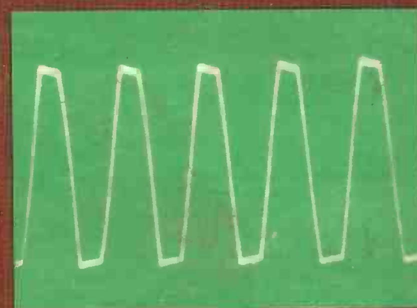
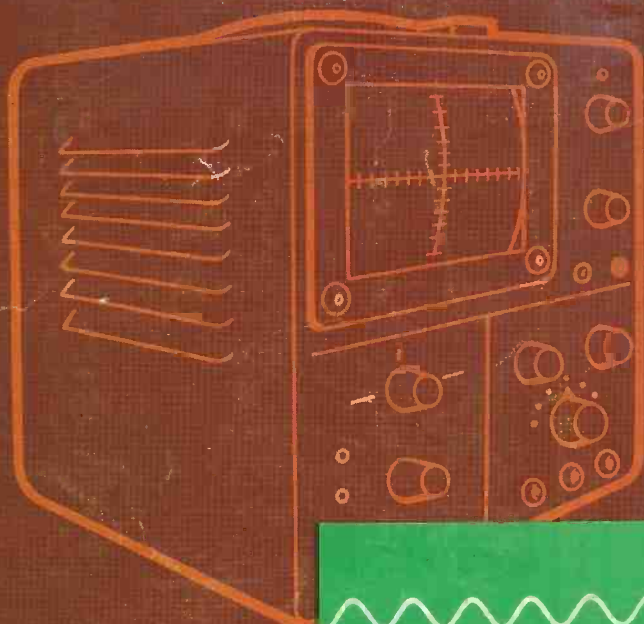
PRACTICAL WIRELESS

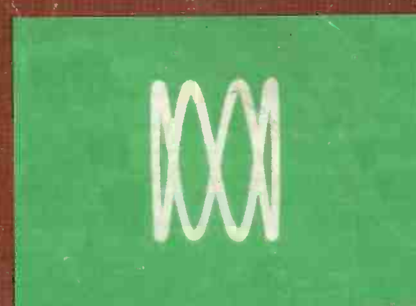
AUGUST 1972

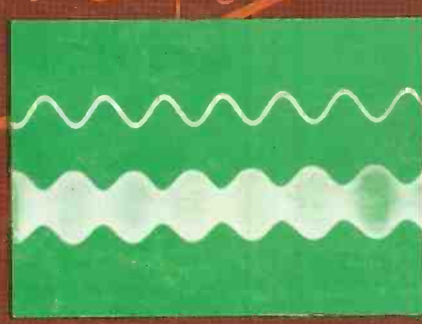
20p

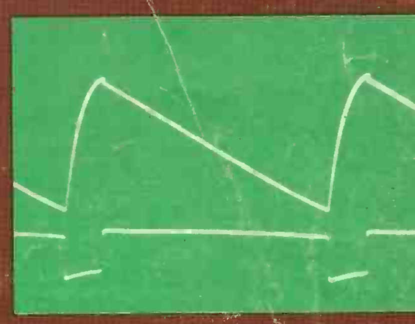
THE OSCILLOSCOPE at work











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INSTALLING YOUR CAR RADIO

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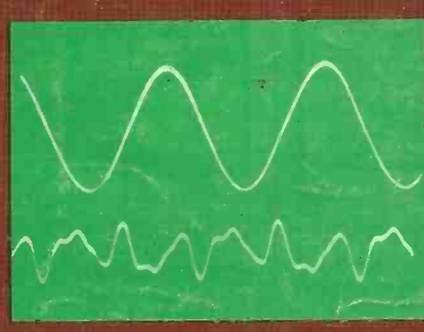
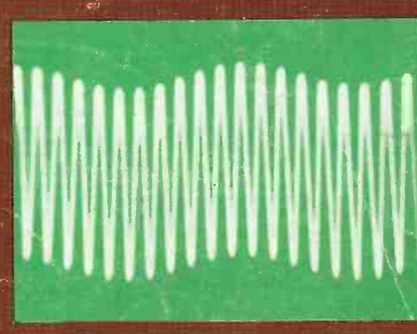


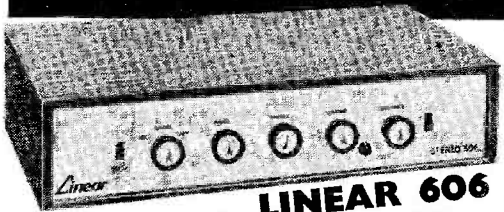


NEW FROM LINEAR

Representing really exceptional value

TWO STEREO AMPLIFIERS

IN ELEGANT TEAK FINISH CASES!



LINEAR 606

6+6 WATTS

0-200-230-250v. 50 Hz A.C. mains operation.

Inputs for magnetic or Ceramic Pickup, Tape or Radio Tuner.

