	1·40	1·30	1·20
BP160 = 74160	Sync. decade counter	1·80	1·70	1·60
BP161 = 74161	Sync. 4-bit binary counter	1·80	1·70	1·60
BP190 = 74190	Sync. up-down BCD counter	3·50	3·25	3·00
BP191 = 74191	Sync. binary up-down counter (single clock line)	3·50	3·25	3·00
BP192 = 74192	Sync. up-down decade counter	2·10	1·95	1·75
BP193 = 74193	Sync. binary up-down counter (tow clock lines)	2·10	1·95	1·75
BP196 = 74196	Pre-setable 50MHz decade counter	1·80	1·70	1·60
BP197 = 74197	Pre-setable 50MHz binary counter	1·80	1·70	1·60
BP198 = 74198	8-bit parallel L-R shift register	5·50	5·00	4·00
BP199 = 74199	8-bit parallel access shift register	5·50	5·00	4·00

Devices may be mixed to qualify for quantity price. Larger quantities—prices on application (TTL 74 Series only).
Data is available for the above series of I.C's in booklet form. Price 13p.

TTL INTEGRATED CIRCUITS

Manufacturers' "Fall outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

PAK No.		PAK No.		PAK No.	
UIC00 = 12 × 7400N	50p	UIC42 = 5 × 7450N	50p	UIC80 = 5 × 7480N	50p
UIC01 = 12 × 7401N	50p	UIC50 = 12 × 7450N	50p	UIC82 = 5 × 7482N	50p
UIC02 = 12 × 7402N	50p	UIC51 = 12 × 7451N	50p	UIC83 = 5 × 7483N	50p
UIC03 = 12 × 7403N	50p	UIC60 = 12 × 7460N	50p	UIC86 = 5 × 7486N	50p
UIC04 = 12 × 7404N	50p	UIC70 = 8 × 7470N	50p	UIC90 = 5 × 7490N	50p
UIC05 = 12 × 7495N	50p	UIC72 = 8 × 7472N	50p	UIC92 = 5 × 7492N	50p
UIC10 = 12 × 7410N	50p	UIC73 = 8 × 7473N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC74 = 8 × 7474N	50p	UIC94 = 5 × 7494N	50p
UIC40 = 12 × 7440N	50p	UIC75 = 8 × 7475N	50p	UIC95 = 5 × 7495N	50p
UIC41 = 5 × 7441AN	50p	UIC76 = 8 × 7476N	50p	UIC96 = 5 × 7496N	50p

UICX1 = 25 × Asst'd 74's £1·50

Paks cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1
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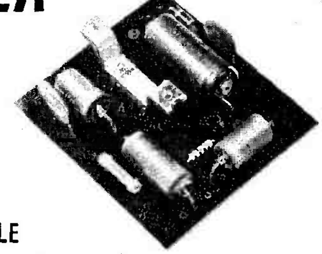

THE NEW **S.G.S.** EA 1000 AUDIO AMPLIFIER MODULE

*GUARANTEED NOT LESS THAN 3 WATTS RMS

Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TA/621 providing unlimited applications for the enthusiast in the construction of radios, record players, Audio and Stereo units. Also ideal for intercom systems, monitoring applications and phone answering machines. OTHER USES: *portable applications where supply rails as low as 9V are of prime importance.*

- **Sensitivity 40 mV for 1 watt VOLTAGE GAIN 40dB but can be varied up to 73dB for some applications.**
- **Signal to Noise Ratio 86dB.**
- **Frequency response better than 50 Hz to 25 KHz for −3dB.**
- **Normal supply Voltage 9-24V.**
- **Suitable for 8-16 OHM Loads.**
- **Overall Size 2″ × 3″ × ¾″.**
- **Typical Total Harmonic distortion at 1 watt less than 1%.**

Supply voltage (Vs) = 24V 15ohm load.

Module Tested and Guaranteed

Quantity	1-9	10-25
Price each	£2·63	£2·28

Larger quantities quoted on request

Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

ROCK BOTTOM PRICES—CAN'T BE BEATEN!

LOGIC DTL 930 SERIES IC's

Type No.	Function	Price 1–24	25–99	100 up
BP930	Expandable dual 4-input NAND	12p	11p	10p
BP932	Expandable dual 4-input NAND buffer	13p	12p	11p
BP933	Dual 4-input expander	13p	12p	11p
BP935	Expandable Hex Inverter	13p	12p	11p
BP936	Hex Inverter	13p	12p	11p
BP944	Dual 4-input NAND expandable buffer without pull-up	13p	12p	11p
BP945	Master-slave JK or RS	25p	24p	22p
BP946	Quad, 2-input NAND	12p	11p	10p
BP948	Master-slave JK or RS	25p	24p	22p
BP951	Monostable	65p	60p	55p
BP962	Triple 3-input NAND	12p	11p	10p
BP9093	Dual Master-slave JK with separate clock	40p	38p	35p
BP9094	Dual Master-slave JK with separate clock	40p	38p	35p
BP9097	Dual Master-slave JK with Common Clock	40p	38p	35p
BP9099	Dual Master-slave JK Common Clock	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

BRAND NEW LINEAR I.C's—FULL SPEC.

Type No.	Case	Leads	Description	Price 1–24	25–99	100 up
BP 201C—SL201C	TO-5	8	G.P. Amp	63p	53p	45p
BP 701C—SL701C	TO-5	8	OP Amp	63p	50p	45p
BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709 —72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P—μA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 711—μA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741 —72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
μA 703C—μA703C	TO-5	6	R.F.-I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293—	TO-74	10	G.P. Amp	90p	75p	70p

All prices quoted in new pence *Giro No. 388-7006*

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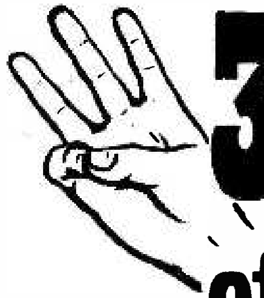

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PRACTICAL WIRELESS

VOL 47 NO 6

Issue 776

OCTOBER 1971

Who makes what?

WELL, of course, that's easy! When you buy a radio set, hi-fi amplifier or piece of electrical equipment, the trade mark tells you that. Or if the mark is an unfamiliar one you can find the piece moulded on the cabinet or printed on the carton which says 'Made in Outer Mongolia' or whatever.

People are interested in where products are made for a variety of reasons. The possible standard of workmanship, value-for-money, reputation, reliability, the position of after-sales service, availability of spare parts—or even personal political motives—are all valid reasons why a purchaser would want to know who makes what, and where.

From November 30th, however, the Merchandise Marks Act comes to an end and from that date it will no longer be obligatory for imported goods to bear a 'country-of-origin' mark. The casual customer will therefore not be sure if he is buying a radio set made in Birmingham or Baluchistan, or an amplifier which is a Chinese-copy of an American design made in Hong Kong or Japan.

Of course, there will still be trade marks which proclaim that the goods are true-blue British or come from well-respected foreign companies. Sadly, though, things are not always what they seem for many tape recorders, radio and TV receivers, bearing the names of old-established British manufacturers have for some time been made overseas and imported for the home market.

From November 30th, protection of the consumer has been thown at the retailer who, when asked, will be expected to disclose where a particular product is made. Unfortunately in may cases he will have no way of giving the required information. For instance, 'household-name' UK companies are none too keen to admit that some of their goods are being made in low-cost labour countries. Moreover, if a retailer does not know the country of origin, or (even inadvertently) gives the wrong answer, he will be at risk under the Trade Descriptions Act!

Apart from the factors mentioned earlier, which allow a customer to assess the advisability or otherwise of making a purchase, a particularly disturbing aspect of electrical goods (notably electric blankets and appliances) is that safety specifications may fall far short of those imposed on British-made goods and expose the user to potential hazards.

So, together with the British Radio Equipment Manufacturers' Association, the Radio and Television Retailers' Association and the Association of Manufacturers of Domestic Appliances, we beg the Secretary for Trade and Industry to think again. And to would-be purchasers after November 30th we can only say, most emphatically *caveat emptor!*

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

SPECIAL FEATURES

NOVEMBER ISSUE WILL BE PUBLISHED ON OCTOBER 8th

NEWS... NEWS... NEWS...

Viscount value

The Viscount III Audio System is the first of a range of audio equipment marketed in the UK by R+TV Components (Acton) Ltd. under the Viscount brand name.

The complete system includes a choice of two amplifiers, a Garrard SP25 Mk III turntable and two Duo type II or type III speakers.

Amplifier RT100 is for ceramic cartridges and model RT101 which has an additional input stage accepts magnetic types. Both amplifiers incorporate f.e.t.'s giving excellent signal to noise ratios.

Prices are: RT100, £17; RT101, £22; Garrard SP25 with ceramic cartridge, £21 or with magnetic cartridge, £23. Duo type II speakers cost £14 the pair and Duo type III, £32.

Savings can be made by buying complete systems.

Impex cases

In last month's issue we stated the following about Impex instrument cases:

"At no additional cost, Impex cases can be supplied with all or some of these specifications: alternative colours of blue or bronze; no hood; no ventilating slots or back/front anodised front/rear panels".

What we should have mentioned is that these additions can only be supplied free of charge for quantities over 24.

NHK's anniversary

June 1 saw the anniversary of the Radio Japan Service. Thirty-six years ago NHK commenced this service in commemoration of the 10th anniversary of radio broadcasting in Japan and the attainment of 2 million licensed subscribers.

From June 1934 to 1945, NHK broadcast its domestic programmes to Korea, Taiwan and Manchuria, then Japan's outlying territories, utilising telephone channels of the International Telephone Company. Shortwave broadcasts were received in various parts other than the areas directed, and reception reports began to come to NHK from Japanese residing abroad and from large numbers of overseas people. In those days, Japanese living in various parts of the world totalled nearly two million. These people raised their voices requesting the establishment of an overseas broadcasting service. In Japan, too, commencement of an overseas broadcasting service was also strongly desired, since this country had been isolated after her withdrawal from the League of Nations and was in need of reinforcing its public relations abroad. At first the service was known as Radio Tokyo (Radio Japan was first used in 1952).

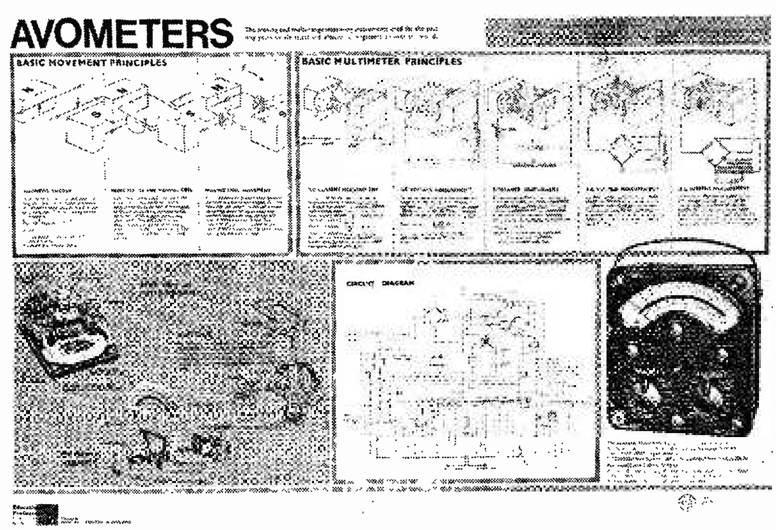
Avo wall chart

Avo Limited (Thorn Group) announce a new wall chart featuring the latest Mark 4 version of the Avometer Model 8. The design and layout is such that it will prove of great interest not only to Avometer users but also to technical schools and general education establishments as a teaching aid.

Information is presented in a clear, logical manner and the theoretical and practical information is both concise and easy to understand. Magnetic theory is developed pictorially to outline the operation of the moving coil movement whilst a mathematical treatment is used to derive the various ranges of a multimeter.

Illustrations of the interior of the instrument include an exploded view of the movement to simplify the constructional detail and a circuit diagram provides an introduction to standard symbols and references.

The Avometer chart (size 20×30in., 508×762mm.) is ideal for blackboard or wall presentation and is available from *Spares Dept., Avo Limited, Avocet House, Dover*, at 75p per copy, including post and packing.



NEWS... NEWS... NEWS...

Windermere VHF

The v.h.f. radio services from the Windermere relay station started on August 7. Radio 2 is on 88·6MHz, Radio 3 on 90·8MHz and Radio 4 on 93·0MHz, all with horizontal polarization.

The v.h.f. radio transmissions from this new relay station, which is situated on Claife Heights, above the western shore of Lake Windermere, will serve Ambleside, Windermere town, Bowness-on-Windermere, and an area around the northern shores of the lake.

Stereo from Rowbridge

The necessary equipment has now been installed at Rowridge to enable the Radio 3 transmitter (90·7MHz) to broadcast stereophony. This is being brought into use immediately, so that listeners can hear the Promenade Concerts in stereo—all except four of the concerts will be broadcast stereophonically in Radio 3. The stereo transmissions from Rowridge will initially be on an engineering test basis; every effort will be made to maintain them, but there may be occasions when it will be necessary to revert to monophonic transmissions. The date for the start of the full stereophonic service will be announced later.

Miniature Electric Tools

A range of battery-operated miniature tools has been introduced by Expo (Drills) Ltd., 62 Neal Street, London, W.C.2.

Two basic models are available. The 'Reliant' is designed for lighter work such as model making, and has a full load current of 1·5A. Its rated torque is 1·38oz. in. (100 gm.cm.). For jobs requiring a more powerful tool and for professional applications the 'Titan Super' is rated at 3·5A on full load. It has a rated torque of 350cmp operating at 4000-9000rpm. An extremely large range of accessories is also available for both models. Various collets and accessories are supplied with the different models, which range in price from £3 to £5·50.

Lectures

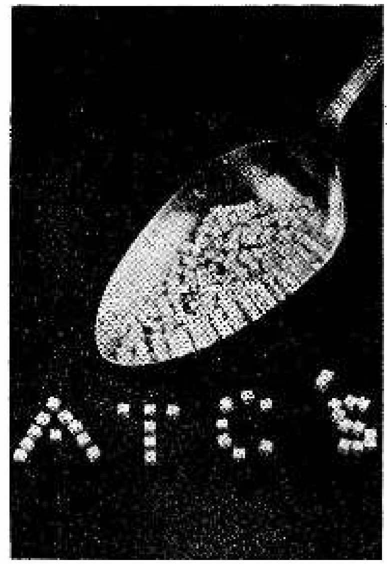
THE Polytechnic of North London Department of Electronic and Communications Engineering is running a course on Audio and Acoustic Measurements on Thursdays 6.30-8.30 p.m. 1971/2. 1971: Oct., 28, Parameters and Standards of Measurement R. N. Baldock, B.Sc., F.B.K.S.T.S. Nov. 4, Measurement of Microphone Performance, H. D. Harwood, B.Sc., B.B.C. Research; 11, Electrical and Mechanical Measurements in Tape Recording, R. L. West, B.Sc., C.Eng., F.I.E.R.E.; 18, Measurements in Professional Recording, Angus McKensie; 25, Electrical and Mechanical Measurements on Disc, Pickups and Accelerometers, S. Kelly, C.Eng., F.I.E.R.E. Dec. 2, Measurement of Loudspeaker Performance I, R. L. West; 9, Measurement of Loudspeaker Performance II, R. C. Driscoll, M.Sc.; 16, Measurement of Studio Characteristics, R. C. Driscoll, M.Sc. 1972: Jan. 13, Measurement of Noise Transmission, J. Moir C.Eng., F.I.E.E.; 20, Assessment of Noise Nuisance, J. Moir, C.Eng., F.I.E.E.; 27, Visit to A.I.R.O. Laboratories, Hemel Hempstead, G. Berry, B.Sc., C.Eng., M.I.Mech.E. and Assocs.

Grand Junk Sale

The Star Short Wave Club, G3ZWA, is holding a "Grand Junk Sale" in aid of Radio Amateur Invalid Bedfast Club funds. It is to be held at the New Inn Hotel, Bramley Town Street, Bramley, Leeds 13. The date is Wednesday September 15th and time 7.30.

If any readers have any junk, the Star Club will collect within a radius of 25 miles from Leeds. Please contact Mr. T. Leeman, G8BUU, 115 Asket Drive, Seacroft, Leeds, LS14 1HX.

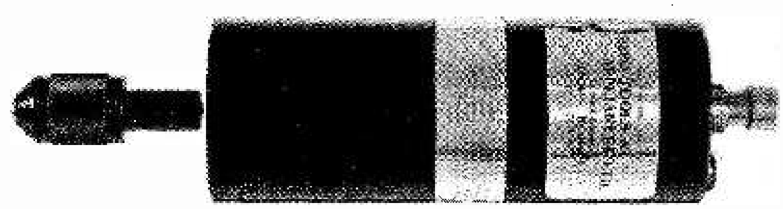
Chip "C's"

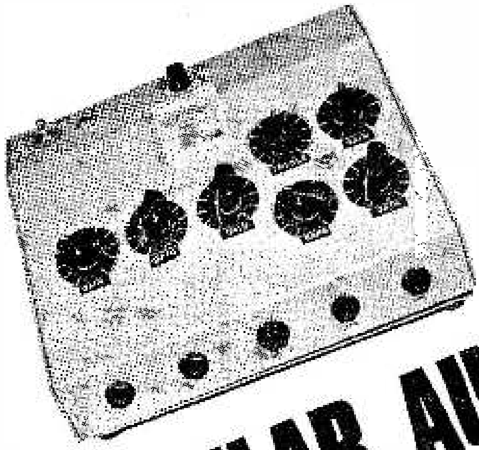


Featuring a very low insertion loss, a very high Q and high capacitance-to-volume ratios, a new range of ceramic and porcelain chip capacitors from Guest International Limited is ideal for u.h.f. and microwave applications. Apart from the basic pellet and chip, there is a wide choice of lead variations: stripline, axial and radial wire, axial and radial ribbon.

ATC 100 series are porcelain chips with an insertion loss of 0·03dB, a Q of over 10,000 and a capacitance range of 0·1 to 1000pF. In a case size of only 0·110in.square, the working voltage is up to 500V d.c.

ATC 200 series are ceramic chips with an insertion loss of 0·05dB. The capacitance range is 10pF to 1·2μF and chips are available in case sizes 0·050, 0·110 and 0·250in.square, depending on the value and the working voltage.





MODULAR AUDIO MIXING SYSTEM

F. C. JUDD

So many audio sources are now in common use that an article describing a specific design would meet the needs of only a few. This problem is overcome here by giving circuits for virtually all sources and care in design has made possible a large number of permutations so that a custom built audio mixer is possible even for those readers unable to design their own. The clever constructional method employed also allows for rapid modification to meet any mixing need.

A STUDY of the four block diagrams in Fig. 1 will show how the various signal preamplifiers, the tone control unit and line amplifier etc. can be used to build audio signal mixing systems to cater for tape recording, public address, discotheque and even Hi-Fi applications. The combinations given are but a few of the permutations which can be extended for stereo use simply by duplication.

Each signal preamp has the same output level, 100mV, and will match directly into either the tone control unit or the line amplifier, both of which are designed to accept a signal level of 100mV. The tone control has unity gain so this provides 100mV output to match into the line amplifier. Any group of signal preamplifiers can therefore be coupled directly to the line amplifier or via the tone control unit and then to the line amplifier. This allows any of the signal preamplifiers to be used with or without the tone control unit.

The line amplifier has a nominal output of 1V r.m.s. at a fairly low impedance and can be used to drive a power amplifier module requiring between 500mV to 1V input, or it can be coupled to a tape recorder or radio input, or to a public address or music amplifier with inputs rated for 500mV to 1V. Groups of the preamplifiers and line amplifier can be run from batteries or from an 18V mains power supply.

COMBINATIONS

A fairly simple arrangement is shown in Fig. 1a and is intended for use as a general purpose signal mixer as shown on the front cover. This would be suitable for tape recording, as it has two microphone inputs, one input for low impedance pick-up (with R.I.A.A. correction), and two line level (200mV to over 1V) inputs. The tone control operates for the mic. and pickup inputs, whilst the line inputs go directly to the line amplifier. The system also includes a VU meter with variable control so that the meter can be set to read with the level meter on a tape recorder.

The combination shown in Fig. 1b has the same input channels but no tone control unit. The arrangement in Fig. 1c might be suitable for a small discotheque with one mic. input, two pickup inputs both via a tone control unit and one line input, suitable for the output from a tape recorder. For music application, Fig. 1d provides two mic. and two guitar inputs with separate tone control units for each guitar input. In each case the VU meter is optional but can be used as an overload indicator as will be shown later.

PERFORMANCE SPECIFICATIONS

Seven preamplifiers will be described, each catering for specific signal sources as follows:—

1. LOW IMPEDANCE MICS. (25 to 600Ω). Direct input, no transformer required. Input sensitivity 50μV. Output 100mV. Frequency response ±1dB. 30 to 30,000Hz. Signal-to-noise −50dB. (Code: **Mic. Lo-Z**).
2. FOR MICROPHONES WITH BUILT-IN TRANSFORMERS. Medium to high impedance. Input sensitivity 1mV. Output 100mV. Frequency response ±1dB 20 to 30,000Hz. Signal-to-noise −60dB. (Code: **Mic. Hi-ZT**).
3. FOR CRYSTAL MICS. High impendance. Input sensitivity 2mV. Output 100mV. Frequency response ±1dB 30 to 12,000Hz. Signal-to-noise −50dB. (Code: **Mic. Hi-ZX**).
4. MAGNETIC PICKUP. Impedance 56kΩ. Input sensitivity 5mV. Output 100mV. Frequency response to R.I.A.A. as shown in Fig. 2. Signal-to-noise −60dB. (Code: **PU Mag.**)

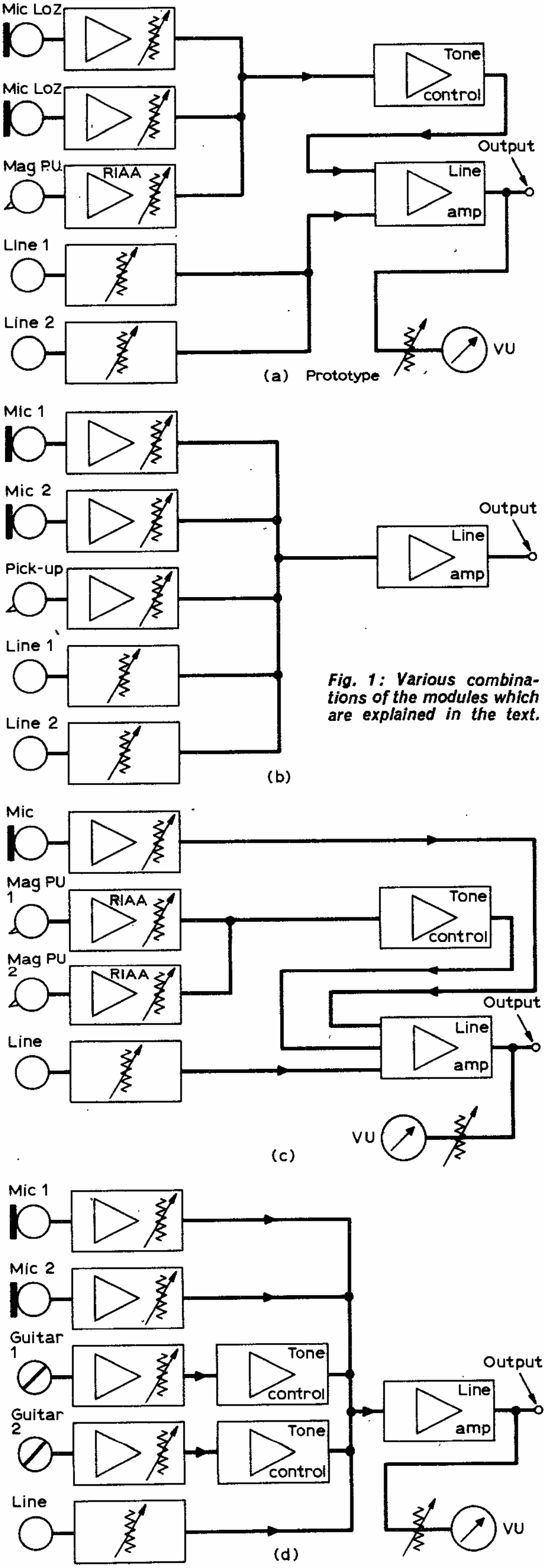


Fig. 1: Various combinations of the modules which are explained in the text.

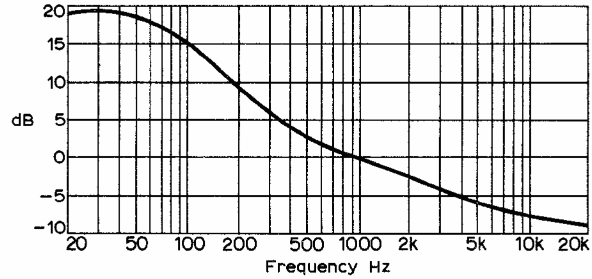


Fig. 2: The RIAA response curve incorporated in the magnetic pickup module.

5. CERAMIC PICKUP. Input impedance 2MΩ. Input sensitivity 60mV. Output 100mV. Frequency response approximately 20 to 20,000Hz ±1dB. Equalisation automatic due to high input impedance. Signal-to-noise −50dB. (Code: **PU Cer.**)
6. CRYSTAL PICKUP. Input impedance about 1MΩ. Input sensitivity 850mV. Output 100mV. Frequency response approximately 20 to 20,000Hz ±1dB. Equalisation automatic due to high input impedance. Signal-to-noise −60dB. (Code: **PU Xtal.**)
7. GUITAR PREAMP. Input impedance medium, 10 to 100kΩ. Input sensitivity variable. 50 to 100mV. Output 100mV. Frequency response ±1dB 20 to 30,000Hz. Signal-to-noise −50 to −60dB. (Code: **G.**)

The tone control unit will take the output from any of the preamps and provides 100mV output so that it can be coupled directly to the line amplifier. Its performance is as follows:— With tone controls neutral the flat response is 10 to 80,000Hz ±1dB. The response of the bass and treble controls is shown in Fig. 3 providing 15dB lift and 12dB cut at 40Hz and 15dB lift to 12dB cut at 20,000Hz The signal to noise performance is better than −90dB. (Code: **TC**).

The line amplifier unit will accept the output from any of the preamps or the tone control unit and therefore has an input sensitivity of 100mV. The output signal level available is 1V r.m.s at an impedance of approximately 600Ω. The frequency response is flat from 10 to nearly 100,000Hz and the signal-to-noise performance −80dB. The output can be fed simultaneously to one or more tape recorders and/or amplifiers via series output resistors as will be shown. The overall gain of the line amplifier is adjustable i.e., the input sensitivity can be increased. (Code: **LA.**)

The line inputs do not require separate preamplifiers as these are arranged in passive network coupling directly to the line amplifier. The input sensitivity will be 200mV to over 1V r.m.s. at approximately 10kΩ impedance. (Code: **L input.**)

CONSTRUCTION

The construction of each of the preamplifier modules is such that the circuit board is mounted on a small screen this, in turn, being secured to the fixing bush of the gain control (VR1 in each circuit). The complete preamp can therefore be secured to a front panel by the lock nut of the gain control. The tone control unit is similar except that there are two potentiometers and both are mounted on the small screen and then secured to the panel. The line amplifier can be simply mounted on a piece of aluminium angle ($^3/_8 \times {}^3/_8$in) or on stand-off pillars as convenient. It need not be fixed to a panel but must

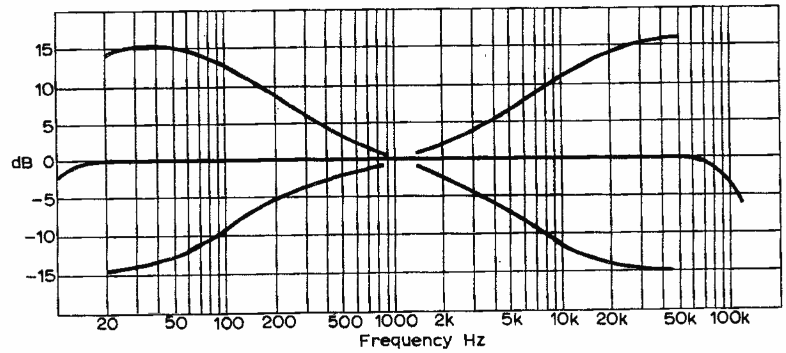


Fig. 3: Response curves of the tone control module.

be fairly well clear of mains power supply components. The input sockets for all inputs must be insulated from the front panel and earthed only at the common earthing point on the preamplifier board. *If the mixing unit is to be mains powered, the components for the power supply must be kept as far away from the amplifier boards as possible and preferably with a screen around them.*

The seven preamplifier boards are exactly the same and details for construction are given in Fig. 4. In each case the gain control (VR1) is fitted as shown

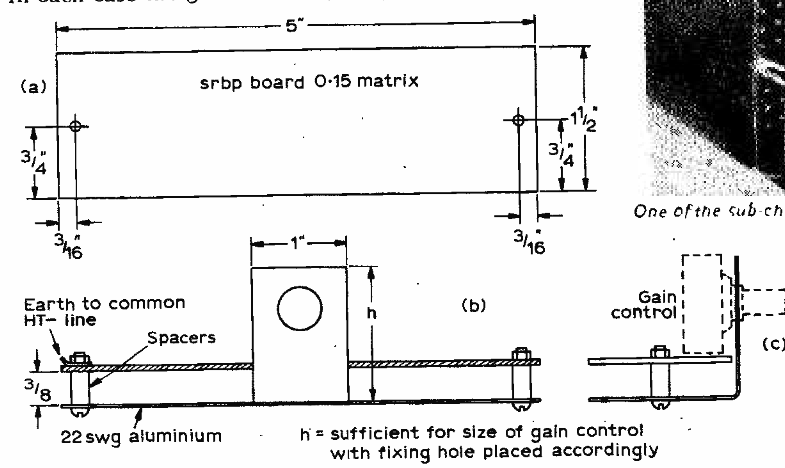


Fig. 4: Details of the sub-chassis used for each module.

in Fig. 4c. The construction of the tone control board is similar except that two controls have to be fitted so the screen has two flaps as shown in Fig. 5. The height of each flap and the position of the fixing hole will depend on the physical size of the potentiometers used.

CIRCUITS AND ASSEMBLY OF THE MODULES

Each of the amplifier modules and the tone control

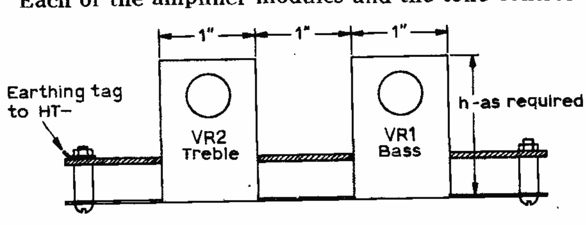
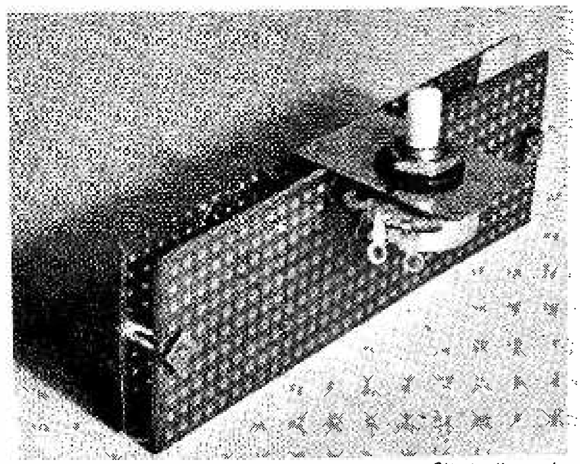


Fig. 5: Modified sub-chassis for the tone control module.

can be tested separately by operating them from an 18V battery (two 9V units) and by checking each one with an audio signal generator and audio voltmeter or by connecting an appropriate input signal source and feeding the output to an amplifier.

LINE AMPLIFIER

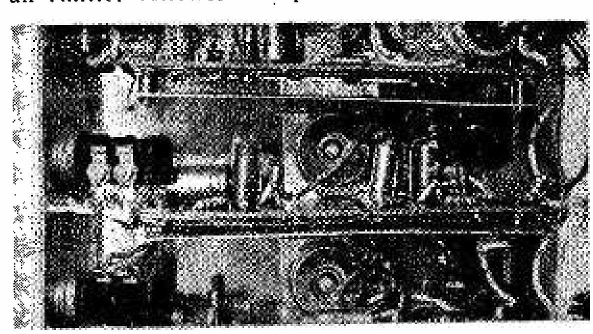
The best order of construction is to build the line amplifier (code: LA) first so that the preamps can be tested with it as each is completed. The circuit is given in Fig. 6 and the board layout in Fig. 7. As



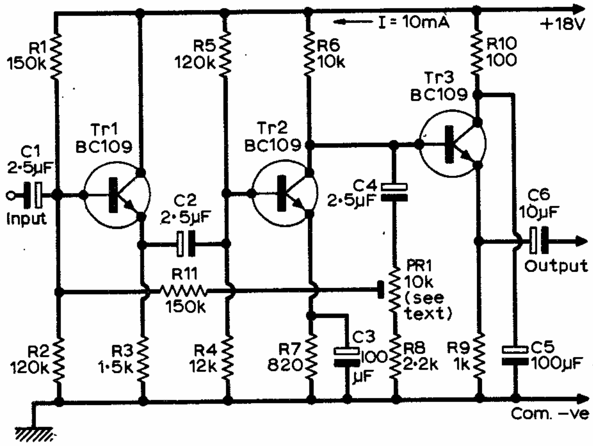
One of the sub-chassis before the components are fitted; dimensions are given in Fig. 4.

with all the circuits except the tone control unit only one type of transistor is used—the BC109 silicon NPN—which is readily available and inexpensive. The line amplifier employs three of these beginning with Tr1 as an emitter follower input stage with Tr2 as the amplifier.

Negative feedback between Tr2 and Tr1 via the pre-set PR1 ensures a linear response and some adjustment over total gain. The pre-set should be adjusted so that with a 100mV input signal the output at C6 is exactly IV. If a signal generator and audio voltmeter are unavailable, set PR1 to midway position. The output transistor Tr3 operates as an emitter follower and provides a low impedance



An internal view of the prototype showing one of the modules. The input jack is on the left with the common wiring on the right.



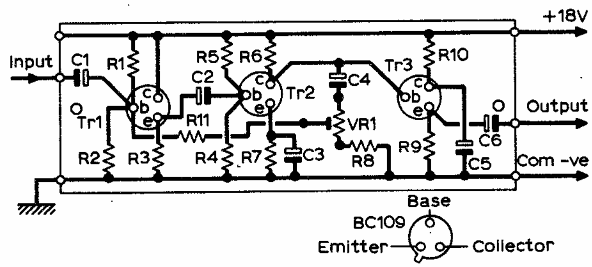
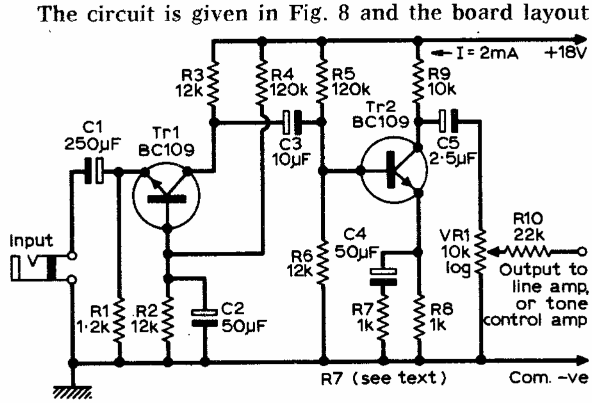


Fig. 6: (above) and Fig. 7 (below): The circuit and layout of the line amplifier module.

output. Details for feeding more than one power amplifier and/or tape recorder from the line amplifier output will be given later.

MICROPHONE PREAMP (Mic Lo-Z)

The circuit is given in Fig. 8 and the board layout



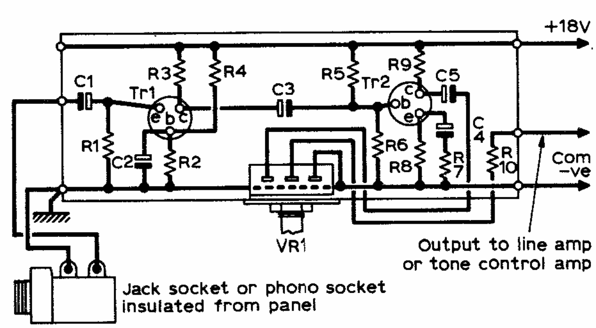


Fig. 8 (above) and Fig. 9 (below): The circuit and layout of the low impedance microphone preamplifier module.

★ components list

Amplifier Modules Circuit Boards

0·15 matrix s.r.b.p. board to sizes given. 22 s.w.g. aluminium for module screens to sizes given

Line Amplifier (LA)

Tr1, Tr2, Tr3		BC109
PR1	10kΩ	Miniature carbon pre-set

Resistors

R1	150kΩ	R6	10kΩ
R2	120kΩ	R7	820Ω
R3	1·5kΩ	R8	2·2kΩ
R4	12kΩ	R9	1kΩ
R5	120kΩ	R10	100Ω

All ¼W, 10% types

Capacitors

C1	2·5µF	25V	C4	2·5µF	25V
C2	2·5µF	25V	C5	100µF	25V
C3	100µF	25V	C6	10µF	25V

Microphone Pre-amplifier (Mic Lo-Z)

Tr1, Tr2		BC109
VR1	10kΩ	Log. Potentiometer

Resistors

R1	1·2kΩ	R6	12kΩ
R2	12kΩ	R7	1kΩ
R3	12kΩ	R8	1kΩ
R4	120kΩ	R9	10kΩ
R5	120kΩ	R10	22kΩ

All ¼W, 10% types

Capacitors

C1	250µF	25V	C4	50µF	25V
C2	50µF	25V	C5	2·5µF	25V
C3	10µF	25V			

Power Supply

Transformer T1	18V Secondary	Henry's Radio Type MT95
Bridge Rectifier MR1		Henry's Radio Type LT119
C1	2500µF	25-30V
C2	5000µF	25-30V
R	¼W—see text	

On/Off mains toggle switch
Panel neon indicator
All electrolytics used in the amplifier circuits should be rated for at least 25V working.
Each pre-amplifier will require an input jack socket or phono socket of the type that can be insulated from the panel on which they are mounted.

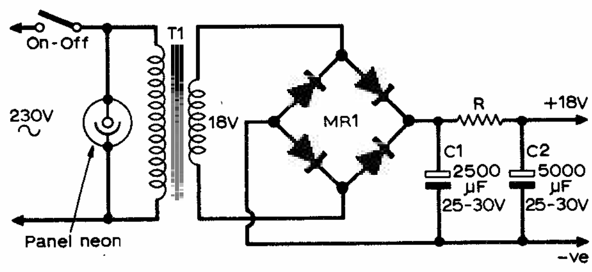
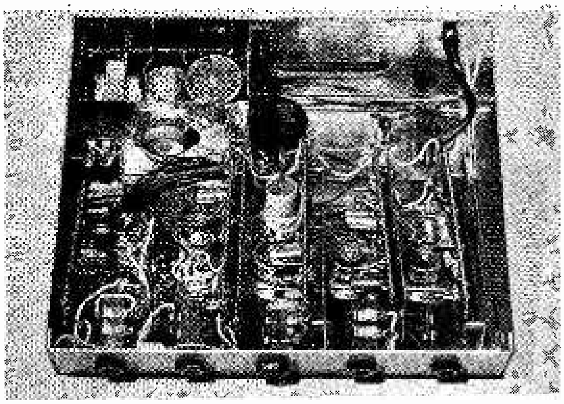


Fig. 10: Suggested circuit for a mains power supply to power the mixer.

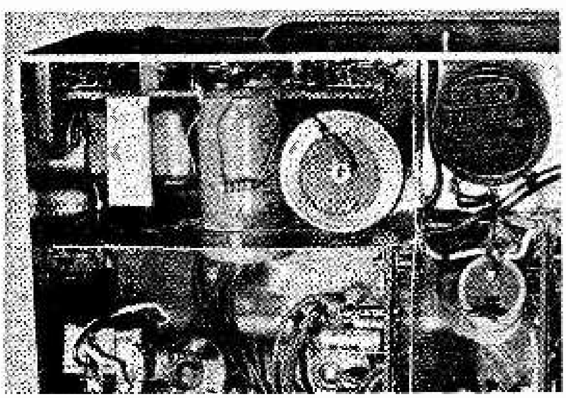
in Fig. 9. The input transistor Tr1 operates as a grounded base amplifier and provides a very low impedance input. Tr2 is a signal amplifier with negative feedback introduced by R7 in series with the emitter by-pass capacitor C4. This resistor can be reduced a little in value to obtain more gain for very low output microphones, although it should not be less than 680Ω otherwise the noise level will rise excessively. As with all the preamplifiers the output is taken to the gain control VR1 and thence via the series resistor (R10) which becomes part of the passive mixing network common to all the preamps.

MAINS POWER SUPPLY

The current consumption of the preamplifiers at



Internal view of the completed prototype.



The power supply should be properly screened as shown.

18V varies between about 2 and 5mA. The line amplifier takes 10mA and the tone control unit 5mA. Four preamplifiers, a line amplifier and say one tone control unit, would require about 25mA which could be drawn from an 18V battery with reasonable economy. Two PP9 batteries would be ideal. Larger mixing units, particularly if built for stereo use and requiring duplication of preamps etc. are best operated from a mains power supply. One that will provide well over 100mA is given in Fig. 10 (see components list for transformer and rectifier details). The resistor R will be around 1kΩ for low current drain and of lower value for higher current drain. With the mixing circuits running, adjust R to obtain 18V across C2.

Part 2 next month, will deal with the rest of the preamplifier modules.

TO BE CONTINUED

CHARLES MOLLOY

THE Medium Wave Column

A NEW 1000kW station on 1457kHz located near Tirana in Albania is being heard in this country as a background to BBC Radio 4, (South and West). It relays Radio Peking and has been heard at 2100hrs GMT with the identification 'Govarit Pekin' followed by programmes in Russian. An increasing number of superpower broadcasters are appearing on the medium waves. Urumchi in Western China (2000kW) is audible all evening on 1525kHz; listen between Prague 1520kHz and Vatican Radio 1529kHz for Russian speech plus jamming. Libya has two megawatters—El Beida on 1124kHz and Tripoli on 1250kHz. El Beida is the stronger of the two; it is heard with EAJ15 Barcelona on the same frequency throughout the evening. Tripoli suffers from interference from Dublin/Cork until 2245hrs when the latter close down, leaving the channel clear. Further east, Riyadh (1200kW) in Saudi Arabia is on 587kHz and has been logged before midnight with Arabic programming.

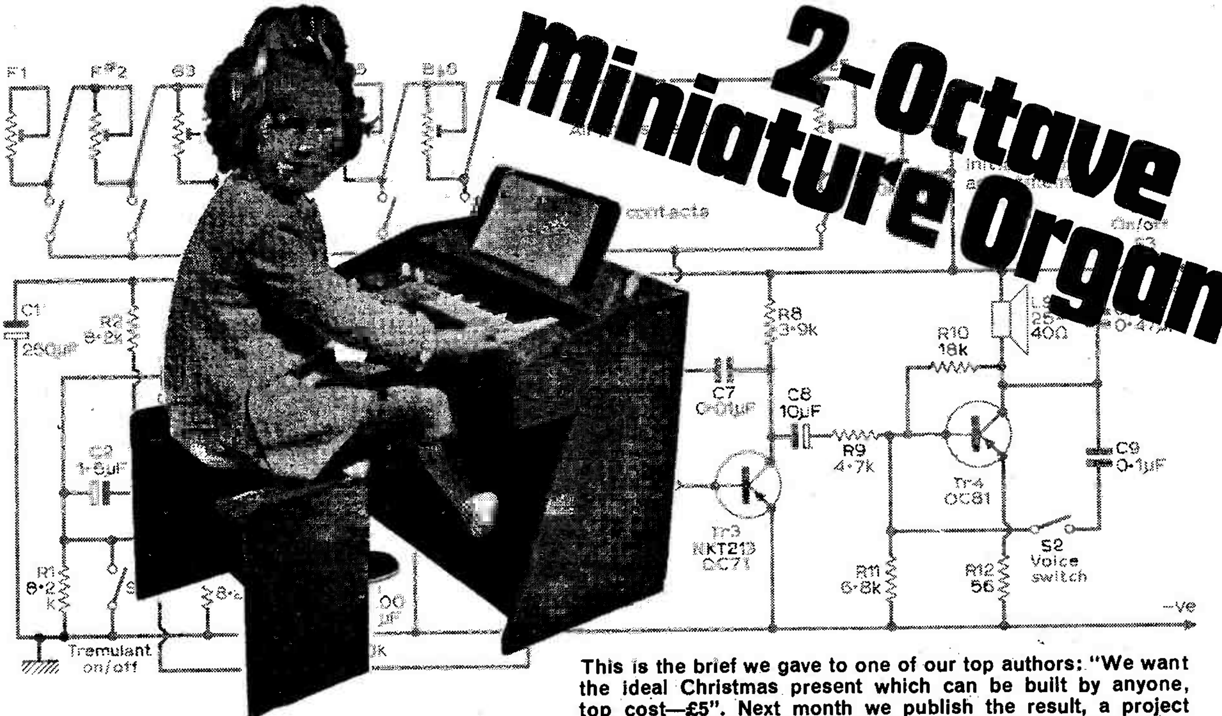
Calcutta 1130kHz (1000kW) was heard frequently last winter before sign-off at 1700hrs. It is now on extended schedule and has been several times during the summer at 2230hrs GMT, as it changes from Chinese to Indian programming. There are three Voice of America stations in the Far East, each with 1000kW, all of which have been heard in the U.K. Bangkok, Thailand 1580kHz was logged at the end of September last year at 2200hrs GMT while Poro 1140kHz in the Phillipines and Okinawa 1178kHz in the Ryuku Islands are both heard in winter before sign-off at 1700hrs.