Recommended Retail Price

£22·50

TECHNICAL DETAILS

Bass Control ± 12 dB at 40 Hz.
Treble Control ± 12 dB at 14 KHz.
Sensitivities Mag. P.U. 3·5 m.v. into 47K ohm R.I.A.A. Ceramic P.U. 35 m.v. into 100K ohm. Tape Amp. 100 m.v. into 100K. Radio Tuner 400 m.v. into 400K ohm.
Crosstalk 53 dB.
Hum and Noise—75 dB min. vol.—65 dB max. vol.
Total Harmonic Distortion 0·1% at 1watt into 15 ohms.
Output (per channel) 6·5 watts I.H.F.M.

- ★ Individual Bass and Treble Controls.
- ★ Frequency Response ± 1½ dB 20 Hz to 65 KHz.
- ★ Outputs for Speaker impedances between 3 and 15 ohms.
- ★ Stereo/Mono Switch.
- ★ Input Selector Switch.
- ★ Solid State Circuitry.
- ★ Attractive silver finished metal facia and matching control knobs.

- ★ A modestly priced solid state unit.
- ★ The Silver Facia with black lettering enhanced by matching control knobs, provides a high standard of appearance.
- ★ Suitable for crystal Gram. Pick-up cartridges and Radio input.
- ★ A wide range of tone variation is provided by the separate Bass and Treble 'lift' and 'cut' controls.
- ★ A selector switch permits instantaneous selection of Gram. or Radio.
- ★ Speaker impedances between 3 and 15 ohms are suitable.

TECHNICAL DETAILS

Frequency Range 20 Hz to 20 KHz
Output (per channel) 5 watts I.H.F.M.
Bass Control ± 12 dB at 60 Hz.
Treble Control ± 14 dB. at 14 KHz.

PRINTED CIRCUIT CONSTRUCTION EMPLOYING 10 TRANSISTORS

LINEAR 505

5+5 WATTS

Recommended Retail Price

£17·50

0-200-250v. 50 Hz A.C. mains operation

Wholesale and Retail enquiries to the Manufacturers

ALL LINEAR AMPLIFIERS GUARANTEED FOR 12 MONTHS

LINEAR PRODUCTS LTD., Electron Works, Armley, Leeds. LS12 3SA Tel. 630126

SOUND BARGAINS

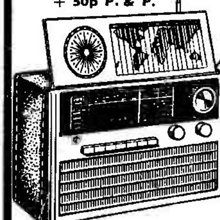
GIANT POWER MULTI-WAVEBAND COMMUNICATIONS RECEIVER

WITH 3 in 1 AC/DC POWER SUPPLY SYSTEM
MAINS/BATTERY plus BUILT-IN BATTERY BOOSTER

£10·50 + 40p. P. & P.

THIS NEW 1972 RADIO. No less than **3 VHF BANDS.** Picks up **Aircraft Transmissions, Pop Pirates, Taxis, Ambulances, Local Radio, Continental and all BBC, VHF Stations plus fascinating Public Service Transmissions we are not allowed to mention! Even TV Sound in certain areas. PLUS A SPECIAL WEATHERBAND.** Frequency ranges: MW540-1600 KHZ, FM88-108 MHZ, Airband 108-145 MHZ, VHF 145-175MHZ, 23 semi-conductors—12 transistors 11 diodes and thermistors. Automatic frequency control stops irritating station drift. Built-in adjustable 8-section 31" telescopic aerial. Runs off mains AC 230/250 volts or off 4 U2 batteries, or use re-chargeable nickel alkali cell. Finished in strong leather grained case with carrying handle. Approx. size 10¾" x 6¾" x 3¾". Written gurantee. **Special magnetic ear-piece for personal listening, dry batteries FREE. HURRY!** Limited quantity only from Marktyme. **Money back guarantee.**

OUR PRICE **£28·95** + 50p P. & P.



Tune into the world with this amazing communications receiver. A truly exceptional unit in performance and looks—leatherette with Stainless steel trim. Looks good anywhere. Use either as a portable with standard batteries or plug it directly into 220-240 volt domestic mains supply. 14 Transistors; 9 diodes; 1 thermister. Internal ferrite rod antenna plus telescopic aerial. Separate tone, volume and tuning controls with push-button selectors for the **8 WAVE-BANDS.** Complete with Hi-Fi earphone for personal listening. Frequency ranges: **Long wave** 150-350Kcs. **Medium** 353-1605Kcs. **Marine** 1·6-4·5Mcs. **Short Wave** 12-24Mcs. **FM/VHF** 88-108Mcs. **Aircraft** 108-135Mcs. **PUBLIC SERVICE BANDS** 135-174Mcs. Fully guaranteed.

N.B. The Ministry of Post & Telecommunications has pointed out that a licence (not generally available to the public) is required for reception of transmissions by Fire Brigade, Aircraft, Shipping, etc.

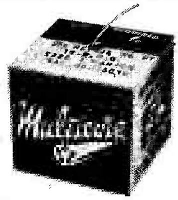
MARKTYME (DEPT. PW3), 372 EDGWARE ROAD, LONDON, W.2 Tel. 01-723 0094. Callers welcome Monday to Saturday 9 a.m. to 6 p.m.