'Book of the World 1971' is the title of an unusual paperback now on sale in the bookshops. Sections deal with 181 different countries, each with a map plus details of the type of government, languages spoken, religions and currency. As well as providing the DXer with a valuable aid to station identification, this book gives background information on countries logged and adds interest to the hobby.

Broadcasts in English on the medium waves can be heard from a number of unexpected places during the late evening. Timisoara, Rumania on 755kHz has a programme in English, French and German at 2230hrs GMT, which should not be confused with the Voice of the West, in Portugal, also on 755, which starts its English programmes at 2245hrs. The Voice of America in Rhodes is 1259kHz is heard regularly in English between 2100hrs and midnight, with some interference from Wroclaw in Poland. Rhodes is one of the Dodecanese Islands situated near the coast of Turkey, which are usually counted as a separate country by DXers. The VOA is also heard in English from Thessalonika, Greece 791kHz between 2100hrs and 2130hrs. Enugu, Nigeria 1320kHz, although only 10kW, is a weak but consistent signal at 2300hrs GMT when it carries it's final news in English before closing down. ELBC Monrovia, Liberia on 629kHz has English programming and is usually logged between 2330hrs and sign-off at 0045hrs.

IN NEXT MONTH'S PRACTICAL WIRELESS

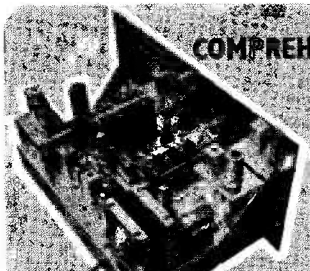
2-Octave Miniature Organ



This is the brief we gave to one of our top authors: "We want the ideal Christmas present which can be built by anyone, top cost—£5". Next month we publish the result, a project which will go down as one of the all-time 'greats', a **2-Octave Miniature Organ**—complete with voicing and tremulant. The electronics is dead simple (just look at the circuit sketch above!) and the cabinet woodwork can be built by anyone who can use a saw. The £5 cost includes everything—just as you see it.

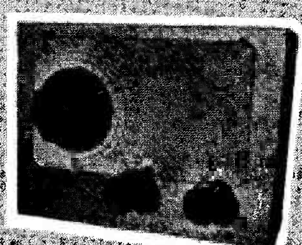
Special Feature

What to look for at the AUDIO FAIR



COMPREHENSIVE MULTI-BAND RECEIVER

Do you want to build a communications receiver in easy stages? This design initially provides a basic 3 valve receiver, complete in itself, covering 550kHz to 30MHz with full bandspread. At your leisure add an RF stage, a simple crystal filter, a carrier oscillator/product detector for receiving SSB/CW and finally a crystal marker. Full constructional details.



BASIC SIGNAL GENERATOR

A signal generator is essential for the testing, alignment and calibration of receivers and for quick tests of audio circuits. For the beginner or occasional dabbler, this basic design should prove ideal, with modulated or unmodulated outputs from 150kHz to 1·6MHz plus a direct audio source; all outputs are fed via a variable attenuator.

ALL IN THE NOVEMBER ISSUE ON SALE OCTOBER 8th

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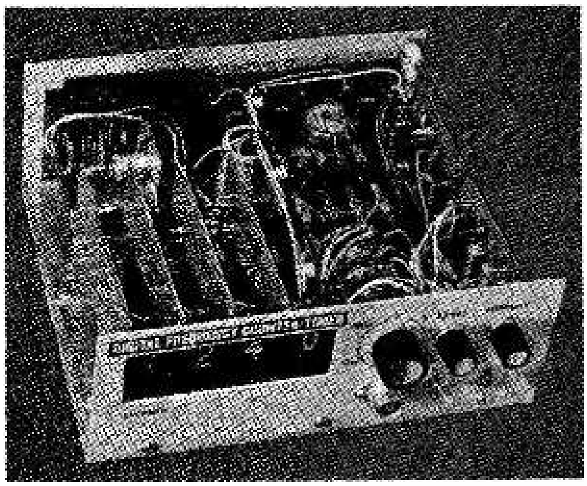
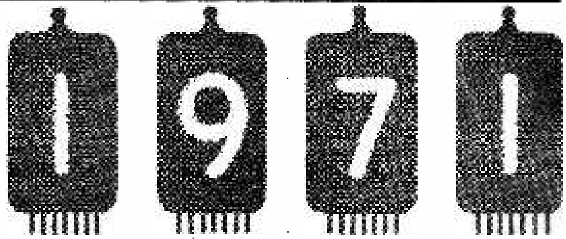
DIGITAL FREQUENCY COUNTER/TIMER





J. THORNTON-LAWRENCE GW3JGA

NOTE

Several wiring connections were omitted from figure 6 in the September issue. Pin 10, on IC's 3, 4, 5, 6 and 7, should be shown connected to the OV rail. Pins 1 and 12 on IC's 9, 11, 13 and 15, should be shown joined.

On IC1, pin 4 is the +5V supply rail and pin 11 is OV supply rail. On IC2, pin 14 is +5V supply rail and pin 7 OV supply rail. These latter connections were omitted from figure 6 for clarity.

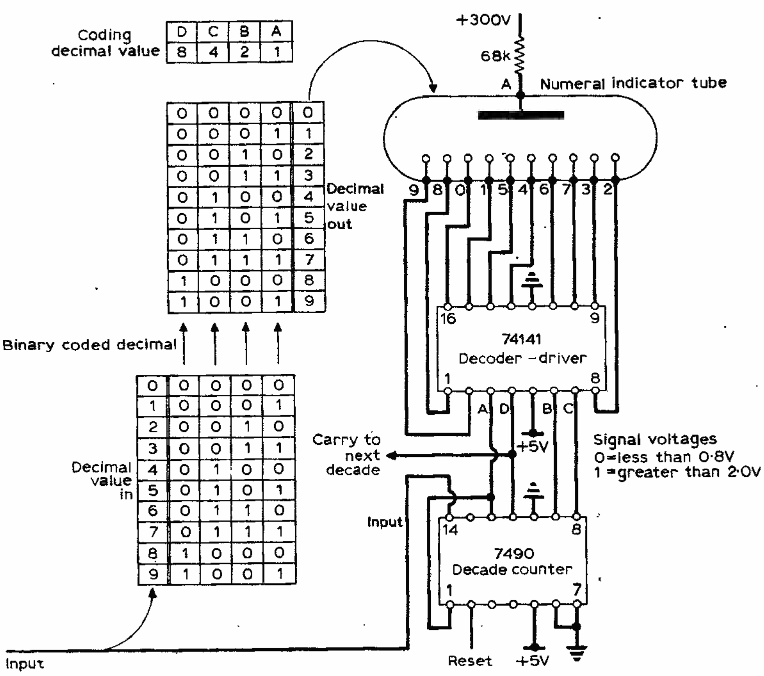
PART 2 *(continued from the September issue)*

This negative going step is passed by C5 to Tr7 base which moves by −5 volts thus cutting off Tr7 and allowing the collector of Tr7 to rise to +5V.

The current through VR2 and R14 discharges C5 so that the negative voltage on Tr7 base rises exponentially until Tr7 conducts. The rate is determined by the setting of VR2, the DISPLAY control.

When Tr7 conducts, its collector voltage starts to fall, turning off Tr6 and thus increasing the base current to Tr7 and producing a fast negative going voltage at Tr7 collector. This voltage step is differentiated by C7, R16 and R17 and inverted by IC2d to give a positive pulse of 200μS duration.

The positive going edge of this pulse resets the counter to zero and the negative going edge sets the JK flip-flop IC1a and causes the cycle of operation to be repeated. The time for which the reading is displayed is controlled by the DISPLAY control and this is adjustable from about 0·5 second to 2 seconds.



D	C	B	A	
8	4	2	1	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Fig. 9: Table showing the operation of the decade counter and decoder-driver.

Counter and Display

The counter and display has four decades, each decade operates in the same way. The output of one decade is linked to the input of the next higher decade to perform the 'carry' operation and a reset connection is common to all decades.

The input to the counter is a series of pulses. The counting has to be carried out in binary form and then decoded into decimal form for display.

This is done using a decade counter I.C. type SN7490N, which consists of 4 master-slave flip-flops forming a ÷2 counter and a ÷5 counter.

The input signal goes to the input of the ÷2 counter (pin 14) and the output of this (pin 12) is linked externally to the input of the ÷5 counter (pin 1).

The outputs of the four flip-flops are called A, B, C, D and have a decimal value of 1, 2, 4, 8 respectively. The table showing the operation of the decade counter is included in Fig. 9.

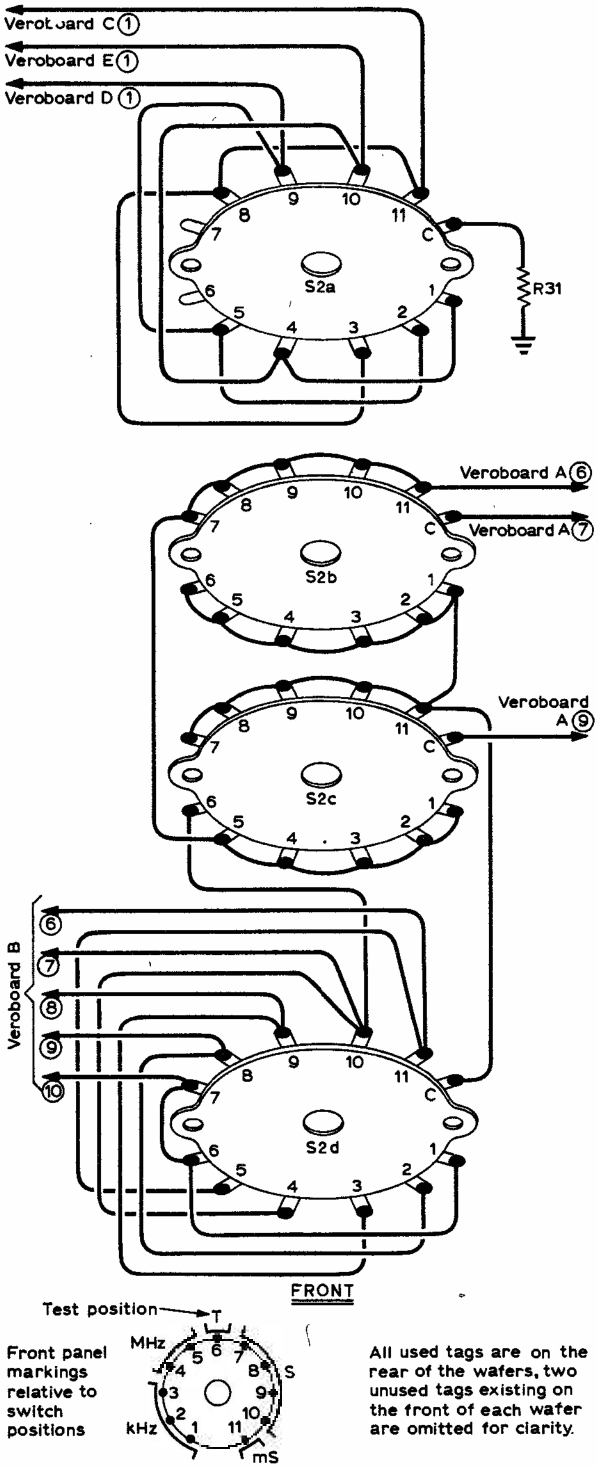


Fig. 10: Exploded view of the function switch S2, viewed from the front.

The counter can be reset to zero at any time by the application of a positive pulse to pin 2.

The binary coded decimal output from the counter, A, B, C, D is connected directly to the inputs of the decoder/numeral tube driver I.C. type SN74141N. Here the inputs are decoded back into decimal form for driving the numeral tube (Hivac Type XN13).

The numeral tube contains neon gas at low pressure and has an anode and 10 wire cathodes in the form of numerals, 0-9.

With the anode connected to HT+ through a current limiting resistor, any cathode which is connected to 0V will be surrounded by a glow showing up the shape of the number.

The outputs of the decoder-driver are collector circuits of high voltage transistors which, when made to conduct, effectively connect the appropriate cathode to 0V. For example, suppose the input to the decade counter receives 5 pulses or cycles of input signal. The output will be D low, C high, B low, A high, representating a binary number of 0101. This number is decoded in the decoder/driver to figure 5 and the figure 5 output (pin 14) becomes switched to 0V causing the figure 5 to be displayed in the numeral tube.

Each counter, decoder/driver and tube is built on a Veroboard panel and the inter connection of these panels is shown in the main diagram Fig. 6.

The decimal indication is provided by miniature wire ended neon indicator lamps mounted between two numeral tubes and these are switched by the function switch S2a.

Function Switch

The function switch S2 is made up from Radiospares Miniature 'Maka Switch' parts and consists of a shafting unit and 4 break-before-make 1 pole 12 way wafers. The wafers are spaced by 2 spacers on each side. Only 11 positions are used and the stop on the indexing mechanism is adjusted accordingly.

The wafers are lettered a, b, c and d, starting at the rear and working towards the indexing mechanism. Wafer 'a' controls the decimal point neon lamps, wafer 'b' the clock period input to the gate, wafer 'c' the signal input to the gate and wafer 'd' the output from the clock divider.

In the frequency positions 1 to 5, the output from the input stage is fed to the 'Signal Input' of the gate and the appropriate clock signal is fed to the 'Clock Period Input' of the gate. In the time positions, 7 to 11 of the switch, the output from the input stage is fed to the 'Clock Period Input' of the gate and the appropriate clock signal is fed to the 'Signal Input' of the gate.

A test position is provided in position 6 where the 1kHz clock output is counted for a period of 1 second to give a reading of 1,000. The test position only serves to check that the gate, counter and display are functioning, it does not provide a check of the crystal oscillator frequency.

The wiring and connections to the switch are shown in Fig. 10. The method of assembly is as follows:

1. On the shafting unit, check that the lengths of studding are screwed fully into the indexing mechanism plate and remove the end nuts and washers.

2. Rotate the switch spindle to the fully anti-clockwise position (as viewed from the front). The flats on the wafer end of the spindle should be in line with the studding. This is position "1".

3. The switch should now be held so that the lengths

of studding are at each side and the control knob end of the spindle is towards you, as shown in Fig. 10.

4. Take a 1 pole 12-way wafer and hold this with the side having the majority of tags, away from you and with the two tags that are facing you positioned in the top right hand segment. Rotate the rotor section until the common or rotor contact is making contact with tag 1. The slot in the rotor should now be horizontal.

5. Assemble the wafer on to the shafting assembly, keeping the side with the majority of tags facing away from the indexing mechanism. This wafer is now wafer "d" in Fig. 10.

6. Fit 2 spacers on each piece of studding.

7. Fit another wafer as described in operation 4 and 5 (wafer "c").

8. Repeat operations 6 and 7 until four wafers have been fitted (wafers "b" and "a").

9. Fit washers and fixing nuts to the studding.

10. The rotation of the switch should now be checked to see that all parts operate smoothly.

11. The rotatable stop plate, which is located on the face of the indexing mechanism, should now be set to give 11 positions, working clockwise and commencing from the maximum anti-clockwise position. This is the position at which all the wafers have been set. The stop plate may be held in place temporarily by the mounting nut, ready for assembly to the front panel.

12. The wiring of the switch may now be carried out as shown in Fig. 10. 22 s.w.g. tinned copper wire is used for wiring from tag to tag, sleeving being necessary only when crossing between wafers.

13. The correctness of the wiring can be checked by using an ohm or continuity meter and measuring between the appropriate tags whilst the switch is rotated, e.g. S2b/C is connected to S2d/C in positions 1, 2, 3, 4, 5 and 6.

Power Supply

The power supply consists of a Radiospares Midget Mains transformer which with its associated rectifiers smoothing and regulators provides

+300V	at 10mA	Unregulated
+5V	at 350mA	Regulated
−5V	at 5mA	Regulated

The output from the 250 volt secondary winding is rectified by D7 and smoothed by C12 to give about +300V output. The negative return is through R24 and D9 to 0V. The negative supply derived in this way is smoothed by C13 and regulated by the zener diode D9 to give −5V. The I.C. logic requires about 350mA at +5V and this is provided by the 6·3 volt filament winding on the transformer.

The 6·3 volt output is full wave bridge rectified to give about +7·5 volt across the reservoir capacitor C14. This feeds the zener diode D6 and the power emitter follower Tr11 to give the required 5V output.

Veroboard Panels

The layout drawings of the 0·1×0·1in matrix Veroboard show the copper strip side of the panel the components on the reverse side being "seen through" the copper strips.

Each copper strip is given a letter code and each

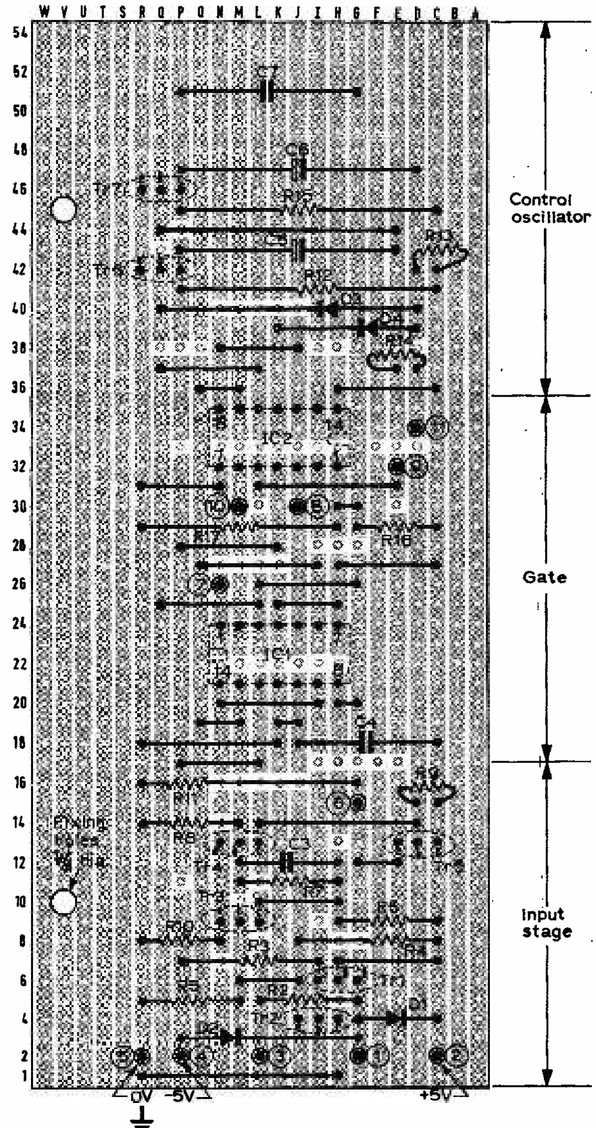


Fig. 11. Veroboard panel A. Input stage, gate and control oscillator. Viewed from copper side. Note correct orientation of integrated circuits when fitting. The integrated circuits and their holders are indented at one end to assist orientation.

horizontal row of holes, a number.

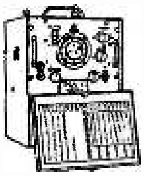
All solid horizontal lines represent wire links which connect one strip to another.

The orientation of integrated circuits and transistors should be noted carefully, some transistors may have unusual lead positions and these may have to be crossed over for the connections to be correct. Assembly of the components, etc., must be carried out in a systematic manner or errors will result. A suggested method is as follows:

1. Cut the Veroboard to the correct dimensions using a fine toothed saw and working from the copper side. Apart from checking the physical dimensions, also check that the correct number of holes appear in each direction.

2. Fix strips of masking tape on all four edges of the Veroboard panels. Also fix masking tape to the same edges on the reverse (copper) side of the board.

BETTER GET 'SET'



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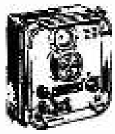
125 KHz—20 MHz. Complete with valves, crystal and charts. ONLY £13·50. Carr. £1·50. LIMITED NUMBER — ORDER NOW!

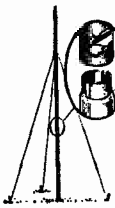
CRYSTAL CALIBRATOR



No. 10 Crystal controlled heterodyne wave-meter covering 500 KHz—10 MHz (Harmonics up to 30 MHz). Power required 300V. D.C. 15mA. 12v. 0·3A. D.C. Test equipment for 62TM/RC.
ONLY £4·25. P. & p. 50p.
FEW ONLY—No. 62 TM/RC 1·5—10 MHz £17·50. Carr. £2.

MARCONI 801A SIGNAL GENERATOR
10—310 MHz. In original transit case. £45. Carr. £2·50.

AERIAL MAST EQUIPMENT



20' TELESCOPIC MASTS £3·75. Carr. £1.
5' 2" Extension Sections to fit bottom of above mast to increase height. £1·25 each (any number supplied).
35' MAST (7—5' 2" interlocking sections) with base plate and 12 nylon guys with semi-auto tensioner. £22·50. Carr. £2·50.
70' MAST. Ditto.16 guys, block and tackle. £45. Carr. £2·75.

AERIAL RODS 3ft.
Screw-in 1" dia. sections. Brand New, green finish. Suitable for many other uses. 10 for £2. Carr. 50p. 25 for £5. Carr. Paid.

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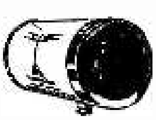
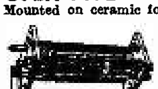


Cylinder design 10" x 4½". Precision calibrated scale. Suitable for tuning most aerials for increased signal strength. A must for serious operators for RC or TM. Full instructions.
ONLY £1·75. P. & p. 25p.

R.F. ANTENNA TUNER (A.T.U.) OPEN TYPE
Mounted on ceramic former and feet.



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Scaled 0–600 and 0–15V. Brand new, boxed £1·25 Post Paid. (Quantity prices on request.)

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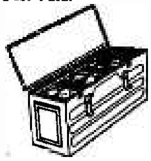

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Suitable for Farms, Building Sites etc. Communication up to 5 miles or more. Rugged construction, will last a lifetime.
ONLY £5·75 PAIR. Carr. £1.
(Twin telephone wire for above available—ask for price.)
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BARGAIN PARCELS 14lb at £1·45 plus 32½p p.p.; 28lb at £2·75 plus 52½p p.p.; 56lb at £4·50 plus £1·25 p.p. Contain pots, Res, Valves, Diodes, Tagboards, Chassis, Valve-holders, etc. Good value save £££s. Lucky Dip Service.

NEW 6 ft. VHF AERIALS. Freq. 75-78 Mc/s. 70 ohms. £2·50p, p. & p. 50p.

VHF Receiver, Type 715, less crystal 60·100 Mc/s can be operated on 2 or 4 meters or made tunable 12 volt input, not tested; complete with valves and speaker.
£3 plus £1 p.p.

VHF AERIAL TUNING UNITS consisting of the following: 1–1½" 500 micro/ampmeter. 1 small 2-gang 75 PF capacitor. 1 various large wattage resistors for dummy load. Pair gears B.N.C. type sockets. Will tune 10 mtrs with 25/30 watts R.F. input. Size only 5½" x 4½" x 5" Sealed. Price £1·37½ p.p. 25p

CRYSTALS AS NEW: Hc 6u, 5,345; 5,030; 5,005; 4,945; 4,875; 4,840; 4,795; 4,580; 4,660; 4,520; 4,510; 2,300; 2,295 Kc/s. 50p each plus 8p. p.p.

SCOOP PURCHASE OF BRAND NEW CARBON RESISTORS. 10% tolerance ½ & ¼ watt. Preferred values in packets of 10. Our price 50p per 100, 50p per 200, £1·35 per 300, 500 at £2·12½. Our selection. p.p. 8p per 100 and 2½p per extra 100.

TRIMMER BARGAINS. These are 10PF sub-min. air-spaced trimmers on board with min. wire ended Xtal. Brand new. No details: Contents 12 trimmers, some ceramic caps. Xtal frequency 3RD overtone 249 mc/s–250 Mc/s, 255 Mc/s. No choice.
Trimmers without Xtal—60p per doz. plus 17½p p.p.
Trimmers with Xtal—75p per doz. plus 17½p p.p.
Also 20 PF min. brand new air spaced.
50p per doz. plus 17½p p.p.

ANY HEIGHT AERIAL TUBULAR SECTIONS ½" dia x 3 ft. long. Brass screw in type, copper coated and painted. New 20p each. p.p. 5p. each. Minimum order 6.

BRAND NEW HARTLEY OSCILLOSCOPES CT316 in original packing. Band width up to 5 Mc/s. Mains supply. Price £40, p. & p. £1·50p.

AERIALS NEW CONDITION. Whip type 4ft 25p, 14ft. 77½p. Used condition 4ft. 20p, 14ft. 62½p. All collapsible type p. and p. 4ft. 10p, rest at 17½p. Bases for above 25p, p.p. 12½p. New matching unit coax connection for above 30p. p.p. 5p.

Huge release of valves for the 62 set TX/RX. in original rubber packing consisting of QV04/7 x ßlM, ARP12 etc. 10 valves in all at the bargain price as seen
87½p plus 17½p p.p.

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New Headphone and Mike, rubber muff type. Low impedance. 97½p. p. & p. 17½p.

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Headphones, ex Gov. DLR No. 5 high impedance. New 87½p 17½p p.p. Used condition 62½p 17½p p.p.

MUIRHEAD DECADE A.F. SIGNAL GENERATOR.
This precision instrument can be used:
1. To Measure Gain up to 50 dbs.
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4. As an Audio Frequency Generator covering 100 Hz to 41 kHz. With a dial setting accuracy of ±0·5 Hz. Output :—1 M/W into 600 SL. Complete with mains power unit. Tested. Good Condition. £12, p & p. 75p.

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EXPERIMENTERS' ECONOMY KIT
Speed adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £6·30 plus 25p P. & P.

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Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1–80 f.p.s. Price £10·50. P. & P. 50p.

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This strobe has been designed and produced for use in large rooms, halls and the photographic field, and utilizes a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Speed adjustable 0–30 f.p.s. Light output approx. 4 joules. Price £12·00 P. & P. 50p. Suitable metal case £3·50 extra.

AND NOW! THE 'SUPER' HY-LIGHT KIT
Approx. four times the light output of our well proven Hy-Lyght strobe.
Incorporating:
- Heavy duty power supply.
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The brilliant light output of the SUPER" HY-LYGHT gives fabulous effects with colour filters.
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Ideally suited for above Strobe kits. Price 53p. P. & P. 13p or post paid with kits.

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All parts incl. ORP.12, relay, transistor and circuit. 6 or 12v. operation Price £1·25 plus 12p P. & P.

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Transformer, rectifier, special relay 1 make, 1 break. £2·38. P. & P. 20p inc. circuit.

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In black, red, white, yellow, blue and green. New, 10p eacg post paid.

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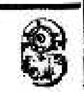
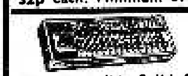


200/250V Ex. GPO. Tested.
Manually set 2 on, 2 off every 24h.
Override switch: 10A £2·75, 15A £3·25, 20A £3·75. P. & P. 20p.
Also available with solar dial ON dusk, OFF dawn. Price as above.

200-250V A.C. NEON INDICATOR

Available in red or amber at 20p each. Or in green at 32p each. Minimum order 3 units. P. & P. 5p.



ELECTRONIC ORGAN KIT
Easy to build, Solid State. Two full octave (less sharps and flats). Fitted hardwood case. Powered by two penlite 1½V batteries. Complete set of parts including speaker etc., together with full instructions and 10 tunes. Price £3·00. P. & P. 22p.

50 in 1 ELECTRONIC PROJECT KIT
50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price £7·75. P. & P. 30p.

CRYSTAL RADIO KIT
Complete set of parts, including Crystal Diode, Ferrite Aerial, Drilled Chassis, and Personal Ear Piece. No soldering, easy to build, full step by step instructions. £1·75 inc. post.

12 VOLT DC MOTOR

Powerful 1 amp. REVERSIBLE motor. Speed 3,750 RPM complete with external gear train (removable) giving final speed of 125 RPM. Size: 4½" x 2½" dia. Price 95p inc. p

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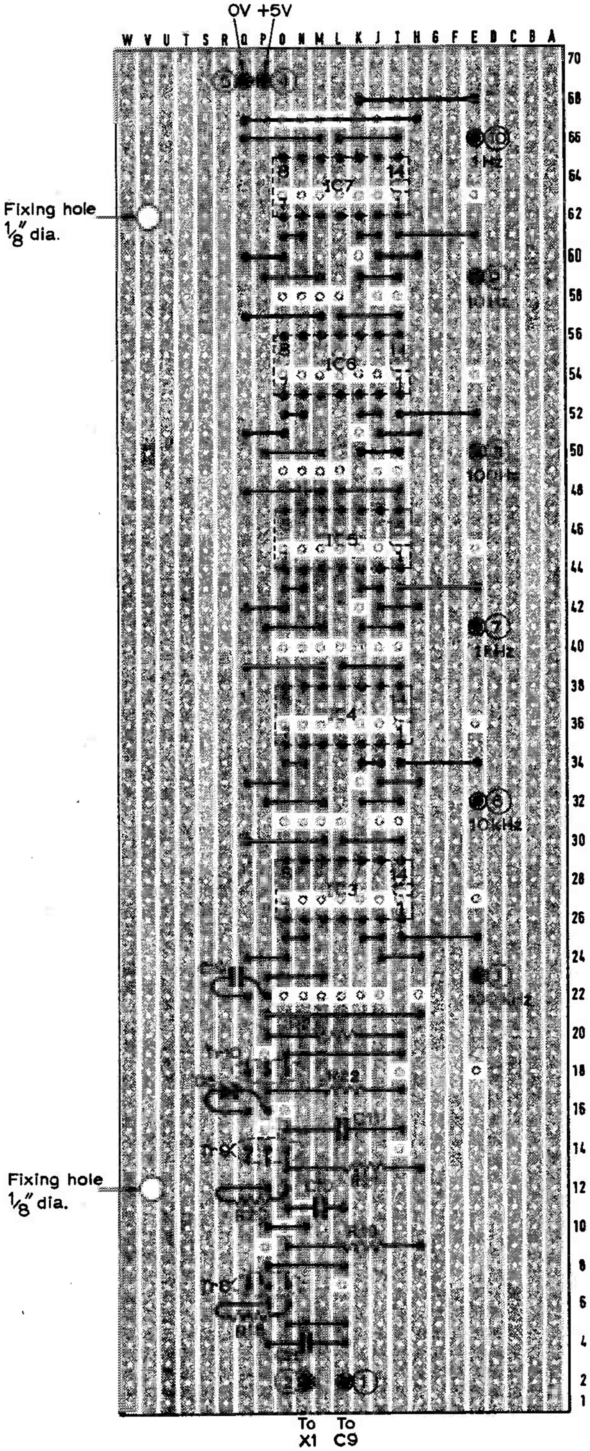


Fig. 12. Veroboard panel B. Crystal clock and divider. Viewed from copper side

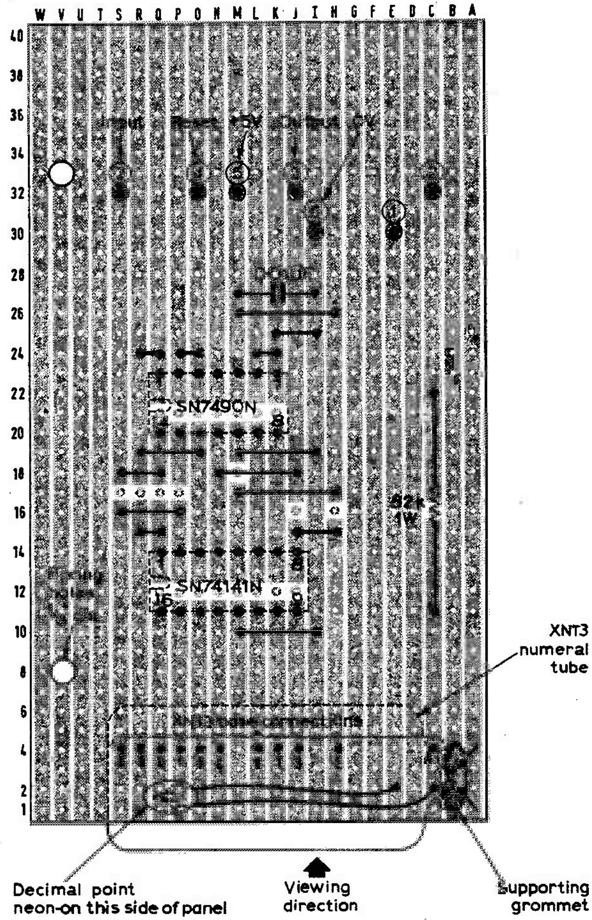


Fig. 13: Counter and display panels C. D. E. F. Panel F. does not require a neon "decimal".

3. By writing on the masking tape, letter all the vertical strips and number all the horizontal rows of holes on both sides of the board.

4. The breaks in the copper may be made using the appropriate Vero tool, part No. 2022 or by using a $\frac{5}{16}$in. drill held in a pin vice. Each copper break on the layout drawing should be identified by its co-ordinates, e.g. D38 and the copper strip removed by carefully rotating the tool or drill by hand using the identified hole as a guide.

Experience has shown that just counting the position of a hole is not reliable and errors are very likely to result.

5. Wire links are formed from pre-stretched 22 s.w.g. tinned copper wire. A length of about 3ft of 22 s.w.g. TC wire is stretched slightly by using a pair of pliers at each end, until it becomes stiff. All wire links are fitted on the components side.

A length, in excess of the length of the link required, is cut off and two right angled bends are made in the appropriate places to form the required "U" shaped link. A pair of pointed nosed pliers is useful for this and the span of the link can be checked by holding it against the panel in the appropriate place. When the link is inserted, the end wires may be bent outwards slightly to hold the link in place while it is soldered.

6. Components should be fixed starting at one end of the panel and the position and value checked before soldering.

7. The soldering should be carried out using a soldering iron with a small chisel shaped bit, no wider than $\frac{1}{16}$in. The cored solder used should be no larger than 20 s.w.g.

Check each soldered joint using a magnifying glass as it takes only a very small piece of swarf or solder to bridge the 0·025in gap between the copper strips.

8. Connections to the Veroboard panel are made to pins inserted in the appropriate places and soldered to the copper strip. These pins are Vero type TP 11032 or similar.

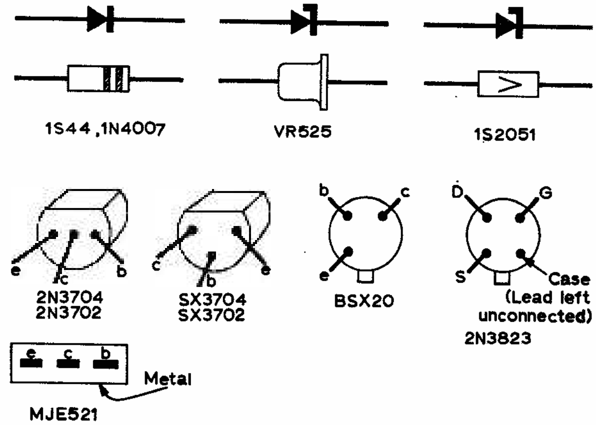
An insertion tool for this pin is Vero part No. IT 2151.

9. Tick off each break, link, component and pin on the drawings as they are fitted, this will identify any items which otherwise might be missed.

Semiconductors

The 3702 and 3704 transistors are specified in the components list as being the '2N' types, these are the most popular version and are readily available.

The 3702 and 3704 transistors are also available



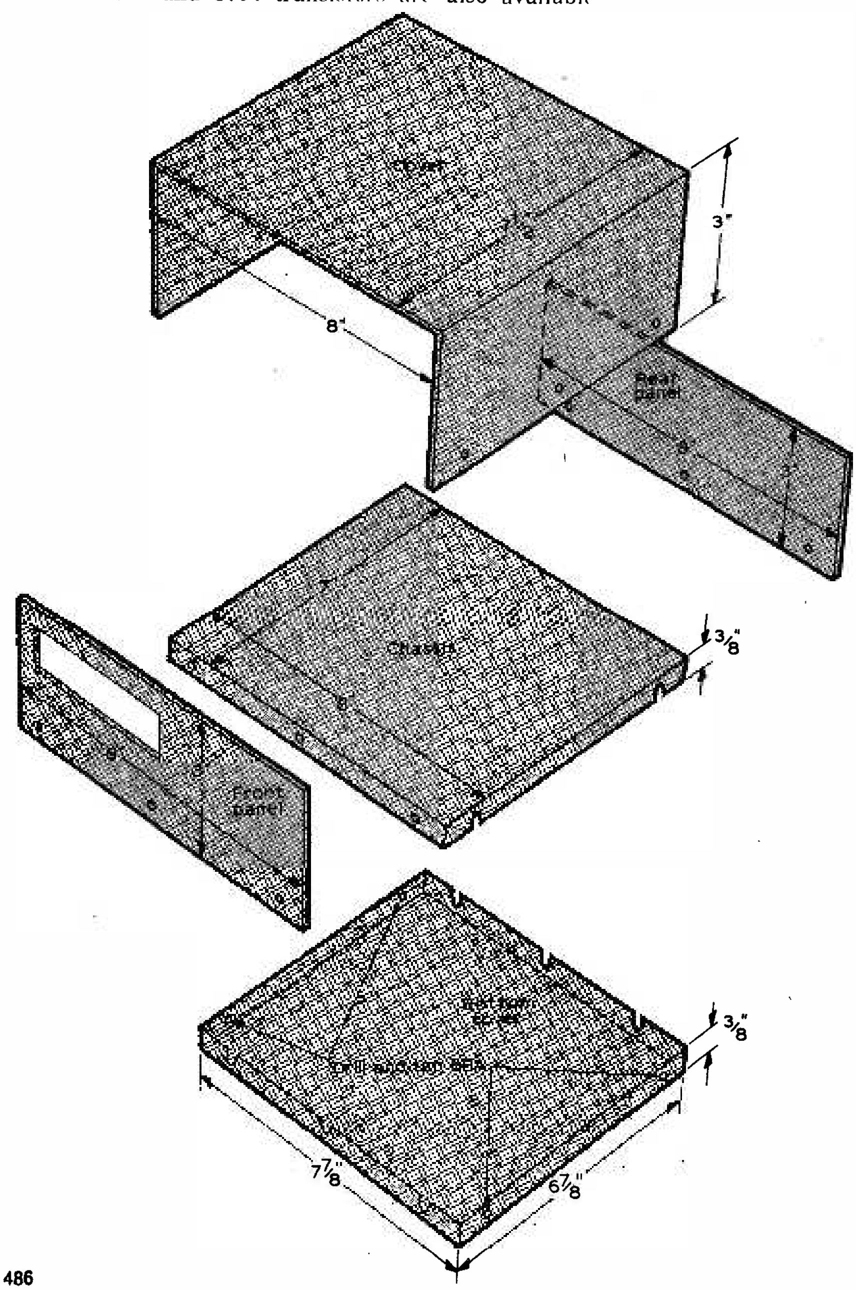


Fig. 14 (left) Cabinet and chassis construction.

in an 'SX' version. The lead connections for these types are all different from each other and are shown in the diagram above.

It should be noted that on the Veroboard panels, the connections run e.b.c. and when the '2N' version is used, the collector and base leads will have to be crossed over to line up with the appropriate holes in the Veroboard panel.

Sockets for Integrated Circuits

Sockets are used for all the integrated circuits and although this increases the overall cost and is not essential for the operation of the instrument, it does provide the facility for disconnecting or changing an I.C. should a fault condition exist, also it does allow various parts of the instrument to be tested without incurring the expense of buying all the I.C's at once, 16-way sockets are required for I.C.8, 10, 12 and 14 and 14-way sockets for all the others.

The instrument is built using a simple aluminium chassis, panel and cover type of construction, as shown in Fig. 14. The finished chassis size is $8 \times 7 \times \frac{3}{8}$in deep and has a front and rear panel, each size 8×3in, fastened to the front and rear edges with 6BA screws and nuts.

(*To be continued*)

ATTRACTIVE DISCOUNTS at all times

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EVERYTHING BRAND NEW & TO SPEC • LARGE STOCKS • NO SURPLUS

BARGAINS IN NEW SEMI-CONDUCTORS

MANY AT NEW REDUCED PRICES · ALL POWER TYPES WITH FREE INSULATING SETS

40361	55p	2N2905	44p	2N4291	15p	BC148	9p	BFX87	29p
40362	68p	2N2905A	47p	2N4292	15p	BC149	10p	BFX88	26p
2N696	17p	2N2924	20p	AC107	46p	BC153	19p	BFY50	23p
2N697	18p	2N2925	22p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	12p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	11p	BSX20	16p
2N1131	29p	2N3055	60p	AC153K	22p	BC159	12p	C407	17p
2N132	29p	2N3702	13p	AC176	16p	BC167	11p	MC140	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	10p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	11p	MPS6534	30p
2N1304	26p	2N3705	13p	AD140	63p	BC177	14p	NKT211	25p
2N1305	26p	2N3706	13p	AD142	50p	BC178	13p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	58p	BC179	14p	NKT214	23p
2N1307	33p	2N3708	10p	AD161	33p	BC182L	11p	NKT274	18p
2N1308	36p	2N3709	11p	AD162	36p	BC183L	10p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	24p	BC184L	11p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	24p	BC212L	16p	OC71	38p
2N1711	26p	2N3819	23p	AF117	22p	BC213L	16p	OC81	25p
2N1893	54p	2N3904	35p	AF124	24p	BC214L	16p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	22p	BCY70	18p	ZTX300	14p
2N2218	34p	2N4058	13p	AF139	33p	BCY71	33p	ZTX301	16p
2N2218A	44p	2N4059	10p	AF239	36p	BCY72	15p	ZTX302	22p
2N2219	38p	2N4060	11p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4061	11p	ASY28	27p	BF167	18p	ZTX304	27p
2N2270	62p	2N4062	12p	BC107	12p	BF173	19p	ZTX500	18p
2N2369A	19p	2N4124	18p	BC108	11p	BF194	14p	ZTX501	21p
2N2483	35p	2N4126	27p	BC109	12p	BF195	15p	ZTX502	25p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	22p
2N2646	47p	2N4286	15p	BC126	22p	BFX84	25p	ZTX504	52p
2N2904A	42p	2N4289	15p	BC147	10p	BFX85	32p		

RESISTORS 10% — 5% — 2%

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below)	100 up
C	1/20W	5%	82 Ω–220K Ω	E12	9	8	7
C	1/8W	5%	4·7 Ω–470K Ω	E24	1	0·8	0·7
C	1/4W	10%	4·7 Ω–10M Ω	E12	1	0·8	0·7
C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·9
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3·5	3
WW	1W	10% ± 1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	12 Ω–10K Ω	E12	7	7	6
WW	7W	5%	12 Ω–10K Ω	E12	9	9	8

Codes: C = carbon film high stability low noise
MO = metal oxide Electrosil TR5 ultra low noise
WW = wire wound Plessey.

Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of 1p. on total value of resistor order)

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

ZENER DIODES

5% full range E24 values; 400mW: 2·7V to 30V **15p** each 1W: 6·8V to 82V **27p** each 1·5W: 4·7V to 75V **60p** each Clip to increase 1·5W rating to 3 watts (type 266F) **4p**.

CARBON TRACK POTENTIOMETERS, long spindles

Double wiper ensures minimum noise level.

Single gang linear	220 Ω, to 2·2M Ω	12p
Single gang log	4·7K Ω to 2·2M Ω	12p
Dual gang linear	4·7K Ω to 2·2M Ω	42p
Dual gang log	4·7K Ω to 2·2M Ω	42p
Log/antilog	10K, 47K, 1M Ω only	42p
Any type with ½A D.P. mains switch, extra		12p

Please note: only decades of 10. 22 and 47 are available within ranges quoted.

CARBON SKELETON PRE-SETS

Small high quality, type PR, linear only 100 Ω, 220 Ω 470 Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10M Ω Vertical or horizontal mounting **5p** each.

ENAMELLED COPPER WIRE even No S.W.G. only. 2oz reels 16.22 S.W.G. **25p**; 24-30 S.W.G. **30p**; 32-34 S.W.G. **33p**; 36-40 S.W.G. **35p**; 4oz reels 16·22 S.W.G. only **41p**.

MULLARD polyester C280 series

250V 20% 0·01; 0·022; 0·033, 0·047 **3p** ea. 0·068; 0·1, 0·15 **4p**, 0·22 **5p**, 10%: 0·33 **7p**, 0·47 **8p**, 0·68 **11p**, 1μF **14p**. 1·5μF **21p**, 2·2μF **24p**.