ERSIN Multicore 5 CORE SOLDER

for fast, easy reliable soldering

Ersin Multicore Solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.

IDEAL FOR HOME CONSTRUCTORS



Size 1 cartons all at 25p each in 40/60, 60/40, or Savbit alloys in 7 gauges.

EASY-TO-USE DISPENSERS

Size 5 (Savbit) 18swg, 18p (illustrated)

Size 19A (60/40 alloy) 18swg. 18p

Size 15 (60/40 alloy) 22swg. 22p

BIB WIRE STRIPPER AND CUTTER

NEW!

Model 3A. Strips insulation from cable or flex without nicking wire. 4 different settings, 4&6 BA spanner ends, ground cutting edges Price 32p. Also available, de luxe Model 8. Price 58p.

From Electrical and Hardware Shops. If unobtainable, write to: Multicore Solders Ltd., Hemel Hempstead, Herts.

A QUARTER TURN RIGHT!

...opens a world of real stereo sound

VISCOUNT III AUDIO—£52 complete

PRICES SYSTEM 1	Viscount III R101 amplifier	£22·00 +90p p&p
	2 × 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+£3·50 p&p

PRICES SYSTEM 2	Viscount R101 amplifier	£22·00 +90p p&p
	2 × 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

14 + 14 watts r.m.s. 40 Hz to 40kHz ± 3dB. Total distortion at 10 watts at 1kHz —0·1%

This is real value for money! We have designed 2 systems and the heart of them is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For both systems we have chosen the famous Garrard SP25 Mk. III deck which comes complete with simulated teak plinth and dust cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

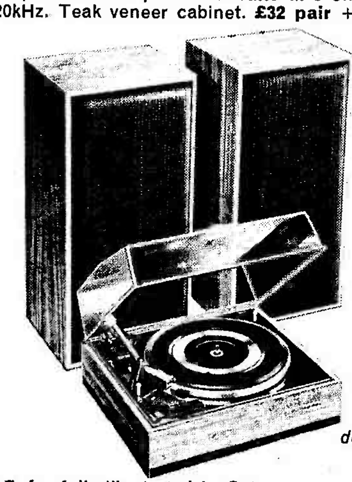
SPECIFICATION

14 watts per channel into 3 to 4 ohms (suitable 3-15 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.)—P.U.1 and radio —65dB. P.U.2 —58dB. *Cross talk* better than —35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13$\frac{3}{4}$in × 9in × 3$\frac{3}{4}$in.

SPEAKERS

Duo Type II
Size approx. 17in × 10$\frac{3}{4}$in × 6$\frac{3}{4}$in. Drive unit 13in × 8in with parasitic tweeter. Max. power 10 watts, 8 ohms. Simulated Teak cabinet. **£14 pair** + £2 p&p.

Duo Type III
Size approx. 23$\frac{1}{2}$in × 11$\frac{1}{2}$in × 9$\frac{1}{2}$in. Drive unit 13$\frac{1}{2}$in × 8$\frac{1}{4}$in with H.F. speaker. Max. power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair** + £3 p&p.



Goods not despatched outside U.K.

R T V C

S.A.E. for fully illustrated leaflet
Radio and TV Components (Acton) Ltd. 21c High Street, Acton, London W3 6NG. 323 Edgware Road, London W2.
Mail orders to Acton. Terms C.W.O. *All enquiries S.A.E.*

£25 *takes the wraps off* UNISOUND

a new concept in stereo

See opposite page for address

The whole system is complete *including superb cabinets in simulated teak* —just simply screw together the components and you save pounds! Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge with (diamond stylus), teak simulated plinth and tinted acrylic cover. Plus the big 13″ x 8″ EMI Twin-cone speakers ready for mounting in their elegant cabinets.
Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.

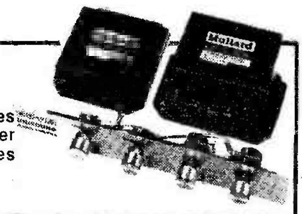
£25 complete plus £2·80 p. & p.

Power output: 4 watts per channel into 8 ohms.
Inputs: 120 mV (for ceramic cartridges).
Stereo headphones with adaptor £4·00

R T V C

UNISOUND MODULES ONLY £6.95

If you prefer, you can buy the three modules —pre-amplifier, power supply/dual power amplifier, and control panel—by themselves for only **£6·95.** P. & P. 50p extra.

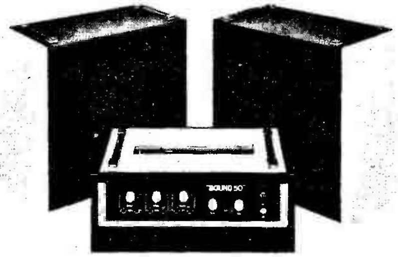


RELIANT Mk IV

★ 5 Electronically Mixed Inputs. ★ 3 Individual Mixing Controls. ★ Separate bass and treble controls common to all 5 inputs. ★ Mixer employing F.E.T. (Field Effect Transistor). ★ Solid State Circuitry. ★ Attractive Styling.