MULLARD SUB-MIN ELECTROLYTIC

C426 range axial lead **6p** each

Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

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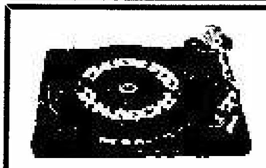

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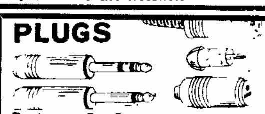

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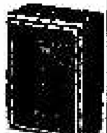

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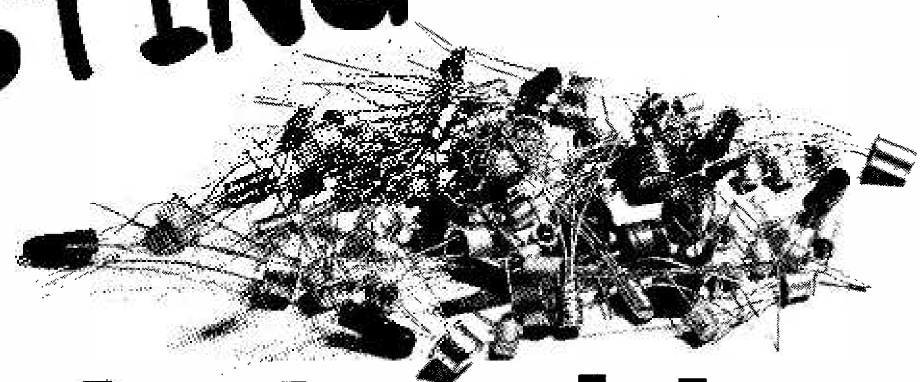
R A BUTTERWORTH

TESTING surplus transistors



THE technical press offer so many transistor projects that many of us have bought and acquired a fair stock of transistors gathered from bargain packs or labouriously removed them from surplus computer boards. We then go through them only to find that many are un-marked, indecipherable, or have some queer markings not contained in any lists. The manufacturers are reluctant to supply data because they have been made to *"customer requirements"*. A few hours spent in sorting these into NPN or PNP and grading them into four categories will save a lot of time, patience and money on the next project development. The methods of grading are only approximate and there are only four grades:—

1. RF types.
2. Low gain types.
3. High gain types.
4. All others which do not pass the tests described.

PRELIMINARY TESTING

First do a thorough visual examination and sort the transistors into *known* and *unknown*. The *knowns*, however, should be put through the tests since they may be blown or below spec. If your collection contains transistors removed from computer boards, the leads will be short. Fortunately when these boards are assembled, small plastic spacers are fitted, in most cases to comply with manufacturer's recommendations as to bending and heat dissipation. The makers also usually bend over about $\frac{1}{8}$in on the solder side with the result that the lead lengths are in a safe condition. Any that are too short should be thrown away. Figure 1 shows the bases of seven categories into which these recovered units fall. Some may have a coloured dot, usually red or white, indicating the collector lead, also some are internally connected collector-to-can. Do not be fooled however by coloured sleeving on the leads; not all manufacturers use the same code. Of course a really good transistor checker can make things very easy but this will cost a good deal of money.

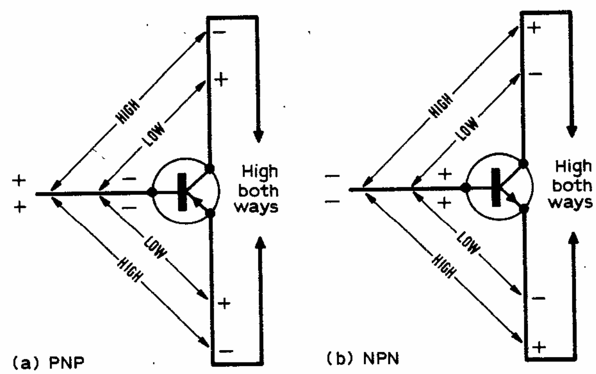


Fig. 2 : Resistance readings found on a good transistor—see text for details.

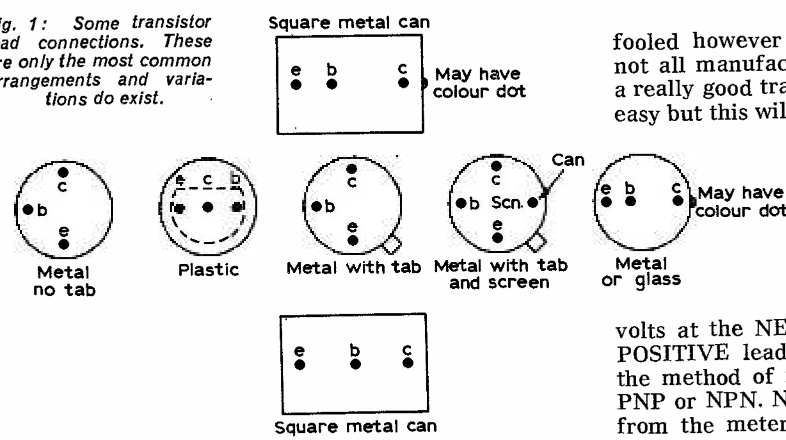


Fig. 1: Some transistor lead connections. These are only the most common arrangements and variations do exist.

IDENTIFYING THE LEADS

The first checks, sorting the PNP and NPN types and the leads are done with a multimeter on its low ohms range. *A word of warning first* about that multimeter. Most meters on the ohms range give positive volts at the NEGATIVE LEAD and negative at the POSITIVE lead, so check first. Figure 2 illustrates the method of finding out whether the transistor is PNP or NPN. Never be scared of reversing the leads from the meter; with about 1·5V, which is usually available from the meter on low ohms ranges, you won't do any harm. Should you get a low resistance reading both ways between base and either of the other connections you can be fairly certain that there is an internal short. If you get a low reading between the base and one lead and a high at the other it is either bad or you are not on the base. It is probable that you will meet with marginal readings at times, so make tests as follows with reference to Fig. 3.

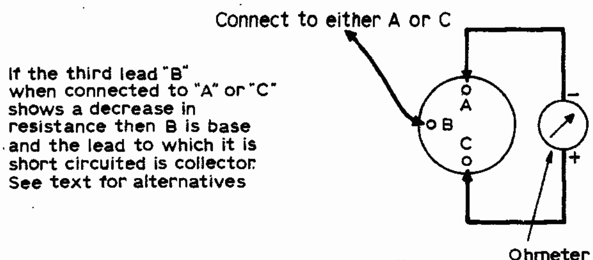


Fig. 3: Tests for identifying the base connections.

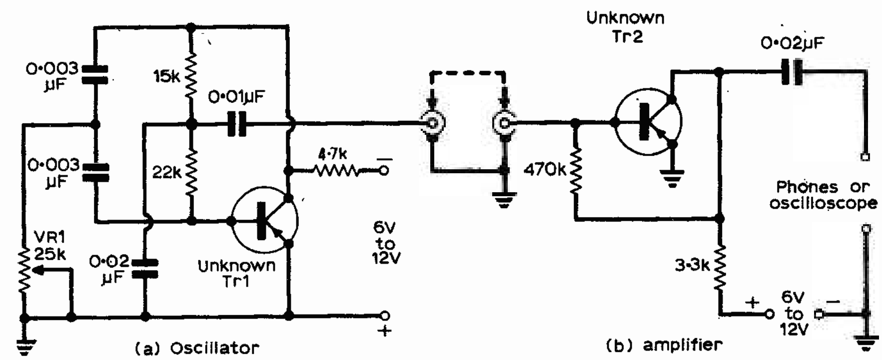


Fig. 4: The circuit used for the gain and amplification tests. Note that for NPN devices the battery polarity must be reversed.

Draw a base diagram of the base of the transistor and mark them 'A', 'B', 'C'; you are now faced with three permutations, of pairs 'AB', 'AC' 'BC'. Now take any pair and connect to the ohmmeter on low ohms range, then connect the other lead to each lead in turn: if the resistance falls the unpaired lead is the base lead and the lead to which the base was shorted is the collector. Check to see if this lead is connected to the metal can, this could confirm that it is the collector. If you do not get these results then check each of the three pairs using the same procedure. If the base cannot be identified for certain and there is high resistance both ways it is most probable that the third lead is base. To check, assume this is base and check with the meter whether it is a PNP or NPN in Fig. 1. You should then have established the base connection; the emitter and collector connections will be identified by reversing the leads in the grading test.

TESTING FOR GAIN

To test for gain two simple circuits are required as shown in Fig. 4. Good quality transistor sockets are essential since we are most likely dealing with short leaded transistors and soldering in and out will become tedious. The assembly of the the circuits is an individual choice, though the author used 'S-Dec' and found it ideal. When the test rig is assembled, put in two good known transistors, say an OC44 or OC45 for Tr1 and an OC70 or OC72 for Tr2, connect up the battery and headphones. If you can use a 'scope, all the better. Now adjust VR1 until a tone (or trace) is observed, then start to substitute the unknowns for Tr1. If a tone is present the gain will be more than 30, if no oscillation occurs then it is less than 30. At this point those transistors which have connections which are difficult to identify can be checked and identified by insertion, keeping the assumed base connection and reversing the other two unknown leads in the socket. If no oscillation occurs, keep it for the two further tests. Do not be afraid to reverse leads even at this higher voltage; if it blows then it was probably useless anyway.

AMPLIFICATION TEST

Now replace the original test transistor i.e. the OC44/45 (or one of the good ones known to oscillate) and then one by one test all those which failed the high gain test by substitution in the Tr2 position. The note heard in the headphones will tell you if it will amplify at all. If it is possible to use an oscilloscope, a little more information will be gained on this last test which is for low gain. By means of the trace shown on the 'scope, you can classify some transistors in the large signal class because the waveform will be distorted or clipped. The assumption in the tests up to now has been that the surplus transistors are in the small signal group.

R.F. TESTS

All the transistors available should be put through the r.f. test, irrespective of whether they have passed the previous tests. The r.f. test circuit is shown in Fig. 5. Here the reader will have to arrange for the crystal, Tr1, L1 and C1, according to what he has available, to check frequency. As a guide, with a 20MHz overtone crystal, an OC170, L1 being eight turns of 18s.w.g. on a ½in former, tuned with a 50pF capacitor, the circuit will cover the range up to

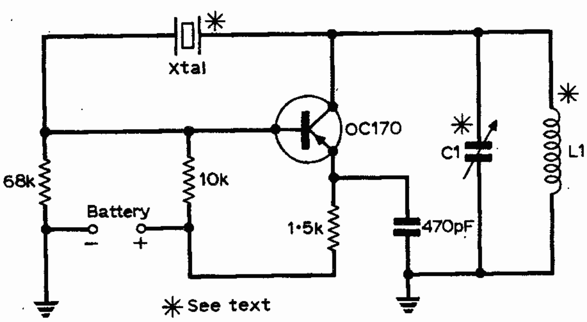


Fig. 5: The r.f. test circuit. For NPN devices the battery polarity must be reversed.

30MHz. Here a receiver or G.D.O. is necessary to detect the oscillation. Once oscillation is established it is merely a matter of substituting as before.

With your collection graded, as outlined, it is simply a matter of substitution of various types within that grade for optimum results in a particular project. The methods described are by no means comprehensive but at least you will have got a little order out of chaos and the building of many projects will be made much easier. ■

GENERAL PURPOSE power supply

M. WALLIS

IN the "good old days" of valves, power supplies were simple. Some 90 per cent of equipment operated with an h.t. supply of about 300V and the heaters were nearly all 6·3V. A single power supply would operate the vast majority of equipment that one was experimenting with. Today the semiconductor rules the day and power supplies are very much less standardised. Checking through a recent copy of *Practical Wireless* showed that there were six circuits given—and five different supply voltages were specified, ranging from 6V to 30V. Batteries can cope with a number of these, especially the most common 9V supply, but even the most half-hearted experimenter needs quite a range of batteries to pursue his hobby—even for quick lash-ups.

One can of course build a sophisticated, stabilised power supply with variable output covering quite a large range but such circuits are expensive, are by no means simple in their construction and most of the time the sophistication is not required.

By incorporating a simple two-pole, six-way rotary switch into the circuit of a standard power supply, it is possible to build a power unit with six different outputs—all with low internal impedance—and which will simulate exactly the supply that you finally build into the equipment.

A few refinements can be incorporated into such a power supply such as an indicator neon and fuse protected output which are not always necessary on the final supply which is fitted permanently but which make life simpler (and cheaper!) while experimenting.

the circuit

The wide proliferation of supply voltages needed for semiconductor designs has brought about the introduction of mains transformers with a wide range of secondary tappings and it is simply by selecting the appropriate ones of these that various output voltages can be obtained.

The transformer specified in the components list is a good one to use but other types with multiple secondaries can be adopted.

This one is fitted with 12, 15, 20, 24 and 30V tappings (these of course refer to a.c. r.m.s. volts)

TABLE 1

VOLTS (d.c.)	VOLTS (a.c.)	Connections from which derived
4·5	3	12—15
6	4	20—24
7·5	5	15—20
9	6	24—30
12	8	12—20
13·5	9	15—24
15	10	20—30
18	12	0—12 or 12—24
22·5	15	0—15 or 15—30
27	18	12—30
30	20	0—20
37·5	24	0—24
45	30	0—30

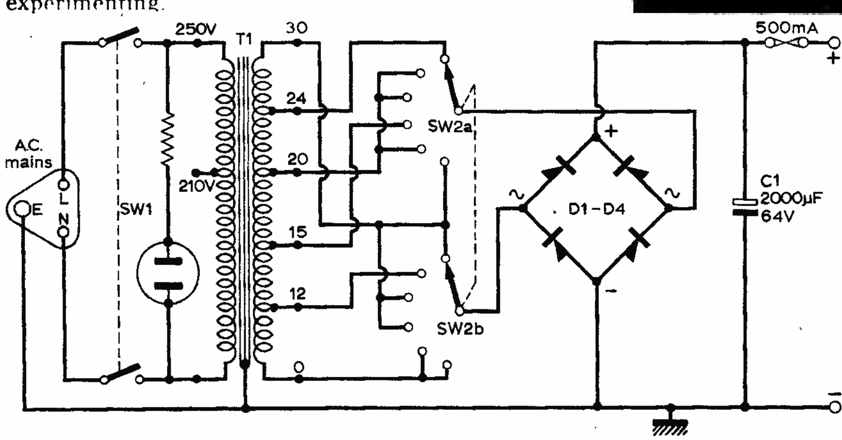


Fig. 1: The circuit of the general purpose power supply.

and a total of 13 different voltages can be selected from this as shown in the table. Those shown in the drawings, and for which the wiring is done, tend to be the higher voltages as batteries are still the best bet up to about 9V but it is a matter of personal choice which are selected.

Note that the d.c. voltages are those which should be read with no loading and are only approximate. In any case it has been found by

★ components list

T1	Mains transformer 250V primary with multiple secondaries as shown, 500mA. Douglas Type MT112AT or similar.
D1-D4	Silicon Bridge Rectifier BY164 or similar.
C1	2000μF 64V
SW1	Double pole on-off switch.
SW2	2-pole 6-way rotary switch.
Neon panel with built-in resistor.	
500mA fuse and fuse holder.	
Red and Black insulated terminals.	
Tag strip for rectifier.	
Capacitor clamp.	
Aluminium chassis, 6×4×2½in. H. L. Smith, Ltd., 287 Edgware Rd., London W.2.	

experience that the secondary taps are by no means always accurate and quite large differences have been measured from the theoretical voltage but as exact voltages are rarely needed, variations are allowable.

The output voltage from the prototype, which can be seen marked on the chassis, are those measured, not those calculated, and these discrepancies can only be due to winding inaccuracies as it is wired up exactly as in Fig. 1.

The current rating required from a general purpose power supply will depend on the uses to which it is put. Only power amplifiers at peaks take more than about 500mA and that was the rating chosen; it is sufficient for nearly all experimental work.

More than one company makes transformers with the voltage taps used here, but the most widely available is possibly the Douglas MT112AT. The same transformer with a 2A rating is coded MT3AT and although it will just fit into the chassis shown, it is a tight fit and a larger one is recommended.

The mains supply is connected to the correct primary (either 210V or 250V) of the transformer via a double-pole switch. A panel neon, connected

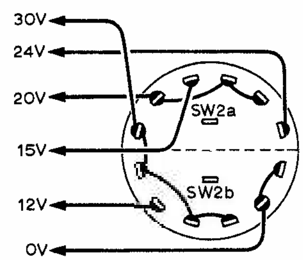


Fig. 3: The switch wiring used on the prototype.

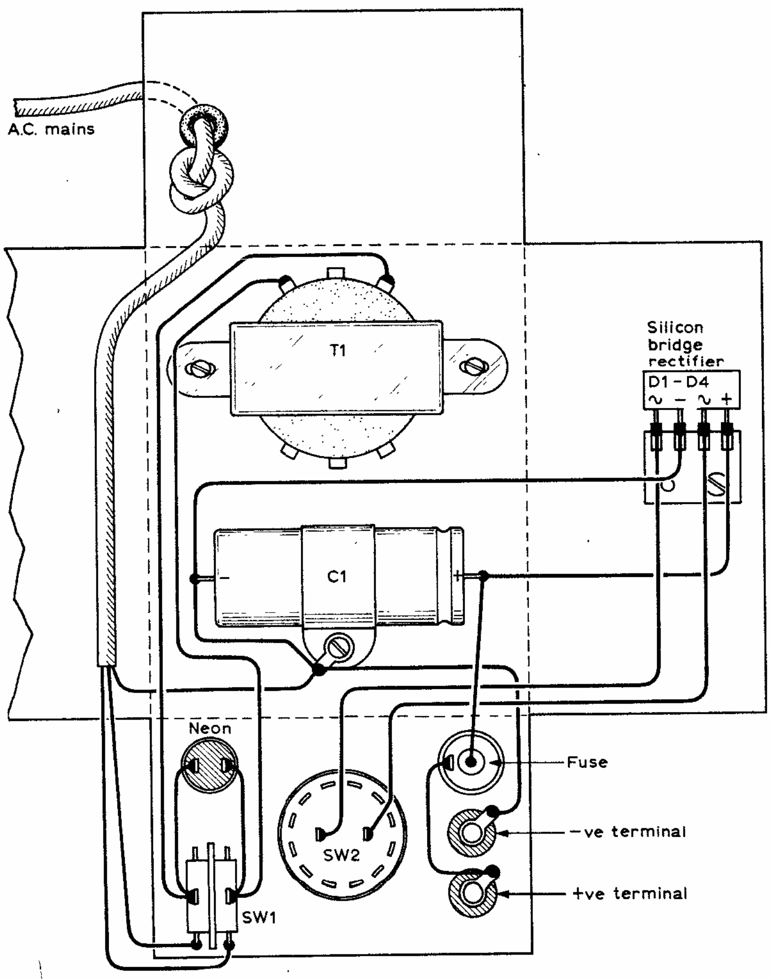


Fig. 2: The component layout and wiring details.

across the primary is very useful. Today most neons are supplied with a built-in resistor but if one is not fitted, a 220kΩ should be wired in series as shown in the circuit.

The earth line is shown connected to the negative line but may equally well go the positive if used in conjunction with PNP type equipment which is earthed by some other means. Whatever happens the aluminium chassis should be earthed for safety reasons.

The various connections to the voltage selector switch are taken from the appropriate tappings and the switch wipers are connected directly to the bridge rectifier a.c. contacts. Plastic encapsulated silicon bridge rectifiers are widely available at reasonable prices and come under a variety of codings. The ratings must be 50V peak, 1A. The Mullard BY164 is suitable here.

Adequate smoothing for all purposes is provided by the 2000μF capacitor; the voltage rating of this should be well above the 45V or so applied and a 64V type was used in the prototype.

To provide a measure of protection, a 500mA fuse should be connected in the supply as shown.

construction

The prototype was built in a

small aluminium chassis size 5 x 4 x 2½ inches, fitted with a drop-in lid. These chassis are available from H. L. Smith Ltd., the address is given in the components list.

The layout of the components is shown in Fig. 2 and can be seen in the photograph.

The bridge rectifier can be mounted on a small tag strip on one long side. the transformer and the

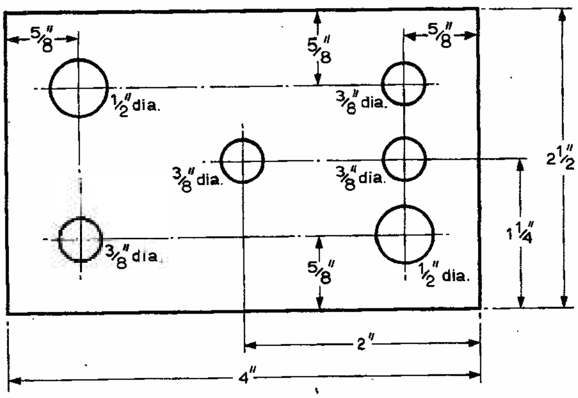
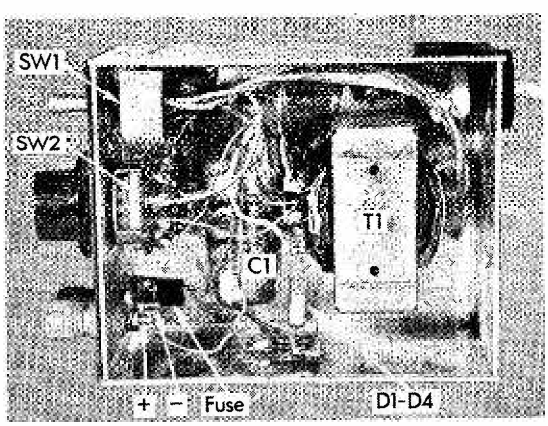


Fig. 4: The front panel drilling details.

capacitor on the base, with the remaining components on the front panel.

The switch wiring needs quite a lot of planning unless that used in the prototype is copied exactly, this is shown in Fig. 3. If other voltages, selected from the table, are required, the wiring should be planned carefully first of all. It is far easier to do the wiring on the switch leaving a few inches of wire which will finally be wired to the transformer.

When all wiring is completed a thorough check should be made to see that there is no possibility of



Internal view of the prototype showing component siting. Compare this with Fig. 2.

mains being applied to the case and that no bare wires can touch each other.

Connect a voltmeter to the terminal sockets and switch on, ensuring that a voltage reading is obtained in each switch position. Wrong wiring on a switch of this sort can lead to a direct short of the secondary and—unless noted very quickly—unpleasant things can happen to both the transformer and the switch.

There may be a very small amount of sparking while switching but this does no harm. The prototype has been in use continuously for several months with no ill effects.

There is just one point that must be made. The charge stored in a smoothing capacitor of this size lasts for a long while and if the power supply has been on a high range the capacitor should be shorted out (with the mains switch off) before being applied to a circuit where a high voltage could cause damage. This should be done through a resistor, not directly, as the fuse may blow otherwise.

If, due to the nature of the experimenting, a considerable amount of switching is envisaged, a resistor can be wired permanently between the output terminals so that a small current is drawn at all times and the capacitor will then settle down very quickly to the applied voltage. A 4·7kΩ resistor with a ½W rating will serve this purpose. ■

CROSSWORD No.2
WINNERS and SOLUTION

The Practical Wireless Crossword Competition No. 2, published in the June 1971 issue, has now closed and the prizes of £10 vouchers, exchangeable with any advertiser in Practical Wireless have been awarded to:

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SOLUTION TO COMPETITION NO. 2

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7 F	I	N	E		O		T		8 T	R	A	P
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A			Y		E		I		Y			U
12 S	E	13 N	S	O	R		14 I	N	S	15 E	R	T
H		U				16 D				N		Y
		17 M	I	18 C	R	O	W	19 A	V	E		
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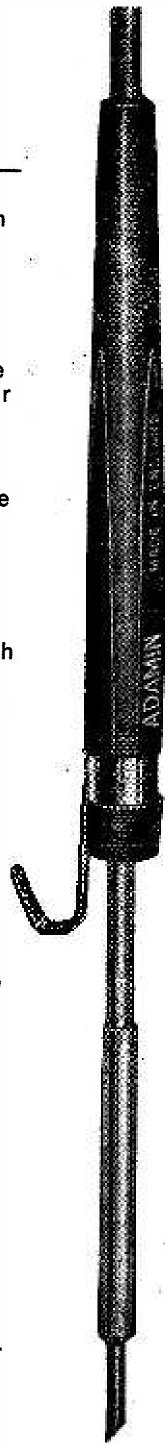
AT HOME SOLDERING ?



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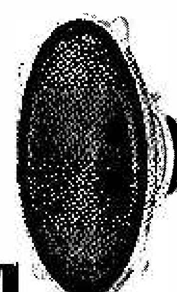

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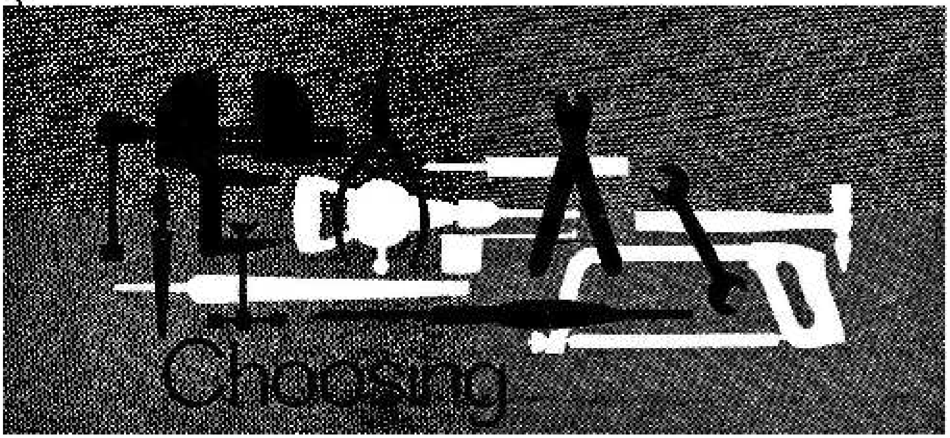


PRACTICAL WIRELESS
SUPPLEMENT
OCTOBER 1971

SMALL WORKSHOP TOOLS

S. YEATMAN

SINCE YOU ARE reading Practical Wireless the chances are that you have already tried your hand at constructing one of our projects. If you are already well fitted out with tools or have access to workshop facilities the bending up of a piece of aluminium to make a chassis or the punching and drilling of various holes would not have presented you with much of a problem. But if you are a newcomer to home electronics you have probably employed 'knife and fork' techniques, utilising kitchen knives and similar tools!

This really is doing things the hard way and the effort involved can put a considerable damper on anyone's enthusiasm for home construction, apart from any ensuing domestic problems when the lady of the kitchen discovers that her best kitchen knife now looks like a hacksaw blade!

If you are really taken with the idea of constructing electronic gear then be prepared to start off properly by buying a few good essential tools designed for the job in hand. Forget Dad's woodworking screwdriver with its $\frac{1}{2}$" wide blade filed so thin that it seems to fit any screw head from 8BA upwards! Very convenient, of course, but what a mess it makes of screw heads! Dad's pliers, too, are very handy—they 'fit' any size of nut you like to mention but by the time they have slipped a couple of times that nut looks pretty sorry for itself.

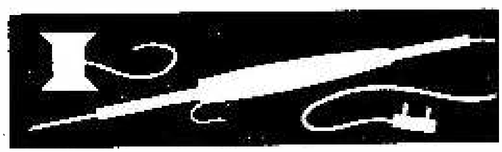
When you find out what fun these electronic projects can be you will begin to take pride in the finished job and Mum's knives and Dad's tools just won't be good enough. So, start off on the right foot by getting the proper tools and remember that, like most 'bargains', cheap tools can turn out to be expensive in the long run. Spend a little more on tools from manufacturers of repute and scorn imported tools made of inferior materials.

The following review lists small workshop tools more or less in the order of necessity bearing in mind the requirements of the home constructor. The soldering iron takes precedence since even the simplest bought kit of parts needs the odd soldered joint or two.

In a review of this kind only general reference can be made to the great variety and range of tools that are available today. Specific recommendations are impossible without some knowledge of the amount of money it is intended to spend and the precise nature of the work to be undertaken in the workshop.

Workshops tend to 'just grow' from a few simple tools. As the limitations of these tools become apparent so more tools are bought to fill the gaps, thus it can be seen that a large initial outlay is not necessary.

Spreading the cost over a period allows emphasis to be made here on the requirement to buy quality, a policy which, if followed, will not be regretted.



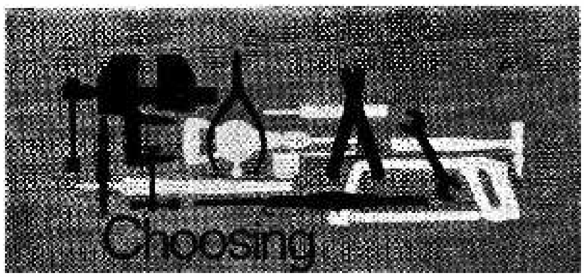
SOLDERING IRONS. There is a wide variety of electric soldering irons available today, the main problem being the selection of one of a suitable wattage for the home constructor of radio gear. For the average Practical Wireless project a 25 watt iron should prove satisfactory but if a lot of work is likely to be done on printed circuit boards a 15 watt iron would be more appropriate. These circuit boards often contain many small components fitted quite close together and thus vulnerable to the heat of a soldering iron. Excessive heat can also damage the copper strips of the board itself.

With these irons goes a wide range of copper bits of differing diameters, some straight and some angled. Initially a straight bit $\frac{1}{8}$" or $\frac{3}{16}$" in diameter can be chosen for general purpose work with an angled bit for the awkward spots. At a little extra cost special bits are available which contain additives to the copper designed to prolong the life of the bit.

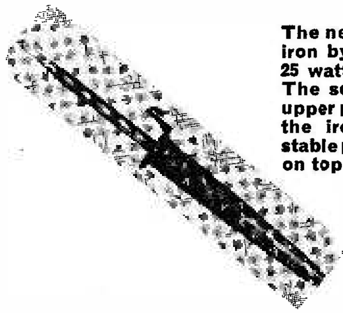
For home use a soldering iron operating directly from the 230 volt mains supply is usual but, for anyone who might feel a little happier with a lower working voltage, irons are available to work from as low as 6 volts via a mains isolating transformer.

When wiring an electric iron to its mains plug ensure that the instructions supplied with the iron are strictly adhered to so that the iron is properly earthed. This is a very important point for the builder of electronic equipment when wiring in transistors and other solid-state devices. Irreparable damage can be caused to these devices by stray earth currents if the soldering iron is not properly earthed.

Advancing rapidly in popularity are the soldering guns or 'heat guns', as they are sometimes known. The copper bit is, in fact, part of a low voltage secondary winding of the built-in transformer. Exaggerated claims are sometimes made concerning the short heat-up time for these guns,



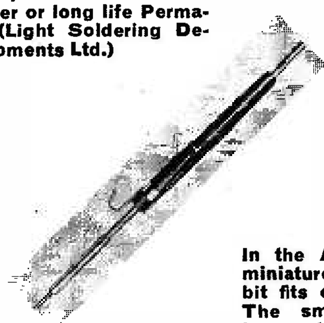
Choosing SMALL WORKSHOP TOOLS



The new Invader soldering iron by Adcola is rated at 25 watts and has a $\frac{3}{16}$" bit. The square styling of the upper part of handle causes the iron to remain in a stable position when placed on top of the workbench.

One of the Litesold range of irons available in ratings from 10 to 60 watts, covering all requirements in

electronic soldering. Various tips are obtainable in copper or long life Permatip. (Light Soldering Developments Ltd.)



In the Adamin series of miniature irons the copper bit fits over the element. The smallest, Model 6, has a rating of only 6 watts at 6 volts. (L.S.D. Ltd.)

This soldering iron bench stand guards against accidental burns or even fires. The iron maintains its normal operating temperature while in the stand. A bit cleaning pad is fixed to the front of the stand. (L.S.D. Ltd.)

typically 10 seconds, but the better known makes can be relied upon in this respect.

The trigger style on-off switch on these guns often has two positions, for fast heat-up and for running heat, thus giving a dual-heat facility. Sometimes other types of bit are available which can be used to cut sheet plastics or to weld plastic sheet and so on.

Solder today, as used on electronic work, invariably has several cores of flux to ensure better distribution of the flux around the joint and consequently a better joint. The solder contains tin and lead in varying proportions which affect the temperature at which the solder will melt. The usual ratio of tin to lead is 60/40 for radio work and the diameter of the solder can be between 18 and 22 s.w.g. depending upon the fineness of the work being done.

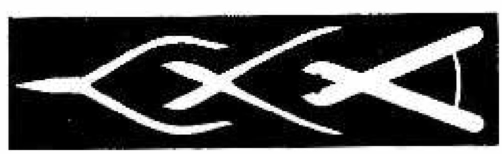
While short lengths of solder can be bought for a few pence the ½ or 1lb. reel will be found to be more economical for the home constructor. If however he wishes to experiment with various solders he will find many easy-to-use dispensers and handy-packs available with different types of solder such as 40/60 or 60/40 tin-lead alloys as well as solders containing a small amount of copper which is calculated to reduce the amount of wear on the copper soldering bit.

Although soldering irons are usually fitted with a hook of some kind so that they can be hooked onto a convenient point it is a good policy to provide some kind of metal stand for use on top of the bench. Such a stand can be easily made out of an odd piece of aluminium or tinplate.

Soldering iron manufacturers naturally produce their own stands or 'protective shields' for their irons and these are designed to ensure that the iron does not overheat when the iron is not being used but is still switched on. For convenience a cleaning pad for the bit may be incorporated and possibly a holder for a reel of solder.

A 'must' in soldering is a sharp pick or long needle for clearing out holes in soldering tags and removing surplus solder. Commercial versions are usually made of aluminium, to prevent the solder sticking to the needle, and with a plastic handle or covering. One end may be pointed and the other end split to enable wires to be unravelled from tags etc., while the solder is molten.

Another de-soldering aid available is in the form of copper wire braid. When the end of the braid is touched on a hot soldered joint surplus solder travels up the braid by capillary action. The end of the braid is snipped off ready for the next joint.



PLIERS AND CUTTERS. Again a very large field of choice and again the rejoinder to pay a bit extra to get quality. Two pairs of pliers will suffice for most constructional work, a long-nosed pair with tapered jaws coming to a reasonable fine point and a heavier pair with stocky jaws, maybe ½" wide, and probably incorporating a pair of sidecutters.

The long-nosed pliers will always be in the hand of the electronics constructor, for twisting wires round tags and forming the wire ends of components before soldering them into position. Don't forget that a wiring joint should always be mechanically sound before it is finally soldered, although the true experimenter will not go along with this principle because he will want to use the same components time and again!

Variations on the pliers theme include those with angled jaws of various lengths, round jaws and flat narrow jaws rather than pointed ones. When buying pliers see that the opening and closing action is not too loose or the jaw tips will not close together properly and it will be difficult to get hold of fine wires when wiring up.

Wirecutters will be used as often as the pliers so, again, only the best must be chosen. They should be about the same size as the long-nosed pliers with the cutting edges at an angle to the body. Other types have the cutting edges across the top or parallel with the body.

When buying sidecutters hold them up to the light and see that the cutting edges come together cleanly and evenly throughout their length. Try this test with a cheap imported pair of cutters and see the difference! The previous remarks concerning the action of pliers applies just as much to sidecutters. A loose action and the cutting action will be greatly impaired. On the other hand, there is nothing more annoying than a pair of cutters or pliers that need two hands to open them!

WIRESTRIPPERS. Different people have different ways of stripping the insulation from wire, varying from the use of the front teeth to an old kitchen knife! If the wire is nicked, and it often is, it will eventually break if it is subject to vibration or flexing. The ordinary sidecutters are frequently pressed into service as wirestrippers mainly because they will have just been used to cut off a piece of wire and are still in the hand! However there are plenty of wirestrippers on the market designed for the job so there is no excuse for improvisation.

Wirestrippers usually have some means of adjustment to cater for different size wires. It is important not to try to strip wires of a larger gauge than that for which the wirestripper has been set, or the wire will be nicked. One of the latest style wirestrippers on the market has a four position cam that can be adjusted immediately to another gauge of wire, while still held in the hand. Incidentally, this model also has wire cutters which have ground edges, a great improvement.

A feature on some types of wirestrippers, which the author considers of great importance, is the provision of a spring that keeps the cutters normally open, the cutting action taking place against the spring.

SCREWDRIVERS. Strictly speaking, every different sized screw needs its own screwdriver, if the blade is to fit the screw slot properly, but not many of us are likely to go to that extreme. The width of the blade should be about the diameter of the screw head or wider, rather than narrower. For electronic construction work it is best to buy a set of screwdrivers with blade widths from about $\frac{1}{8}''$ up to $\frac{1}{4}''$ or $\frac{5}{16}''$. Three screwdrivers should be sufficient. A useful addition is one for the Philips style screws, that is the screws with crossed slots.

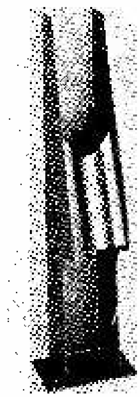
Screwdriver sets are available consisting of several blades that can be fitted to a common handle. Although these may be cheaper than individual screwdrivers they are less convenient in practice.

The screwdriver blade itself should be about 6″ or so long depending upon the blade width. One very useful size of blade is one about $\frac{3}{32}''$ wide for use with knob setscrews. The blade should be as long as possible so as to reach a knob in spite of the clutter of other knobs, dials etc. on a panel.

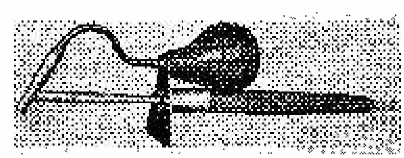
Don't take any notice of the markings on some screwdrivers that seem to indicate that one can use them with safety on 10000 volt circuits! Anyone having that sort of voltage around should know the precautions he should take. They would not include the use of a screwdriver on 10000 volts!

Variations on the basic screwdriver include the ratchet

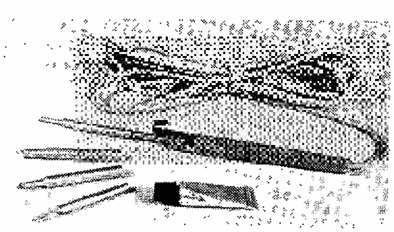
A most useful de-soldering aid is a reel of specially treated copper braid which will completely remove unwanted solder from a joint by capillary action.



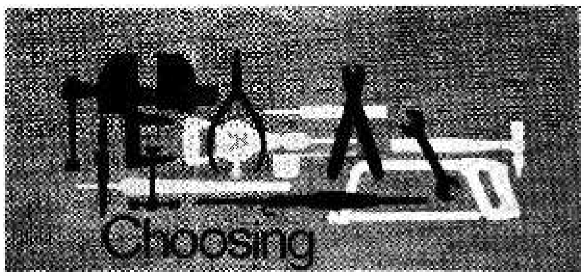
The Adcola protective shield is intended for wall or bench mounting and has slots for a spindle carrying a reel of solder.



This de-soldering tool (L.S.D. Ltd.) could be invaluable when stripping components from surplus equipment. It is self-contained and simple to operate and may be used as a conventional soldering iron.



The Adamin miniature iron, Model 15, can be obtained complete with a set of four bits of differing size. The tube of special lubricant is used to prevent the bits from sticking to the heating element.



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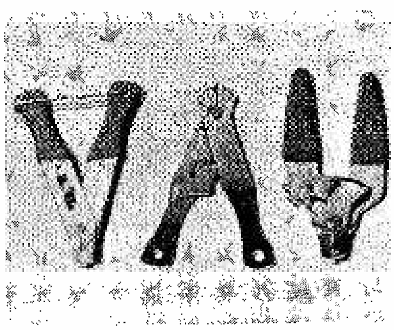
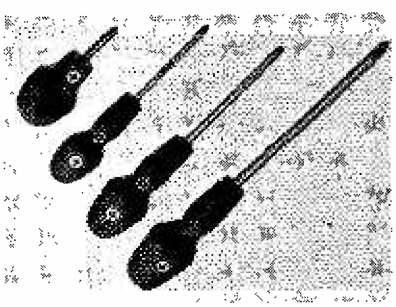
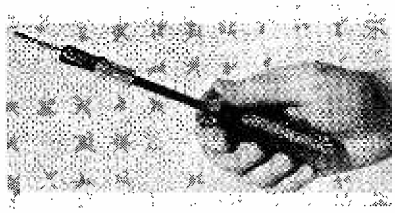


Three of the Bib range of wirecutter/ strippers by Multicore Solders Ltd. The latest, centre, is the Model 3A with an instantly adjustable cam enabling the strippers to deal with most wire sizes. The cutters have ground cutting edges. The ends of the arms are, in fact, flat spanners for 4 and 6BA nuts, a most unusual feature.



A set of Stanley 'Pozidrive' screwdrivers enabling Philips type screws to be reached in the most awkward corners.



The Stanley range of 'Spee-D-Grip' screwdrivers incorporating a spring clip which holds screws in position for starting in inaccessible places.

types which remove the necessity of continually lifting the screwdriver from a screwhead thus, incidentally, reducing the risk of the blade slipping and doing damage. Of course, if one used a screwdriver properly, the blade should never leave the slot, but this seldom happens!

A most valuable addition to a set of screwdrivers is one having a spring attachment at the tip of the blade to firmly hold a screw while it is being inserted into place. Its value in awkward spots is inestimable. Such an attachment can sometimes be bought separately for use on almost any screwdriver.

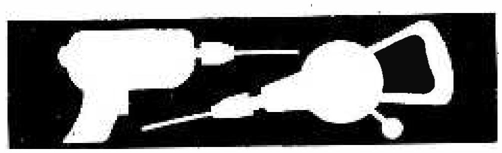
SPANNERS. There is always a temptation to use a pair of pliers on any nut that needs tightening, usually because the pliers are ready to hand. It should be remembered that the opposite faces of a nut are parallel to each other where-as the jaws of a pair of pliers are only parallel when they are closed. That's why the pliers always slip off the nut and cause damage.

First of all, get a set of box spanners covering 0 to 8BA either single or double ended. The single ended ones with a wooden or plastic handle are recommended. Just two, for 4 and 6BA, are worth their weight in gold in a workshop. Having long stems they are invaluable for placing nuts into odd corners where fingers or pliers cannot reach.

It is always good practice, wherever possible, to tighten a nut on to a screw rather than use a screwdriver on the screwhead. This is particularly important where the screwhead is visible such as on the front panel of a piece of equipment where a damaged slot on a screw would be an eyesore.

Another requirement in the spanner line is a set of flat spanners, again covering the BA sizes, possibly 0 to 8BA. These can very well be double ended ones since the length of the spanners is not of much importance.

Some sets are single ended but bolted together at one end so that one can be selected and the others swung out of the way, rather like a set of feeler gauges.



DRILLS. In the past a hand drill would have been a first acquisition in a workshop, followed by an electric drill when the money was available. Today the cost of electric drills is such as to justify buying one from the outset.

The simple electric drill will have a single speed and accommodate drills up to $\frac{1}{4}$″ in diameter, ('twist drill' is really the proper name for the bit that does the cutting). This model will perform just about all the routine drilling jobs in a workship where electronic projects predominate. A chuck adaptor to take drills up to $\frac{3}{8}$″ in diameter is highly desirable, enabling the usual holes for mounting potentiometers etc. to be drilled without having to resort to files or reamers.

If the drill is likely to be used for other duties around the house then the two speed drill with a chuck taking drills up to $\frac{1}{2}$″ in diameter can be considered. A popular accessory for the electric drill is the speed controller which is an electronic device enabling the speed to be varied continuously from a few r.p.m. to maximum speed. Such controllers are available in kit form or ready assembled.

If a lot of drilling is anticipated, particularly on chassis work, a drill stand will prove a boon. Most electric drill manufacturers have such stands but their design is such that they will accommodate most makes of drill. Such stands ensure that holes are drilled vertically, which may not be very important on sheet metal work but could be critical with a deep hole. Holes will be more accurate both in size and positioning when drilled on a stand rather than with a hand held electric drill.

When using drill adaptors enabling, say, a $\frac{3}{8}$″ drill to be used in a chuck of nominal $\frac{1}{4}$″ capacity, remember not to overload the motor by exerting excessive pressure on the drill especially in hard materials.

Hand operated drills suitable for the small workshop range from the simplest single speed ones with a $\frac{1}{4}$″ capacity to those taking drills up to $\frac{1}{2}$″ and having an integral gearbox providing either a low speed or a high speed at the chuck. A little extra spent on a good hand drill will be a worthwhile investment. In particular the gears will run more smoothly and require less energy and the chuck will be of a better quality.

Now, what about the twist drills themselves? These are bought singly, as required, or, if starting more or less from scratch, then in a set complete with a stand for use on top of the bench. They may be had in sizes from about $\frac{1}{32}$″ to $\frac{1}{4}$″ in diameter or in a numbered range from No. 80 (0·0135″) to No. 1 (0·228″). Letter drills carry the range on upwards from 'A' (0·234″) to 'Z' (0·413″).

For many years the author has had just four drills always to hand, No's 12, 24, 32 and 43. These will cover the drilling of holes for tapping or clearing for 2, 4 and 6BA screws.

As far as the quality of twist drills is concerned, it is necessary to take a little more care over their selection than with other tools since there are a lot of drills on the market that seem to be made of little more than soft iron! So once again beware of cheap imitations and if the pocket will stand it, buy a small set of genuine high speed drills. These will last for ever and seldom need sharpening if not abused.

PUNCHES. Whenever it is required to drill a hole in a chassis, or anywhere else for that matter, it is essential to use a centre punch to mark the spot where the hole is required. Otherwise it is almost certain that the drill will wander off the spot, scratching or damaging the surface being drilled. This particularly applies to hard surfaces and when using a hand held electric drill especially if care is not taken to keep the drill vertical.

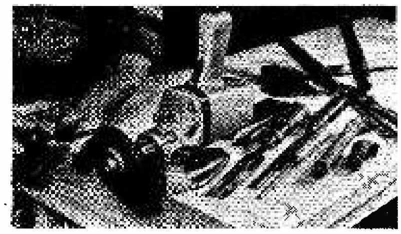
There's not much to say about centre punches. A good one will be of tempered steel with a sharp round point, usually machine ground. Spring loaded punches are available which obviate the need for a hammer, so these punches are very convenient and the extra cost well justified.

Chassis punches are a necessity although the number bought for a small workshop will probably depend upon the funds available. These punches will cut holes ranging from $\frac{3}{8}$″ to 3″ in diameter but it is recommended that at least two be obtained, $\frac{5}{8}$″ diameter for B7G valveholders and $\frac{3}{4}$″ diameter for B9A valveholders. These punches require a suitable Allen key to operate them and their cutting limit is about 16 s.w.g. mild steel. They will cut through the usual 16 s.w.g. aluminium sheet like the proverbial knife through butter, thus saving a great deal of time and energy.

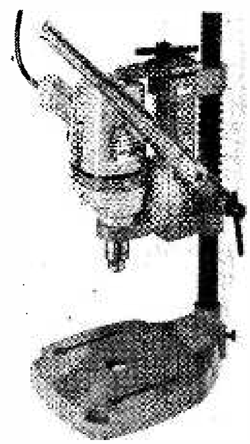
A useful tip . . . the resulting hole will have a burr on one side so place the cutting part of the punch on the side of the panel or chassis that might be of some importance from the point of view of appearance.

Other chassis cutters are available that will cut square or rectangular shaped holes but the infrequent need for such cutters does not justify their purchase.

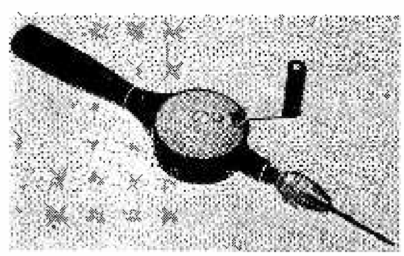
The predecessor of the chassis cutter was the tank cutter. This had an adjustable cutting bar for different diameters of hole, but unless used in a lathe or drill press,



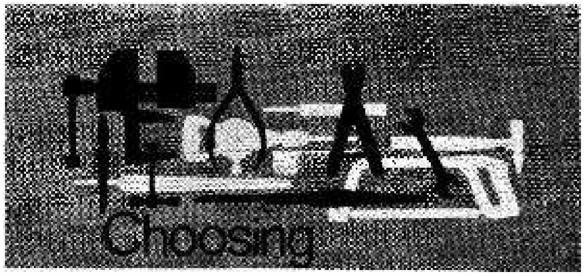
This bench clamp enables a portable electric drill to be used with grinding, polishing or other attachments (Wolf). The drill is a Wolf Sapphire 73.



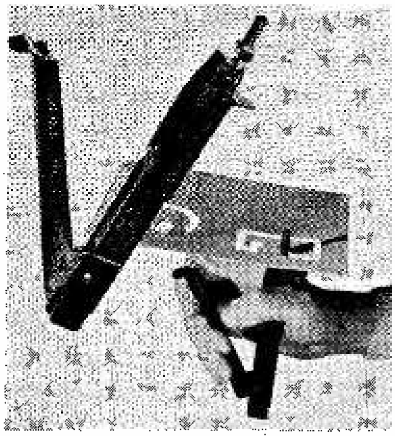
For precision drilling a bench drill stand is essential. The spring loaded press magnifies the hand pressure some ten times. (Wolf)



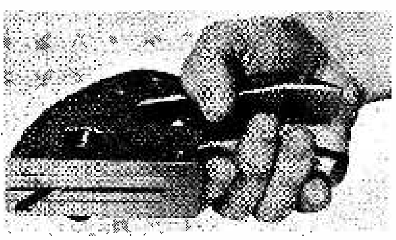
The old-fashioned hand drill now has a streamlined appearance. In this Stanley drill the gears are completely enclosed protecting them from dirt, swarf etc. and obviating nipped fingers!



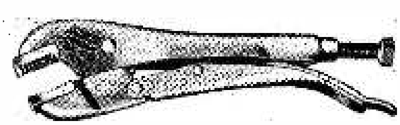
SMALL WORKSHOP TOOLS



Requiring only a $\frac{7}{16}$" hole to begin operations this Adel nibbling tool will cut a hole of any shape or size in sheet steel up to 18 gauge steel or aluminium up to 16 gauge. (West Hyde Developments Ltd.) The punch and die action cuts without distorting the metal.



This precision made Mole 'Supercut' tool has a powerful action capable of cutting long straight lengths, curves or angles in sheet materials such as steel, aluminium, plastic laminates etc. A replacement blade can be fitted very easily.



The standard Mole wrench has many uses in the small workshop. In spite of its immense gripping power it can be opened at a touch on the release lever.

the resulting hole could be a little rough in appearance. A slow cutting speed was essential and for this a carpenter's brace was ideal.

Other hand tools for cutting holes in sheet metal include the family of "nibblers'. A small hole is first drilled in the sheet metal, the nibbler inserted and the action of the tool nibbles the material away to form a hole of almost any shape desired. The hole can be finished off with the usual files.

Shears, or tinsnips, will be needed for cutting sheet metal and a 10" pair with straight jaws should suffice for general work. The will make a straight cut in sheet metal for a limited distance although the 'goosebill' type will usually prove better for this work.

TAPS. Now and again the necessity will arise to tap a thread in a hole and for this two taps for each size thread are required, together with a tap wrench. The first tap is tapered, to start the thread, and the second tap is full size. Sometimes a third tap of intermediate taper is used but this is not really required for small threads.

The tap sizes most likely to be required are the usual 2, 4 and 6BA. Taps can be broken off relatively easily and for this reason a proper tap wrench is strongly recommended.

The simplest and probably the best tap wrench is the bar type with a screw grip on to the tap. The chuck model is more expensive but it does enable the tap to reach positions that would be inaccessible with the bar type wrench.

FILES. For finishing off the edges of metalwork and suchlike a 10" flat file will be quite adequate. That known as 'second cut' will prove best being neither too coarse nor too fine for work on soft metals. A similar sized half round file is very useful for finishing off large holes such as those required for meters. While smaller holes, for valveholders etc., can be cut with chassis punches the cost of similar punches for large meter holes tends to be prohibitive, especially as they are used relatively infrequently. Such large holes can be made by drilling a circle of small holes, then knocking out the disc of metal and finishing the work with a half round file.

A $\frac{1}{4}$" round file completes the essential complement of files. This will find most use in enlarging small holes in the absence of a reamer or for 'drifting' holes that are not quite where they ought to be! Perhaps the spot was not properly spotted with a centre punch before drilling!

With the advent into common use of slide switches on electronic equipment the need has arisen for a couple of small needle files, one round and the other square, for finishing off the rectangular holes required in panels for these switches. If a set of needle files can be managed then so much the better as these sets contain files of circular, triangular and flat sections as well as those already recommended.

When buying files get suitable wooden handles for them at the same time. Don't try to use a file without a handle or there will be a grave risk of the tang of the file entering the wrist if the file should jam or stick in the work.

HAMMERS. As far as hammers are concerned the small workshop should have one with a plastic or rubber head for bending sheet metal, without causing undue marking of the metal. A second hammer should be a light one of the 'ball-pein' variety for general work around the place. A good make is advisable to ensure that the hammerhead is properly attached to the shaft as a hammerhead in orbit around the workshop is not funny!

REAMERS. During the construction of a piece of electronic equipment one always seems to need to drill a hole that is between the sizes of the drills available. In such a case a tapered reamer can be invaluable, as an alternative to filing out the hole with a round file, a process that does not endear one to one's family, if they are within earshot!

A pair of reamers can deal with holes between ⅛" and 1" in diameter producing a clean circular hole with little or no burr. They are usually intended for use in a hand brace but can on occasion be held in the hand.

VICES. If a bench or table is permanently available for constructional work then a vice of some sort will prove to be a great boon especially when fabricating metal work. While smaller sizes are obtainable, an engineer's vice with 4" wide jaws should be the smallest size to be considered. Such a vice is extremely rugged and will take a lot of punishment, including using it as an anvil!

Since the vice jaws are made of hardened steel, and serrated at that, it is essential to make up a pair of soft jaws to protect work held in the vice. These jaws can be made from pieces of aluminium or other soft metal. Other vices have clip-on jaws which are plain, serrated or slotted to hold tubing or round material more securely. Another model of vice has a separate mounting plate that can be attached to almost any flat surface by means of a suction pad.

A carpenter's vice with 6" or 8" jaws is even better for sheet metal work since the jaws can be opened to a far greater extent than those of an engineer's vice. However the space needed to permanently mount a carpenter's vice, especially below and behind the vice, is considerably more than that needed for an engineer's vice. However, there are some portable vices on the market that seem to combine the best points of both types.

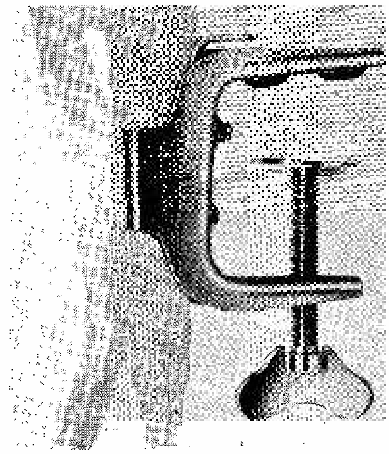
Although one may possess a bench vice there is always a need for a portable clamping or holding device and this is where the wrench comes in very handy.

The modern version of the wrench has an easily operated lever that allows the wrench to be locked on to the work and just as easily released. A clamp to hold the wrench is also available, which can be fitted to a table or bench top with a single clamping screw, thus providing a fixed vice if necessary. The jaw opening of the wrench can be adjusted over a wide range by a single screw fitting.

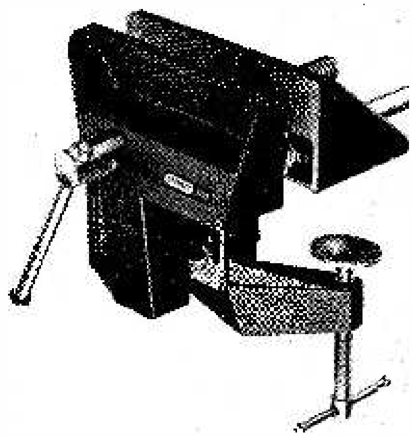
RULES. For marking out on sheet metal a rule and a square (trysquare) will be required, if an accurate job is to be done. A 12" rule is good enough and although it would seem that choosing such a simple tool would be no problem, the choice is, in fact, very wide indeed, ranging from rather inaccurate wooden rules, with printed graduations, to engraved steel ones.

Although a 6" square can be bought separately it really pays to buy a combination square since this incorporates a rule and square, usually of reasonable quality.

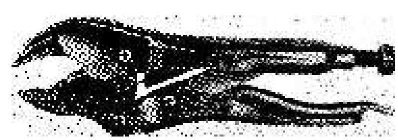
HACKSAWS. The hacksaw will come in for quite a bit of use in the small workshop, mainly for cutting sheet metal to size before forming into a chassis. Some of the cheaper hacksaw frames will be found to twist when the blade is tightened up, so a good quality frame will be a sound buy. The adjusting nuts, too, can be difficult to turn owing to poorly formed threads.



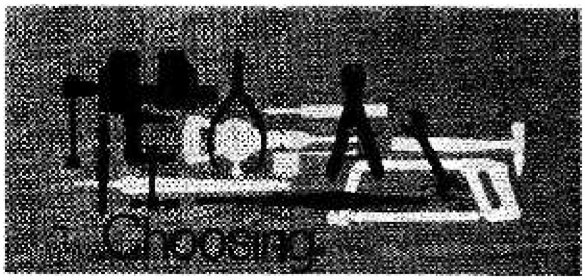
The versatility of the Mole wrench can be greatly increased by the use of this table or bench clamp, converting the wrench into a portable vice.



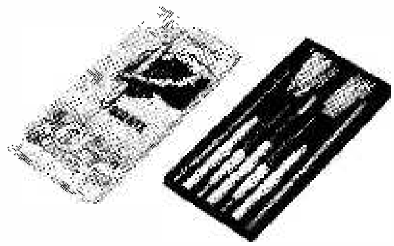
This Stanley aluminium portable vice has 5" jaws and can be clamped to any convenient surface. It is eminently suitable for bending sheet metal into chassis etc.



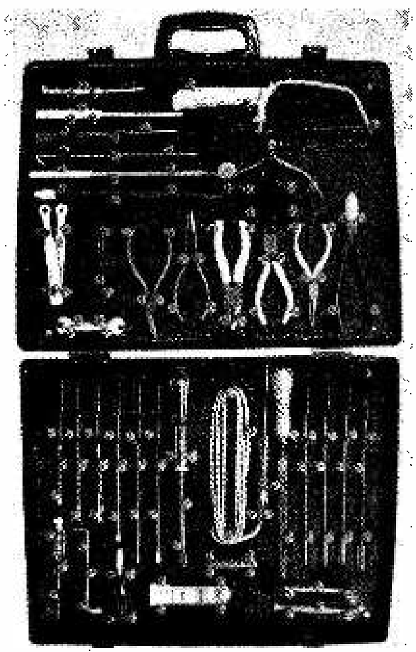
The Mini-Mole is just 5" long and very useful for getting into those tight corners, inaccessible to its 'big brother'. The curved jaws provide maximum contact with round or irregular shapes.



SMALL WORKSHOP TOOLS



This set of Philips trimming tools and adaptors will cover every conceivable requirement when aligning electronic equipment. The compact packaging makes the set particularly useful to the service engineer. (Combined Electronic Services Ltd.)



If you don't feel like tramping around the tool shops to gather together your collection of small workshop tools then this very comprehensive tool kit may be the answer. It has a wide variety of spanners, screwdrivers, pliers, cutters, a soldering iron and solder, and even an angled mirror for viewing components tucked away in tight corners. (C.E.S Ltd.)

A frame to take 10" or 12" blades is big enough and the blades themselves can be of the low tungsten flexible type. These will deal with general cutting of mild steel, brass and aluminium etc. and absorb a lot of misuse without breaking. For maximum performance high speed flexible blades are to be preferred although they are a little more expensive.

For maximum efficiency the size of the teeth on the blade must be related to the material being cut. For soft metals, such as aluminium, a coarse blade is desirable to prevent the teeth from clogging, but on harder metals such as brass or on thin sheet metal a finer toothed blade is required. The number of teeth per inch of blade normally runs from 14 to 32 for hand held saws.

A very useful addition to the standard hacksaw is the 'junior' or bow-frame saw in which the blade is held under tension by the bow. The standard blade is 6" long with fine teeth. This saw is very handy for the smaller, finer jobs where the standard hacksaw would prove clumsy. In the electronic workshop the bow saw will be used a great deal for shortening the spindles of potentiometers, capacitors etc. Remember to hold the unwanted end of the spindle in the vice while cutting, rather than the component itself.

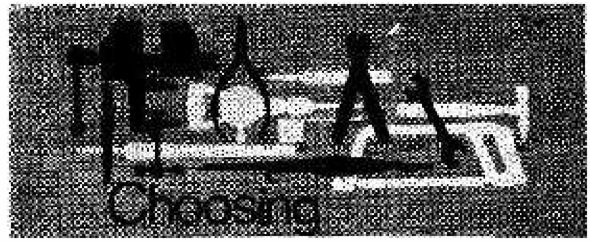
TRIMMING TOOLS. Although perhaps it is wandering into the realms of servicing it is not inappropriate in this review to mention trimming tools for electronic equipment. After all, having built a lovely radio set in our nice new workshop, it won't be of much use unless the tools to align it are to hand.

These trimming tools can be bought individually, as needed, but preferably they ought to be obtained as a kit. This will prevent the use of ordinary screwdrivers for adjusting iron cores which can only cause damage in the long run.

A kit may consist of one basic tool holder with several types of trimming tool that can be fitted into the holder or, in the more expensive kits, a complete trimmer for each purpose, such as adjusting iron cores, capacitors and special types of capacitors, such as the Philips pre-set beehive capacitors, which are met with quite frequently.

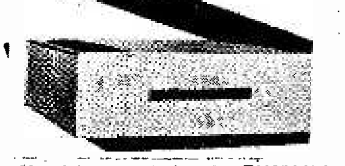
In conclusion it should be pointed out that for every basic tool mentioned in this review there are a dozen or more variations on the market. Like women, there are short ones, tall ones, thin ones and fat ones! Each one to his own fancy! The average D.I.Y. or tool shop is sated with gadgets that promise to relieve us of the tedium and work required to do a particular job. Few succeed, and those that do probably take twice as long to set up to do the job as one would take using basic tools alone.

It's surprising how often one resorts to basic methods and tools in the workshop. If funds are limited then put them to good use by buying only the best in tools from reliable manufacturers. If their names happen to be a household words they would not have reached those dizzy heights by selling rubbish.



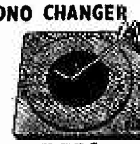
SMALL WORKSHOP TOOLS

PHILIPS PORTABLE PLAYER CABINET



Size 18 × 15½ × 7½in. Cut for B.S.R. UA12/14/15/16/25 deck. Amplifier space 14 × 5 × 3½in. Satin aluminium front grille. Really smart appearance. Black/White. Chrome fittings. **£4** Post 25p

BSR C.109 SUPERSLIM
STEREO AND MONO CHANGER



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13½ × 11½in. Above motor board 3¼in. below motor board 2½in. with STEREO and MONO XTAL **£7.75** Post 25p.

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R.C.S. TEAKWOOD BASE. Ready cut out for mounting (State player make and model) **£2.75**

R.C.S. PLASTIC COVERS FOR ABOVE BASE. Durable tinted plastic, attractive appearance. **£2.75**

EMI PICK-UP ARM with mono xtal and stylus £1·25.
HI-FI PICK-UP CARTRIDGES. Diamond Stereo/Mono 9TA £2·90; GP94 £2·75; GP93 £2·25; Mono GP91 £1·50; GC8 £1·25; ACOS L.P. only 50p.
All standard fixing complete with stylus.

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As used in LEAK Troughline Tuner. Brand New. Pre-aligned with 9 semi conductors. 24v. D.C. at 6mA. Complete with circuit and connections 3¼×2×1in. **£4** Post Free

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RA2W Ferrite Aerial	65p	Spare Cores	3p
Osc. P50/1AC	30p	Driver Trans. LFDT4	50p
I.F. P50/2CC 470 kc/s.	33p	Printed Circuit, PCA1	50p
3rd I.F. P50/3CC	33p	J.B. Tuning Gang	65p
P51/1 or P51/2	33p	Weyrad Booklet	10p
P50/3V	33p	OPTI	55p

Mullard Ferrite Rod 8 × ⅜in. 20p, 6 × ⅜in. 25p.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

80ohm Coax 4p. yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1·40; 60 yd. £2. FRINGE LOW LOSS Ideal 625 and colour. **10p** yd.

WIRE-WOUND 3-WATT POTS. Small type with small knob. Values 10 Ω to 30 K., Carbon 30 K to 2 meg. **25p**

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 10 OHMS to 100 K. **40p**

VEROBOARD 0·15 MATRIX
2½ × 5in. 19p. 2½ × 3¾in. 16p. 3¾ × 3¾in. 19p. 3¾ × 5in. 26p.
EDGE CONNECTORS 16 way 25p; 24 way 38p.
PINS 36 per packet 17p. FACE CUTTERS 38p.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 3p per 1in., 3¾in. wide 4p per 1 in.; 5in. side 5p per 1in. (up to 17in.).
S.R.B.P. undrilled ⅟₁₆in. Board 10 × 8in. 15p.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides. 6 × 4in. 45p; 8 × 6in. 50p; 10 × 7in. 70p; 14 × 9in. 90p; 16 × 6in. 90p; 12 × 3in. 50p.
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Battery 9-12v or H.T. line 200-300v D.C. operation. Size 1½" x 1¼" x ½". Response 25 c.p.s. to 25 Kc/s. 26db gain. For use with valve or transistor equipment. Full instructions supplied. Brand new. Guaranteed. Details S.A.E. **90p** Post 10p

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8/450V	14p	500/25V	20p	60+100/350V	58p
16/450V	15p	8+8/450V	18p	32+32/250V	18p
32/450V	20p	8+16/450V	20p	32+32/450V	33p
25/25V	10p	16+16/450V	25p	32+32+32/350V	43p
50/50V	10p	32+32/350V	25p	100+50+50/350V	48p

SUB-MIN. ELECTROLYTICS, 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p; 500, 1000mF 12V 18p; 2000mF 25V 35p.
CERAMIC 1pF to 0·01 mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 4p, 0·5 18p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p. 1,000V-0·001, 0·0022, 0·0047, 8p; 0·01, 0·02, 12p; 0·047, 0·1, 16p.
SILVER MICA. Close tolerance 1% 2·2-500pF 8p; 500-2·200 pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p; each.
TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 365+365 with 25+25pF, 50p 500pF slow motion, standard 45p; small 3-gang 500pF £1·10. SHORT WAVE. Single 25pF 55p
CHROME TELESCOPIC AERIAL, swivel base, 23in. 20p.
TUNING. Solid dielectric. 100pF. 500PF, 35p each.
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RECTIFIERS CONTACT COOLED ½ wave 60mA 38p; 85mA 48p. SILICON BYZ13 80p; BY100 30p; BY127 30p.
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HIGH STABILITY. ½ w. 2% 10 ohms to 1 meg., 10p.
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½in. 83p	1in.	98p	1¼in.	£1·03	1¾in. £1·45		2½in. £2·86		
¾in. 84p	1⅛in.	98p	1⅜in.	£1·08	2in.	£1·99	1in.sq. £1·88		

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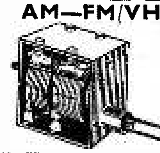

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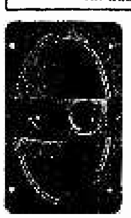

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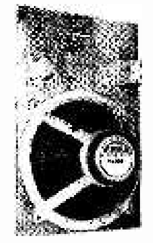

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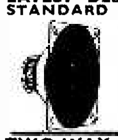

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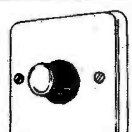

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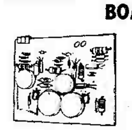

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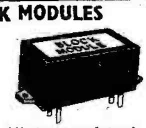

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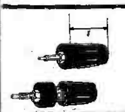

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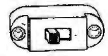

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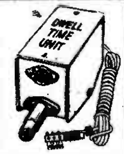

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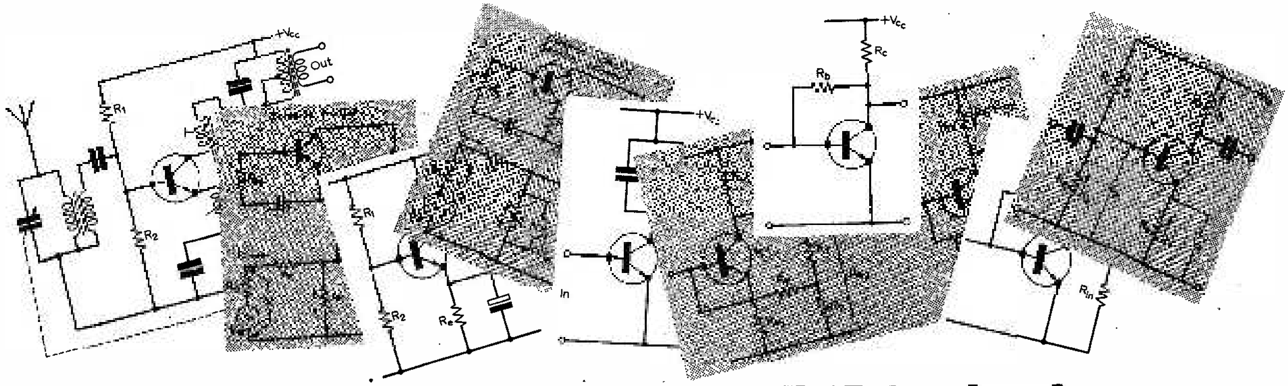

TRANSISTOR CIRCUITRY for beginners'

PART 1

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WHEN the idea for this series was first broached, everything seemed straightforward and simple. We would entitle the wallchart 'Building Bricks,' said the Editor, in an inspired moment, and the articles would take up each 'brick' and develop it so that newcomers to transistor circuitry could understand what was happening inside those inscrutable black boxes.

Which was all very fine—but it completely overlooked the fact that any beginner worth his salt is going to say 'But Why???'

No good my declaring '. . . an input signal to the base of Tr1 turns it on, which causes Tr2 to turn off and Tr3 and Tr4 to return to the stable mode, releasing Tr5, which now bottoms and allows . . . etc.' It would sound like a paragraph from Henry!

To understand transistor action, it is imperative that we begin by understanding what makes the darned things tick, That means going back to pure physics, not too deeply, preferably without mathematics, and then progressing to the methods of construction and the reasons why there are essential parameters—rules of operation, if you like—and this is what we shall begin with.

Semiconduction

As the name implies, the semiconductor is neither pure insulator nor electrical conductor, but something in between. Its resistivity lies roughly midway between that of conductors and insulators. This resistivity, moreover, decreases with increase of temperature (the resistance of a conductor increases slightly as the temperature is raised). This is one important difference between semiconductors and conductors.

Next, perhaps more important, is the way in which current flows in a semiconductor. There can be two processes; either a flow of negative electrons, as in the case of a conductor, or a flow in the opposite direction of positive 'holes'. The concept of hole flow is so vital to the understanding of transistor operation that we must begin with a simple discussion of atomic structure in order to get a grasp of it.

Atomic Structure

An atom consists of a central nucleus containing positively charged protons with a number of negatively charged electrons orbiting around it. The negative charge carried by an electron is equal to, and exactly opposite to, the positive charge of a proton. In a neutral atom, the numbers of each are equal.

Different elements have atoms containing different numbers of electrons, orbiting at different distances from the nucleus. The electrons close to the nucleus are tightly bound to the nucleus, but those circling in the outer orbits are more loosely bound, and are easier to dislodge from the parent atom. The outer ring is called the **valence ring,** and the valence electrons are those with which we are mainly concerned in this work. The looser they are bound to the atom—in any material—the better a conductor a piece of that material will make. This is because loosely bound valence electrons are free to be attracted by a positive charge, such as a voltage applied across a conductor by means of a battery.

Electrons flow out of the conductor into the battery at the positive connection, but an equal number pass from the negative connection of the battery into the conductor at the negative terminal, keeping the overall total of electrons the same.

Conversely, an insulator is a material in which all electrons are tightly bound to the nucleus, so that a large amount of energy is needed to break any loose to make a current flow.

Crystal Structure

The structure of a crystal of germanium or silicon is depicted in Fig. 1. It can be seen that there are four valence electrons in the outer ring and these are balanced in the nucleus by four positively charged protons, as indicated. In the three-dimensional structure that exists in reality, every atom is equi-distant from four other atoms and each valence electron forms a pair with one from an adjacent atom.

In two-dimensional form this can be shown as in Fig. 1, with pairs of electrons forming co-valent

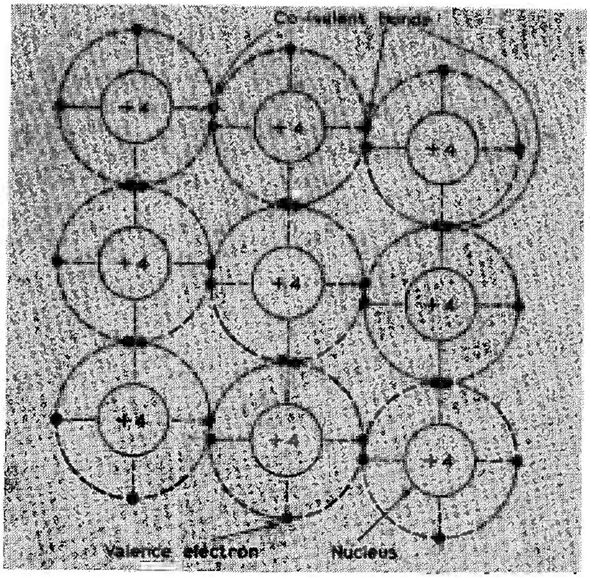


Fig. 1: Illustrating the structure of a germanium or silicon crystal.

bonds. This is a perfect crystal, with no impurities; and no electrons are dislodged from their atoms. This is, in fact, the basic structure of a perfect insulator, at absolute zero temperature, but as temperature increases, the energy of each atom is increased and some electrons can break away. If a voltage is applied, these free electrons are attracted to the positive pole and a current flow results. The space left in the crystal structure by a dislodged electron is termed a 'hole' and this represents a net positive charge.

We can therefore think of a movement of negative electrons toward the positive voltage terminal and a virtual movement of positive 'holes' (as successive electrons move to fill the vacant spaces) toward the negative pole.

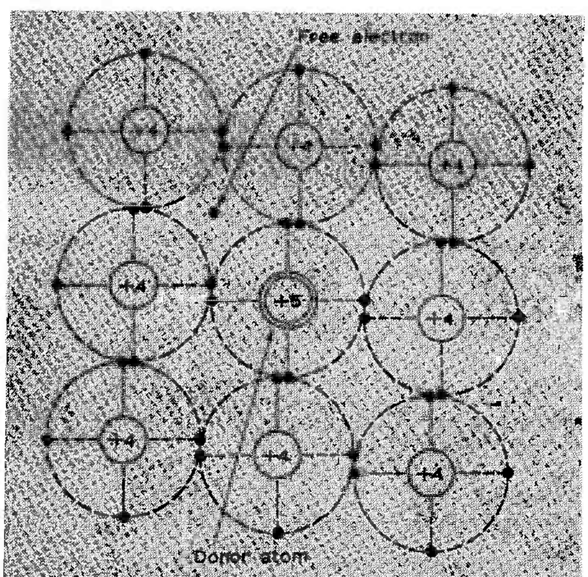


Fig. 2: Adding a 'donor' atom producing an excess free electron. N-type crystal.

N- and P-Type Semiconductor

This is a simplified explanation, but suffices to show the principle of hole movement. In a pure semiconductor there must be one hole for each free electron. Such a pure semiconductor is termed an **intrinsic material**. However, if an element of impurity is added to the intrinsic material an imbalance is obtained. If, for example, a "donor atom" having five valence electrons is added to the crystal, as in Fig. 2, there is an excess free electron. Four of the donor atom's valence electrons form co-valent bonds, in the manner previously described, but the free atom cannot do so and orbits loosely.

Some materials with a valency of five are antimony, arsenic and phosphorus. These can be added to the germanium or silicon crystal in proportions of as little as one part in a hundred million and reduce the resistivity of the germanium from 70 ohms/cm to 1 ohm/cm. Because the donor atoms in such a material contribute free electrons, which carry a negative electric charge, a material "doped" in this

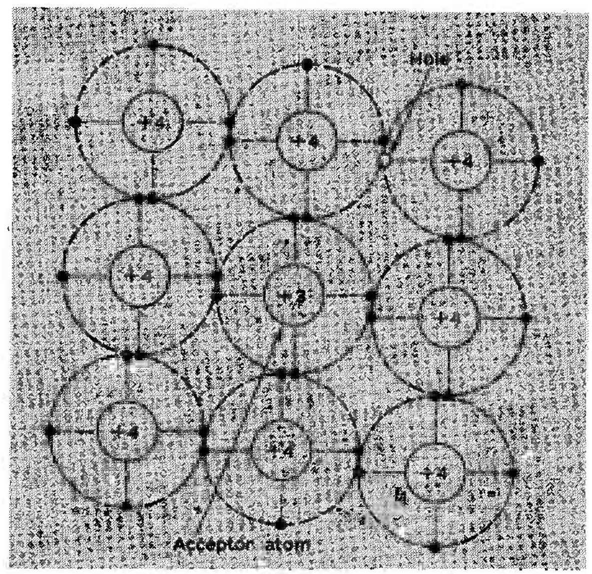


Fig. 3: In this case, an 'acceptor' atom creates a 'hole'. P-type crystal.

way is called an **n-type** semiconductor (i.e. it possesses an excess of negative current carriers).

The opposite process takes place if indium, borium or aluminium atoms are added to the basic semiconductor material, germanium or silicon. These materials have three valence electrons, and the addition of them creates holes in the semiconductor material, as shown in Fig. 3. The resultant semiconductor material has an excess of positively charged holes and is termed **p-type**.

Minority Carriers

Minority carriers are another important factor of semiconductor physics. If a few electrons are injected into p-type material they are called minority carriers (the majority of current carriers in p-type material being, as we have seen, holes). Recombination takes place as the electrons move to fill the holes.

Similarly, holes injected into an n-type material form minority carriers in this type of material, and small currents arise as recombination takes place. The time this takes to happen, termed the minority carrier lifetime, is an important property of a semiconductor material and the operation of most transistors depends on the movement of minority carriers.

PN Junction

A single piece of p-type or n-type semiconductor material is purely resistive: reversing the applied voltage does not alter the current flow. But if p-type and n-type regions are formed in a piece of semiconductor material, with the regions adjoining each other, a rectifying device is formed: when voltage is applied in one direction, current flows, but in the other direction little or no current flows. Such an arrangement is termed a pn junction.

In Fig. 4, the region to the right of the centre line is n-type, possessing a certain density of free electrons. To the left of the line is a region of p-type material possessing a number of positively charged holes. When the junction is first formed, it becomes an area of activity for a short period as free electrons tend to cross into the p-type region and holes move over to the n-type region.

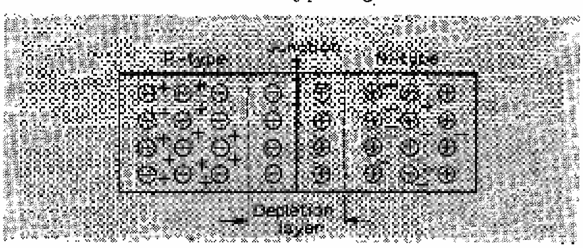


Fig. 4: Showing the charges existing in an unbiased PN junction.

This process of diffusion results in a potential building up across the junction, as the p-region gains a net negative charge with respect to the n region in the vicinity of the junction, and vice-versa, and this potential prevents further diffusion. This potential is termed the barrier potential and the region in the immediate vicinity of the junction, where there are very few free current carriers remaining after the initial diffusion, is termed the depletion layer or region, as shown in Fig. 4.

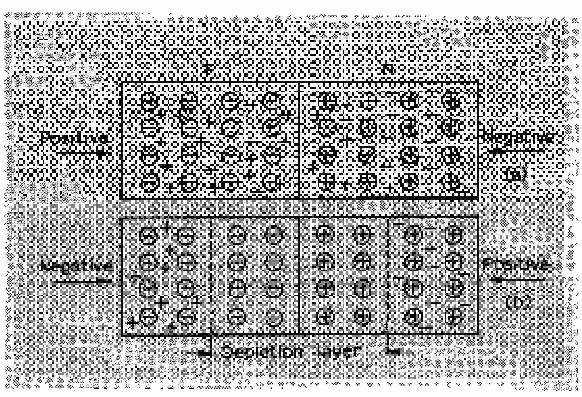


Fig. 5(a): Position of the charges with forward biasing and Fig. 5(b): with reverse biasing.

Forward and Reverse Biasing

We now have a piece of material with pronounced non-linear characteristics: when an external voltage is applied, current will flow in one direction only. If the p-type side is made positive with respect to the n-type (see Fig. 5(a), forward biasing), the effect is that the barrier potential is reduced. Majority carrier holes will diffuse across to the n-type (where they become minority carriers), and majority carrier electrons will move in to the p-type region. A relatively large current can flow across the junction in this way.

Reversing the bias, i.e. applying it as shown in Fig. 5(b), increases the barrier potential (since the external voltage adds to that across the depletion layer already) so that current flow is made very low —in fact virtually nil. However, due to the effect of temperature a number of holes and free electrons will be generated on either side of the junction—this happens even at room temperatures—and this will give the effect of a small reverse current flowing across the junction. The forward current may be quoted in milliamps but the reverse current only in microamps.

Characteristics of PN Junction

Fig. 6 shows the characteristics of a pn junction. As the forward voltage is increased from zero, the forward current increases slowly at first until the junction barrier is overcome, then rises rapidly. (In alternative terms, it can be said that the resistance of the forward biased junction is low.) In the reverse direction, the current remains low and practically

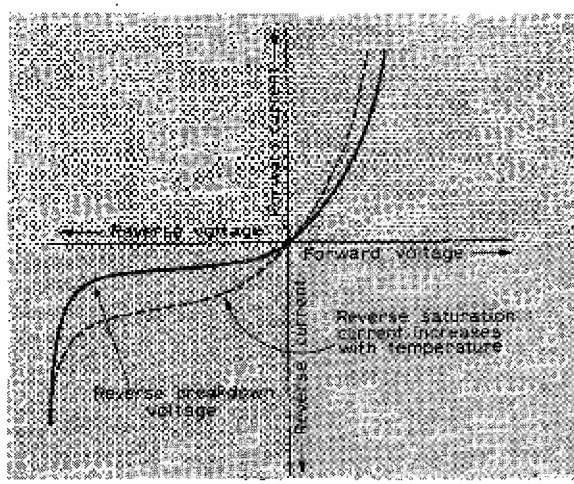


Fig. 6: The electrical characteristics of a PN junction.

constant as voltage is increased, i.e. reverse resistance is very high. Eventually, however, a point is reached where the reverse voltage accelerates the reverse current carriers to such a speed that they break down covalent bonds in the crystal structure, thereby releasing more carriers and producing an avalanche breakdown (when the junction may be destroyed). The value of voltage at which this occurs depends on the resistivity of the material.

As the reverse saturation current is due to the effect of heat, it increases with temperature, giving

—continued on page 512

I.C. OF THE MONTH

L.A.J. IRELAND

Number 24 — **LM373 Multiple-mode Detector**

SOME months ago these notes described the Motorola MC1596 balanced mixer integrated circuit and outlined its operation as a multiple-mode detector in receiver circuits. The unit discussed now goes further; full i.f. amplification facilities, at any chosen frequency up to 12MHz., are incorporated, as well as multiple-mode detection. It is the National Semiconductors (U.S.A.) type LM373, available in the U.K. from: Athena Semiconductor Marketing Co. Ltd., 140 High Street, Egham, Surrey: or Rastra Electronics Ltd., 275 King Street, Hammersmith, London W.6.

Uses

The unit is intended, not just to operate in each mode, but to make it possible to design a receiver in which intermode switching would be simple without reduction of performance. As well as the standard a.m. and f.m. modes, as used for broadcast entertainment in the m.f. and v.h.f. bands, the LM373

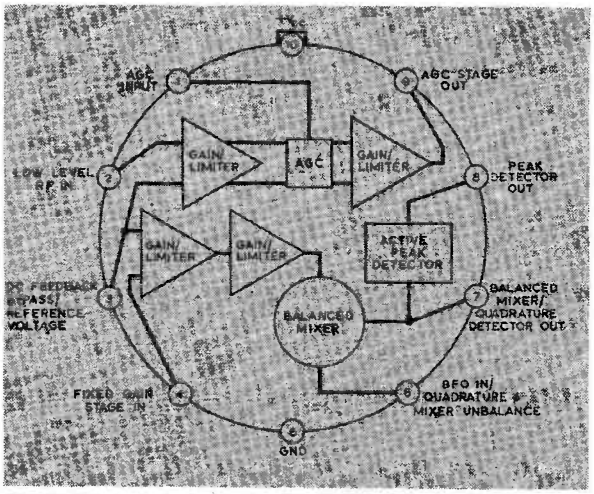
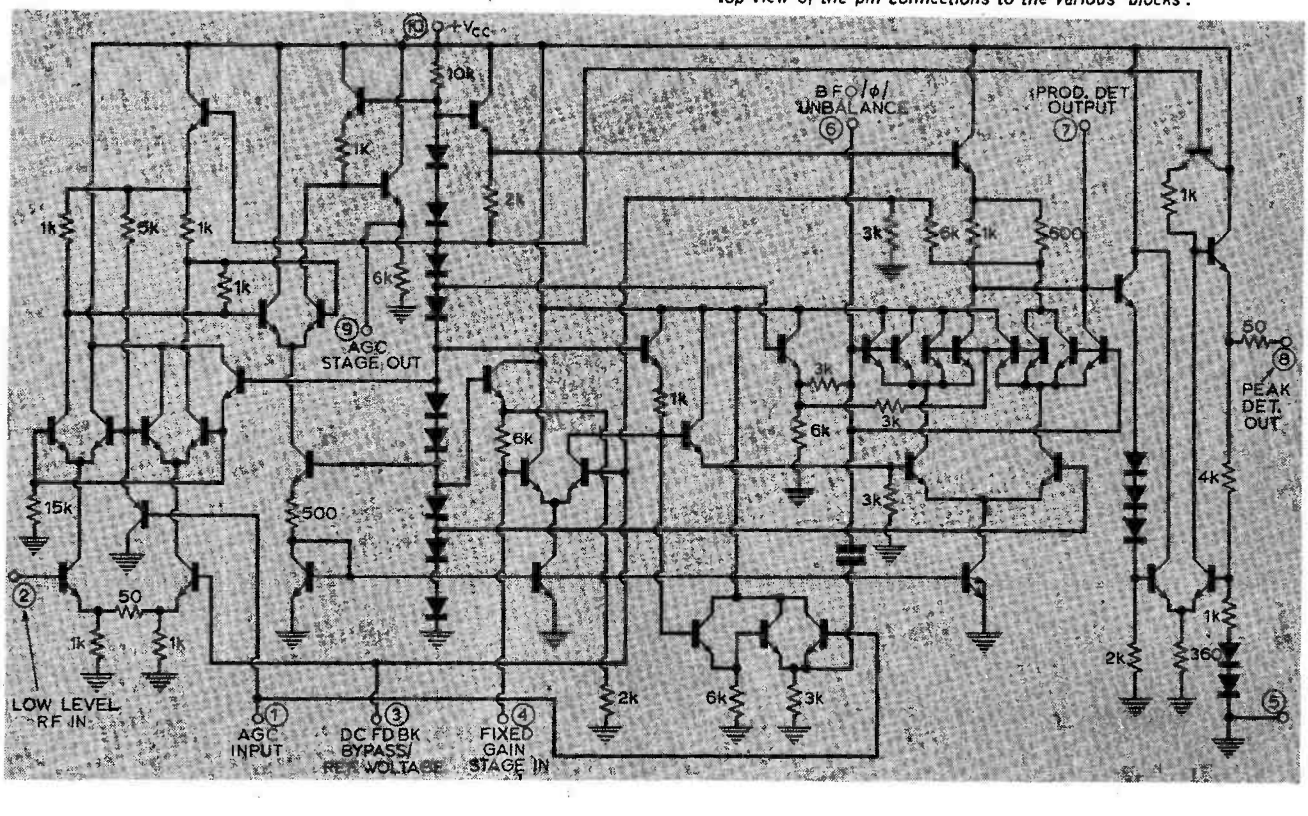


Fig. 1: The equivalent circuit of the LM373 (below) with (above) the top view of the pin connections to the various 'blocks'.



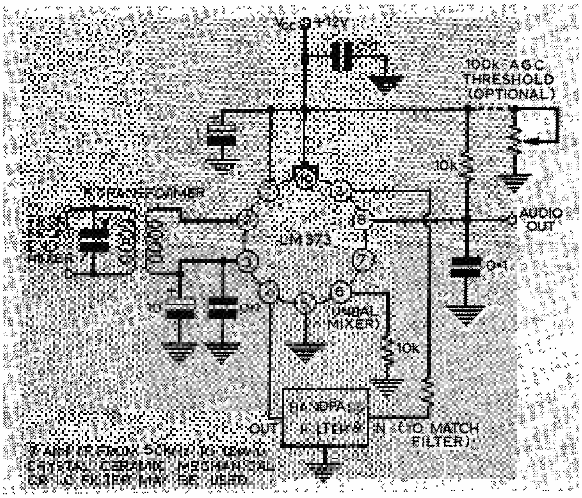


Fig. 2: External circuitry required for the LM373 when used as an AM IF strip.

can handle n.b.f.m. (narrow-band frequency modulation) increasingly used in mobile radiotelephone systems, and s.s.b. (single sideband suppressed carrier) transmissions of commercial or amateur origin.

Design

Considerable ingenuity is exercised in the design of the i.c. to reconcile the conflicting demands of each transmission system with the minimum of inter-mode switching in the receiver. A.M. and s.s.b. receivers must have a linear amplitude response, maintained, despite the wide range of signal strength received off the air, by an automatic gain control subcircuit. An f.m. i.f. amplifier strip, on the other hand, is essentially nonlinear, in that any input signal is amplified to a limiting level before application to the detector stage. It follows that automatic gain control has no place in such a system.

To provide the facilities indicated, the LM373 incorporates four gain blocks, which can be operated in a limiting mode, as well as an automatic gain

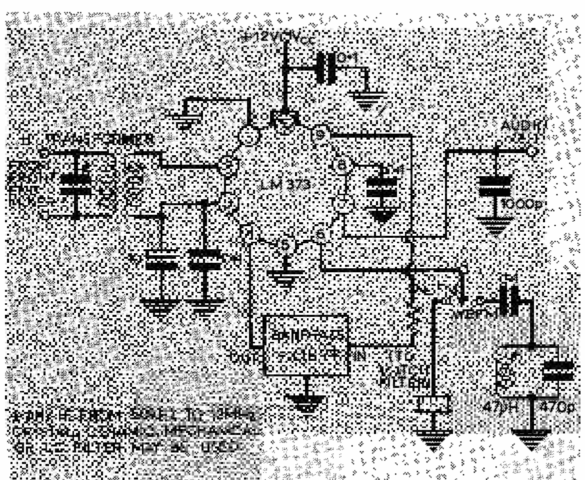


Fig. 3: The LM373 in its role of an FM IF strip suitable for narrow or wideband reception.

control system and two detectors, one a balanced mixer similar to that in the Motorola circuit already mentioned, and the other a peak detector for a.m. operation. The equivalent circuit and pin diagram given in Fig. 1 allows these sections to be identified.