£9.50 plus p. & p. 60p

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 @ 60Hz. Treble control range ±12dB @ 15KHz. Separate ON/OFF Switch. Neon Indicator. **POWER OUTPUT:**—12 Watts R.M.S. into 3 to 4 ohms speaker. **SIGNAL/NOISE:**—Better than −60dB on inputs 3, 4 and 5 & −50db on 1 & 2. **SUPPLY:**—220-250 AC Mains. **SIZE:**—12½″ × 6″ × 3½″.



SOUND 50

50 WATT AMPLIFIER AND SPEAKER SYSTEM

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 10KHz. **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 I 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.

DUETTO MK. II I.C.

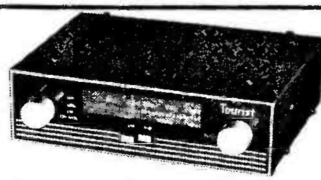
STEREO AMPLIFIER

Mullard built stereo pre-amplifier/tone control module and the highly efficient I.C. monolithic power chips ensure reliability and very low distortion at all power levels.
INPUTS:—P.U. 150mV. @ 2·2 Meg (for ceramic cartridge)
Auxiliary 100mV. @ 1 Meg (for radio, tape etc.)
OUTPUTS:—5 watts R.M.S. per channel into 8–15Ω speakers.
Switched stereo headphone socket with power correction.
CONTROLS:—Mono/stereo switch, selector switch, treble, bass, volume, balance and on/off switch. Neon indicator.
TONE CONTROLS:—Treble ±14db @ 15KHz.
Bass ±14db @ 60Hz.
POWER BANDWIDTH:—±2db 20Hz-25KHz.

£10.50 plus P. & P. 60p.

TOURIST MK 3

CAR RADIO ALL TRANSISTOR



Beautifully designed to blend with the interiors of all cars. Permeability tuning and long wave loading coils ensure excellent tracking, sensitivity and selectivity on both wave bands.
R.F. sensitivity at 1MHz is better than 8 micro volts. Power output into 3 ohm speaker is 3 watts. Pre-aligned I.F. module and tuner together with comprehensive instructions guarantees success first time. 12 volts negative or positive earth. Size 7in × 2in × 4½in deep.
Circuit diagram 13p. Free with parts. Speaker, baffle and fixing kit £1·25 extra, plus 23p p. & p. Postage free when ordered with parts.

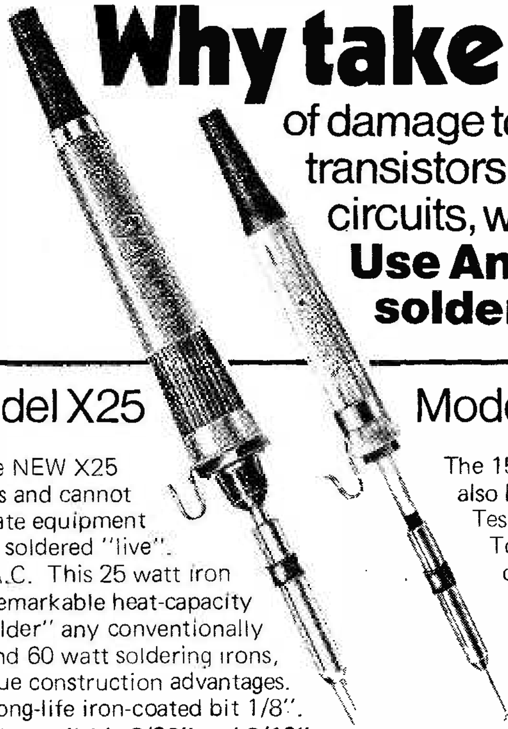
SET OF PARTS
£6.30
plus P. & P. 50p.

R T V C
See opposite page for addresses

Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

Use Antex low-leakage soldering irons



Model X25
220-240 Volts or 100-120 Volts

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". **2 other bits available 3/32" and 3/16".**

Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed

PRICE: £1.75 (rec. retail)
Suitable for production work and as a general purpose iron

Model CCN
220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32"

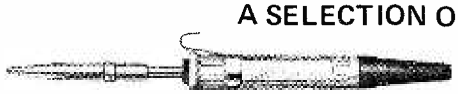
4 other bits available 1/8", 3/16" 1/4" and 1/16"

PRICE: £1.80 (rec. retail)

OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

A SELECTION OF OTHER SOLDERING EQUIPMENT.