Operation

Some discussion of the circuit would appear necessary. Each gain block is essentially the familiar differential amplifier, which can be operated in its linear region when the circuit is used for a.m. or s.s.b. reception, or driven to full gain as a limiter for f.m.

The automatic gain control characteristic is secured through a pair of transistors shunting the differential interstage coupling components. When no a.g.c. voltage is applied, these transistors are cut off, but as the control voltage is increased, they draw off an increasing fraction of the signal current; finally the point is reached where the signal from

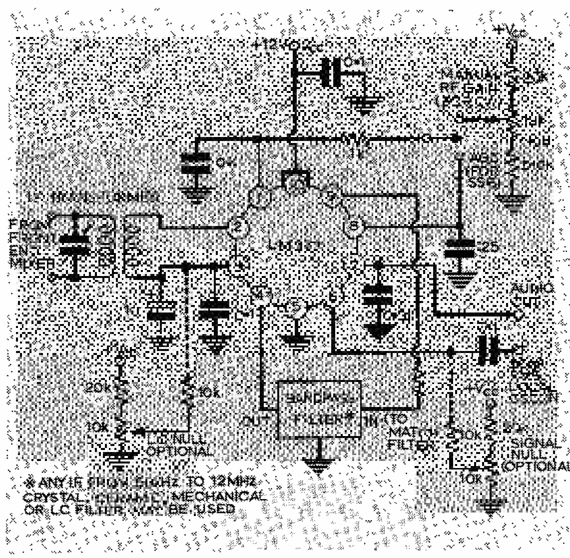


Fig. 4: The SSB/CW IF strip shown here further demonstrates the versatility of the LM373.

the first gain block is shorted out, and coupling to the second is merely through stray capacitance.

This approach secures the unusual a.g.c. range of over 70dB., enabling linear a.m. detection to be attained with input signals from 40 microvolts up to 200 millivolts. The string of reference diodes and emitter follower transistors from the d.c. +ve. line provide power supplies with decoupling to each stage of the amplifier strip, together with appropriate bias voltages to set the operating point of each element. As well as simplifying the external decoupling requirements of the circuit, these imply that each stage essentially has its own regulated supply, so minimising the effects of power line variations.

The balanced mixer stage is easily identified by the cross-coupling of its component transistors. For f.m. it operates as a quadrature detector, a system outlined when describing the MC1496, as was the product detector system used for s.s.b. In a.m. operation, this section is deliberately unbalanced by an externally applied bias, leaving only one side of the differential system connected to its load effectively.

N.b.f.m. demodulation requires a quadrature element of a higher Q factor, i.e. more rapid change of phase with frequency, and therefore a quartz crystal is substituted for the more familiar l.c. circuit. The final section is the peak detector, acting as a.m. detector and a.g.c. voltage source for linear a.m. and s.s.b. operation.

A few precautions are necessary for successful operation. The a.g.c. stage output at pin 9 has a very low impedance, being taken from an emitter follower. A value of 70 ohms is quoted, so that if a high Q crystal filter is employed here a series resistor is advocated, so that the resonance peak of the component will not be damped. The manufacturer of the crystal in question will quote a recommended source impedance, allowing selection of an appropiate resistor.

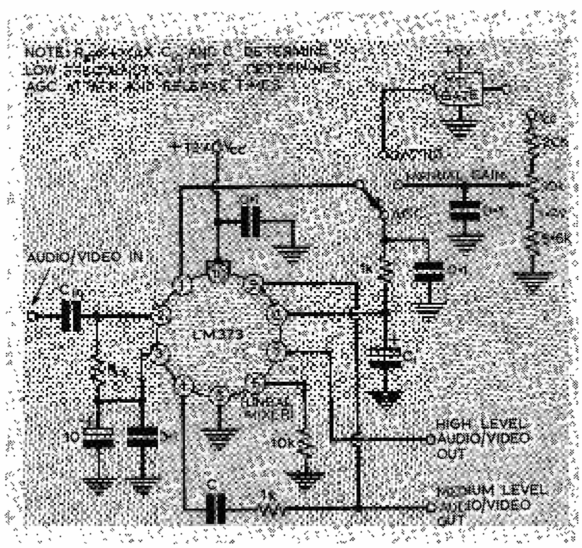


Fig. 5: In TV circuitry the LM373 can be used as an audio/video amplifier with a.g.c., manual gain control or gating.

The d.c. feedback loop at pin 3 must be carefully bypassed, since the decoupling must be effective throughout the passband of the LM373; an electrolytic or tantalum capacitor, as used for a.f. decoupling, has too high a reactance at high frequencies to be effective alone, so a small disc ceramic or silver mica is added.

For s.s.b., bypassing of r.f. at pin 7 is particularly important, as any local oscillator component reaching the peak detector would increase the a.g.c. voltage generated, and lead to an unnecessary reduction of system gain. The optional nulling circuits may be used to maximise gain should that prove necessary (an unlikely event).

Figs. 2-5 indicate the circuitry in which the LM373 may be employed, and it should be noted that the communications receiver applications for which it was designed do not exhaust the potential of this versatile unit, as is indicated by the circuit for a wideband amplifier indicated in Fig.5. Other reported applications have included use as an amplitude-modulated r.f. oscillator, an s.s.b. generator, or indeed any of the applications open to the balanced mixer circuit in which extra wideband gain is useful. So presumably more will be heard of the LM373!

TRANSISTOR CIRCUITRY FOR BEGINNERS

—continued from page 509

the effect shown by the dotted line in Fig. 6.

Junction devices of this type are known as diodes, and widely used in radio, television and other electronic applications. The diode is essentially a one-way valve, as we have seen from the forward and reverse bias characteristics.

Germanium diodes were the first types developed for commercial use, but the current-handling capacity of these devices was limited, and it was not until research provided a means of treating silicon that power rectifier semiconductors became a practical proposition. Silicon is more difficult to melt and purify than germanium, but can be doped with donor and acceptor impurities in the same way as germanium, is less sensitive to temperature, and will handle higher powers more efficiently. Common types pass currents of half-an-ampere and more with a practically negligible forward resistance. Silicon diodes have a high reverse voltage rating. (On the other hand, a germanium has greater efficiency at low voltages and at higher frequencies, and is thus retained for signal circuits.)

The pn junction forms the basis of most forms of semiconductor diode and transistor. One other form of construction is important in connection with diodes—the point contact type. In this the rectifying property is possessed by a contact between a thin metal wire and a piece of semi-conductor material. Though junction devices predominate today, point contact diodes are still much used as detectors in radio equipment. Their characteristic is similar to that of the pn junction, shown in Fig. 6, except that as the reverse current increases beyond the reverse breakdown point, reverse voltage tends to fall.

TO BE CONTINUED

SERVICING

AN INTRODUCTION TO FAULT-FINDING

PART 6

G. J. KING

THIS MONTH G. J. KING RETURNS TO THE SERIES TO ELABORATE ON AUDIO MATTERS, DEALING WITH CONVENTIONAL VALVE AMPLIFIERS AS WELL AS TRANSISTORISED HI-FI EQUIPMENT.

NOW that colleague Hellyer has cleared the decks on alignment, superhet theory and f.m. stereo, it is my turn to have a go on audio equipment.

GRAM AUDIO STAGES

An ordinary radiogram differs little at the pre-audio stages from a radio receiver, so much of the information presented earlier will also be applicable here. However, most contemporary radiograms are equipped for f.m reception, possibly with a decoder to abstract the stereo information and to direct the left and right channel signals separately to the corresponding audio channels. Thus, many radiograms and record reproducers feature a pair of audio channels and speaker systems. These are very much twin partners, the design of one following very closely the design of the other.

A mono radiogram has just the single audio channel and speaker system (though some designs employ more than one speaker unit, the mono signal being applied to them all in suitable frequency division). Whether mono or stereo, the f.m. front-end is a fairly common factor, the demodulator these days usually being the ratio detector in unbalanced or (in better quality equipment) balanced mode.

However, while the f.m. detector in a mono receiver feeds the audio channel direct (via the 50μS de-emphasis), the f.m. detector in a stereo receiver delivers the multiplex signal to the stereo decoder, the function of which is to process the sidebands of the stereo information (the difference signal) in conjunction with the mono information and the 38kHz reference signal (derived by frequency multiplication from the 19kHz pilot tone) to retrieve the left and right transmitted audio signals in the best isolation (e.g., with the least crosstalk).

De-emphasis and sometimes subchannel suppression (deleting the residual 19kHz and 38kHz multiplex components which can interfere with the audio section and add whistles to tape recordings) are engineered into the left and right audio channels, prior to the power amplifiers.

I shall be having something to say about f.m. front-ends, i.f. channels and stereo decoders later, but for now let us concentrate on the audio channels.

The simplest audio channel is designed round the triode-pentode valve, the triode receiving the detector's signal, amplifying it and then passing it to the control grid of the pentode for power amplification, Fig.1. Quite a lot of valve radiograms are equipped with this kind of audio section, as also are the inexpensive species of record reproducers. These were in fashion when stereo started, so early stereo models boast two such audio sections.

The advent of stereo was concurrent with the development of transistor equipment, which was fortunate for the receiver designers, so the audio channels we now find in stereo eqipument are mostly transistorised.

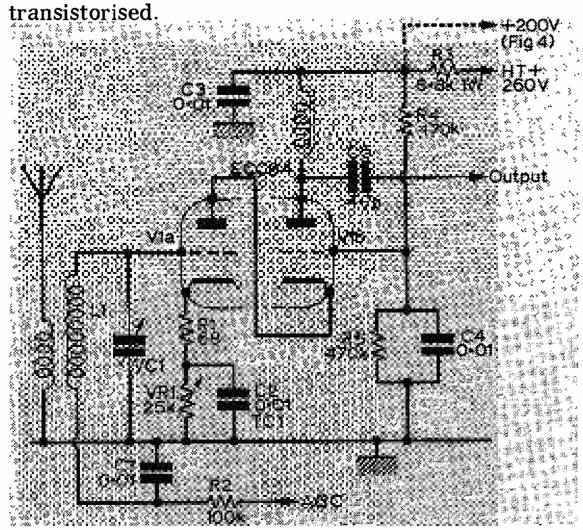


Fig. 1: A typical mono audio amplifier using a single triode-pentode valve.

Some designers favoured the use of a triode voltage amplifier (often one section of a double-triode valve) followed by a separate power pentode. This allows for greater audio power than generally possible from the pentode section of a triode-pentode valve, particularly so far as the early triode-pentode valves are concerned. Such a circuit is shown in Fig. 2, which will be seen to have much in common with that in Fig. 1.

Better quality receivers have been made with a pair of triode-pentodes in each channel to provide push-pull working. In this type of circuit the two pentodes are the push-pull output valves, while the two triodes are arranged as phase splitters supplying the anti-phase drives to the pentodes. However, since few receivers like this are in the field, there is not much point in detailing the circuit, but it is worth bearing in mind.

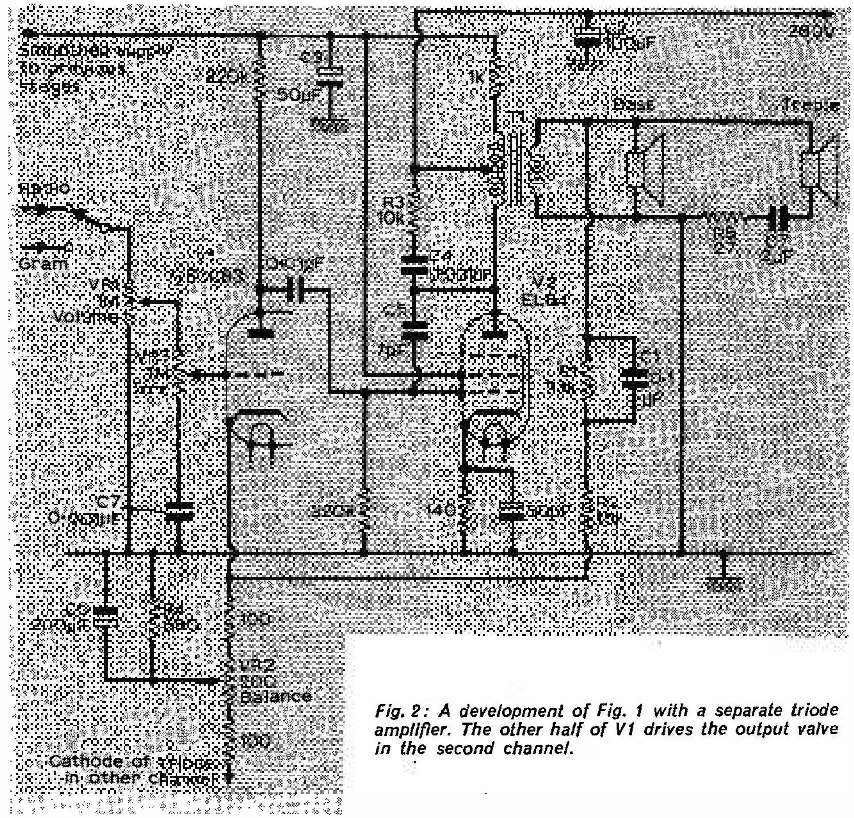


Fig. 2: A development of Fig. 1 with a separate triode amplifier. The other half of V1 drives the output valve in the second channel.

Let us return to Fig. 1. The audio signal from pickup or radio detector is coupled by C1 to the top of the volume control VR1, the selected level of signal then being applied via C2 to the triode grid. Note that the grid is returned to chassis through R1 (10MΩ) and that the cathode of the triode is returned direct to chassis. This is a common trick to secure grid bias for the triode. Contact potential in the valve causes a minute current to flow through R1, and because of the high value of this resistor a small potential developed across it, and since it is negative at the grid it serves as grid bias. It requires an electronic testmeter to measure this bias (since a normal meter would swamp the 10MΩ with its own resistance).

A common cause of distortion in this kind of circuit stems from a faulty triode, the fault resulting in excessive grid current and hence a potential across R1 in opposite polarity to that of the bias. The triode anode current rises, and often the valve tends to overheat.

R2 is the triode anode load, with R3 and C3 the decoupling components. The signal across R2 is coupled by C4 to g1 of the pentode, which is biased by the voltage drop across the cathode resistor R4, the grid being returned to chassis through R5. C5 is the cathode bypass capacitor (always an electrolytic in audio output stages).

The anode of the pentode is loaded by the low impedance speaker via the output transformer T1. C6 across the primary attentuates high-order harmonic distortion and makes the reproduction more palatable, as there is no negative feedback and no cancellation of second-harmonic distortion by any push-pull action.

FAULTS

Owing to the simplicity of this circuit, (Fig. 1) faults are not generally very difficult to define or locate. A cause of bad distortion is poor insulation of the coupling capacitor C4. This would permit a positive potential to exist at the control grid of the pentode with a consequent counteracting of the negative bias. It would be accompanied by excessive positive voltage at the cathode of the pentode, which could result in the failure of C5. The valve would also run very hot, possibly with the pentode anode glowing red.

Complete failure (e.g., audio drive at the top of the volume control VR1, but no speaker output) should first lead to a valve test, followed, if necessary, by voltage checks on the appropriate electrodes. C6 is subjected to audio voltage peaks which sometimes result in it shorting. This would cut the output completely, of course, but without affecting the pentode anode voltage much, so look out for this if the valve and electrode voltages seem to be normal.

Open-circuit of T1 primary deletes the pentode anode voltage, a fault condition which is often revealed by the screen grid (g2) of the pentode glowing red hot.

Low gain or volume at maximum volume control setting, assuming normal audio drive from the detector or gram pickup, is not uncommonly caused by C5 going open-circuit or low in value. This results in negative current feedback from the audio then developed across R4. The quickest way of checking this is by shunting an electrolytic across C5.

The symptom can also be caused (possibly accompanied by distortion) by the triode anode load R2 going high. If R3 goes high or C3 becomes electrically 'leaky,' the voltage at the top of R2, and hence the triode anode voltage, will drop, which again will cause low gain and possible distortion.

Before going on to more modern transistor circuits, let us have a look at some possible fault conditions in the valve circuit in Fig. 2. The faults described for Fig. 1 circuit would also be applicable here, with one or two qualifications. First, there are two separate valves involved, the triode voltage amplifier in this case being one section of a double-triode, the other triode serving as the voltage amplifier of the partnering stereo channel (not shown).

If one channel only is in trouble one can easily compare the voltages, etc. with those at the same points in the active channel, which is a quick way of bringing the fault to light. It is also possible to substitute the same type of valves (V2, for example) between the two channels, which would tell conclusively whether the valve is responsible.

There are refinements in Fig. 2, not found in Fig. 1 circuit. For example, voltage negative feedback is applied from the secondary of the output transformer T1 to the cathode of the voltage amplifier V1, and for this to happen one side of the secondary has to be connected to chassis. The amount of feedback is determined by R1 and R2, while C1 in parallel with R1 corrects the phase of the feedback signal, ensuring that it remains substantially negative over the audio spectrum. Thus, if there is a significant rise in gain (e.g., full output at a low setting of the volume control VR1) and abnormally high distortion, then R1 and R2 should be checked for value.

C1 open-circuit could encourage instability at certain frequencies, and this is sometimes 'triggered' by transients of the music. The oscillation could be at a frequency above audio, and the only way to prove this is by connecting an oscilloscope across the secondary of the output transformer T1, preferably when the amplifier is driven by a sinewave signal from an audio generator. The oscillogram in Fig. 3 gives some idea of what the spurious signal could look like on the sinewave. The audio generator would be coupled to the grid of the triode, of course.

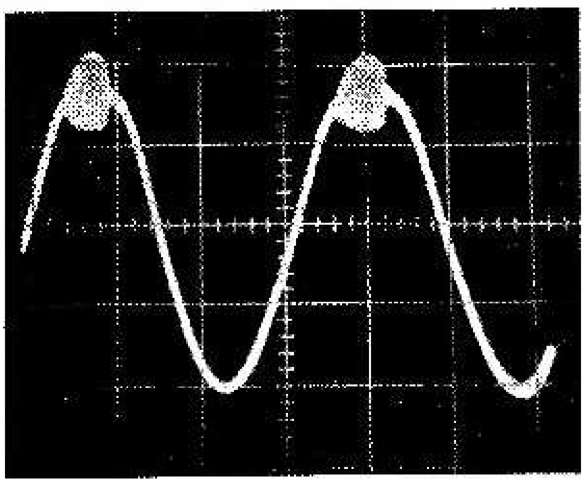


Fig. 3: This oscillogram shows spurious oscillation triggered off by transients in the signal

If the earth and feedback connections are reversed on the transformer the feedback would be positive and the amplifier would turn into a violent oscillator! Take care, therefore, when fitting a replacement transformer! Moreover, designs like this are geared to an output transformer of specific characteristics, so if it becomes necessary to replace the transformer, and the exact type is not available, then it might be necessary to alter the feedback resistors and the phase-correcting capacitor so that the values provide the correct conditions of feedback.

An interesting feature of the circuit is the tap on T1 primary. An output transformer of this kind serves both for speaker coupling and for 'smoothing' the h.t. supply fed to the earlier stages. In fact, it acts in part rather like a smoothing choke. In the circuit, C2 is the reservoir capacitor across the power supply output and C3 is the main smoothing electrolytic.

R3 and C4 series combination across the signal part of T1 primary attenuates the higher-frequency distortion components while, with C5, providing a degree of corrective phase shift.

The triode V1 in this circuit is cathode-biased, the main cathode resistor being R4, decoupled by C6. VR2 is the stereo balance control, which feeds either side the 100-ohm resistors (one to the cathode circuit of the partnering channel). The 100-ohm resistors provide a small degree of negative current feedback since they are out of the decoupling influence of C6. The voltage developed either side of VR2 relative to the slider also contributes to the feedback. Thus it will be appreciated that by adjusting VR2 from its centre setting, the feedback on one channel will decrease, while increasing on the other channel. This, therefore, allows the gains of the two channels to be adjusted relatively for the most desirable stereo effect.

VR3 is a simple 'tone' control which works as a reactive potential-divider in conjunction with C7. With increasing frequency the reactance of C7 falls, which means that as the slider of VR3 is turned towards this end of the track the bass is lifted and the treble diminished.

It will also be seen that two speaker units are employed. That for bass is connected directly across the secondary of T1, while the treble unit receives drive via R5 and C7. R5 reduces the power, while C7 passes only the higher frequency signals. This is a very simple frequency-divider, which cannot be regarded as 'hi-fi.'

HI-FI CIRCUIT

One channel of a slightly different circuit which, possibly differing in detail, is found in some hi-fi equipment. This is the power amplifier department only, Fig. 4, where Tr1 is the input transistor, coupling to the d.c.-coupled pair Tr2/Tr3 via C1. The coupling is from Tr1 **emitter** (the collector 'earthed' to signal through C2). The stage is thus an emitter-follower, which has a relatively high base input impedance, giving the correct match from the control section.

Tr4/Tr5 constitute a complementary driver pair (complementary because one is n.p.n and the other p.n.p.). These drive the push-pull output transistors Tr6/Tr7 alternatively into conduction and cut-off on each half-cycle of signal. It will be noted that the base of Tr4 is fed from the same source (e.g., Tr3 collector) as the base of Tr5. Thus on a positive half-cycle Tr4 conducts and pushes a positive half-cycle into Tr6 base. At the same time Tr5 is driven downwards and since Tr7 base is connected this time to Tr5 collector a negative half-cycle appears at Tr7 base, pushing this transistor into cut-off. On a negative half-cycle of drive the conditions reverse, so that Tr6 is driven into cut-off and Tr7 into conduction.

The two half-cycles are reconstituted as a complete waveform in the load comprising the speaker, coupled through C3.

C4 is a bootstrapping capacitor which applies feedback in such a way as to increase the driver input impedance. A.C. negative voltage feedback is applied to Tr2 emitter circuit from the push-pull pair, via C5

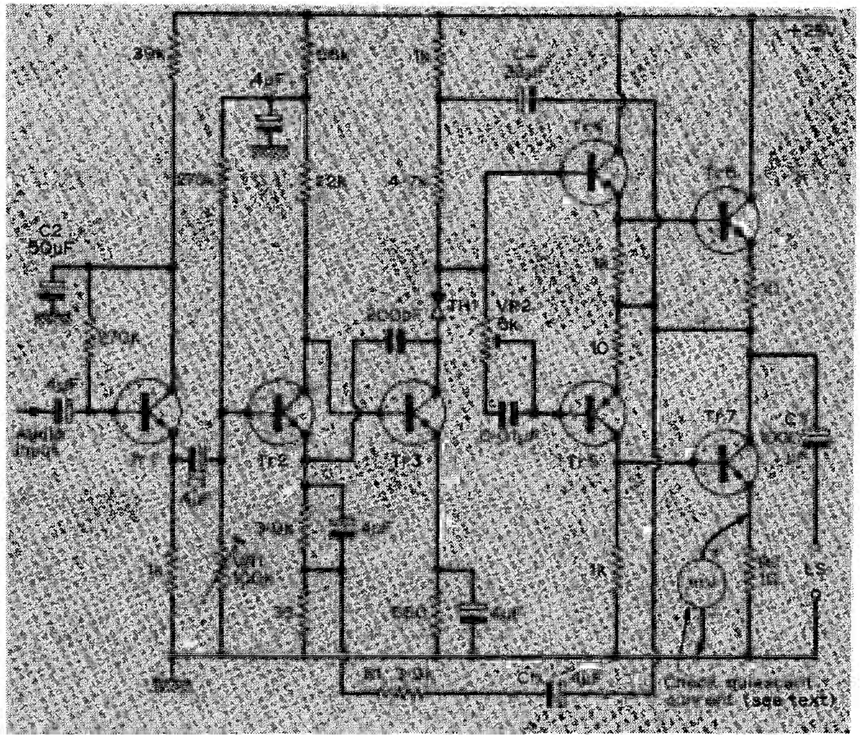


Fig. 4: Circuit of one channel of a transistorised hi-fi stereo amplifier.

and R1. Feedback of 60dB is a common hi-fi value, which reduces the output impedance to a fraction of one ohm.

D.C. coupling exists right through to the output transistors from Tr2, so by adjusting the d.c. conditions, both the drive 'balancing' and the quiescent current of the output transistors are affected. Some circuits have no means of adjusting these parameters, so if the value of a critical component alters, so might the quiescent current and balancing.

However, in Fig. 4 VR1 adjusts the balancing and VR2 the quiescent current, which leads us neatly to hi-fi equipment fault-finding and tests. But before going on to this it is noteworthy that temperature stabilisation is often provided in or around VR2 circuit to hold the quiescent current steady with increase in temperature of the transistors. The 'thermal element,' TH1 in Fig. 4 provides this function.

AMPLIFIER TESTS AND FAULT FINDING

For detailed testing in audio circuits, especially high quality circuits in which transistors are employed, we require an audio signal generator, audio millivoltmeter and an oscilloscope, at least. For distortion tests, we require in addition a distortion factor meter or similar instrument.

If it is assumed that the radio or pickup source signal is reaching the input of the amplifier and there is no output from the speaker, then we should check as far as possible into the amplifier with a signal tracer (e.g., pair of headphones, etc.—see Part 3, PW July 1971). In Fig. 4, for example, we could get to the base of Tr2, but possibly not any further owing to the d.c. couplings of the subsequent stages. Indeed, it is often necessary to consider the power amplifier proper as a complete circuit from the testing point of view. This is because a faulty transistor or component in one stage could reflect fault conditions into the other stages as a result of the d.c. couplings. This possibility is often overlooked when testing in circuits of this kind.

When we reach the point where the signal disappears, therefore, we may have to continue the exercise in terms of voltage measurements at the electrodes of the various transistors, comparing them with the correct values given in the service manual or on the circuit. Complete failure commonly implies significant change in the d.c. conditions, so the fault area should soon be revealed by voltage testing. If a coupling capacitor has failed, then signal tracing should reveal this without much trouble.

More difficult faults to locate are those resulting in low gain, intermittent crackling and distortion at all powers or only at high power. Starting first with distortion, a preliminary test should be that of quiescent current (assuming the amplifier to be 'Class B,' which it usually is in these days of transistors).

If possible, one should avoid connecting a milliammeter in series with the output pair for this test, owing to the resistance of the meter movement. In a circuit like that in Fig 4, the voltage across the emitter resistor (R2) of Tr7 should be measured on a d.c. millivoltmeter. The voltage will be very low because R2 is only 1 ohm! Anyway, suppose we measure 25mV, then by Ohm's law be can calculate that the current is 25mA (1 ohm resistor, since $I=V/R$, where I is in mA when V is in mV). A current of 25mA is, in fact, a common quiescent current value, and it can be adjusted accurately by a preset such as VR2.

If there is no preset and the current is way out, the values of the resistors associated with this part of the circuit should be measured (also the thermistor, etc., if used). Excessive quiescent current will cause the output transistors to run hot and limit the output

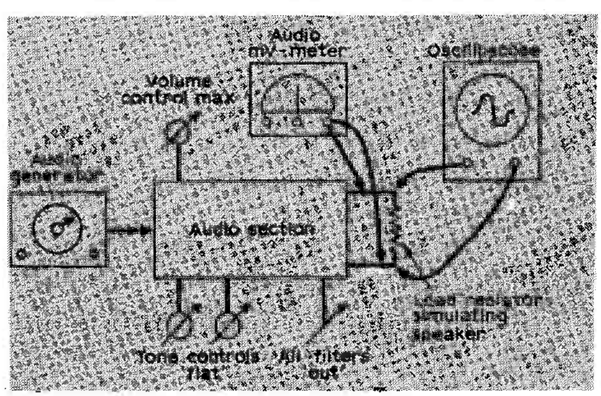


Fig. 5: Equipment set-up required to check the balance of output transistors.

power, while too low a value will precipitate high distortion (crossover distortion) at low volume.

Balancing requires an oscilloscope to monitor the output sinewave fed in from an audio generator. The setup is shown in Fig. 5 where is will be seen that the speaker is replaced by a load resistor of suitable power rating (to match the steady-state power of the amplifier). The volume control should be fully advanced, and the generator signal increased until the tips of the displayed waveform commence to clip. When the balancing is correct both tips will clip together. If one clips before the other then the balancing preset (such as VR1 in Fig. 4) should be adjusted for symmetrical clipping. The waveforms are shown in Fig. 6.

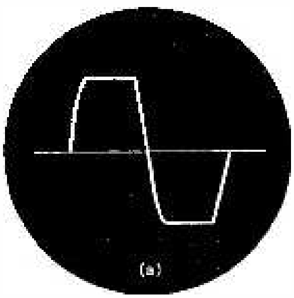


Fig. 6(a) Symmetrical clipping of the waveform when the gain is advanced indicates correct balance.

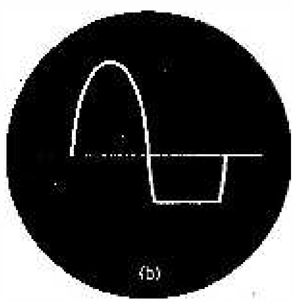


Fig. 6(b) Output waveform with an unbalanced stage.

We can use the setup in Fig. 5 to measure the steady-state power of the amplifier. For this test the oscilloscope should either be accurately calibrated in peak-to-peak voltage (so that the r.m.s. voltage of the waveform can be determined by multiplying the peak voltage—i.e., half p-p voltage-by 0·7) or an r.m.s.-reading audio millivoltmeter should also be connected across the load, as shown in Fig. 5.

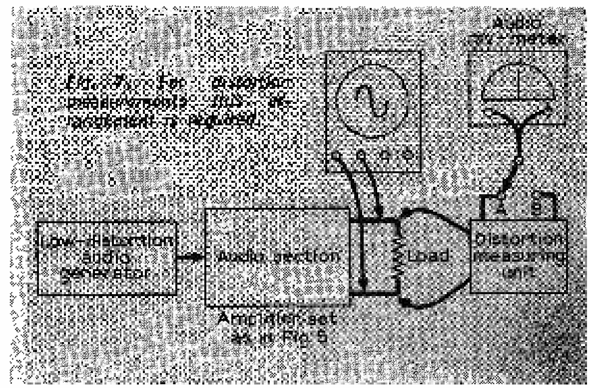
The load voltage just prior to the clipping point should be noted, and the steady-state power in watts is equal to the load voltage squared divided by the load value in ohms (i.e., $W=V^2/R$). The power is usually taken at 1kHz, but the power bandwidth can be appraised by noting the reduction in power at the low and high frequency ends of the spectrum.

Low power, but good waveshape often signifies low supply rail voltage, and this can result from low mains voltage or incorrect mains voltage tapping.

DISTORTION TEST

Finally, total harmonic distortion testing. For this we require either a complete distortion factor meter or the set-up in Fig. 5 with a distortion measuring unit which, as was noted in the Test Instrument supplement, April 1971, is a 'notch filter' which tunes out the fundamental frequency of the output signal, leaving only the harmonic components, the voltage sum of which is compared in ratio with the voltage of the fundamental frequency across the load, to give the dB or percentage total harmonic distortion.

The complete set-up is shown in Fig. 7. The voltage across the load is first measured at the required power (use the oscilloscope for maximum power test to indicate the clipping level) with the switch in postion A, then switching to position B, allowing the audio millivoltmeter to read the voltage of the summed harmonics. For this to happen, however, the distortion measuring unit needs to be very accurately tuned and balanced for the **least** indication on the audio millivoltmeter, which requires the range of the millivoltmeter progressively to be stepped down. The total harmonic distortion is the voltage ratio between the readings at switch postions A and B.



For example, if voltage A is 9V (which across 8 ohms would correspond to about 10W) and voltage B is 90mV, the ratio would be 100:1 or 40dB, corresponding to 1% t.h.d. With 9mV at B it would represent a ratio of 1000:1 or 60dB, corresponding to 0·1% t.h.d.

Remember, though, that a simple distortion measuring set 'notches out' only the fundamental, leaving wideband noise as well as t.h.d. components, so the distortion readout will include noise. Residual hum is generally removed by a high-pass filter in the test set-up, but such filtering, of course, cannot be used for distortion measurements at low-frequency for obvious reasons.

END OF PART SIX

Back Numbers Important Announcement

We regret to inform readers that owing to the closure by the Company of the department concerned it will no longer be possible to supply back numbers of **Practical Wireless** and **Television**.

To ensure obtaining regular copies of these magazines readers are strongly urged to place a regular order with their local newsagent, or to take out an annual postal subscription.

Reference to past issues of the magazines may sometimes be obtained at certain public libraries who may hold bound volumes. A few libraries are said to offer a photostat service. Alternatively, we are always willing to insert a free request for specific back numbers in our "CQ" column which appears in most issues.

practically wireless commentary by HENRY

No. 84

Ted and Lid

NO, not *that* Ted. Henry is not taking the lid off political chicanery—leave that to out-of-office politicians. TED, or, more properly, T.E.D., is a beautiful phrase I heard during a broadcast interview recently. That ubiquitous character, A. Spokesman, was defending the Post Office in the face of polite but relentless attacks from the BBC, who were following up listeners' complaints about crossed lines.

'How does it happen,' came the suave question, *'that we pick up our telephone and find our conversation interrupted by a pair of drooling lovers or an irate customer who has lost his laundry?'*

Ah, well, our indefatigable spokesman countered, that is probably caused by a Transient Equipment Defect. Isn't that lovely? Imagine, Joe, when wifey grumbles about the birdies that chirp unwantedly during her 'Housewives' Choice', being able to say airily: *"Can't do much about that, I'm afraid. That's TED."*

The point is that the faults are not just short-lived, ephemeral, unidentified phenomena—giving them a name has fixed them, preserved them for posterity, entered them on the list of recognisable bugbears.

Wireless work is full of such instances; for example, the intermittently blowing fuse. We pursue diligent tests before replacing the offending glass tube. We measure resistance, cheer when we get a half-scale reading, then remember that we intended to change the battery of the meter last time we used it.

We cheer when we get a half-scale reading . . .

Baffled by the lack of short-circuits we decide to beat the brute by checking the current. Meter in series—ah, which way round? Switch on. No, the other way around: *is* that pointer bent? But the reading is no greater than expected, and certainly less than the rating of the fuse, which we refit. Perhaps it is the result of overheating. We cover the now smug-looking set with our jacket and wait.

It is a bad habit of some manufacturers to let dirty great heat-sinks jut out at the back, and the fallacy about cool-running transistors is shattered as we smell singeing Harris Tweed and realise we have a Class A output to contend with.

Touching the fins to confirm our nose, we snatch fingers back with a howl and, sucking them, muse that the problem could not have been temperature at all. And the fuse still holds.

Obviously, TED has been at work. He is only waiting for us to settle comfortably with a book and a glass at our elbow before blowing the fuse again. Or, more likely, lulling us into a false sense of security, will allow us the whole evening's listening, then, while we sleep through the small CQ hours, will sneakily contract that vulnerable thread of wire again so that rising betimes, we gaily throw the switch and get: silence!

TED is no fool. That Post Office bloke urged 'sweet reasonableness' upon subscribers when their lines were crossed. The inference was that if we pretended not to notice the fault it would go away. Any *PW* reader could have told him that is the wrong approach.

. . . and we snatch our fingers back with a howl.

How many times have you had a piece of equipment propped up on the bench, festooned with test leads, bedizened with warning lights, burbling away in the corner of your mind, and leaped into the breach as the expected fault occurs, only to be greeted with a return to normality the moment you touch the chassis?

Tracking down TED is the work of an expert. One tests piecemeal. One uses not sweet reasonableness, but bitter reason. Diagnosis, as our soon-to-finish series on Servicing has emphasised, is the secret of success. And for *diagnosis,* where TED is concerned, read *inspired guesswork.* This is where LID comes in. LID is one of those contractions I am no longer likely to forget, since talking to Bob Stockwell, publicity manager of Bang & Olufsen, the day after an exhausting exhibition.

'How do you manage to organise it?'

'It's not easy,' he said, *'but we begin by catering for the Largest Imaginable Disaster and take it from there. . . .'*

That is the secret of dealing with TED. Put the LID on him: when the fuse blows, imagine the worst that could happen and assume that it has! But don't try to telephone the repairman—you will probably get the laundry company again.

ELECTRONIC VALVES

OA2	0·38	6SL7GT	0·35	DY87	0·35	PCC88	0·55
OA3	0·45	6SN7GT	0·35	DY802	0·50	PCC89	0·50
OB2	0·35	6SQ7	0·40	E88CC	0·65	PCC189	0·55
OB3	0·60	6SR7	0·40	E180F	0·95	PCC805	0·85
OC3	0·38	6T8	0·35	E810F	2·90	PCC806	0·80
OD3	0·35	6U4GT	0·60	EABC80	0·35	PCF80	0·30
1B3GT	0·38	6U8A	0·40	EAF42	0·55	PCF82	0·35
1CP31	6·00	6V6GT	0·38	EBC33	0·50	PCF84	0·50
1L4	0·20	6X4	0·30	EBC41	0·55	PCF86	0·60
1R4	0·35	6X5GT	0·35	EBC81	0·30	PCF87	0·85
1R5	0·35	6X8	0·55	EBF80	0·40	PCF801	0·50
1S4	0·27	6Y6G	0·65	EBF83	0·40	PCF802	0·50
1S5	0·25	7Y4	0·60	EBF89	0·30	PCF805	0·75
1T4	0·25	9BW6	0·50	EC53	0·50	PCF806	0·70
1U4	0·27	10C2	0·50	EC86	0·60	PCF808	0·75
1U5	0·50	10D1	0·50	EC88	0·60	PCH200	0·70
1V2	0·45	10D2	0·40	EC90	0·33	PCL81	0·50
1X2B	0·40	10F1	0·90	EC91	0·50	PCL82	0·35
2D21	0·35	10F9	0·50	EC92	0·35	PCL83	0·65
3A4	0·35	10F18	0·45	EC93	0·50	PCL84	0·45
3B28	2·15	10L1	0·45	EC8010	2·25	PCL85	0·40
3BP1	2·75	10LD11	0·60	ECC40	0·60	PCL86	0·45
3Q4	0·40	10P13	0·55	ECC81	0·33	PCL88	0·90
3S4	0·35	10P14	1·10	ECC82	0·30	PCL800	0·93
3V4	0·45	12AB5	0·60	ECC83	0·30	PCL801	0·70
5R4GY	0·60	12AC6	0·40	ECC84	0·30	PD500	1·50
5Y4G	0·33	12AL5	0·45	ECC85	0·40	PF86	0·60
5U4GB	0·42	12AQ5	0·43	ECC88	0·40	PF818	0·85
5V4G	0·42	12AT6	0·30	ECC89	0·50	PFL200	0·70
5Y3GT	0·32	12AT7	0·33	ECC91	0·20	PL33	0·35
5Z3	0·50	12AU6	0·30	ECC189	0·60	PL36	0·55
5Z4G	0·40	12AU7	0·30	ECF80	0·35	PL81	0·50
6/30L2	0·75	12AV6	0·33	ECF82	0·35	PL82	0·45
6AB4	0·35	12AV7	0·50	ECF86	0·65	PL83	0·45
6AF4A	0·50	12AX7	0·30	ECF804	1·50	PL84	0·40
6AG7	0·40	12AY7	0·70	ECH42	0·70	PL302	0·80
6AH6	0·50	12B44A	0·55	ECH81	0·30	PL504	0·80
6AJ8	0·30	12BA6	0·35	ECH83	0·40	PL508	0·90
6AK5	0·30	12BA7	0·35	ECH84	0·45	PL509	1·30
6AK6	0·57	12BE6	0·35	ECL80	0·40	PL801	0·80
6AL3	0·43	12BH7	0·40	ECL81	0·45	PM84	0·50
6AL5	0·20	12BY7	0·55	ECL82	0·35	PY31	0·80
6AM5	0·32	12K5	0·55	ECL83	0·65	PY33	0·63
6AM6	0·33	12K7GT	0·35	ECL84	0·55	PY80	0·35
6AQ5	0·35	12Q7G	0·30	ECL85	0·55	PY81	0·30
6AQ6	0·55	12SR7	0·35	ECL86	0·40	PY82	0·30
6AR5	0·35	14S7	0·80	ECLL800		PY83	0·38
6AR6	0·40	20D1	0·45		1·50	PY88	0·40
6AR11	1·25	20L1	1·10	EF37A	0·60	PY500	1·00
6AS5	0·35	20P1	0·50	EF39	0·40	PY800	0·50
6AS7G	0·80	20P4	1·10	EF40	0·50	PY801	0·50
6AT6	0·30	20P5	1·20	EF41	0·65	PZ30	0·35
6AU6	0·25	25C5	0·50	EF42	0·70	QQV2-6	2·15
6AV6	0·30	25L6GT	0·45	EF80	0·25	QQVO3-10	
6AW8A	0·55	25Z4G	0·30	EF83	0·55		1·25
6BA6	0·25	25Z6GT	0·65	EF85	0·35	QQV03-20A	
6BE6	0·30	30A5	0·45	EF86	0·30		5·25
6BF5	0·80	30AE3	0·40	EF89	0·28	QQV06-4A	
6BF6	0·50	30C1	0·30	EF91	0·33		5·50
6BH5	0·45	30C15	0·80	EF92	0·40	TT21	2·65
6BJ6	0·45	30C17	0·85	EF95	0·30	TT22	2·80
6BK7A	0·55	30C18	0·75	EF97	0·65	U18/20	0·75
6BN5	0·43	30F5	0·85	EF98	0·65	U25	0·75
6BN6	0·40	30FL1	0·70	EF183	0·30	U26	0·75
6BQ5	0·25	30FL12	0·93	EF184	0·35	U31	0·45
6BR8	0·65	30FL14	0·75	EF800	1·00	U37	1·50
6BS7	1·30	30L1	0·40	EF804	1·25	U52	0·33
6BW6	0·55	30L15	0·85	EK90	0·30	U76	0·30
6BW7	0·70	30L17	0·80	EL33	1·25	U78	0·30
6BX6	0·25	30P12	0·80	EL34	0·50	U191	0·75
6BZ6	0·35	30P19	0·80	EL36	0·50	U201	0·35
6C4	0·33	30PL1	0·70	EL37	1·25	U281	0·40
6C5GT	0·40	30PL13	0·93	EL41	0·55	U282	0·40
6CB6	0·30	30PL14	0·90	EL42	0·58	U301	0·40
6CD6GA	1·15	35A3	0·55	EL81	0·55	U403	0·50
6CG7	0·50	35A5	0·75	EL83	0·42	U404	0·40
6CH6	0·55	35B5	0·65	EL84	0·25	U801	1·00
6CL6	0·50	35C5	0·40	EL85	0·43	UABC80	0·35
6CW4	0·63	35D5	0·70	EL86	0·40	UAF41	0·50
6CY5	0·43	35L6GT	0·50	EL90	0·35	UAF42	0·55
6CY7	0·65	35W4	0·30	EL95	0·35	UBC41	0·50
6D3	0·45	35Z3	0·60	EL803	1.00	UBC81	0·40
6DC6	0·75	35Z4G	0·30	EL821	0·55	UBF80	0·40
6DK6	0·48	35Z5GT	0·40	EL822	0·90	UBF89	0·35
6DQ6B	0·63	50A5	0·70	ELL80	0·75	UBL1	0·50
6DS4	0·75	50B5	0·45	EM34	0·90	UBL21	0·60
6EA8	0·58	50C5	0·40	EM71	0·75	UC92	0·35
6EH7	0·30	50CD6G	1·65	EM80	0·40	UCC85	0·40
6EJ7	0·35	50L6GT	0·50	EM81	0·60	UCF80	0·55
6EW6	0·65	85A2	0·40	EM84	0·35	UCH21	0·60
6F1	0·70	90AG	2·40	EM85	1·00	UCH42	0·70
6F5	0·50	90AV	2·50	EM87	0·55	UCH43	0·75
6F6G	0·30	90C1	0·60	EN91	0·35	UCH81	0·35
6F11	0·38	90CV	1·25	EY51	0·40	UCL81	0·60
6F13	0·38	807	0·50	EY80	0·45	UCL82	0·35
6F14	0·65	813	3·75	EY81	0·40	UCL83	0·60
6F15	0·65	866A	0·75	EY83	0·55	UF41	0·60
6F18	0·45	5642	0·65	EY86	0·40	UF42	0·60
6F23	0·80	6080	1·50	EY87	0·43	UF43	0·60
6F24	0·75	6146	1·50	EY88	0·43	UF80	0·35
6F25	0·75	6360	1·25	EZ40	0·45	UF85	0·40
6F26	0·35	6870	2·50	EZ41	0·45	UF89	0·35
6F28	0·60	6939	2·15	EZ80	0·25	UL41	0·65
6J4	0·50	7199	0·75	EZ81	0·28	UL84	0·30
6J5GT	0·30	7360	1·80	GY501	0·80	UM84	0·20
6J7	0·45	7586	1·25	GZ30	0·40	UY1N	0·50
6K6GT	0·55	7895	1·25	GZ31	0·33	UY11	0·65
6K7	0·35	9002	0·35	GZ32	0·48	UY41	0·45
6K8G	0·35	9003	0·50	GZ33	0·70	UY82	0·50
6K25	0·75	AZ1	0·48	GZ34	0·60	UY85	0·30
6L6GT	0·45	AZ31	0·55	HABC80	0·40	W729	0·60
6L7	0·40	CBL1	0·80	HK90	0·35	Z759	1·85
6L18	0·45	CBL31	0·90	KT66	2·05	Z803U	0·90
6LD20	0·40	CY31	0·35	KT88	2·00		
6N7GT	0·40	DAF96	0·42	N78	1·45		
6P1	0·60	DF96	0·42	PABC80	0·40		
6P25	1·25	DK40	0·55	PC86	0·60		
6P28	0·65	DK92	0·50	PC88	0·60		
6Q7	0·40	DK96	0·42	PC97	0·50		
6SA7	0·40	DL96	0·42	PC900	0·48		
6SG7	0·35	DM160	0·65	PCC84	0·40		
6SK7	0·35	DY86	0·33	PCC85	0·40		

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2N3392	20p	ACY17	27½p	AF126	20p	BC143	P.A.	BF195	27½p	OC140	32½p
						BC147	17½p	BF196	42½p	OC170	30p
						BC148	15p	BF197	31½p	OC171	20p
						BC149	17½p	BF198	42½p	OC200	32½p
						BC152	17½p	BF200	36½p	OC202	47½p
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Capacitance	Working Voltage	
1000 pF	630	25p
1500 pF	630	25p
2200 pF	630	25p
3300 pF	630	25p
4700 pF	630	25p
6800 pF	630	25p
0·01 μF	630	27p
0·015 μF	630	29p
0·022 μF	630	29p
0·033 μF	630	33p
0·047 μF	630	40p
0·068 μF	630	42p
0·1 μF	630	50p
0·15 μF	630	56p
0·22 μF	630	67p
470 pF	1000	29p
680 pF	1000	29p
1000 pF	1000	25p
1500 pF	1000	25p
2200 pF	1000	27p

WIMA TROPYFOL

Capacitance	Working Voltage		Capacitance	Working Voltage	
47 pF	400	21p	0·022 μF	630	27p
68 pF	400	21p	0·033 μF	630	31p
100 pF	400	21p	0·047 μF	630	36p
150 pF	400	21p	1000 pF	1000	21p
220 pF	400	21p	1500 pF	1000	21p
330 pF	400	21p	2200 pF	..1000	23p
470 pF	400	21p	3300 pF	1000	23p
0·01 μF	400	19p	4700 pF	1000	25p
0·015 μF	400	21p	6800 pF	1000	27p
0·022 μF	400	23p	0·01 μF	1000	27p
0·033 μF	400	23p	0·015 μF	1000	31p
0·047 μF	400	25p			
0·068 μF	400	27p			
0·1 μF	400	33p			
0·22 μF	400	46p			
1500 pF	630	21p			
2200 pF	630	21p			
3300 pF	630	21p			
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0·01 μF	630	25p			
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ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

THE BROADCAST BANDS

Malcolm Connah

Frequencies in kHz • Times in GMT

THE first report this month comes from a new reporter D. A. Hairon from Jersey in the Channel Islands. The equipment used was a Codar CR70A receiver, a 50ft long wire and a 19 metre band dipole. This combination enabled him to hear the following stations:—

9480 Radio Peking in English at 0130.
9625 CBC, Canada in English at 0200.
11710 R. Nacional de Espana in Spanish at 0130.
11720 CBC, Canada in English at 0200.
11730 R. Nederland, Bonaire, English at 0200.
11745 HCJB, Quito, Ecuador, English at 0000.
11775 TWR, Bonaire in Spanish at 0215.
11810 RAI, Rome in English at 0100.
15195 R. Ankara, Turkey, Turkish at 1600.
15250 RSA, South Africa in French at 1856.
15300 HCJB, Quito, Ecuador in Spanish at 2145, and in Portuguese at 0000.
15305 SBC, Switzerland in English at 1315.
15345 Radio Kuwait in English at 1630.
15355 ABC, Australia in English at 0530.
17655 R. Cairo, U.A.R. in English at 1730.
17715 ABC, Australia in French at 2315.
17810 R. Nederland, Bonaire in Spanish at 2130.
17830 R. Lebanon in English at 1830.
17825 NHK, Japan in English at 0800.
21525 WNYW, U.S.A. in English at 1800.
21640 R. Nederland, Bonaire, English at 1830.
25730 R. Norway in English at 1200.