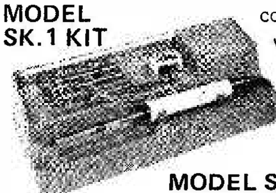


MODEL CN
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24
PRICE: £1.70 (rec. retail)

MODEL CN2
Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.
PRICE: £1.70 (rec. retail)

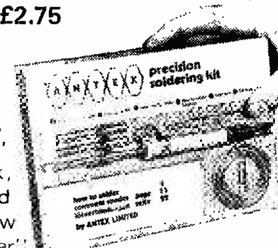
MODEL G
18 Watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.
PRICE. £1.83 (rec. retail)

MODEL SK.1 KIT

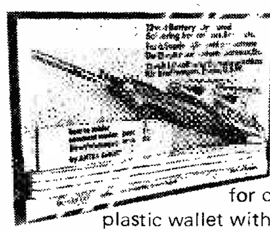


contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE £2.75

MODEL SK.2 KIT



contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder and booklet "How to Solder"
PRICE £2.40



MODEL MES.KIT Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder." **PRICE £1.95**

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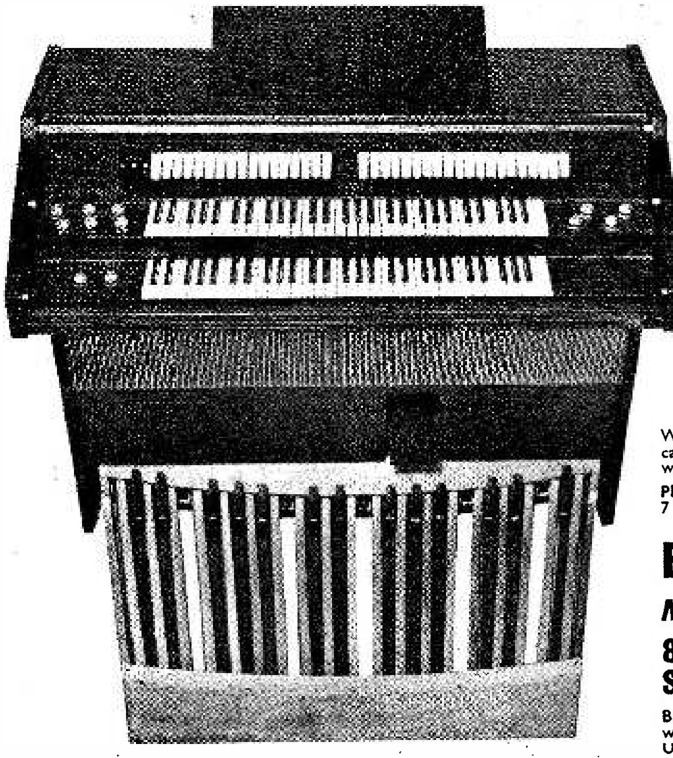

ORGAN KITS

Build your own Electronic Organ, if you want the best value for your money. Yes you really save over 50% and get the best and up-to-date designs. There are four models to choose from.

★ Portable—4 octave keyboard with 10 voices, 3 pitches—vibrato, at **£103·00,** P/P £1·50.

★ Console—5 octave keyboard with 10 voices, 3 pitches . Keyboard can be split into solo and accompaniment. Vibrato built in amplifier and 50 watt 12" Goodmans speaker at **£167·00,** P/P £5·00.

★ Console—2 x 4 octave keyboards and 13 note pedal board, 29 voices, Vibrato, Delay Vibrato, Sustain Reverberation, Precussion, Wah Wah, etc. at **£406·00.** Carr. paid on complete kit U.K. only.

★ Console—2 x 5 octave keyboards and 32 note pedal boards, 32 voices. Vibrato, Delay Vibrato, Sustain Reverberation, Precussion, 3 Couplers, etc., at **£572·55** carr. paid on complete kit U.K. only.

We regret H.P. facilities are not available, but components can be bought separately. Trade and overseas enquiries welcomed. Send 15p for latest catalogue.

Please call in for demonstration. Business hours: 10 a.m. to 7 p.m. Monday to Saturday. Thursday closed.

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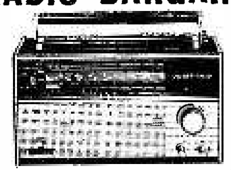
RADIO BARGAINS



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PRACTICAL WIRELESS ELECTRONIC IGNITION SYSTEM

This Capacitor-discharge Electronic ignition system was recently described in Practical Wireless and has proved extremely popular. We are able to offer the kit in two forms; the Standard kit containing the electronic components only, enabling the customer to tailor these to his own layout, or the De-luxe version containing a ready-drilled roller-trimmed printed circuit board and fully machined die-cast case with electrical connection block. Each kit is supplied with a custom wound transformer, first-grade components and full construction details. Suitable for 12V. systems only, pos. or neg. earth. All components available separately. Case size 4¾" x 3½" x 2". Complete assembly and wiring manual 25p, refundable on purchase of kit.

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ACY17	0·20	2G303	0·13
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AF186	0·20	2N1302-3	0·15
AF139	0·30	2N1304-5	0·17
BC154	0·20	2N1306-7	0·20
BC107	0·10	2N1308-9	0·22
BC108	0·10	2N3819FET	0·35
BC109	0·10	2N4416FET	0·35
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BF274	0·20	**Transistors**	
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BSY27	0·13	OC26	0·25
BSY28	0·13	OC28	0·30
BSY29	0·13	OC35	0·25
BSY95A	0·10	OC36	0·37
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OC44	0·13	AUY10	1·25
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OC72	0·10	**Diodes**	
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H9	2	OCP71 Light Sensitive Photo Transistor	50p
H12	50	NKT155/259 Germ. diodes, brand new stock clearanee	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO-5 can	50p
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H38	30	Short lead Transistors, NPN Silicon Planar types.	50p

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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
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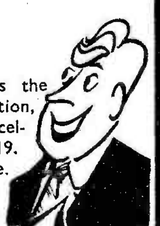

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SL403D Audio Amp., 3-Watts	1·50	1·37	1·32
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ARMSTRONG 521	59·00	44·95
DULCI 207M	32·00	19·50
FERROGRAPH F307 Mk. II (cased)	64·00	44·90
GOODMANS Maxamp	54·00	34·95
LEAK Delta 30 (cased)	65·00	47·95
LEAK Delta 70 (cased)	79·50	58·95
METROSOUND ST20E	39·50	24·95
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PHILIPS RH590	52·00	35·50
PHILIPS RH580	29·00	19·95
PIONEER SA500A	45·50	30·95
PIONEER SA600	89·60	58·95
PIONEER SA800	119·85	75·95
PIONEER SA900	133·83	90·95
PIONEER SA1000	147·83	93·75
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RANK Rotel 310	47·50	31·95
RANK Rotel 610	74·50	49·50
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ROGERS Ravensbourne (cased)	69·50	49·50
ROGERS Ravensbrook Mk. II	50·50	35·95
ROGERS Ravensbrook (cased) Mk.II	55·50	39·95
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Project 60/2 x Z30/PZ5	23·90	15·95
Project 60/2 x Z50/PZ8/trans	34·86	21·95
Project 605	29·95	18·90
AFU	5·98	4·50
Neoteric	61·95	42·93
3000	45·00	29·50
TELETON SAQ 206B	33·00	19·50
307	33·00	20·95
GA202 15 watt RMS P. Chan.	Spec. Price	28·50
WHARFEDALE Linton Amplifier	60·00	39·95

All take both ceramic and magnetic cartridges.

TUNERS

	Rec. Retail Price	Comet Price
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*ARMSTRONG 524 FM	40·97	30·95
ARMSTRONG M8 Decoder	9·50	6·95
*DULCI FMT.7 FM	24·43	17·50
DULCI FMT.7S Stereo	32·89	24·50
GOODMANS Stereomax	75·74	46·95
LEAK Delta FM	73·00	53·95
LEAK Delta AM/FM	87·00	65·95
PHILIPS RH 690	44·15	31·95
PHILIPS RH 691	83·40	62·95
PIONEER TX500 AM/FM	70·93	52·50
PIONEER TX600 AM/FM	100·37	77·95
RANK ROTEL 320	53·38	38·50
RANK ROTEL 620	86·33	69·95
ROGERS Ravensbourne chassis	57·95	42·50
ROGERS Ravensbourne in teak case	62·63	47·25
ROGERS Ravensbrook chassis	42·14	30·95
ROGERS Ravensbrook (cased)	48·00	34·95
SINCLAIR 2000	45·00	32·95
SINCLAIR 3000	45·00	32·95
SINCLAIR Project 60 tuner (stereo)	25·00	18·50

All above Tuners are complete with MPX Stereo Decoder except where starred.

TUNER/AMPLIFIERS

	Rec. Retail Price	Comet Price
AKAI AA 8500	228·34	169·95
AKAI 6600	145·26	105·50
AKAI 6300	125·83	92·50
AKAI 6200	97·09	72·50
ARENA 2600	111·30	65·95
ARMSTRONG M8 Decoder	9·50	6·95
ARMSTRONG 525	90·14	67·75
ARMSTRONG 526	102·72	77·50
GOODMANS Module 80, 35w. RMS	89·02	66·95
GOODMANS Module 80 Compact	160·38	125·95
GOODMANS Module 110 FM/MW/LW/SW 100W RMS	131·22	104·95
LEAK Delta 75	160·00	127·95
MIDLAND 19/542	49·56	36·75
PHILIPS RH 790	134·00	74·95
PIONEER SX770 AM/FM	135·80	104·95
PIONEER SX440 AM/FM	101·60	78·95
ROGERS Ravensbrook Chassis	96·57	74·25
ROGERS Ravensbrook (cased)	105·35	79·95
ROTEL RX150	67·93	51·95
TANDBERG 1171 MPX	103·03	84·95
TANDBERG TR200 MPX	96·23	79·95
TELETON F2000	51·50	27·25
TELETON CR55	125·26	68·50
TELETON R8000 AM/FM	42·16	21·95

All the above take magnetic cartridges except Teleton F2000 and R8000 which take ceramic only.

All include MPX Stereo Decoder with the exception of Armstrong where M8 decoder is extra.

TURNTABLES

	Rec. Retail Price	Comet Price
GARRARD SP25 Mk III	16·17	9·45
GARRARD SL65B	20·93	13·95
GARRARD SL95B	49·21	31·95
GARRARD 401	39·04	25·95
GARRARD SL72B	32·60	22·95
GARRARD Zero 100A	57·42	39·95
GARRARD Zero 100S	52·83	38·95
GARRARD WB4 base Mk IIZ to fit Zero 100 & Zero 100S	6·55	4·95

The following Turntables are complete with base, plinth, perspex cover and cartridge. Fully wired and ready for use. All at special prices.