Ray Warren of Bury St. Edmunds has used his Koyo 1661 receiver to good effect and heard the following:—

3980 Voice of America in English at 1720.
5970 R. Free Europe, Germany at 1450.
6075 WNBC, New York, news at 1630.
6085 R. Nederland in English at 0930.
9030 R. Peking in English at 2050.
9390 R. Tirana, Albania in English at 1530.
9750 SBC, Switzerland, news in English, 1540.
15300 HCJB, Quito, Ecuador, English news, 1410.

Peter Hall of Pocklington, Yorkshire, has a Meridian 10 transistor superhet and a 50 foot aerial which enabled him to hear:—

6070 R. Sofia, Bulgaria in English at 1930.
6130 HCJB, Quito, Ecuador in English at 0800.
7275 RAI, Rome in English at 1940.
9550 Radio Finland in English at 1815.
9580 BBC, Ascension Island relay at 2115.
9620 R. Belgrade, Yugoslavia at 1800.
9625 Israel B.C. in English at 2045.
9630 R. Trans Europe, Portugal at 2100.
9700 R. Sofia, Bulgaria in English at 2140.
11620 AIR, Delhi in English at 2010.
11672 R. Pakistan in English at 2030.
11755 R. Finland in English at 0930.
11915 BBC, Cyprus relay at 1645.
11965 TWR, Monaco in English at 1700.

Ross Pullen of Crawley used his Murphy A72 communications receiver and a 100 foot long-wire to hear some interesting stations:—

6015 VOA, Rhodes, music and talk at 2200.
6145 R. Nacional, Brazil in Spanish at 2245.
9510 R. Noumea, New Caledonia, French at 0910.
9605 HCJB, Quito, Ecuador, English at 0730.
9745 R. Baghdad, Iraq in English at 2015.
9775 R. Diffusion-Television Nationale Congolaise, African music at 2200.
11672 R. Pakistan, English at 2002.
11965 Rwanda relay of Deutsche Welle at 2037.
17705 R. Havana, Cuba, Spanish news at 2015.

F. Wall of Walthamstow, London, E.17, has a homebrew 5-valve superhet and a 20 foot wire aerial, this equipment enabling him to hear:—

6035 R. Warsaw with Polish news at 1620.
6070 R. Sofia, Bulgaria in English at 1930.
9912 AIR, Delhi English news at 2000.
9630 R. Sweden 'Calling DXers' at 1230.
9660 R. Trans Europe in English at 1250.
9833 R. Budapest, Hungary, requests at 1945.
11735 R. Belgrade, Yugoslavia, English at 1530.
11740 ABC, Australia at 1530.
11755 R. Finland in English at 1500.
11765 ABC, Australia, sports programme at 0830.
11955 BBC, Malaysian relay at 1815.
15325 CBC, Canada, sports news at 1200.
21460 HCJB, Quito, Ecuador sign-on in French at 2015.
21535 RSA, South Africa, English news at 0930.
21595 CBC, Canada with news at 1910.
25790 RSA, South Africa, English news at 1500.

Stephen Mathews of Hull with his Bush 4-valve domestic receiver and 90 foot loft aerial heard the following:—

9660 YVLM Radio Rumbos, Venezuela at 0320.
9833 R. Espana Independiente, clandestine at 2230.
11765 ZYB8, R. Diffusion, Brazil at 0220.
11795 WINB, Red Lion, U.S.A. English at 2100.
11815 ZYW24, R. Brazil Central at 0045.
15260 FEBA, Seychelles testing at 1700.
17890 BED-40, Taiwan, weak at 0330.
21690 WIBS, Grenada in English at 1945.
21720 R. Ghana in English at 1445.

Reports should arrive by the 15th of the month and be addressed to the author at 5 Ranelagh Gardens, Cranbrook, Ilford, Essex.

THE AMATEUR BANDS

David Gibson, G3JDG

Frequencies in kHz • Times in GMT

HIGH noise levels have been the main complaint this past month with many people confessing to giving up and going off to watch television (sacrilege!). Despite these conditions there was still a large number of listeners who persisted, despite the noise, and managed to log some worthwhile DX as reward for their labours. Just goes to show, while you are busy moaning about the QRM and QRN, someone else is just getting on with it and working half the world.

News that G5ZT has received slow-scan television pictures from FG7XT in Guadeloupe makes you think. Many people would be only too pleased to hear an FG7 on c.w. **John Rimmer** (Deal) warns that VS9MF is on from Gan—a small island in the Maldive group of islands. Listen on 14 and 21MHz; sorry, no specific freqs given.

No activity reported on ten metres this month and it rather looks as though everyone has migrated to 14MHz. This latter band is an early morning/late night affair nowadays with everything dying out from mid-morning to late afternoon. On fifteen metres the same remarks apply, although occasionally South American stations appear during the daytime. For those who would like to persist on 28MHz, suggested time for a listen is from 1400 to 1600hrs.

Incidentally, this is one of the best bands on which to play with aerials since these normally work out to a very reasonable size. A quarter wave vertical is only around the 8ft. 6in. mark, exact size depending upon frequency since ten metres is one of the widest bands we have among those l.f. of 144MHz. If sunspot counts are any indication, then September would be a very good time for ten metres

A few contests this month just to get your ears in trim for the long winter evenings. September 11 and 12, WAE phone contest; 12, 3·5MHz Field Day; October 2 and 3, u.h.f./s.h.f. Field Day; 2 and 3, Oceania contest—a chance to bag a nice list of VK/ZL callsigns; 2 and 3, IARU Region 1 u.h.f./s.h.f. contest. Don't forget the Cumulative Activity on 70MHz from October 9 to December 30. This is our "use or lose" band and all support is very welcome, if not essential. You might try listening for some of the RAEN activity on four metres. The Radio Amateur Emergency Network has numerous "local" groups and the favourite band is 70MHz. How about listening out for your local group, or perhaps even joining them? Name and address of the Secretary of RAEN is; E. Bassett, 57 Upper St Helen's Road, Hedge End, Southampton, SO3 4LG.

Logs

A solitary log for two metres arrived this month from **David Sheekay** (Ashford). Gear is a super-regen using three transistors and an i.c. audio amplifier, homebrew, and antenna is described as "telescopic". Stations logged include; G2JF, G2VB, G3EFX/P, G3JXN, G3LTF, G3TDP/M, G3UNT, G4AAR, G4AAZ/M, G5OX, G8BYC, G8CCO, G8EBV, G8ELW and F0UJ. What about it all you converter and superhet types—you can't let a super-regen show you up, or can you?

Richard Mortimore (Cardiff), is now up to 20 w.p.m. at c.w. and says that he recommends all s.w.l.s to learn morse. Small sample from his list of c.w. pickings on 21MHz includes; CR6ID, JA3IL, KZ5BB, PY2EYE, PY4UK, W4NZK, WB4QVQ.

Mark Marsden (Ilford) uses a cassette tape recorder which has its input wired in parallel with the headphones. He claims this is very useful for checking calls heard against calls logged afterwards. Seems a very good idea. Calls heard, checked, recorded and logged on 14MHz include signals from; CE5ID, JA3JH, KV4HE, KZ5JF, PY2ZAC, PY4AEB, SV0WZ, VK3ART, VK4PJ, VP2AA, WA1DYR/MM, WB6YIY/MM, YV5CPA, YN2SC, ZL5ISJ, 4X4JU, 4X4OC, 9Q5IA.

"My uncle has given me all the PWs he can spare", writes **Kevin Davies.** Receiver is an R107 and the antenna 120ft. l.w. The following were in evidence on 14MHz s.s.b.; CT1ZE, EA3KO, EA4LM, EL2C, EL4A, HR3VSJ, JA1VK, K1WPS/CT1, LU4DMG, W1CMG/P1, W1MYA/MM, WA5KHM, WB6YIY, 4U1ITU, 4X4HT.

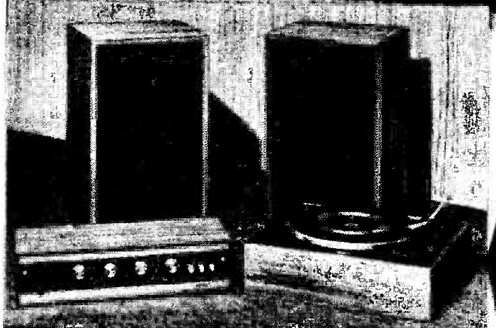
Paul Newman is at a new QTH which is some 680ft. a.s.l. Antenna at present is an 80ft. end fed and the receiver a modified BC348R ex G3HXS. With this gear, and from his lofty perch at Aylesbury, Paul bagged these on 14MHz; OD5BV, PY6AT, PY8LM, (Sao Luis Island), WA5STY/P/YV5 (Caracas) 4X4BL, 4X4GV, 5Z4KL, 9K2AL.

Jim Martin says that as it's the start of his holidays he thought he'd send in a report. (May the sun shine on your antenna, Sir.) His recently-purchased HA500 is nourished with an inverted V and rewards on 14MHz were; CR6EF, CR7IK, EL2CY, FP8CS, HC6CB, JA3IXL, JA4EDY, JA6FUV, JY9XL, KG4AN, KH6FP, KH6BB (Kure Island), KL7DIV, KR6US, KV4AD, KZ5AO, LG5LG, MP4MBC, PY1FN, PJ2MI, PZ1AD, PZ1AW, TG9GF, VK3JS, VP2MO, VQ9R, VS5CB, VS9MT, VU2BEZ, YV5EC, ZE1DO, ZP5GU.

On 3·5MHz c.w. it was UA1YUZ. Up on 7MHz, signals came from CX6CG, LX1BJ, PYCVX, PZ1AX, UW3NG, ZB2A, and ZP5AR. Gear is a JR500SE with 132ft. end fed. Operator's ears belong to **Julian Iredale** (Llandudno), and up on 14MHz s.s.b. Julian heard CR6GA, HV3SJ, OG5A, (Finnish Field Day prefix), PY2ZAC, PY4ATL, PZ1DL, TI2J, 5A4DL.

P. McKay advises that he never notices any logs for 7MHz in the Amateur Bands, and sends in a list of G-stations heard on this band. Well, the G's must have been working someone, so how about a listen this month?

Logs, in alphabetical order please, to arrive by the 15th of the month to:
12, Cross Way, Harpenden, Herts.



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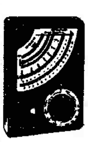

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SP5	5"	600'	P.V.C.	42p	SP7	7"	1200'	P.V.C.	62p
LP5	5"	900'	P.V.C.	50p	LP7	7"	1800'	ACETATE	75p
DT5	5"	1200'	POLYESTER	75p	DT7	7"	2400'	POLYESTER	£1·25
					TT7	7"	3600'	POLYESTER	£2·50

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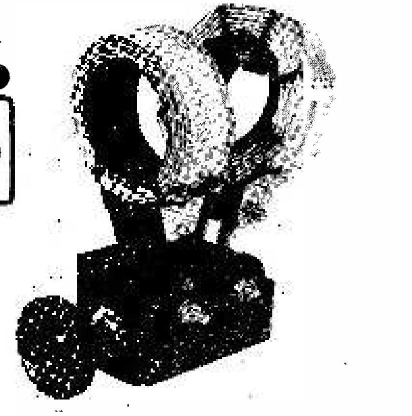
GOING BACK...

1970 60 50 40 30 20



COLIN RICHES
ARTHUR DOW

MANY readers have written to ask us if we can suggest any gramophone records that may help them to bring alive even more vividly the days of vintage radio. After a certain amount of research we have discovered that Fountain Press, the book publishers, have now announced a new "Fountain" record label of Vintage Jazz music. The first 12in. LP releases feature historic jazz and blues recordings but future plans include Music Hall, Opera and other music of the "Good Old Days".

The records are housed in attractive double sleeves which open, displaying an authentically documented note section with accurate historical background information and photographs.

The first two releases are: "Original Dixieland Jazz Band and the Louisiana Five"—from the extremely rare Aeolian sessions of 1917 (catalogue number FJ-101). "Ladds Black Aces—Vol. 1"—the first 16 sides recorded by another pioneer white jazz band during 1921-1922 (Cat. No. FJ-102). Following soon are "Naylor's Seven Aces" (c 1923-4). "Jelly Roll Morton" 1923-4 piano solos. "Lovie Austin's Blues Serenaders" (1924-6), and "Annette Hanshawe. Vol. 1"—Miss Hanshawe enjoyed public acclaim as a singer of popular songs in the 1920's and 1930's and her records are great collectors' items today.

These records are available from record shops at £2·10 or direct at £2·25 which includes post and packing, from *Fountain Records, 46 Chancery Lane, London WC2A 1JU.*

If you have any questions or queries on these records or any other Vintage records or performers please write to us at Practical Wireless and we'll do our best to help you.

The Mystery of the ST.200

We would, at this point, like to thank the many enthusiasts who have been kind enough to write and help us try to clear up the mystery of the missing John Scott Taggart design "ST.200" mentioned in "Going Back", August 1971.

One theory put forward by **Mr. F. W. Snow,** Belper, Derby, is that there never was a design called the ST.200 but one called "The ST Twin"—a 2-valve reflex. It was published in *The Wireless Constructor* and not the *Popular Wireless* magazine during the late 1924's and early 1925's.

Mr. J. Crossley hailing from Failsworth, Manchester, also maintains that the ST.200 never existed. He says that J.S.T. visited the United States just after the advent of the ST.100. On his return, he was full of enthusiasm about a gentleman by the name of Armstrong, and *Popular Wireless* published a circuit by this man which J.S.T. had brought back with him. It was the "Armstrong Regenerative Circuit". J.S.T. then went on to publish the ST.300 design, so it appears that Armstrong's receiver may have taken the place of the missing ST.200.

Mr. A. H. Jenkins, Dringhouses, York, writes to say that as far as he recollects, the ST.200 may well have been just a mains-operated version of the ST.100 and therefore did not differ operationally from that design. It did however, need an extra valve. Mr. Jenkins also informs us that the S.T. series did not start at ST.100, although this was the most famous. He says that he used to have a limp covered book of J.S.T. circuits which started at crystal sets and worked up through one valvers. He seems to remember an ST.37 which was quite well-known at the time.

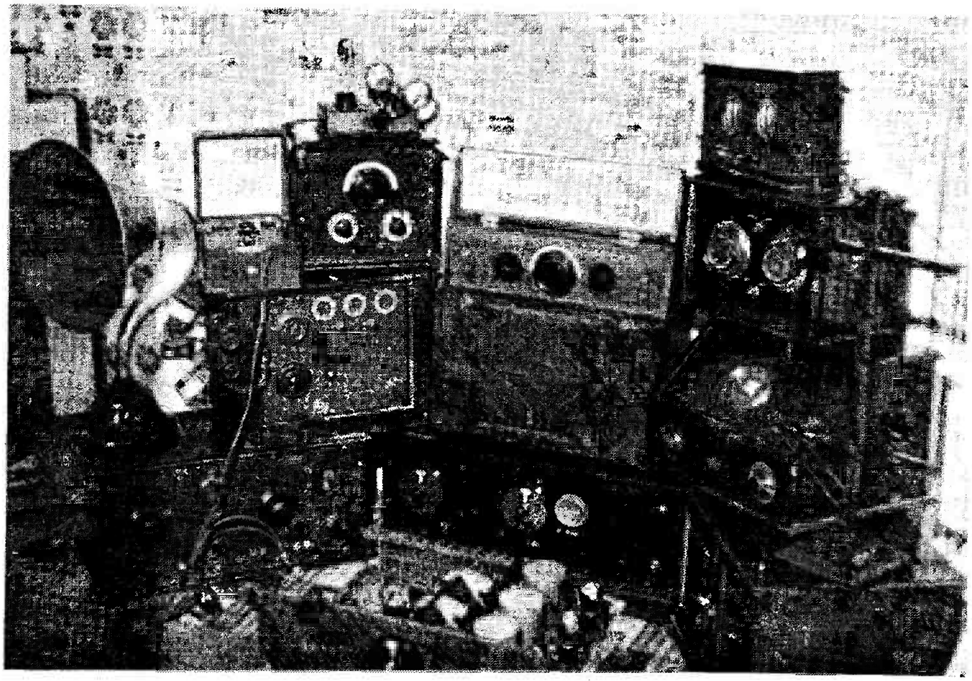
Vintage Sets

Mr. William Pozniak, from 37 Manley Road, Oldham, Lancashire, has loaned us some photographs. He says that for three years he has been routing through old cellars and derelict radio shops throughout the North (we hope you came out for food now and again, Mr. Pozniak) and has produced the collection of Vintage gear shown in the first picture. He says that it takes him most of his time to strip down and restore these sets to as near as possible their original condition. The sets he has are as follows: The Burndept Screened Four, The Burndept Portable Five, the Burndept Ethophone Five and the Burndept Ethophone Two.

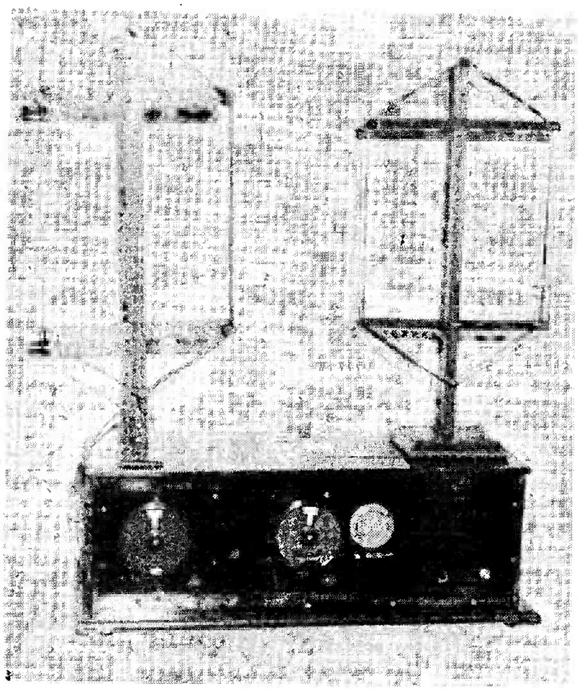
Mr. Pozniak believes there were about 20 Burndept receivers. This figure is agreed by Mr. Keith Lancaster who we mentioned some time ago as wanting to start a Vintage Radio Club. Incidentally, response has not been too good and if readers are interested in such a Club, would they please contact *Keith Lancaster, 40 Great Gardens Road, Hornchurch, Essex.*

The rest of Mr. Pozniak's collection contains a Marconiphone Type 32 three valver, a domestic Cossor two valver, a small set in a metal case named a GECoPHONE Victor 3 and a few home-constructed receivers.

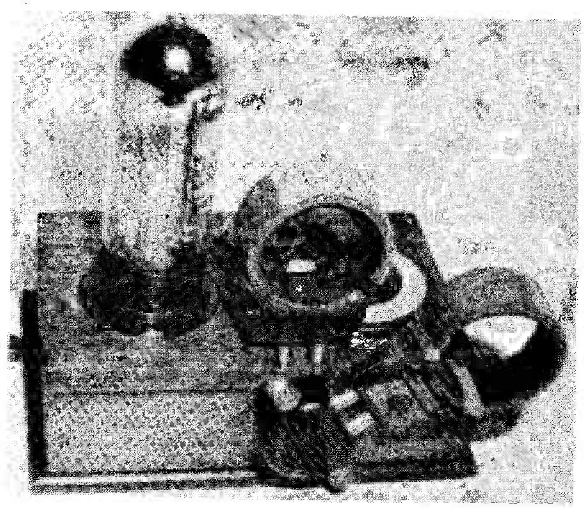
The receiver shown in the second picture is a



An overall view of Mr. Pozniak's collection of Burndept receivers. The small receiver shown at the top centre of the picture and the set in the centre of the picture together with frame aerials are shown enlarged below.



The James Super Six All Waver (c 1927).



Louwe receiver with encapsulated components.

1927 James Super Six All Waver (medium, long and short). The reader says that he purchased this set from an old radio shop which was a booming concern in the 1920's, together with a BTH horn speaker, and the person who sold it to him, told him, as he removed the set from the dusty shelf, that he was the first person to touch the set in 40 years.

The neat little receiver shown in the third photograph seems to Mr. Pozniak to be an unusual type, for he says that there appear to be two resistors and two capacitors encapsulated in glass tubes which have then been assembled inside the glass envelope of the valve. The make on the case reads "Louwe Radio Berlin" and on the valve it states "Louwe Radio British Made". This set is in working order on headphones although it was originally made to drive some sort of speaker. The reader would like to know the date and origin of this set if anyone can help him and he would also be interested if anyone could supply him with original Burndept valves for any of their makes of receivers.

TITANIC DISASTER

We would like to thank the many readers who have written to us about the Titanic Disaster. We are gradually answering all the letters and we hope you will bear with us.

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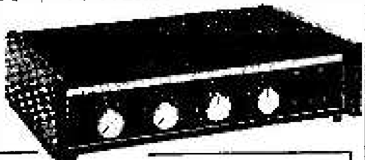

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Overall Size 12"w. x 8"d. x 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

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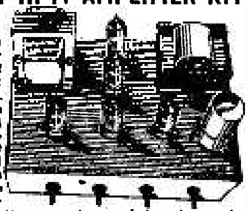

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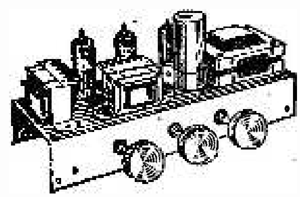

A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built & tested to a high standard. **PRICE £8·92** P. &P. 45p

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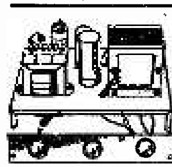

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½" w. × 4" d. × 4¾" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, donble wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·75**. P. & P. 35p.
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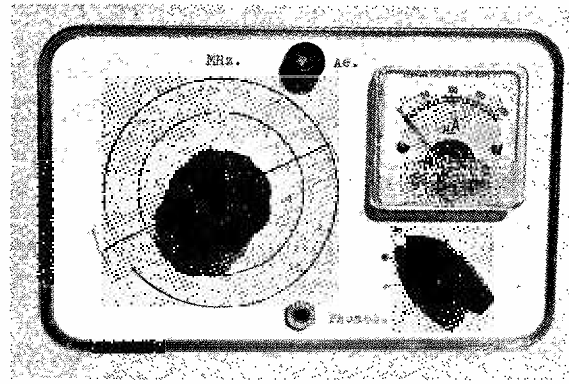
WAVE METER MONITOR



R. F. GRAHAM

THIS unit has four switch-selected bands, covering from 1600kHz to 100MHz and it can be used as a wavemeter, field strength meter or phone transmission monitor. It is fully enclosed, self-contained, and requires no battery.

Figure 1 shows the circuit. One pole of the switch, S1, selects the inductors L1, L2, L3 or L4, which are tuned by VC1. Pole S2 switches the diode D1 to the appropriate small coupling winding. When the circuit is tuned to resonance by VC1, rectified current is indicated by the meter.

To monitor phone signals, high impedance headphones or earpiece can be plugged into the phone jack and the phones are then in series with the meter. C1 is for r.f. and a.f. by-pass purposes, while C2 is an r.f. by-pass capacitor.

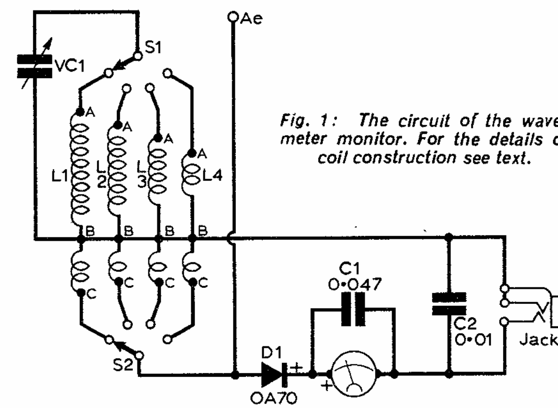


Fig. 1: The circuit of the wavemeter monitor. For the details of coil construction see text.

★ components list

VC1	200pF Wavemaster variable capacitor.
C1	0·047µF or similar.
C2	0·01µF or similar.
D1	OA70 or OA81 diode.
S1/S2	2-pole 4-way miniature rotary switch.

Small closed circuit jack.
200µA miniature meter.
Inductors as text.
Paxolin, perspex, box about 6 x 3½ x 2½in., aerial socket, knobs etc.

INDUCTORS

L1, L2 and L3 are wound on ½in. diameter paxolin formers. These can be prepared by cutting 1½in. lengths of ½in. diameter tube, and drilling small holes to secure the ends of the windings. The tubes can later be fixed with adhesive, with small brackets or by having them a push fit on small discs of insulating material screwed in place. Surplus or junk box formers could probably be utilised, but if these are of different diameter it may be necessary to modify the number of turns to suit.

L1 is wound with 34 s.w.g. enamelled copper wire. The tuned portion A to B is 65 turns, in a compact pile about 5/16in. long. A space of about 3/16in. is left and section B to C is wound on in the same direction, and has 8 turns side by side.

L2 also uses 34 s.w.g. enamelled copper wire. A to B is 50 turns wound side by side. A space is left as before, and a 4 turn coupling winding ends at C.

L3 uses 24 s.w.g. enamelled wire and has 12½ turns from A to B, and 2 turns from B to C. Figure 2 shows the general construction of L1, L2 and L3.

The windings are doped, smeared with clear *Bostik 1* or with some other suitable coil cement.

L4 is self-supporting, of 16 s.w.g. bare wire, and is shown in Fig. 3. It is wound and shaped to have 8 turns in all and is ½in. outside diameter, and 1in. long. B is a tapping 2 turns from end C. This coil is soldered directly to tags A and C of the 4-way switch as shown in Fig. 3. A lead runs from tapping B

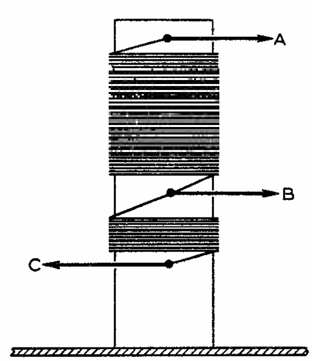


Fig. 2: The general construction of coils L1, L2 and L3 wound on ½in. diameter paxolin formers. Details of L4 are given in the text and in Fig. 3

directly to the moving plates tag of the variable capacitor.

CONSTRUCTION

The wavemeter was built to occupy a rigid plastic 'snack box' approximately 6in.×3½in.×2½in. deep. A piece of paxolin sheet, a little under 6in.×3½in., was cut to fit inside the box lid. The wavemeter is built wholly on this paxolin panel.

Screws holding L1, L2 and L3 are countersunk. A piece of stout paper to bear dial markings is cut the same size as the paxolin, and cemeted to it. The wavemeter is then assembled and calibrated and the scales are marked. The meter and fixing nuts of the switch, jack, and VC1 are then removed and the paxolin panel is fitted inside the box lid. This places the scales under the transparent material of the lid. Paxolin and lid are held together by the meter and the nuts mentioned.

Holes for the jack, switch and VC1 are first drilled in the paxolin and the meter hole cut with an adjustable washer or tank cutter. The paxolin is then placed in the lid, and the positions of holes marked on the lid itself, so that they can be made to match up correctly with those in the paxolin.

The box should be of material which is reasonably strong. It should be drilled and cut with tools which are really sharp, and without forcing, to avoid cracking.

A suitable case could be assembled from ¼in. thick wood, glued and pinned at the joints. The paxolin panel would then be large enough to be fixed with small wood screws.

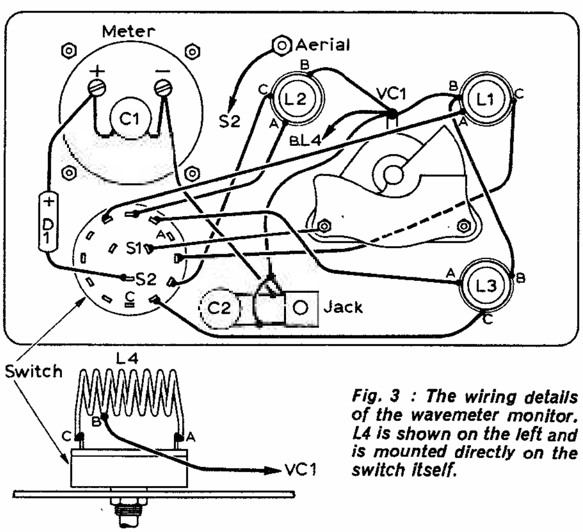
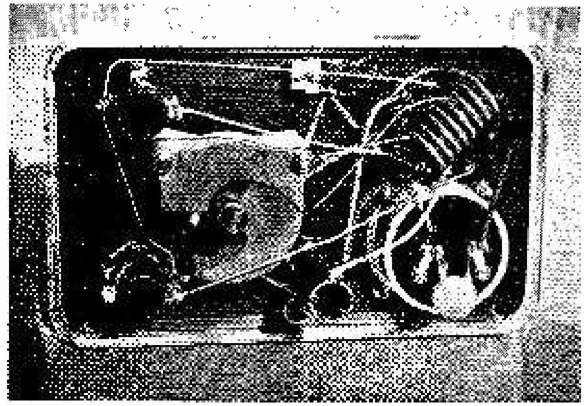


Fig. 3 : The wiring details of the wavemeter monitor. L4 is shown on the left and is mounted directly on the switch itself.

All wiring is shown in Fig. 3. Connections should be of stout wire and run clear of each other, and should be reasonably short and direct, especially for L3 and L4.

VC1 is 200pF, but this exact value is not essential, provided that the ranges overlap a little. If an alternative diode is fitted, be sure it is suitable for frequencies up to 100MHz.

A 100μA meter would be a little more sensitive than the one specified, but would also cost a little more. Should a 500μA meter be to hand, it is suitable, though less sensitive. The sensitivity with a 1mA meter becomes rather low so an instrument in the neighbourhood of 200μA is probably most suitable.



An internal view of the completed prototype.

The dial cursor is a 2¾in. piece of perspex about ⅝in. wide, marked with a hair line. Readings will be confused if VC1 can rotate through 360°, so the extreme corner of the back moving plate was turned up with pliers to limit rotation to about 180°.

Values used for C1 and C2 are not particularly important. A medium or high impedance pair of headphones will give best general results.

CALIBRATION

Actual band coverage with the inductors described is as follows

Range 1	1·6-4MHz
Range 2	2·8-10MHz
Range 3	8-32MHz
Range 4	21-100MHz

This gives 160 and 80m bands in Range 1, 80 and 40m bands in Range 2, all h.f. bands 20-10m in Range 3, and 15-10m bands and harmonics in Range 4, without having to use the extreme h.f. end of the ranges, where readings become close together.

The simplest means of calibration is to use a grid dip oscillator, placing its coil 2in. or so from the appropriate inductor in the wavemeter. This allows complete calibration of all ranges with a minimum of difficulty.

A transmitter can be used for calibration in the amateur bands, and these will probably be of most importance. Place the wavemeter some distance from the transmitter, its dummy load or the aerial lead or tuner, as required to obtain a deflection on the meter.

Some signal generators have an r.f. level meter. If the output of the generator is coupled to the wavemeter by a small loop, a dip may be observed on the level meter when the wavemeter is tuned to resonance. This offers another possible way to secure calibration.

If the wavemeter is coupled to a receiver having a sensitive S-meter, a *slight* dip in the S-meter reading can be observed when the wavemeter is tuned to the receiver frequency. Input to the receiver can be from a signal generator, or transmission.

All calibration is made with no external connection to the wavemeter and minimum coupling to avoid unnecessary inaccuracy.

USES

A wavemeter is normally used to indicate frequency bands and harmonics, not exact frequencies within a narrow band. It is placed or held to pick up sufficient r.f. energy from the circuit being investiga-

—continued on page 534

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2G303	20p	2N3414	22½p	40312	47½p	BCY31	30p	BSX61	62½p	NKT402	90p
2G306	42½p	2N3415	22½p	40314	37½p	BCY32	50p	BSX76	22½p	NKT403	75p
2G308	30p	2N3416	37½p	40320	47½p	BCY33	25p	BSX77	27½p	NKT404	62½p
2G309	30p	2N3417	37½p	40323	32½p	BCY34	30p	BSX78	27½p	NKT405	75p
2G371	15p	2N3570	£1·25	40324	47½p	BCY38	40p	BSY10	27½p	NKT406	62½p
2G374	20p	2N3572	97½p	40326	37½p	BCY39	60p	BSY11	27½p	NKT451	62½p
2G381	22½p	2N3605	27½p	40329	30p	BCY40	50p	BSY24	15p	NKT452	62½p
2N404	22½p	2N3606	27½p	40344	27½p	BCY42	15p	BSY25	15p	NKT453	47½p
2N696	20p	2N3607	22½p	40347	57½p	BCY43	15p	BSY26	17½p	NKT603F	32½p
2N697	17p	2N3702	11p	40348	52½p	BCY54	32½p	BSY27	17½p	NKT613F	32½p
2N698	25p	2N3703	10p	40360	42½p	BCY58	22½p	BSY28	17½p	NKT674F	30p
2N706	12½p	2N3704	11p	40361	47½p	BCY59	22½p	BSY29	17½p	NKT677F	30p
2N705A	12½p	2N3705	10p	40362	57½p	BCY60	97½p	BSY32	25p	NKT713	25p
2N708	15p	2N3706	09p	40370	32½p	BCY70	20p	BSY36	25p	NKT781	30p
2N709	62½p	2N3707	11p	40406	57½p	BCY71	25p	BSY37	25p	NKT10419	30p
2N718	25p	2N3708	07p	40407	40p	BCY72	17½p	BSY38	22½p	NKT10439	
2N726	30p	2N3709	09p	40408	52½p	BCZ10	27½p	BSY39	22½p		37½p
2N727	30p	2N3710	09p	40410	62½p	BCZ11	42½p	BSY40	32½p	NKT10519	
2N914	17½p	2N3711	12p	40467A	57½p	BD116	£1·12½	BSY51	32½p		32½p
2N916	17½p	2N3715	£1·23	40468A	35p	BD121	65p	BSY52	32½p	NKT20329	
2N918	30p	2N3716	£1.30	40600	57½p	BD123	82½p	BSY53	37½p		47½p
2N929	22½p	2N3791	£2.06	AC107	30p	BD124	60p	BSY54	40p	NKT20339	
2N930	27½p	2N3819	35p	AC126	20p	BD131	75p	BSY56	90p		37½p
2N1090	22½p	2N3823	97½p	AC127	25p	BD132	85p	BSY78	47½p	NKT80111	
2N1091	22½p	2N3854	27½p	AC128	20p	BDY10	£1·37½	BSY79	45p		77½p
2N1131	25p	2N3854A	27½p	AC154	22½p	BDY11	£1·62½	BSY82	52½p	NKT80112	
2N1132	25p	2N3855	27½p	AC176	25p	BDY17	£1·50	BSY90	57½p		97½p
2N1302	17½p	2N3855A	30p	AC187	62½p	BDY18	£1·75	BSY95A	12½p	NKT80113	
2N1303	17½p	2N3856	30p	AC188	37½p	BDY19	£1·97½	BSW41	42½p		£1.12
2N1304	22½p	2N3856A	35p	ACY17	27½p	BDY20	£1·12½	BSW70	27½p	NKT80211	
2N1305	22½p	2N3858	25p	ACY18	25p	BDY38	97½p	C111	75p		92½p
2N1306	25p	2N3858A	30p	ACY19	25p	BDY60	£1·25	C424	27½p	NKT80212	
2N1307	25p	2N3859	27½p	ACY20	25p	BDY61	£1·25	C425	55p		92½p
2N1308	30p	2N3859A	32½p	ACY21	25p	BDY62	£1·00	C426	40p	NKT80213	
2N1309	30p	2N3860	30p	ACY22	20p	BF115	25p	C428	37½p		92½p
2N1507	17½p	2N3866	£1.50	ACY28	20p	BF117	47½p	C744	30p	NKT80214	
2N1613	25p	2N3877	40p	ACY40	20p	BF163	37½p	D16P1	37½p		92½p
2N1631	35p	2N3877A	40p	ACY41	25p	BF167	18p	D16P2	40p	NKT80215	
2N1632	30p	2N3900	37½p	ACY44	40p	BF173	19p	D16P3	37½p		92½p
2N1638	27½p	2N3900A	40p	AD140	52½p	BF177	30p	D16P4	40p	NKT80216	
2N1639	27½p	2N3901	97½p	AD149	57½p	BF178	30p	GET102	30p		92½p
2N1671B	£1·00	2N3903	35p	AD150	62½p	BF179	30p	GET113	20p	OC20	75p
2N1711	25p	2N3904	35p	AD161	37½p	BF180	35p	GET114	20p	OC22	50p
2N1889	32½p	2N3905	37½p	AD162	37½p	BF181	32½p	GET118	20p	OC23	60p
2N1893	37½p	2N3906	37½p	AF106	42½p	BF184	25p	GET119	20p	OC24	60p
2N2147	82½p	2N4058	17½p	AF114	25p	BF185	42½p	GET120	52½p	OC25	50p
2N2148	57½p	2N4059	10p	AF115	25p	BF194	17½p	GET873	12½p	OC26	27½p
2N2160	57½p	2N4060	12½p	AF116	25p	BF195	15p	GET880	30p	OC28	62½p
2N2193	40p	2N4061	12½p	AF117	25p	BF196	42½p	GET887	20p	OC29	62½p
2N2193A	42½p	2N4062	12½p	AF118	62½p	BF197	42½p	GET889	22½p	OC35	50p
2N2194A	30p	2N4244	47½p	AF119	20p	BF198	42½p	GET890	22½p	OC36	62½p
2N2217	27½p	2N4285	17½p	AF124	22½p	BF200	52½p	GET896	22½p	OC41	22½p
2N2218	23p	2N4286	17½p	AF125	20p	BF224	14p	GET897	22½p	OC42	25p
2N2219	23p	2N4287	17½p	AF126	20p	BF225	19p	GET898	22½p	OC44	20p
2N2220	25p	2N4288	17½p	AF127	17½p	BF237	23p	MJ400	£1·07½	OC45	12½p
2N2221	25p	2N4289	17½p	AF139	37½p	BF238	23p	MJ420	£1·12½	OC46	15p
2N2222	30p	2N4290	17½p	AF178	42½p	BF244	23p	MJ421	£1.12½	OC70	15p
2N2270	47½p	2N4291	17½p	AF179	72½p	BFW61	47½p	MJ430	£1-02½	OC71	12½p
2N2297	30p	2N4292	12½p	AF180	52½p	BFX12	22½p	MJ440	95p	OC72	12½p
2N2368	17½p	2N4303	47½p	AF181	42½p	BFX13	22½p	MJ480	97½p	OC74	32½p
2N2369	17½p	2N5027	52½p	AF239	42½p	BFX29	30p	MJ481	£1·25	OC75	22½p
2N2369A	17½p	2N5028	57½p	AF279	47½p	BFX30	30p	MJ490	£1·00	OC76	22½p
2N2410	42½p	2N5029	47½p	AF280	62½p	BFX42	37½p	MJ491	£1·37½	OC77	30p
2N2483	27½p	2N5030	42½p	AF211	32½p	BFX44	37½p	MJ1800	£2·17½	OC81	20p
2N2484	32½p	2N5172	12½p	ASY26	25p	BFX68	67½p	MJE340	62½p	OC81D	22½p
2N2539	22½p	2N5174	52½p	ASY27	37½p	BFX84	25p	MJE520	60p	OC83	25p
2N2540	22½p	2N5175	52½p	ASY28	27½p	BFX85	32½p	MJE521	73p	OC84	25p
2N2613	35p	2N5176	45p	ASY29	27½p	BFX86	25p	MPF102	42½p	OC139	32½p
2N2614	30p	2N5232A	30p	ASY36	25p	BFX87	27½p	MPF103	37½p	OC140	32½p
2N2646	52½p	2N5245	45p	ASY50	25p	BFX88	25p	MPF104	37½p	OC170	30p
2N2696	32½p	2N5246	42½p	ASY51	32½p	BFX89	62½p	MPF105	37½p	OC171	30p
2N2711	25p	2N5249	67½p	ASY54	25p	BFX93A	70p	MPS3638	32½p	OC200	40p
2N2712	25p	2N5265	£3·25	ASY86	32½p	BFY10	32½p	NKT0013	47½p	OC201	60p
2N2713	27½p	2N5266	£2·75	AU103	£1·25	BFY11	42½p	NKT124	42½p	OC202	75p
2N2714	30p	2N5267	£2·62½	ASZ21	42½p	BFY17	22½p	NKT125	27½p	OC203	42½p
2N2865	62½p	2N5305	37½p	BC107	10p	BFY18	32½p	NKT126	27½p	OC204	42½p
2N2904	30p	2N5306	40p	BC108	10p	BFY19	32½p	NKT128	27½p	OC205	90p
2N2904A	32½p	2N5307	37½p	BC109	10p	BFY20	£1·60	NKT135	27½p	OC207	75p
2N2905	37½p	2N5308	37½p	BC113	15p	BFY21	42½p	NKT137	32½p	OCP71	42½p
2N2905A	40p	2N5309	62½p	BC115	15p	BFY24	45p	NKT210	30p	ORP12	62½p
2N2906	25p	2N5310	42½p	BC116A	15p	BFY25	25p	NKT211	30p	ORP61	50p
2N2906A	27½p	2N5354	27½p	BC118	10p	BFY26	20p	NKT212	30p	P346A	22½p
2N2907	30p	2N5355	27½p	BC121	20p	BFY29	50p	NKT213	30p	TIS34	62½p
2N2923	15p	2N5356	32½p	BC122	20p	BFY30	50p	NKT214	22½p	TIS43	27p
2N2924	15p	2N5365	47½p	BC125	20p	BFY41	50p	NKT215	22½p	TIS44	10p
2N2925	15p	2N5366	32½p	BC126	20p	BFY43	62½p	NKT216	37½p	TIS45	10p
2N2926		2N5367	57½p	BC140	37½p	BFY50	23p	NKT217	42½p	TIS46	11p
Green	14p	2N5457	37½p	BC147	10p	BFY51	20p	NKT219	30p	TIS47	11p
Yellow	12½p	2S005	75p	BC148	10p	BFY52	23p	NKT223	27½p	TIS48	12½p
Orange	12½p	2S020	£2·00	BC149	12p	BFY53	17½p	NKT224	25p	TIS49	12½p
2N3011	30p	2S102	50p	BC152	17½p	BFY56A	57½p	NKT225	22½p	TIS50	17½p
2N3014	32½p	2S103	25p	BC157	20p	BFY75	30p	NKT229	30p	TIS51	12½p
2N3053	18p	2S104	25p	BC158	11p	BFY76	42½p	NKT237	35p	TIS52	12½p
2N3054	46p	2S501	32½p	BC159	12p	BFY77	57½p	NKT238	25p	TIS53	22½p
2N3055	62p	2S502	35p	BC160	62½p	BFY90	67½p	NKT240	27½p	TIS60	22½p
2N3133	30p	2S503	27½p	BC167	11p	BFW58	27½p	NKT241	27½p	TIS61	25p
2N3134	30p	3N83	40p	BC168B	10p	BFW59	25p	NKT242	20p	TIS62	27½p
2N3135	25p	3N128	70p	BC168C	11p	BFW60	25p	NKT243	62½p	TIP29A	50p
2N3136	25p	3N140	77½p	BC169B	11p	BPX25	£1·85	NKT244	17½p	TIP30A	60p
2N3390	25p	3N141	72½p	BC169C	12p	BPX29	£1·80	NKT245	20p	TIP31A	62½p
2N3391	20p	3N142	55p	BC170	12½p	BPY10	£1·45	NKT261	20p	TIP32A	75p
2N3391A	30p	3N143	67½p	BC171	15p	BRY39	47½p	NKT262	30p	TIP33A	
2N3392	17½p	3N152	87½p	BC172	15p	BSX19	17½p	NKT264	20p		£1·02½p
2N3393	15p	R.C.A.	52½p	BC175	22½p	BSX20	17½p	NKT271	20p	TIP34A	£2·05
2N3394	15p	40050	55p	BC182	10p	BSX21	37½p	NKT272	20p		
2N3402	22½p	40251	32½p	BC183	09p	BSX26	45p	NKT274	20p		
2N3403	22½p	40309	32½p	BC184	11p	BSX27	47½p	NKT275	20p		

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10A	—	52½p	57½p	65p	77½p	86½p	97½p	£1·25
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IS113	15p	BA100	15p	BY103	22½p	OA47	07½p
IS120	15p	BA102	22½p	BY122	47½p	OA70	07½p
IS121	17½p	BA110	32½p	BY124	15p	OA73	10p
IS130	12½p	BA115	07½p	BY126	15p	OA79	09p
IS131	12½p	BA141	32½p	BY127	17½p	OA81	07½p
IS132	15p	BA142	32½p	BY164	57½p	OA85	07½p
1S920	07½p	BA144	12½p	BYX10	22½p	OA90	07½p
1S922	07½p	BA145	20p	BYZ10	35p	OA91	07½p
1S923	07½p	BA154	12½p	BYZ11	32½p	OA95	07½p
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BRIDGE RECTIFIERS

A.	PIV		A.	PIV	
1	100	47½p	4	50	60p
1.4	140	52½p	4	100	70p
2	50	55p	4	400	95p
2	200	70p	5	50	62½p
2	400	80p	6	200	87½p
			4	400	£1·12½

THYRISTORS

PIV	50	100	200	300	400
1A	25p	27½p	37½p	40p	47½p
4A	47½p	55p	57½p	—	77½p
5A	—	55p	65p	—	90p
7A	—	55p	65p	—	97½p

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TAKE 20

JULIAN ANDERSON

No. 30
AUTOMATIC LIGHT

A series of simple transistor projects, each using less than twenty components and costing less than one pound to build.

"WHAT's an automatic light?" you may well ask. Well, lights are only needed when it's dark, and a very simple electronic switch circuit can be made to turn a small light on as soon as the general light level drops below a certain level; this has its most obvious application in motor cars. Many parts of the country have local regulations requiring cars to display lights shortly after sunset, even when parked. In other areas car parking lights are needed only when the local street lighting is turned off, which in some areas is as late as 2 a.m. There cannot be many people who relish the thought of going out to their cars at that hour to turn on the side or parking lights.

Porch lights which automatically turn themselves on after dusk are another application and although the circuit as shown is not really meant for this, many readers will realise the potential and modify the circuit to operate a thyristor or relay to apply the mains supply to the porch light.

THE CIRCUIT

Like last month we are making use of a light dependent resistor, that is a resistor whose value in ohms falls with an increase in light falling on it. Also like last month this component is coupled into the base bias potential divider circuit, thus controlling the bias on the transistor, Tr1. R1 may have to be altered in value in order to make the "switch" operate at the correct light level.

As darkness falls, the potential at the base of Tr1 falls as the value of the LDR rises and after a certain point Tr1 begins to turn off, less current is passed and the potential between the emitter and the collector rises. This in turn starts to turn Tr2 on. This transistor, when light was falling on the LDR, thus holding Tr1 on, was off since the potential between base and emitter was held at a very low level due to the small potential across Tr1. As soon as Tr2 begins to conduct this increases the current through R4, thus causing Tr1 to cut off even more and in turn switching Tr2 more on. This action takes place very quickly and Tr2 is switched fully on, applying the supply voltage across the bulb causing it to light up.

This switching circuit is known as the *Schmitt Trigger* and a very useful circuit it is too, with applications in many fields of electronics. As can be seen, only a few components are required and the switching action, using modern transistors, is very rapid and very positive. As soon as the potential at the base of Tr1 either reaches or falls to a preset level, Tr2 will switch.

The supply necessary to operate the circuit is taken directly from the car battery, though it is good practice to take this via the car's fuse as any

—continued overleaf

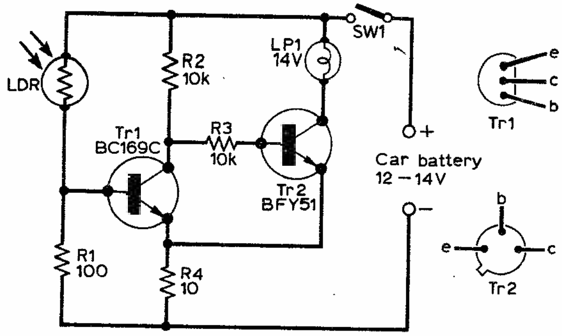

Fig. 1: The circuit of the automatic light with the lead connections of the transistors shown on the right.

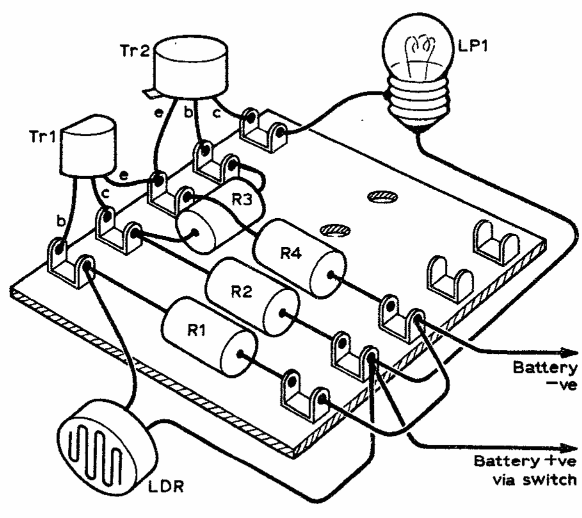

Fig. 2: A suggested component layout on a small piece of tag board.

★ components list

Tr1	BC169C [illegible]	[illegible]
Tr2	BFY51	[illegible]
LDR	Light Dependent Resistor	[illegible]
R1	[illegible]	[illegible]
R2	[illegible]	[illegible]
R3	[illegible]	[illegible]
R4	[illegible]	[illegible]
LP1	14V LES bulb, Radiospares [illegible]	[illegible]
SW1	DPST toggle switch	[illegible]
		[illegible]

[illegible]

The Radiospares bulb is available from most component stockists. [illegible]

TAKE 20—*continued from previous page*

mistakes or serious component failure could create a fire risk.

Car batteries are capable of giving very high currents and therefore the quiescent current is of no great importance but it is in fact low, in the order of 2mA. The recommended bulb draws 40mA and it can be seen that these currents can be supplied by a number of dry batteries, though operation in this manner will not be cheap.

The bulb should last a considerable time as it is being slightly under-run; there is of course a small volts drop across R4 and Tr2.

CONSTRUCTION

A suggested layout is shown in Fig. 2 but this is not critical. One point must be watched however; if the light from the bulb is allowed to fall onto the LDR it will switch the circuit in the same way that sunlight will. This will cause the circuit to oscillate; this can easily be seen as the bulb will flicker or flash. To avoid this the LDR must be pointed away from the bulb. ■

WAVEMETER MONITOR—*by R. F. GRAHAM*

continued from page 530

ted. Tuning resonance is shown by maximum meter reading. In driver and similar circuits with small power, the wavemeter needs to be reasonably close to the circuit inductor. For P.A. and high power circuits, it can be at some small distance.

To check the frequency of low level multipliers and similar circuits, or those which are inaccessible, a link line may be used. This is twin flex or co-axial cable about 2ft. long with a loop of two or three turns each end. One loop is held near the equipment inductor, and the other near the wavemeter inductor. Clipping a lead to jack and aerial socket also allows the coil primaries to be used for coupling. Resonance will be shown by a dip in grid current in a subsequent stage.

To monitor the audio of an outgoing transmission, plug in phones, tune to resonance and situate the unit where pick-up gives adequate volume.

To tune an aerial, transmitter, tuner or coupling device for maximum radiation from the aerial, a vertical rod or wire is plugged into the aerial socket of the unit, which should be at some distance. Adjustments are then for maximum meter reading, which corresponds to maximum field strength. It is also possible to link couple a dipole or aerial-earth system to the wavemeter for this purpose, or take a short aerial to VC1, ignoring calibration.

The wavemeter produces no signal. It can be used to find bands on a t.r.f. receiver by adjusting the latter until oscillation *just* arises, and holding the wavemeter coil in line with the receiver coil. Resonance when tuning the wavemeter is then shown by the receiver going out of oscillation. ■

BLUEPRINT SERVICE

We would like to draw readers' attention to the fact that the BLUEPRINT SERVICE has been discontinued and therefore no further BLUEPRINTS are available.

Electronotes..

S. GINSBERG

IN the beginning there were photocells enclosed in glass envelopes. Variations of these were more sensitive and multi-electrode secondary emission cells appeared like the 931A photomultiplier tube.

In more recent years, many experimenters, and indeed, most of the electronics industry too, has opted for solid state when thinking in terms of a light sensing device. An example here is the ORP12 light-dependent resistor, not to mention the earlier plastic-encapsulated transistors with some of their paint removed!

In America, work is currently proceeding on a technique known as charge coupling for imaging devices. One oxidised surface of a tiny silicon chip is covered with some 288 minute electrodes. These are arranged into groups of three, the last electrode in each group being a common conductor for the whole array.

The area immediately beneath each group of three elements forms a tiny light sensitive device in its own right. Minority carriers are generated in the silicon beneath the electrodes whenever light is focussed onto them. The greater the intensity of the light, the greater the charge, thus forming a direct relationship between light intensity and electrical charge.

The centre electrode of each group is purposely made more positive than the other two elements and thus the charges on minority carriers are attracted to, and congregate at, these centre electrodes.

Individual charges are next moved along the array from one electrode group to the next by putting a successively greater positive voltage on the electrode next to the one which is holding the charge. Eventually all the charges will have been passed along to the end of the device where they are collected by an output electrode.

Because the size of the charge will be dependent upon the amount of original light applied, the final electrode has, in effect, an analogue electrical signal which has a linear relationship to original light patterns of intensity.

How big is a 100,000μF capacitor—think of the size of some electrolytics. Now imagine how big a one Farad capacitor would be. Just to stretch the imagination even further, think of a 50 Farad capacitor. Fantastic—but they exist and are for sale. Twist in the tale is that the 50F is contained within one-third of a cubic inch. The devices will also retain their storage (if charged with a voltage) and leakage is so low that even after 16 months they will have retained over 97 per cent of the original charge. Think; they could be charged up and used as a form of battery. When discharged, they could simply be recharged again ad infinitum.

Also see next two pages

SEMI-CONDUCTORS/VALVES

ALL DEVICES BRAND NEW AND FULLY GUARANTEED

Transistors

		2N3415	22p	2N5458	35p	BC114	15p	BFW90	22p	NKT219	30p
		2N3416	27p	2N5459	48p	BC115	15p	BFW91	20p	NKT223	27p
2G301	20p	2N3417	37p	28102	25p	BC116	15p	BFX12	22p	NKT224	22p
2G302	19p	2N3439	130p	28103	25p	BC118	15p	BFX13	22p	NKT225	22p
2G303	20p	2N3440	97p	28104	25p	BC119	35p	BFX29	25p	NKT229	30p
2G306	30p	2N3564	17p	28301	47p	BC121	20p	BFX30	25p	NKT237	35p
2G308	30p	2N3565	15p	28302	47p	BC122	20p	BFX37	30p	NKT238	25p
2G309	30p	2N3566	22p	28303	57p	BC125	15p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	28304	72p	BC126	25p	BFX68	67p	NKT241	27p
2G374	20p	2N3569	25p	28501	32p	BC134	15p	BFX84	25p	NKT242	20p
2G381	22p	2N3570	125p	28502	35p	BC135	15p	BFX85	32p	NKT243	62p
2N388A	49p	2N3572	97p	28503	27p	BC136	15p	BFX86	25p	NKT244	17p
2N404	20p	2N3605	27p	3N83	40p	BC137	15p	BFX87	25p	NKT245	20p
2N696	15p	2N3606	27p	3N128	70p	BC138	37p	BFX88	20p	NKT261	20p
2N697	15p	2N3607	22p	3N140	77p	BC140	35p	BFX89	62p	NKT262	30p
2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
2N699	42p	2N3638A	20p	3N142	55p	BC147	15p	BFY11	42p	NKT271	20p
2N706	9p	2N3641	18p	3N143	67p	BC148	11p	BFY18	25p	NKT262	20p
2N706A	11p	2N3642	18p	3N152	87p	BC149	15p	BFY19	25p	NKT274	20p
2N708	15p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	45p	2N3644	25p	40250	50p	BC153	35p	BFY24	45p	NKT278	25p
2N718	25p	2N3645	25p	40251	82p	BC154	35p	BFY29	40p	NKT281	27p
2N718A	30p	2N3691	15p	40309	22p	BC157	15p	BFY30	40p	NKT401	87p
2N726	25p	2N3692	18p	40310	45p	BC158	15p	BFY41	50p	NKT402	90p
2N727	25p	2N3693	15p	40311	35p	BC159	15p	BFY43	62p	MKT403	75p
2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	22p	NKT404	62p
2N916	17p	2N3702	10p	40314	37p	BC167	15p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	37p	BC168B	14p	BFY52	22p	NKT406	62p
2N929	23p	2N3704	12p	40316	47p	BC168C	15p	BFY53	17p	NKT451	62p
2N930	24p	2N3705	10p	40317	37p	BC169B	14p	BFY56A	57p	NKT452	62p
2N937	52p	2N3706	10p	40319	55p	BC169C	15p	BFY76	42p	NKT453	47p
2N1090	22p	2N3707	12p	40320	47p	BC170	12p	BFY77	57p	NKT713	20p
2N1091	22p	2N3708	8p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	10p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	10p	40326	47p	BC175	22p	BSX20	17p	NKT736	35p
2N1302	17p	2N3711	10p	40329	30p	BC177	22p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	222p	40348	52p	BC182	10p	BSX28	32p	OC19	37p
2N1306	24p	2N3716	290p	40360	42p	BC182L	10p	BSX60	82p	OC20	75p
2N1307	24p	2N3773	240p	40361	47p	BC183	10p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	275p	40362	55p	BC183L	10p	BSX76	15p	OC23	60p
2N1309	24p	2N3819	34p	40370	32p	BC184	15p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	57p	40406	57p	BC184L	12p	BSX78	25p	OC25	37p
2N1613	21p	2N3823	75p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
2N1632	30p	2N3854A	27p	40409	55p	BC212L	12p	BSY26	17p	OC29	60p
2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	17p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	110p	2N3856A	35p	40468A	35p	BCY30	24p	BSY32	25p	OC42	25p
2N1711	24p	2N3858	25p	40528	72p	BCY31	30p	BSY36	25p	OC44	17p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	50p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	20p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	25p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	30p	BCY38	30p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	24p	BCY39	80p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
2N2194A	30p	2N3900	37p	AC152	22p	BCY42	15p	BSY54	40p	OC75	22p
2N2217	27p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	22p
2N2218	20p	2N3901	97p	AC176	22p	BCY54	32p	BSY79	45p	OC77	30p
2N2219	20p	2N3903	25p	AC187	25p	BCY58	22p	BSY90	25p	OC78	20p
2N2220	25p	2N3904	25p	AC188	27p	BCY59	22p	BSY95A	12p	OC81	20p
2N2221	25p	2N3905	30p	ACY17	27p	BCY60	97p	C424	15p	OC81D	20p
2N2222	20p	2N3906	30p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	15p	ACY19	25p	BCY71	20p	GET102	30p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	20p	OC83	25p
2N2368	15p	2N4060	12p	ACY21	20p	BCY78	30p	GET114	15p	OC84	25p
2N2369	17p	2N4061	12p	ACY22	10p	BCY79	30p	GET118	20p	OC139	25p
2N2369A	17p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	32p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	14p	BD112	57p	GET880	30p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	25p	BD116	112p	GET887	15p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	40p	BD121	65p	GET889	22p	OC201	50p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	75p
2N2613	27p	2N4255	42p	AD149	47p	BD124	75p	GET896	22p	OC203	40p
2N2614	30p	2M4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	47p	2N4285	17p	AD161	35p	BD132	85p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	90p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	30p	OC207	75p
2N2713	27p	2N4288	15p	AF114	35p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	15p	AF115	25p	BDY62	100p	MAT121	30p	ORP12	50p
2N2904	20p	2N4290	15p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	112p	ORP61	42p
2N2905	25p	2N4292	15p	AF118	44p	BF152	23p	MJ421	112p	P346A	22p
2N2905A	30p	2N4294	17p	AF121	30p	BF154	23p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	28p	MJ440	95p	ST141	20p
2N2906A	25p	2N4964	15p	AF125	19p	BF159	57p	MJ480	97p	TIS34	62p
2N2907	23p	2N4965	18p	AF126	18p	BF163	35p	MJ481	125p	TIS43	40p
2N2923	15p	2N5027	52p	AF127	16p	BF167	25p	MJ490	100p	TIS44	12p
2N2924	15p	2N5028	57p	AF139	28p	BF170	33p	MJ491	137p	TIS45	13p
2N2925	15p	2N5029	47p	AF178	42p	BF173	30p	MJE340	62p	TIS46	13p
2N2926G	13p	2N5030	42p	AF179	45p	BF177	30p	MJE370	95p	TIS47	13p
2N2926O	13p	2N5172	12p	AF180	50p	BF178	35p	MJE371	87p	TIS48	12p
2N2926Y	13p	2N5174	52p	AF181	40p	BF179	30p	MJE520	87p	TIS49	12p
2N3011	24p	2N5175	52p	AF186	39p	BF180	35p	MJE521	87p	TIS50	17p
2N3014	25p	2N5176	45p	AF239	30p	BF181	35p	MPF102	42p	TIS51	12p
2N3053	20p	2N5232A	30p	AF279	47p	BF182	30p	MPF103	35p	TIS52	12p
2N3054	49p	2N5245	45p	AF280	47p	BF184	30p	MPF104	37p	TIS53	22p
2N3055	72p	2N5246	42p	AFZ11	82p	BF185	30p	MPF105	37p	XB112	12p
2N3133	25p	2N5249	67	ASY26	25p	BF194	17p	MPS3638	32p	XC141	35p
2N3134	30p	2N5265	325p	ASY27	31p	BF195	15p	NKT124	42p	ZTX107	14p
2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	11p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	17p
2N3390	25p	2N5307	37p	ASY50	25p	BF198	42p	NKT128	27p	ZTX300	11p
2N3391	20p	2N5308	27p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	17p
2N3391A	30p	2N5309	62p	ASY54	25p	BF224	20p	NKT137	32p	ZTX302	18p
2N3392	17p	2N5310	42p	ASY67	45p	BF225	20p	NKT210	30p	ZTX303	18p
2N3393	15p	2N5354	27p	ASY86	37p	BF237	22p	NKT211	30p	ZTX304	25p
2N3394	15p	2N5355	27p	ASZ21	37p	BF238	22p	NKT212	30p	ZTX500	16p
2N3402	22p	2N5356	32p	AUY10	150p	BF244	82p	NKT213	30p	ZTX501	16p
2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	22p	ZTX502	20p
2N3404	32p	2N5366	32p	BC108	10p	BFW87	25p	NKT215	22p	ZTX503	17p
2N3405	45p	2N5367	57p	BC109	10p	BFW88	22p	NKT216	37p	ZTX504	40p
2N3414	22p	2N5457	34p	BC113	15p	BFW89	20p	NKT217	40p	ZTX531	28p

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CA3022	130p	FJJ101	50p	SN7473	43p
CA3023	126p	FJJ111	50p	SN7474	43p
CA3026	100p	FJJ121	60p	SN7475	47p
CA3028A	74p	FJJ131	60p	SN7476	45p
CA3028B	105p	FJJ141	125p	SN7483	87p
CA3029	87p	FJJ181	75p	SN7486	50p
CA3029A	165p	FJJ191	65p	SN7490	100p
CA3030	137p	FJJ211	125p	SN7492	87p
CA3035	122p	FJJ251	125p	SN7493	87p
CA3036	72p	FJL101	125p	SN7495	87p
CA3039	82p	FJY101	25p	SN7496	87p
CA3041	109p	IC10	250p	SN74107	43p
CA3042	109p	IC12	250p	SN74153	140p
CA3043	137p	L900	40p	SN74154	220p
CA3044	120p	L914	40p	SN74160	180p
CA3045	122p	L923	40p	SN74161	180p
CA3046	81p	MC724P	66p	SN74164	220p
CA3047	137p	MC780P	247p	SN74165	225p
CA3048	204p	MC788P	82p	SN74192	225p
CA3049	160p	MC790P	124p	SN74193	225p
CA3050	185p	MC792P	66p	TAA241	162p
CA3051	134p	MC799P	66p	TAA242	425p
CA3052	165p	MC1303L	262p	TAA243	150p
CA3053	46p	MC1304P	275p	TAA263	75p
CA3054	109p	MC1305P	386p	TAA293	97p
CA3055	240p	MC838P	549p	TAA300	175p
CA3059	165p	MC1435P	345p	TAA310	125p
CA3064	120p	MC1552G	461p	TAA320	72p
FCH101	85p	MC1709CG	94p	TAA350	175p
FCH111	105p	MFC4000P	112p	TAA435	147p
FCH121	105p	PA222	437p	TAA521	132p
FCH131	50p	PA230	100p	TAA522	360p
FCH141	105p	PA234	100p	TAA530	495p
FCH151	105p	PA237	185p	TAA811	445p
FCH161	50p	PA246	245p	TAB101	97p
FCH171	105p	PA424	235p	TAD100	150p
FCH181	105p	PA264	447p	TAD110	197p
FCH191	105p	PA265	497p	SL403A	187p
FCH201	130p	SN7400	23p	SL702C	147p
FCH211	130p	SN7401	23p	UA702A	280p
FCH221	130p	SN7402	23p	UA702C	77p
FCH231	150p	SN7403	23p	UA703C	137p
FCJ101	160p	SN7404	23p	UA709C	125p
FCJ111	150p	SN7405	23p	UA710C	125p
FCJ121	275p	SN7406	30p	UA716	187p
FCJ131	275p	SN7408	23p	UA723C	162p
FCJ141	525p	SN7409	23p	UA730C	160p
FCJ201	100p	SN7410	23p	UA741C	87p
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		100 PIV 4A	70p
		200 PIV 4A	75p
		400 PIV 4A	80p
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200 PIV 2A	67p	400 PIV 6A	£1·10
400 PIV 2A	80p		

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	IN SERIES 1 AMP	PL SERIES 1·5 AMP	CL SERIES 3 AMP
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4002 100PIV	09p	11p	20p
4003 200PIV	10p	12p	22p
4004 400PIV	10p	12p	25p
4005 600PIV	12p	15p	26p
4006 800PIV	15p	17p	27p
4007 1000PIV	20p	20p	30p

50+ less 15% 100+ less 20%

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400MW	1·5 WATT	10 WATT
3·3-33 V	2·4—100	3·9—100V
15p each	20p each	25p each

25+ less 15% 100+ less 20%

TRANSISTOR DISCOUNTS:- 12 + 10%; 25 + 15%; 100 + 20% any one type. Postage on all Semi Conductors 7p extra.
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2D21	35p	30FL14	75p	EZ40	45p
3Q4	40p	30L15	85p	EZ41	45p
3S4	35p	30L17	80p	EZ80	25p
3V4	45p	30P12	80p	EZ81	28p
5R4	60p	30P19	80p	GZ32	48p
5U4	33p	30PL1	70p	GZ34	60p
5V4	42p	30PL13	93p	KT66	£2·05
5Y3	32p	30PL14	90p	KT88	£2·00
5Z4G	40p	35L6	50p	MU14	60p
6/30L2	75p	35W4	30p	PABC80	40p
6AC7	25p	35Z4	30p	PC86	60p
6AG7	40p	35Z5	40p	PC88	60p
6AK5	30p	50B5	45p	PC97	45p
6AK6	57p	50C5	40p	PC900	43p
6AL5	20p	80	50p	PCC84	40p
6AM6	33p	85A2	45p	PCC85	40p
6AQ5	35p	807	50p	PCC88	55p
6AS6	37p	1625	50p	PCC89	50p
6AT6	30p	5763	70p	PCC189	55p
6AU6	25p	6146	£1·50	PCF80	30p
6AV6	30p	AZ31	50p	PCF82	34p
6BA6	25p	CY31	35p	PCF84	50p
6BE6	30p	DAF91	25p	PCF86	60p
6BH6	45p	DAF96	42p	PCF800	80p
6BJ6	45p	DF91	25p	PCF801	50p
6BQ7A	40p	DF96	42p	PCF802	50p
6BR7	85p	DK91	35p	PCF805	75p
6BR8	65p	DK92	50p	PCF806	70p
6BW6	85p	DK96	42p	PCF808	75p
6BW7	70p	DL92	35p	PCL82	35p
6BZ6	35p	DL94	45p	PCL83	65p
6C4	33p	DL96	42p	PCL84	45p
6CD6	£1·15	DM70	32p	PCL85	40p
6CL6	50p	DY86	33p	PCL86	45p
6CW4	63p	DY87	35p	PFL200	70p
6F1	62p	E88CC	65p	PL36	55p
6F6G	30p	E180F	95p	PL81	50p
6F13	38p	EABC80	35p	PL82	45p
6F14	65p	EAF42	35p	PL83	45p
6F15	65p	EB91	20p	PL84	40p
6F18	45p	EBC41	55p	PL500	75p
6F23	80p	EBC81	30p	PL504	80p
6H6	20p	EBF80	40p	PY32	55p
6J4	50p	EBF83	40p	PY33	68p
6J5	20p	EBF89	32p	PY80	35p
6J5GT	30p	EBL21	60p	PY81	30p
6J6	20p	EC86	60p	PY82	30p
6J7	45p	EC88	60p	PY83	38p
6K8G	35p	ECC40	60p	PY88	40p
6L6GT	45p	ECC84	30p	PY800	50p
6LD20	40p	ECC85	60p	PY801	50p
6Q7	40p	ECC88	40p	U25	75p
6SA7	40p	ECF80	35p	U26	75p
6SG7	35p	ECF82	35p	U50	32p
6SJ7	40p	ECF86	65p	U52	33p
6SK7	35p	ECH21	57p	U191	75p
6SL7	35p	ECH35	80p	U281	40p
6SN7	35p	ECH42	70p	U282	40p
6SQ7	40p	ECH81	30p	U301	40p
6U4	60p	ECH83	40p	U801	£1·00
6V6G	25p	ECL80	40p	UABC80	35p
6V6GT	32p	ECL82	35p	UAF42	55p
6X4	30p	ECL83	65p	UBC41	50p
6X5G	30p	ECL86	40p	UBC81	40p
6X5GT	27p	EF37A	60p	UBF80	40p
10C2	50p	EF39	40p	UBF89	35p
10F1	90p	EF40	50p	UCC84	49p
10P13	55p	EF41	65p	UCC85	40p
10P14	£1·10	EF42	70p	UCF80	55p
12AT6	30p	EF80	25p	UCH21	60p
12AT7	30p	EF85	35p	UCH42	70p
12AU7	30p	EF86	30p	UCH81	35p
12AX7	30p	EF89	28p	UCL82	35p
12AV6	33p	EF91	33p	UCL83	60p
12BA6	35p	EF92	40p	UF41	60p
12BE6	35p	EF183	30p	UF80	35p
12BH7	40p	EF184	35p	UF85	40p
19AQ5	35p	EH90	40p	UF89	35p
20D1	45p	EL34	50p	UL41	65p
20F2	75p	EL33	£1·25	UL84	30p
20L1	£1·10	EL41	55p	UY41	45p
20P1	50p	EL42	58p	UY85	30p
20P3	60p	EL81	55p	VR105/30	38p
20P4	£1·10	EL84	25p	VR150/30	35p
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AAZ13	10p	BY100	15p	OA47	7p
AAZ15	12p	BY103	22p	OA70	7p
BA100	15p	BY122	37p	OA73	10p
BA102	23p	BY124	15p	OA79	9p
BA110	32p	BY126	15p	OA81	7p
BA111	27p	BY127	17p	OA85	7p
BA112	70p	BY164	57p	OA90	7p
BA115	7p	BY210	35p	OA91	7p
BA141	32p	BYZ11	32p	OA95	7p
BA142	82p	BYZ12	30p	OA200	7p
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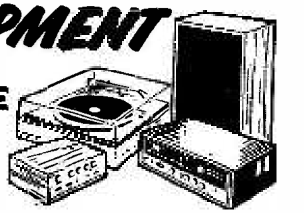
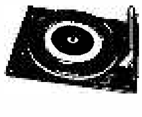


RECORD DECKS



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† Mono * Stereo Cartridge
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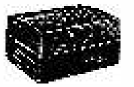

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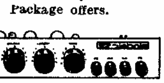

2 x Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. **£16·75** Carr. 37½p. Or with PZ6 power supply **£18·85** Carr. 37½p. 2 x Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. **£20·25.** Carr. 37½p.
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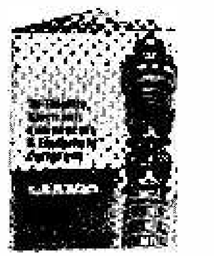

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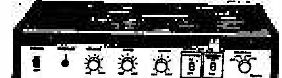
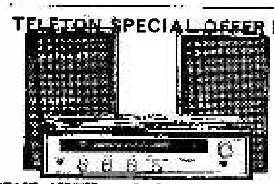


Latest exciting release. Brand new model. 6 + 6 watts rms. Inputs for mag. xtal, aux tape. Volume, bass, treble, sliding balance, scratch filter and loudness controls. List £32.50 OUR PRICE **£18·50** Carr. 37p.



CR10T AM/FM STEREO TUNER AMPLIFIER WITH MATCHING PAIR SA1003 SPEAKER SYSTEMS. Output 4 watts per channel. Excellent reception, AFC, built-in MPX. Cer/XTAL Input. Total List **£50·25.** OUR PRICE **£29·95.** Carr. 62½p.
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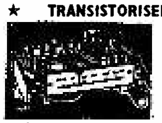

6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6×4×2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9 V battery. Coverage 88–108Mc/s. Ready built ready for use. Fantastic value for money. **£6·37½.** P. & P. 12½p.
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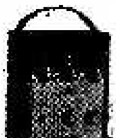

New high quality portable instrument. Sine 1 Hz to 100 KHz. Square 20 Hz to 20 KHz. Output max + 10 dB (10 K ohms). Operation 220/240v. A.C. Size 215mm x 150mm x 120mm.
Price **£27·50.** Carr. 25p.

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Accurate wide range signal generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£15.** P. & P. 37½p. S.A.E. for details.

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latest release 125 KHz—20 MHz. Excellent condition. Fully tested and checked and complete with calibrator charts. **£27·50** each. Carr. 50p.

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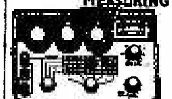

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1% L.1 μ H - 111 HENRYS 6 Ranges2=%C.10pF±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7⅝ × 5 × 2in. **£20.** P. & P. 25p

TE-16A Transistorised Signal Generator. 5ranges 400kHz—30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. **£7·97½.** P. & P. 20p.

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2 pF-2000 mFd 2 ohms 200 megohms. Also checks impedance, turns ratio, insulation, 200/250V. A.C. **Brand New £17·50.** Carr. 37½p.

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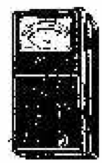

Model U437 20,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/100v/ AC. DC Current 100 wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3MΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE **£5·97** P. & P. 25p.

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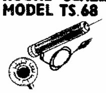
ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0-20K ohms. ONLY **£1·97** P. & P. 13p.

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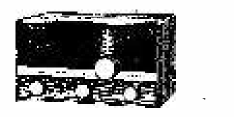
4 Bands covering 550kc/s–30mc/s. FET, S Meter, Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240v. A.C. or 12v. D.C. 12⅞" x 4½" x 7". Brand new with instructions. **£25.** Carr. 37½p.



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4 Bands covering 550kc/s–30mc/s. B.F.O. Built-in Speaker 220/240v. A.C. Brand new with instructions. **£15·75.** Carr. 37½p.

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Small portable crystal controlled wavemeter. Size 7 × 7½ × 4in. Frequency range 500 Kc/s–10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300V. D.C. 15mA and 12V D.C. 0.3A. Excellent condition. **£4·47½.** Carr. 37½p.

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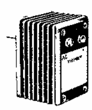

Compact and panel mounting. Ideal for control of lamps, drills, electrical appliances etc. Input 230/240v. A.C. Output continuously variable from 20v—230v. Model MR 2305 5 amp 68 x 46 x 43mm **£8·37½.** Model MR 2310 10 amp 90 x 68 x 60mm **£11·97½.** Postage 12½p.

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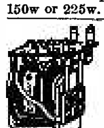

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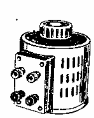

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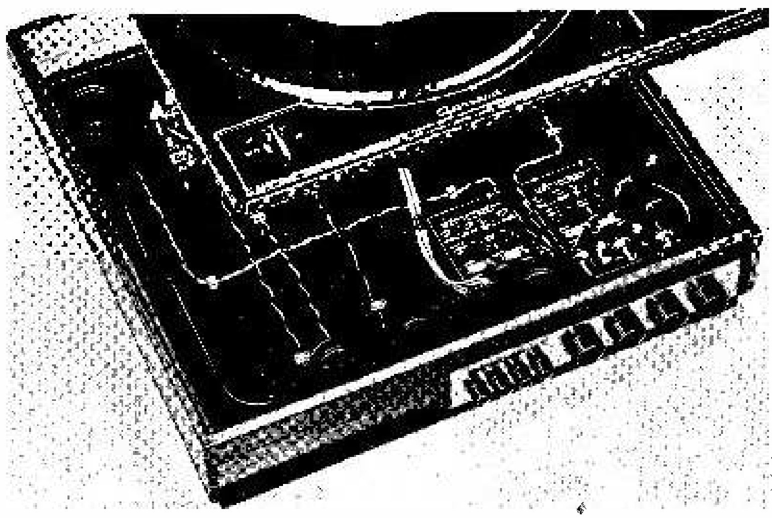
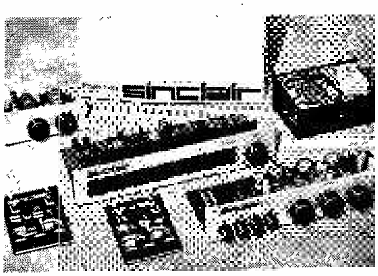
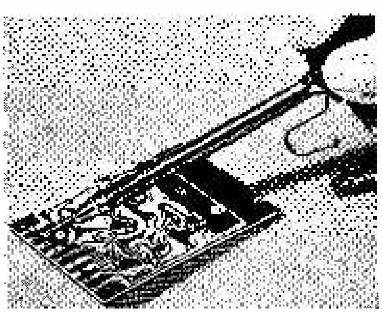
Sinclair Project 60

The World's leading range of high fidelity modules







Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.
Performance characteristics are so good they hold their own with any other available system irrespective of price or size.
Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

Typical Project 60 applications

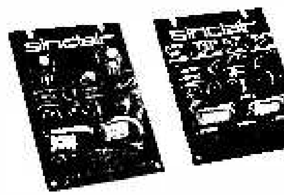
System	The Units to use	together with	Cost of Units
Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**£4.48**
Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
20 + 20 W. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	**£23.90**
20 + 20 W. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.90**
40 + 40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As above	**£34.88**
Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£19.43**

F.M. Stereo Tuner **(£25)** & A.F.U. Filter Unit **(£5.98)** may be added as required.

Sinclair Radionics Limited, London Road,
St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (048 06) 4311

from a simple amplifier to a complete stereo tuner amplifier with Project 60 modules

Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz ±1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size: 14 x 80 x 57 mm.

Z.30
Built, tested and guaranteed with circuits and instructions manual. **£4.48**

Z.50
Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Power Supply Units

PZ.5

PZ.8

Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

PZ.5 *30 volts unstabilised* **£4.98**
PZ.6 *35 volts stabilised* **£7.98**
PZ.8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ.8 *mains transformer* **£5.98**

The Sinclair Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

Project 60 Stereo F.M. Tuner

First in the world to use the phase lock loop principle

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Good reception is possible in difficult areas, and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 2μV for 30dB quieting: 7μV for full limiting. **Squelch level:** 20μV. **A.F.C. range:** ±200 KHz. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10 Hz – 15 KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC. **Indicators:** Mains on; Stereo on; tuning. **Size:** 93 x 40 x 207 mm.

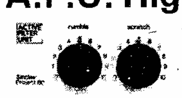
Built and tested. Post free. **£25**

Stereo 60 Pre-amp/control unit

Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A curve ±1dB:20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 15 to —15dB at 10 KHz: BASS ∓ 15 to —15dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.
Built tested and guaranteed. **£9.98**

A.F.U. High & Low Pass Filter Unit



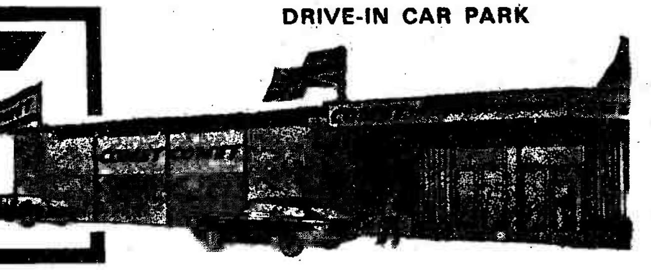
For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28KHz to 5KHz. L.F. cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply (0.02% at rated output. **Size:** 66 x 40 x 90 mm. *Built tested and guaranteed.* **£5.98**

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

Please send ______	Name ______
______	Address ______
______	______
I enclose cash/cheque/money order.	**PW 10**

DRIVE-IN CAR PARK

COMET HI-FI DISCOUNT WAREHOUSES



COMET for after-sales service
THROUGHOUT THE U.K.
Pictured, Service Dept. at Clough Rd., Hull also at Leeds, Stockton, Goole, Wakefield, Doncaster, Bridlington and Birmingham

STEREO AMPLIFIERS	Rec. Retail Price	Comet Price
ALBA UA 700	34·50	26·00
ANSTRAD 8000	25·95	16·95
ARMSTRONG 521	56·00	42·50
DULCI 207M	32·00	21·95
FERROGRAPH F307	62·00	44·00
GOODMANS Maxamp	54·00	38·00
LEAK Stereo 30 Plus	56·50	43·00
LEAK Stereo 30 Plus, in teak case	62·50	47·95
LEAK Stereo 70 Chassis	69·00	52·00
LEAK Stereo 70 cased	75·00	56·95
METROSOUND ST20E	39·50	29·50
PHILIPS RH 591	79·00	61·50
PHILIPS RH 590	52·00	39·50
PHILIPS RH 580	29·00	23·00
PIONEER SA500	62·10	41·95
PIONEER SA700	98·00	68·95
PIONEER SA900	134·10	95·95
PIONEER Reverberation	45·50	31·95
RANK Rotel 310	45·00	32·95
RANK Rotel 610	69·00	49·95
ROGERS Ravensbourne	59·50	45·95
ROGERS Ravensbourne (cased)	64·00	49·50
ROGERS Ravensbrook Mk. II	47·50	36·50
ROGERS Ravensbrook (cased) Mk. II	52·50	41·50
SINCLAIR 2000	35·00	23·95
SINCLAIR Project 60/2 x Z30/PZ5	23·90	16·50
SINCLAIR PROJECT 60/2 x Z50/PZ8/trans	34·86	23·25
SINCLAIR AFU	5·95	4·95
SINCLAIR Neoteric	61·95	46·00
SINCLAIR 3000	45·00	32·50
TELETON SAQ 206	29·00	18·50
TELETON GA101	37·50	28·50
VOLTEX 100w. Stereo Discotheque, 8 electronically mixed inputs	185·00	139·00

All the above take both ceramic and magnetic cartridges.

TUNERS		
*ARMSTRONG 523 AM/FM	53·76	42·00
*ARMSTRONG 524 FM	41·89	33·00
ARMSTRONG M8 Decoder	9·50	8·00
*DULCI FMT.7 FM	26·00	22·00
DULCI FMT.7S Stereo	35·00	29·25
GOODMANS Stereomax	82·52	49·95
LEAK Stereofetic Chassis	66·50	52·00
LEAK Stereofetic in teak case	72·50	59·00
PHILIPS RH 690	47·00	38·00
PHILIPS RH 691	89·00	75·50
PIONEER TX500 AM/FM	77·94	63·50
PIONEER TX900 AM/FM	153·69	123·00
RANK Rotel 320	54·57	42·95
ROGERS Ravensbourne chassis	61·89	47·95
ROGERS Ravensbrook	45·01	38·00
ROGERS Ravensbrook (cased)	51·26	41·00
TELETON GT 101	45·50	31·95

All above Tuners are complete with MPX Stereo Decoder except where starred.

TUNER/AMPLIFIERS		
AKAI AA 8500	229·00	181·00
AKAI 6600	142·53	112·00
AKAI 6300	128·85	99·95
ARENA R500	82·00	67·00
ARENA 2400	90·30	72·00
ARENA 2700	105·00	85·00
ARENA T9000	303·45	258·00
ARMSTRONG M8 Decoder	9·50	8·00
ARMSTRONG 525	91·89	74·50
ARMSTRONG 526	104·71	84·50
GOODMANS Mod. 80, 35w. R.M.S.	95·00	72·00
MIDLAND 19/542	49·56	37·50
PHILIPS RH 790	139·00	112·00
PIONEER SX770 AM/FM	160·43	128·00
PIONEER SX990 AM/FM	194·74	150·00
PIONEER 440	111·10	89·00
TANDBERG 1171 comp. with decoder	110·00	94·00
*TELETON F2000	51·50	39·50
TELETON 7AT20	105·00	77·95
TELETON 10AT1 150w. RMS	160·00	103·00
TELETON TFS50	82·50	59·00
TELETON TFS 50LA MW/LW/VHF	87·50	63·50
*TELETON R.8000 with Speakers	63·25	37·50
TELETON CR55	120·00	87·00
WHARFEOALE 100-1	149·00	119·00

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges.
All the above Tuners and Tuner/Amplifiers include MPX Stereo Decoder with the exception of Armstrong where decoder is extra as listed.

CARTRIDGES	Rec. Retail Price	Comet Price
GOLORING 800	13·00	9·95
GOLORING 800E	18·86	10·95
GOLDRING 800 Super E	26·01	19·50
*GOLDRING CS90 Stereo	5·20	4·25
*GOLDRING CS91/E	7·81	6·25
GOLDRING G850	6·50	5·25
EMPIRE 1000ZE/X	63·00	52·50
EMPIRE 999VE/X	44·50	36·00
EMPIRE 999TE/X	27·60	22·50
EMPIRE 999SE/X	21·00	17·50
EMPIRE 999E/X	16·50	13·00
EMPIRE 999/X	11·50	9·25
EMPIRE 909E/X	12·85	10·25
EMPIRE 909/X	9·00	7·50
EMPIRE 90EE/X	9·75	8·00
ORBIT Magnetic NM 22	Special Price	2·90
PICKERING V15 AC2	8·40	7·00
ORTOFON SL15E	29·65	23·75
ORTOFON 2X15K Transformer	7·00	5·25
SHURE M3DM	7·41	5·50
SHURE M31E	12·05	8·95
SHURE M32E	11·10	8·25
SHURE M32-3	10·20	8·00
SHURE M44-5	11·10	7·95
SHURE M44-7	10·20	8·00
SHURE M-44C	10·20	8·00
SHURE M44E	12·05	8·25
SHURE M55E	12·95	9·50
SHURE M75G	17·60	14·00
SHURE M75-6	16·70	13·00
SHURE M75EJ	19·45	16·00
SHURE M75E-95G	23·15	18·00
SHURE M75E	21·30	14·50
SHURE V15-11	40·78	28·95
SHURE V15-11-7	38·90	29·00

Starred cartridges above are ceramic. All others are magnetic.