	Rec. Retail Price	Comet Price
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GARRARD SP25 Mk III with Shure M.44/7		Special Price £19·75
GARRARD SP25 Mk III with Shure M.44/E		Special Price £20·95
GARRARD AP76 with Goldring G800		Special Price £28·75
GARRARD AP76 with Shure M55E		Special Price £32·25
GARRARD AP76 with Shure M75EJ		Special Price £34·25
GARRARD 2025 with Sonotone 9TAHC		Special Price £13·90
GOLDRING 705/P with G850	£26·00	£10·95
GOLDRING GL75 with G800		Special Price £38·95
THORENS 150 AB complete with TX11 cover Shure M55E cartridge	£60·46	£47·95

	Rec. Retail Price	Comet Price
Base and Cover to fit GARRARD AP76, SL55, SL65B	Spec. Price	3·60
GARRARD 40B	13·63	10·95
GARRARD AP76	28·44	17·95
GOLDRING GL69 MKII	26·86	18·50
GL69P Mk. II	35·23	25·25
GL75	39·06	26·75
GL75P	47·43	34·50
Covers for 69P and 72P	4·36	3·75
Cover for 75P Deluxe	4·88	3·95
C99—plinth and cover for G99	10·75	9·75
GOLDRING G99	27·90	19·25
GOLDRING G101P/G	27·90	20·25
GOLDRING GL72 Chassis	27·90	20·95
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GOLDRING GL85	61·03	46·50
GOLDRING GL85P	70·80	54·75
LEAK Delta	67·50	54·75
McDONALD MP60	14·80	9·50
610	18·79	13·95
HT70	20·68	14·75
HT70 inc. plinth and cover	29·89	22·50
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PHILIPS 202 Electronic	64·65	46·95
PHILIPS 308 transcription unit complete with base and cover	36·55	28·25
PIONEER PL12AC with base & cover	47·15	33·95
THORENS TX25 cover	8·26	6·60
THORENS TD125	73·78	56·50
THORENS TD125AB	112·14	89·95
THORENS TD150 Mk. II	33·64	26·95
THORENS TD150A Mk. II	43·09	32·95
THORENS TD150AB Mk. II	46·63	36·95
THORENS TX11 Cover	4·13	3·75
WHARFEDALE Linton with base and cover and Shure M44-7 cart.	34·50	27·25

PICK-UP ARMS AND HEADS

	Rec. Retail Price	Comet Price
AUDIO TECHNICA AT1005 Mk II	18·78	14·25
AUDIO TECHNICA L2 LIFTS	2·61	1·95
GOLDRING Lenco 75	13·51	9·30
GOLDRING Lenco L69	9·77	6·40
SME 3009 with S2 Shell	32·34	24·50
SME 3012 with S2 Shell	34·44	26·50
SME S2 HEADSHELL	2·59	1·95

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	Rec. Retail Price	Comet Price
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AMSTRAD 138 (pair) 13"×8" twin cone teak	26·00	15·95
B & W Model 70	159·50	111·95
B & W DM2	62·50	51·95
B & W DM3	63·00	46·25
B. & W DM1 (pair)	75·20	57·25
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CELESTION Ditton 120 (pair)	56·40	42·95
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CELESTION Ditton 25	65·00	44·95
CELESTION Ditton 44	54·00	38·50
CELESTION Ditton 66	99·00	74·95
FERROGRAPH S1 inc. stand	95·00	74·95
GOODMANS Havant (pair)	54·42	39·95
GOODMANS Minster (pair)	50·62	34·20
GOODMANS Magister	65·63	37·45

SPEAKERS—*continued*

	Rec. Retail Price	Comet Price
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GOODMANS Mezzo 3	35·70	22·45
GOODMANS Magnum K2	46·20	28·95
GOODMANS Dimension 8	72·44	47·50
GOODMANS DIN 20NT kit	12·19	8·95
KELETRON KN400 2-speaker System (pair)	15·86	11·95
KN600 3-speaker System (pair)	26·46	17·50
KN800 3-speaker System	15·90	10·25
KN1100 4-speaker System	20·40	13·95
KN1600 3-speaker System	25·20	15·95
KN2100 3-speaker System	30·60	20·45
LEAK 150 (pair)	49·00	35·75
LEAK 250 (pair)	63·00	45·50
LEAK 600	49·50	32·45
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METROSOUND HFS 103 (pair)	29·21	23·50
METROSOUND 202	21·50	15·25
METROSOUND Duplex 15	32·00	23·95
METROSOUND Duplex 25	52·00	36·95
PHILIPS RH 402 (pair)	44·70	27·20
PHILIPS 406	34·00	28·20
SINCLAIR Q16	8·98	6·75
STE-MA 450	25·00	16·95
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TANDBERG Tan 11 (pair)	36·94	31·20
TANDBERG Tan 12 teak (pair)	48·82	43·83
TANDBERG Tan 25 teak (pair)	66·08	56·50
TANDBERG Tan 50 teak	65·00	49·95
TELETON 8000 (pair)	21·08	11·95
THORPE Grenville TG 100 (pair)	28·95	17·95
Grenville TG 200 (pair)	41·95	25·95
Grenville TG 300 (pair)	55·95	31·95
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Linton Mark II	49·00	36·95
Melton Mark II	35·00	23·95
Dovedale 3 Mark II	45·00	30·50
Rosedale	65·00	44·95
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Unit 3 Speaker Kit	12·00	8·95
Unit 4 Speaker Kit	18·00	11·95
Unit 5 Speaker Kit	26·00	17·25