PICKUP ARMS		
GOLDRING Lenco L75	12·33	10·50
GOLDRING Lenco L69	9·29	7·00
SME 3009 with S2 Shell	34·47	27·00
SME 3012 with S2 Shell	36·71	39·50

TURNTABLES

The following Turntables are complete with base, plinth, perspex cover and cartridge. Fully wired and ready for use. All at special prices.

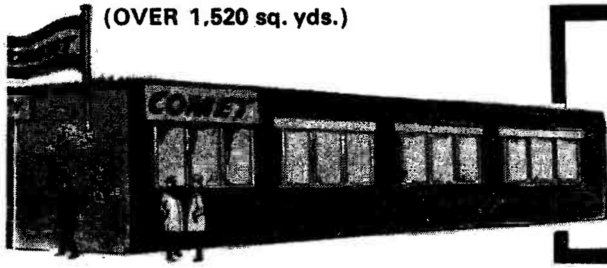
GARRARD SP25 Mk 111 with Goldring G.800 Special Price £21·98
GARRARD SP25 Mk 111 with Shure M.44·7 Special Price £22·95
GARRARD SP25 Mk 111 with Shure M.55E Special Price £23·95
GARRARD AP76 with Goldring G800 Special Price £30·95
GARRARD AP76 with Shure M55E Special Price £32·95
GARRARD AP76 with Shure M75E Special Price £36·95
GARRARD 2025 with Sonotone 9TAHC Special Price £15·50
GOLDRING 705/P with G850 Special Price £15·95
GOODMANS 3025 with G800 Special Price £26·90

DUAL 1219 transcription	60·40	50·00
OUAL 1209 transcription	42·62	35·00
GARRARD SP25 Mk III	16·45	11·90
GARRARD SL65 B	21·25	15·50
GARRARD SL75 B	39·20	26·50
GARRARD SL95 B	50·01	35·50
GARRARD 401	39·67	32·50
GARRARD SL72 B	33·11	25·50
GARRARD 3500, with GKS Cart.	17·23	12·90
Base and Cover to fit GARRARD SP25, SL55, SL65B and 3500	Special Price	4·00
GARRARD 40B	13·84	10·97
GARRARD AP76	28·88	21·50
GOLDRING GL69 Mk. II	26·63	21·25
GOLDRING GL69P Mk. II	35·14	28·50
GOLORING GL75	36·41	31·50
GOLDRING GL75P	46·94	38·50
GOLDRING Covers for 69P and 75P	4·21	3·50
GOLDRING C99—plinth and cover for G99	11·45	9·99
GOLDRING G99	26·00	22·90
GOODMANS 3025	37·74	26·90
McDONALD MP 50	15·75	11·75
McDONALD 610	20·00	15·75
Base and Cover for McDONALD MP 60 and 610	Special Price	4·50
PHILIPS 228	20·00	17·00
PHILIPS GA146	31·50	25·00
PHILIPS 202 Electronic	69·00	54·00
PHILIPS 308 transcription unit complete with base and cover	39·00	32·95
PIONEER PL12A with base & cover	49.93	37·95
THORENS TX25 cover	8·85	7·00
THORENS TD125	79·04	61·95
THORENS TD125AB	120·20	98·00
THORENS TD150A Mk. II	46·16	35·95
THORENS TD150AB Mk. II	49·96	42·95
THORENS TX11 Cover	4·43	3·95

SPEAKERS		
B & W Model 70	159·50	121·95
B & W DM3	63·00	49·95
B & W DM1	32·00	25·50
CELESTION Ditton 120	24·00	18·00
CELESTION Ditton 15	32·00	25·50
CELESTION Ditton 25	65·00	50·95
GOODMANS Minister	25·00	20·50
GOODMANS Magister	62·50	47·95
GOODMANS Maxim	20·39	16·50
GOODMANS Mezzo 3	34·00	25·95
GOODMANS Magnum K2	44·00	33·00
J & S Model SXMT (pair)	26·95	14·95
KEF Cresta	22·17	18·00
KELETRON Speakers		
KN500 4 speaker system (pair)	23·00	15·50
KN700 4 speaker system	27·50	18·25
KN1000 4 speaker system	19·25	13·95
KN1500 4 speaker system	24·75	18·95
KN2000 4 speaker system	28·75	20·95
LEAK 200	24·95	18·90
LEAK 300	32·50	23·95
LEAK 600	49·50	36·90
LOWTHER Acousta (with PM6)	45·50	38·50
LOWTHER Acousta (with PM7)	53·00	46·00
LOWTHER Ideal Baffle	35·50	30·00
METROSOUND HFS103 (pair)	25·00	17·95
METROSOUND 202	21·50	15·95
METROSOUND HFS20 (pair)	39·00	27·95
METROSOUND HFS10 (pair)	27·44	22·95
PHILIPS RH481	11·00	8·95
PHILIPS RH482	18·00	14·95
SINCLAIR Q16	8·98	6·95
STE-MA 275 3 speaker system	23·10	15·95
TANDBERG TAN 7	28·80	24·50
TANDBERG TAN 11	19·30	16·50
TANDBERG TAN 15	45·00	35·95
WHARFEOALE Speakers		
Airedale	69·50	54·95
Denton	19·95	16·75
Super Linton	24·95	20·50
Melton	32·50	24·95
Dovedale 3	42·50	31·95
Rosedale	65·00	50·95
Triton (pair)	59·90	45·95
Unit 3 Speaker Kit	13·00	10·50
Unit 4 Speaker Kit	18·00	13·95
Unit 5 Speaker Kit	26·00	19·95

CHASSIS SPEAKERS		
GOODMANS Axiette 8	8·10	6·50
GOODMANS Twinaxiette 8	9·17	7·50
GOODMANS Axiom 10	9·18	7·75
GOODMANS Axiom 80	28·31	23·75
GOODMANS Axiom 201	14·45	10·95
GOODMANS Axiom 401	17·86	14·95
GOOOMANS Audiom 8P	5·55	4·25
GOODMANS Audiom 10P	6·05	3·58

(OVER 1,520 sq. yds.)



OVER 1000 ITEMS ALWAYS IN STOCK

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	Rec. Retail Price	Comet Price
GOODMANS Audiom 51	13·05	9·75
GOODMANS Audiom 61	18·95	14·00
GOODMANS 12P	12·37	10·00
GOODMANS 15P	20·00	16·97
GOODMANS Audiom 18P	34·00	26·97
GOODMANS Twin Axiom 10	10·23	8·25
GOODMANS ARU172	4·50	3·50
GOODMANS Trebax 100	8·60	6·00
GOODMANS Trebax 5K/20XL	9·70	7·50
GOODMANS Midax	12·95	9·00
GOODMANS Attenuator	3·55	2·50
GOODMANS Crossover Networks XO/950/5000	9·75	7·25
GOODMANS Crossover Networks XO/950	7·40	5·75
GOODMANS Crossover Networks XO/5000	2·65	2·00
WHARFEDALE 8in.Bronze/RS/DD	5·00	4·00
WHARFEDALE Super 8/RS/DD	8·50	7·00
WHARFEDALE Super 10/RS/DD	14·00	11·50
WHARFEDALE WMT1 Matching Transformer	0·84	0·75
HI-FI STEREO SYSTEMS COMPLETE		
ARENA MR15	145·00	109·95
ALBA UA552	45·86	35·50
ALBA UA662	60·32	46·95
DECCA Sound 6013	69·89	57·95
DECCA Sound 6014	70·86	68·95
DECCA Sound 1204	95·30	75·95
DECCA Compact 3	130·14	109·95
DECCALIAN 5 complete with stand	65·50	51·95
EKCO SRG 609	85·44	66·95
EKCO ZU5	159·29	129·00
FERGUSON 3422	84·80	67·95
FERGUSON 3423	114·15	89·95
FERGUSON 3424	119·00	94·95
FERGUSON 3425	140·10	108·00
FERGUSON 3450 with radio	72·40	59·95
FIDELITY UA2 Music Master	44·41	31·95
FIDELITY UA1 Music Master	103·30	82·95
HMV 2416	129·70	99·95
HMV 204/5/6	198·00	159·95
HMV 2452	65·65	53·95
HMV 2450 with stereo radio	134·20	109·00
KB KA1250 complete with two 653 speakers	71·55	58·50
KB KA1250 complete with two 651 speakers	80·25	64·95
KB 2010 with radio	73·40	60·95
LEAK 30/Goldring/Wharfedale	182·65	142·95
LEAK 70/Thorens/Wharfedale	226·87	175·00
MARCONI Unit 4	74·77	63·95
MARCONI Unit 3	84·79	67·95
METROSOUND Stereo 1010	82·30	65·95
PHILIPS 580/481/105	71·00	55·95
PHILIPS GF 823	47·79	38·95
PHILIPS GF 824	67·09	54·95
PHILIPS GF 833	65·16	54·95
PHILIPS GF 834	84·95	69·95
PHILIPS GF 417	96·06	73·95
PHILIPS 882 Less L/S	96·50	76·95
TELETON 2S60F with radio	72·40	53·95
TELETON 8TK Stereo System	54·75	48·00
TOSHIBA SP8507	248·00	175·00
ULTRA 6405	77·00	64·95
TAPE RECORDERS AND TAPE DECKS		
AKAI 1720L	93·67	65·95
AKAI 4000 D 4-track stereo deck	86·68	67·50
AKAI CR 80D 8-track stereo tape deck	91·56	76·95
AKAI CR80 8-track stereo recorder	110·83	96·95
AKAI X200D	183·07	129·95
AKAI 1800SD	192·16	129·00
AKAI 2000SD	300·00	239·00
BUSH Discassette DC70	21·19	16·95
BUSH TP60 Cassette tape recorder	28·38	23·95

	Rec. Retail Price	Comet Price
BUSH TP70 Cassette battery/mains tape recorder	28·91	23·50
FERGUSON 3245 Twin track	36·70	28·95
FERGUSON 3246 4-track	42·55	33·95
FERGUSON 3247 4-track	47·93	38·95
FERGUSON 3248 4-track	52·76	42·95
FERGUSON 3252 4-track	100·70	81·95
FERROGRAPH 702 2-track tape deck	220·22	189·00
FERROGRAPH 704/W 4-track tape deck	220·22	189·00
FERROGRAPH 722	257·52	215·00
FERROGRAPH 724	257·52	215·00
GRUNDIG C200 De Luxe Cassette	38·46	28·95
GRUNDIG TK 121 twin track	55·30	42·95
GRUNDIG TK 149 4-track	57·63	47·95
GRUNDIG TK 141 4-track	61·62	49·50
GRUNDIG TK 146 4-track Auto	67·30	52·95
GRUNDIG 222 stereo cassette	57·70	47·95
GRUNDIG TK 147 4-track Auto	93·96	77·95
MIDLAND TC 144 cassette	18·00	11·95
PHILIPS 2202 cassette	26·89	19·95
PHILIPS 2204 cassette battery/mains	32·30	25·50
PHILIPS 2205 cassette tape recorder	41·59	33·95
PHILIPS 3302 cassette tape recorder	23·04	17·95
PHILIPS 4303 new release	40·55	33·95
PHILIPS 4307 4-track	47·78	37·95
PHILIPS 4308 De luxe 4-track	58·40	43·95
PHILIPS 4404 2-track stereo recorder	91·71	71·95
PHILIPS 4407 4-track stereo recorder	106·19	87·95
PHILIPS 4500 4-track stereo tape deck	121·64	96·95
PHILIPS 4408 4-track stereo	134·18	106·00
PHILIPS Cassette Stereo N2503 tape deck	52·05	44·95
PYE Cassette Recorder/Radio 9000 battery/mains	43·86	35·95
PHILIPS 2400 stereo cassette less L/S	65·55	57·95
TANDBERG 1841 4-track stereo tape deck	69·75	50·95
TANDBERG 3021X twin track stereo	109·90	93·00
TANDBERG 3041X 4-track stereo	109·90	93·00
TANDBERG 4021X twin track stereo	180·00	150·00
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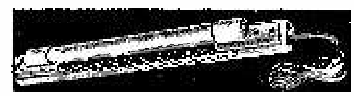

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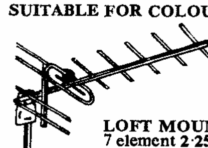

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6AM6	0.33	6EJ7	0.35	6Y6G	0.70	25Z6GT	0.65
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30L15	0.85	5642	0.70	EBC33	0.50	ECH83	0.45
30L17	0.80	6080	1.60	EBC41	0.55	ECH84	0.45
30P12	0.80	6146	1.60	EBC81	0.30	ECL80	0.45
30P19	0.85	6360	1.25	EBF80	0.40	ECL81	0.50
30PL1	0.75	6939	2.25	EBF83	0.40	ECL82	0.35
30PL13	0.98	7199	0.80	EBF89	0.30	ECL83	0.70
30PL14	0.90	7360	2.00	EC53	0.50	ECL84	0.55
35A3	0.55	7586	1.25	EC86	0.60	ECL85	0.55
35A5	0.75	7895	1.25	EC88	0.60	ECL86	0.40
35B5	0.65	9002	0.40	EC90	0.33	ECLL800	1.65
35C5	0.50	9003	0.50	EC91	0.60	EF40	0.50
35D5	0.75	AZ1	0.55	EC92	0.35	EF41	0.65
35L6GT	0.50	AZ31	0.55	EC93	0.55	EF42	0.70
35W4	0.35	CBL1	0.90	EC8010	2.25	EF80	0.25
35Z3	0.70	CBL31	1.00	ECC40	0.65	EF83	0.55
35Z4G	0.35	CY31	0.85	ECC81	0.35	EF85	0.35
35Z5GT	0.60	DAF96	0.45	ECC82	0.30	EF86	0.30
50A5	0.75	DF96	0.45	ECC83	0.30	EF89	0.28
50B5	0.50	DK40	0.60	ECC84	0.30	EF91	0.33
50C5	0.50	DK92	0.55	ECC85	0.40	EF92	0.35
50CD6G	1.20	DL96	0.45	ECC88	0.40	EF95	0.35
50L6GT	0.55	DM160	0.65	ECC89	0.50	EF97	0.65
85A2	0.50	DY86	0.32	ECC91	0.20		

EP98	0.65	GZ34	0.60	PL82	0.45	U301	0.40
EF183	0.30	HABC80	0.45	PL83	0.45	U403	0.60
EF184	0.35	HK90	0.40	PL84	0.40	U404	0.60
EF800	1.00	KT66	2.05	PL302	0.85	U801	0.80
EK90	0.30	KT88	2.00	PL504	0.80	UABC80	0.40
EL33	1.25	N78	1.50	PL508	0.90	UAF41	0.50
EL34	0.50	PABC80	0.40	PL509	1.10	UAF42	0.55
EL36	0.50	PC86	0.60	PL801	0.80	UBC41	0.50
EL37	1.60	PC88	0.60	PL802	0·95	UBC81	0.40
EL41	0.60	PC97	0.50	PM84	0.60	UBF80	0.40
EL42	0.65	PC900	0.48	PY31	0.30	UBF89	0.35
EL81	0.55	PCC84	0.40	PY33	0.83	UBLI	0.60
EL83	0.42	PCC85	0.40	PY80	0.40	UBL21	0.65
EL84	0.25	PCC88	0.55	PY81	0.30	UC92	0.40
EL85	0.43	PCC89	0.55	PY82	0.35	UCC85	0.40
EL86	0.40	PCC189	0.55	PY83	0.38	UCF80	0.55
EL90	0.38	PCC805	0.85	PY88	0.40	UCH21	0.60
EL95	0.35	PCC806	0.80	PY500	1.00	UCH42	0.70
EL821	0.60	PCF80	0.30	PY800	0.40	UCH81	0.40
EL822	1.30	PCF82	0.35	PY801	0.50	UCL81	0.60
ELL80	0.75	PCF84	0.60	PZ30	0.35	UCL82	0.35
EM34	1.00	PCF86	0.60	QQVO2-6	2.25	UCL83	0.60
EM71	0.80	PCF87	0.90	QQVO3-10	1.25	UF41	0.60
EM80	0.45	PCF801	0.50	QQV03-20A	5.25	UF42	0.60
EM81	0.60	PCF802	0.50	QQV06-40A	5.50	UF43	0.60
EM84	0.35	PCF805	0.80	TT21	3.00	UF80	0.35
EM85	1.00	PCF806	0.70	TT22	3.20	UF85	0.40
EM87	0.70	PCF808	0.85	TY2-125	10.00	UF89	0.40
EN91	0.38	PCH200	0.70	U18/20	0.75	UL41	0.65
EY51	0.40	PCL81	0.50	U25	0.80	UL84	0.40
EY80	0.55	PCL82	0.35	U26	0.80	UM84	0.25
EY81	0.40	PCL83	0.65	U31	0.60	UU8	0.60
EY83	0.55	PCL84	0.45	U37	2.10	UY1N	0.50
EY86	0.40	PCL85	0.40	U52	0.35	UY11	1.00
EY87	0.43	PCL86	0.45	U76	0.35	UY41	0.48
EY88	0.43	PCL88	0.90	U78	0.35	UY82	0.50
EZ40	0.50	PCL800	0.98	U191	0.75	UY85	0.40
EZ41	0.50	PCL801	0.75	U201	0.35	W729	0.75
EZ80	0.27	PD500	1.30	U281	0.40	Z759	2.00
EZ81	0.29	PF86	0.65	U282	0.40	Z803U	1.20
GY501	0.80	PF818	0.85				
GZ30	0.40	PFL200	0.65				
GZ31	0.35	PL33	0.35				
GZ32	0.48	PL36	0.55				
GZ33	0.70	PL81	0.50				

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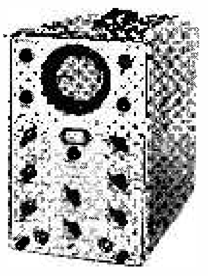
2N705	0.70	AC153	0.20	BD132	0.85
2N706	0.10	AC154	0.15	BD135	0.80
2N708	0.15	AC157	0.20	BF115	0.20
2N753	0.25	AC169	0.10	BF167	0.18
2N929	0.22	AC176	0.25	BF173	0.20
2N930	0.25	AC187	0.30	BF178	0.25
2N987	0.30	AC188	0.30	BF179	0.30
2N1131	0.25	ACY17	0.275	BF180	0.35
2N1132	0.25	ACY18	0.20	BF181	0.25
2N1184	1.25	ACY19	0.25	BF184	0.25
2N1301	0.40	ACY20	0.20	BF185	0.20
2N1302	0.75	ACY21	0.20	BF194	0.15
2N1304	0.25	ACY22	0.15	BF195	0.15
2N1305	0.25	AD140	0.50	BF196	0.20
2N1306	0.25	AD149	0.50	BF197	0.20
2N1307	0.30	AD161	0.35	BF200	0.35
2N1308	0.25	AD162	0.35	BFW87	0.25
2N1309	0.30	ADZ11	1.25	BFW88	0.23
2N1613	0.22	ADZ12	1.25	BFW89	0.20
2N1711	0.25	AF114	0.20	BFW91	0.20
2N1756	0.75	AF115	0.20	BFX88	0.25
2N2147	0.75	AF116	0.20	BFY17	0.40
2N2160	0.65	AF117	0.20	BFY19	0.60
2N2217	0.30	AF118	0.45	BFY50	0.25
2N2218	0.30	AF125	0.25	BFY51	0.20
2N2219	0.35	AF127	0.20	BFY52	0.25
2N2369A	0.20	AF180	0.35	BSY26	0.20
2N2477	0.65	AF181	0.35	BSY27	0.20
2N2646	0.60	AF186	0.40	BSY28	0.20
2N2905	0.35	AF239	0.40	BSY65	0.20
2N2923	0.15	AFZ11	0.45	BSY95A	0.15
2N2924	0.15	ASY26	0.25	OC16	0.50
2N2926	0.125	ASY27	0.30	OC22	0.50
2N3053	0.25	ASY28	0.25	OC23	0.60
2N3054	0.60	ASY29	0.30	OC24	0.60
2N3055	0.75	ASY54	0.25	OC25	0.35
2N3133	0.30	ASZ15	0.70	OC26	0.25
2N3134	0.30	ASZ16	0.70	OC28	0.60
2N3391	0.20	ASZ17	0.75	OC29	0.60
2N3392	0.15	ASZ18	0.75	OC30	0.75
2N3393	0.15	ASZ20	0.25	OC35	0.50
2N3394	0.15	ASZ21	0.40	OC36	0.60
2N3395	0.20	BC107	0.125	OC42	0.20
2N3402	0.15	BC108	0.125	OC44	0.20
2N3403	0.15	BC109	0.125	OC45	0.15
2N3404	0.35	BC113	0.25	OC70	0.10
2N3414	0.20	BC118	0.30	OC71	0.12
2N3415	0.15	BC134	0.30	OC72	0.25
2N3416	0.25	BC147	0.175	OC73	0.30
2N3417	0.25	BC148	0.15	OC75	0.20
2N3702	0.12	BC149	0.15	OC76	0.20
2N3703	0.12	BC152	0.15	OC78	0.25
2N3704	0.17	BC158	0.15	OC78D	0.20
2N3707	0.15	BC175	0.20	OC81	0.25
2N3709	0.12	BC186	0.25	OC81D	0.15
2N3710	0.12	BCY30	0.25	OC83	0.20
2N3819	0.35	BCY31	0.40	OC139	0.30
2N3906	0.20	BCY33	0.25	OC140	0.35
2S702	0.50	BCY34	0.30	OC141	0.60
2S746	0.25	BCY72	0.20	OC170	0.25
AC113	0.15	BCZ10	0.30	OC171	0.25
AC125	0.30	BCZ11	0.40	OC200	0.30
AC126	0.20	BD115	0.80	OC202	0.65

SYNCHROSCOPE TYPE C1-5



3-in tube fitted with telescopic viewing hood, giving bright display in full daylight.
Bandwidth 10 c/s—10 mc/s. Triggered sweep pre-set at 1-2-5-10-30-100-300-1000-3000 μsec per stroke. Free-running time base 20 c/s to 2000kc/s with built-in crystal calibrator providing timing marks at .05-.2-1-5-20-100 μ sec + 5%.
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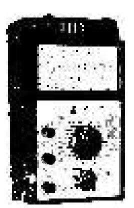

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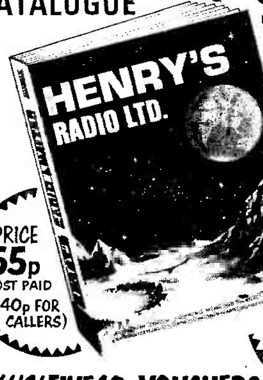

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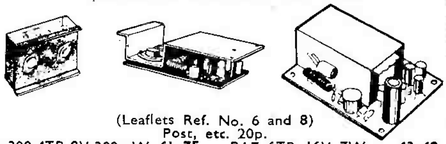

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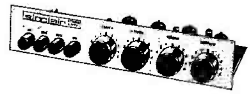

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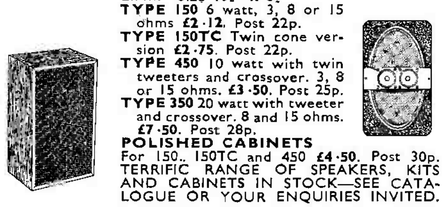

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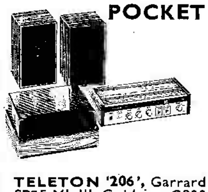

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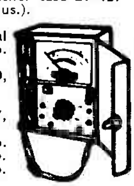

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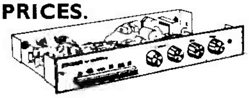

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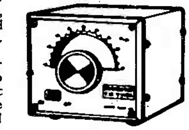

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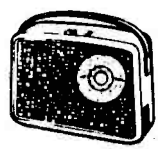

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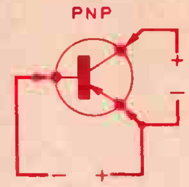

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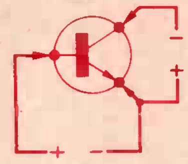

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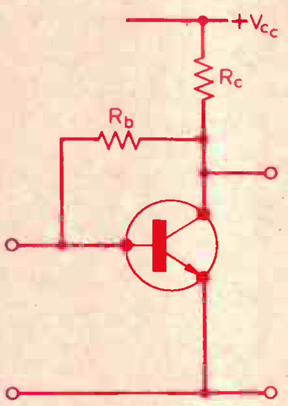
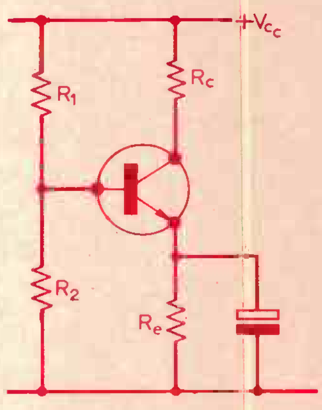
BIASING CIRCUITS



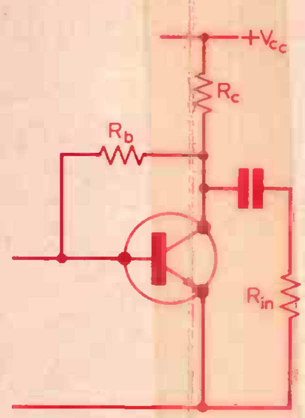
Working out the bias resistors. This circuit is suitable for silicon transistors where I_{cbo} is usually negligible. Collector voltage is about half the supply voltage V_{cc}. So $V_{ce}=V_{cc}-I_cR_b$. If we know the d.c. current gain (h_{FE}), we can work out R_b as $h_{FE}R_c$, choosing the mid-point of the manufacturer's quoted figures. Collector current is approximately emitter current and base current is the voltage dropped across the load resistor, divided by $R_b+h_{FE}R_c$.



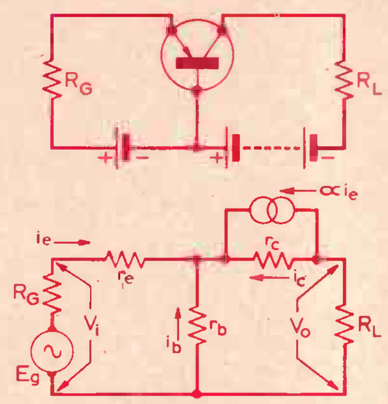
For germanium transistors (with a significant collector/base leakage current) this arrangement may be used. Remember, base-emitter voltage of silicon transistors at low current is 0·7V, but for germanium transistors, 0·1 to 0·2 volts. Here, we can say:

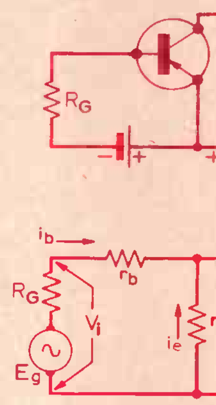
$$V_b=\frac{R_2V_{cc}}{R_1+R_2}$$

Input impedance is increased by current feedback, via R_e. Voltage across R_e is proportional to collector current, I_c.



Coupling two stages this way makes the input resistance of the second stage effectively the load resistance of the first. The value of coupling capacitor depends on the low frequency response of the amplifier. The base bias resistors are in parallel with the input resistance and with the emitter resistance plus internal emitter resistance of the transistor. Voltage-derived feedback is obtained from R_b, effectively reducing input impedance.



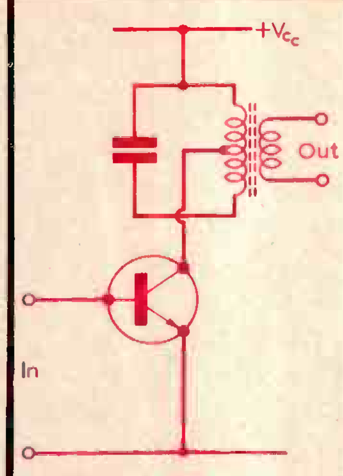


Current Gain	Less than unity	Current Gain	
Input Resistance	Low (200Ω)	Input Resistance	
Output Resistance	High (200kΩ)	Output Resistance	
Voltage Gain	High (about 250)	Voltage Gain	

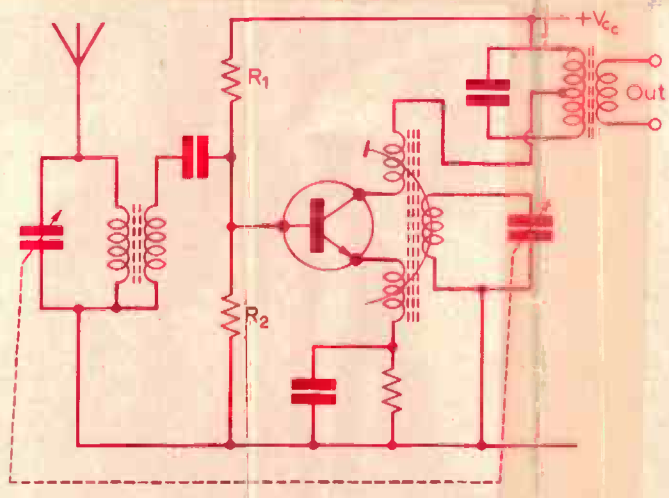
COMMON TRANSISTOR SYMBOLS A

V_{be}	=	Base/emitter voltage
V_{ce}	=	Collector/emitter voltage
I_b	=	Base current
I_c	=	Collector current
β	=	Collector/base current ratio
α	=	Collector/emitter current ratio
α'	=	$\frac{\alpha}{(1-\alpha)}\left[\alpha=\frac{\alpha'}{(1+\alpha')}\right]$
V_{CBO}	=	Max. collector/base voltage
V_{CEO}	=	Max. collector/emitter voltage
V_{CBO}	=	Max. emitter/base voltage
I_{CM}	=	Max. peak collector current
I_{CBO}	=	Max. collector/base reverse current
I_{EBO}	=	Max. emitter/base reverse current

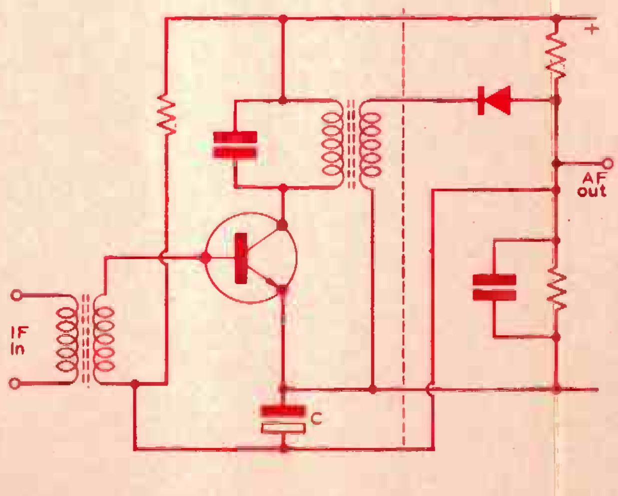
RF CIRCUITS



Typical circuit of r.f. amplifier, with the collector tapped down the tuned circuit to preserve matching. Bias will be obtained from a.g.c. applied to the input circuit.



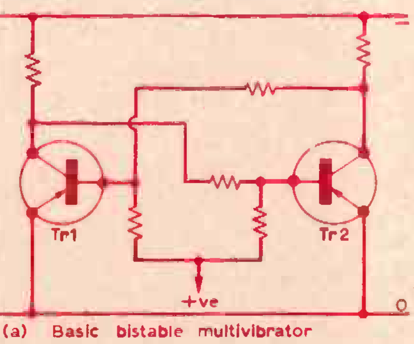
A typical self-oscillating mixer circuit. Oscillator feedback for the emitter is taken through low-impedance coils from the collector. The transistor is biased to Class A by R_1, R_2. As oscillation rises, rectification of the oscillating signal occurs through the base/emitter diode. Loop gain decreases after each cycle, stabilising the amplitude, causing quiescent emitter current to rise.



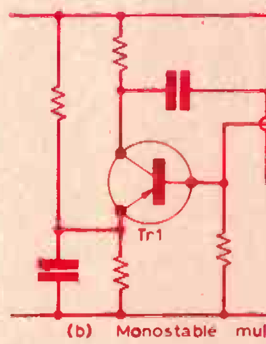
A.G.C. is derived from the detector circuit (to the right of the dotted line) and applied to the input of the first i.f. amplifier. A large electrolytic capacitor, C, is provided to decouple a.f. from the a.g.c. line.

The i.f. transformer may be damped by a diode to improve bandwidth characteristics. The stage shown is for a.m. It is not so necessary to provide a.g.c. for f.m. i.f. stages, where limiting is already applied.

MULTIVIBRATORS



(a) Basic bistable multivibrator



(b) Monostable mult

Three types of transistor switched device are in common use as pulse generators. When a transistor remains in a given state until compelled to change by an external 'trigger' signal, it is termed 'stable'. If, when placed in this state, it then reverts, after a while, to its former state without further external stimulus, it is termed 'unstable'.

Another class of circuit is free-running; that is, it does not stay in either state but automatically switches between 'bistable' when an external trigger pulse is needed to switch it and 'monostable' when it always reverts to its former state after triggering. This type is called 'astable'.

The astable circuit switches at a frequency determined by the circuit time constants. It can be synchronised by an external signal. The multivibrator can be made monostable, bistable or astable by alteration of bias conditions.

In (a) the basic bistable circuit is given. When one transistor is conducting, its collector potential causes the other to be cut off. An external signal causes a change in state. A second external signal causes the circuit to revert to the first state. A recurrent triggering signal will cause a rect-

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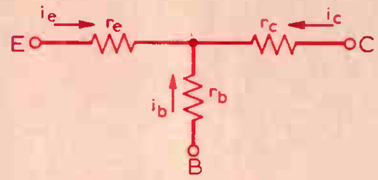

Basic T arrangement of transistor internal resistances

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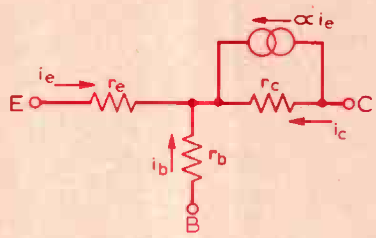
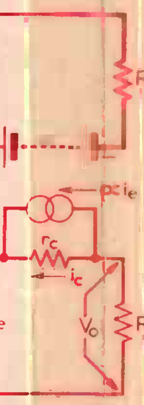
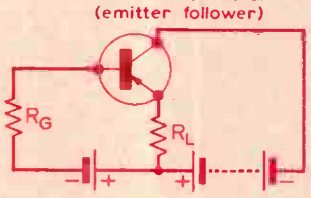


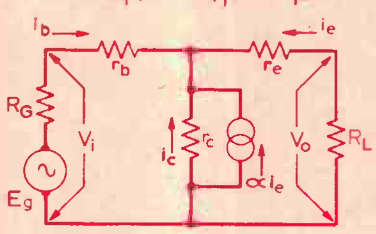
Basic T equivalent circuit

mitter



Common collector (emitter follower)

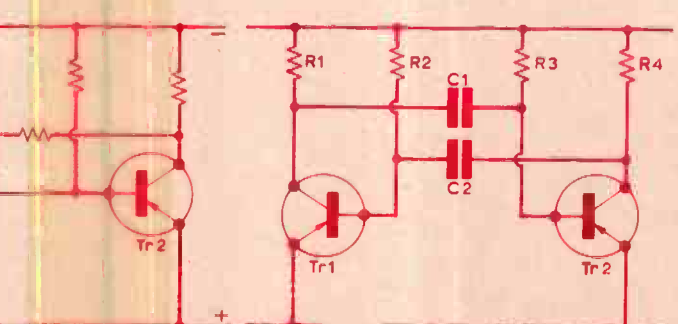




High (50)	Current Gain	High (50)
Medium (1kΩ)	Input Resistance	High (100kΩ)
Medium (40kΩ)	Output Resistance	Low (1kΩ)
High (about 250)	Voltage Gain	Unity

ND ABBREVIATIONS

V_{CEO}(sus)	=	Collector/emitter sustaining voltage
V_{CE}(sat)	=	Collector/emitter saturation voltage
h_{FE}	=	D.C. current gain
h_{fe}	=	Forward current gain, common emitter, output shorted
h_{re}	=	Reverse voltage feedback ratio, common emitter, input open
h_{ie}	=	Input resistance, common emitter, output shorted
h_{oe}	=	Output admittance, common emitter, input open
I'_{co}	=	Collector leakage current (grounded emitter)
I_{co}	=	Collector leakage current (grounded base)



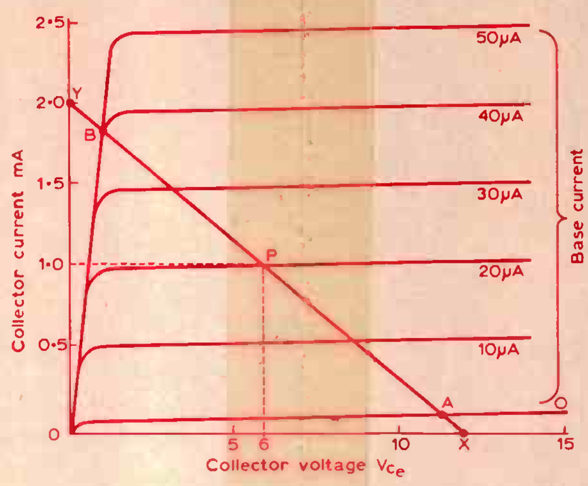
...ivibrator (c) Astable multivibrator

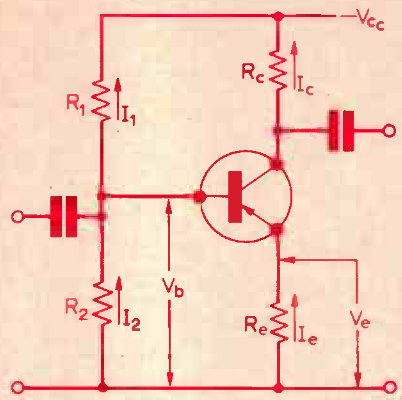
angular voltage waveform to appear at each collector, at half the frequency of the triggering signal.

In (b) is shown the monostable multivibrator circuit, similar to the bistable, except for a change of bias and a capacitor coupling. In the stable state, Tr1 is off and Tr2 on; in its unstable state, Tr2 is off and Tr1 on. The duration of the unstable state is the time the base potential of the non-conducting transistor takes to fall to zero.

If both the inter-stage couplings are made capacitive, an astable multivibrator is obtained. In (c) there is no emitter bias, both bases returned via resistors to the supply line. If R=R2=R3, and C=C1=C2, the multivibrator is symmetrical. As a result, a square waveform should be produced, at both collectors, with a periodicity T=1·38RC. The free-running frequency is the reciprocal of T, i.e. $\frac{1}{1{\cdot}38RC}$ An example of this type of circuit used as an oscillator in a 405-line television receiver, free-running frequency 7·5kHz, triggered frequency 10·125kHz, would have R1 and R4, 3kΩ; R2 and R3, 100kΩ; C1 and C2 0·001μF. A number of transistors will perform adequately in this kind of circuit.

DC CONDITIONS





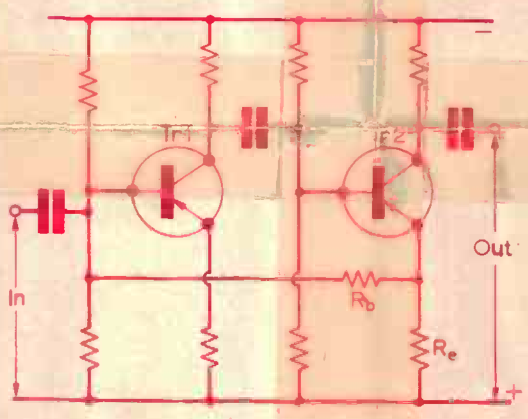
Choosing the right transistor is made easier by reference to its operating conditions. This is a series of curves for different base currents, with collector current plotted against collector voltage. Joining the supply line voltage to the saturation current (quoted in maker's literature) produces a 'load line'. Choose a point midway along this—P in the diagram. Then, in the example, a base current of 20 microamps is required for a collector current of 1mA and a collector voltage of 6 volts. Multiplying the base current for d.c. conditions by the current gain of the transistor gives the required value of collector current.

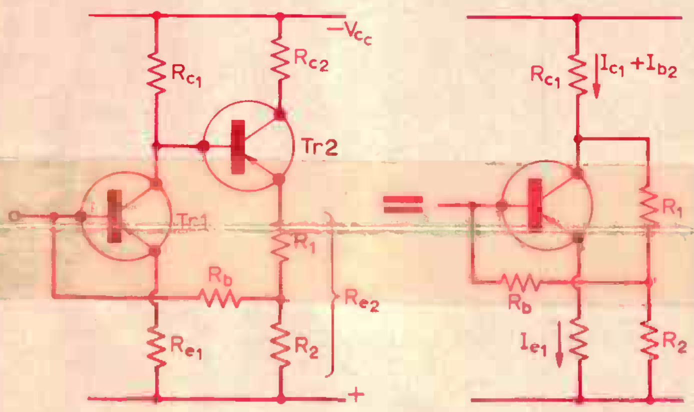
The potentiometer, R_1, R_2, across the supply, provides a tapping point for base control voltage. A bit more bias can be provided by the negative feedback of R_e, in series with the emitter. Ideally, R_1 and R_2 should be as low as possible, but this imposes a drain on the supply, so a compromise solution is reached.

For a typical stage with a supply voltage of 6V, the values of R_1 and R_2 would be 23kΩ and 5kΩ respectively (for a transistor with a current gain of about 50) and R_e would be around 1kΩ. Choice of values is partly determined by the transistor, partly by the power supply. R_1, R_2 must provide a bleed current about ten times that of the base current, but about a fifth of the collector current.

Silicon transistors, with little collector leakage current and a higher 'starting' voltage, will have higher values of R_e. For a typical stage with a supply of 7 volts (positive, this time, for the n.p.n. transistor), R_1 and R_2 would both be 15kΩ. R_e might be 2·7kΩ for a transistor with an h_{FE} of 100 (50–150) using an emitter current of 1mA.

AF CIRCUITS



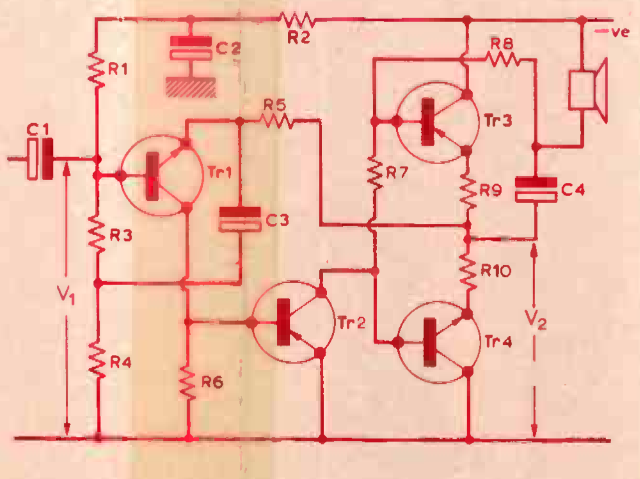


The basis of much simple audio design—a two-stage current amplifier. The current amplifier gives a current output for a voltage input and has a low input resistance and a high output resistance. D.C. stabilisation is included as before and feedback is obtained by R_b from the emitter of Tr2 to the base of Tr1. Overall current gain can be given by R_b/R_e and is independent of transistor parameters. The emitter of Tr1 is decoupled for a.c. negative feedback—i.e., the feedback is frequency-dependent.

For a voltage amplifier (high input resistance, low output resistance), it is more usual for the feedback R_b to be taken from the collector of Tr2 to the emitter of Tr1. The emitter of Tr2 is decoupled and overall voltage gain is again R_b/R_e, but this time R_e is the emitter resistor of Tr1.

Direct coupling of the two-stage amplifier saves components by stabilisation of Tr1 by Tr2. A circuit equivalent shows the way this system operates, with the 'collector' current the sum of Tr1 collector current and Tr2 base current. Bias stability is superior to the previously described two-stage circuit.

In a typical pre-amplifier using silicon n.p.n. transistors, such as the BC109 or BC108 as Tr1 and Tr2, with a supply voltage of 20 volts, the only practical modification would be a further stage of decoupling between the supply to Tr1 and the main supply, which would be positive. This might consist of a 100kΩ resistor with a 2·5μF electrolytic to chassis. Then Rc1 would be 100kΩ; Re1, 680Ω; Rc2, 12kΩ; Re2, 560Ω and Rb, 220kΩ.



The basic complementary push-pull circuit has the signal from the driver transistor Tr2 simultaneously driving the bases of a pair of transistors, one of which is p.n.p. and the other, n.p.n. These conduct during alternate half-cycles of signal. Tr1 is a pre-amplifier and a difference-amplifier to compare the voltages of input and output.

The quiescent bias voltage for the output transistors is developed across R7. Bias is set for a linear combined transfer characteristic, to reduce crossover distortion. In practice, compensation for temperature changes would be made by fitting a thermistor across R7, and for supply changes by the use of diodes in this part of the circuit.