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	Rec. Retail Price	Comet Price
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Twin Axiom 10	9·58	7·75
Axiom 401	17·68	12·25
Audiom 8P	5·20	4·15
Audiom 10P	5·67	4·70
Audiom 12P	13·00	9·90
Audiom 15P	21·00	15·75
Audiom 18P	35·70	25·95
Audiom 100 40 watts DIN	12·00	9·50
ARU 172	4·50	3·20
Axent 100	6·90	4·90
Midex 650	13·59	9·30
Attenuator	3·73	2·70
Crossover Network XO/950	7·77	5·25
WHARFEDALE 8in. Bronze/RS/DD	4·50	3·40
Super 8/RS/DD	8·00	6·60
Super 10/RS/DD	13·00	11·00
WMT1 Matching Transformer	0·84	0·70

CARTRIDGES

	Rec. Retail Price	Comet Price
AUDIO TECHNICA AT66	6·47	3·95
GOLDRING G850	6·10	3·45
GOLDRING G800	12·21	5·80
GOLDRING G800E	17·67	8·95
GOLDRING G800 Super E	24·41	14·40
*GOLDRING CS90 Stereo	4·88	4·20
*GOLDRING CS91/E	7·33	6·20
EMPIRE 1000ZE/X	59·12	44·95
EMPIRE 999VE/X	42·14	32·50
EMPIRE 999TE/X	24·58	19·25
EMPIRE 999SE/X	19·90	15·25
EMPIRE 999E/X	15·57	11·70
EMPIRE 909E/X	12·12	9·25
EMPIRE 90EE/X	9·57	7·15
ORBIT Magnetic NM 22	Sp Price	2·75
ORTOFON M15E	27·60	22·75
SHURE M3DM	6·10	3·95
SHURE M31E	11·63	6·95
SHURE M32E	10·73	6·50
SHURE M32-3	9·84	7·65
SHURE M44-5	8·30	5·25
SHURE M44-G	8·30	5·25
SHURE M44-7	7·90	5·15
SHURE M-44C	7·90	5·40
SHURE M44E	8·60	5·50
SHURE M55E	9·70	5·95
SHURE M75G	14·70	8·45
SHURE M75-6	13·60	7·90
SHURE M75EJ	15·40	9·25
SHURE M75E	19·00	11·50
SHURE M75 ED	19·00	11·50
SHURE M75E/95G	20·80	14·25
SHURE V15-11	39·40	26·95
SONOTONE 9TAHC Diam/Saph.	3·75	1·95

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BASES AND COVERS

	Rec. Retail Price	Comet Price
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WB4 Base	5·60	4·70
SPC1 Cover	3·68	2·90
SPC4 Cover	4·38	3·50
Special offer of Base and Cover to fit SP25, SL55, SL65B and 3500	Special Price	3·60
WB4 base Mk IIZ to fit Zero 100 and Zero 100S	6·55	4·95
GOLDRING Plinth 75	8·37	7·00
GOLDRING Plinth 69	8·37	7·00
GOLDRING Covers for 69P and 72P	4·36	3·75
Cover for 75P De luxe	4·88	3·95
THORENS TX25 (for TD125AB)	8·26	6·60
THORENS TX11 Cover	4·13	3·75
Base and Cover for TD125	12·39	10·50
SME Plinth System 2000 with motor-board	46·20	37·00
MOTORBOARDS only	5·85	3·95

BLANK TAPES

	Rec. Retail Price	Comet Price
SCOTCH DYNARANGE CASSETTES		
C60	0·71	0·45
C90	0·99	0·55
C120	1·49	0·80
SCOTCH HIGH ENERGY COBALT CASSETTES		
C60	1·45	0·95
C90	1·90	1·25
SCOTCH 8 Track Blank Cartridges		
40 mins	1·50	0·95
80 mins	1·80	1·10
SCOTCH LONG LIFE SPOOLED TAPE		
5" L.P. 900	1·41	0·95
5¾" L.P. 1200	1·76	1·20
7" L.P. 1800	2·52	1·70

Postage—Tape, cassettes and 8T cartridges 1-9 items 5p per order. Packs of ten post free.

HI-FI STEREO SYSTEMS COMPLETE

	Rec. Retail Price	Comet Price
ALBA UA552	47·75	34·65
AMSTRAD Stereo 1000	48·00	33·95
BUSH A1005	69·89	53·25
DANSETTE Consort Stereo	34·43	24·95
DECCA Sound 613	Special Price	53·95
DECCA Sound 614	Special Price	57·95
DECCA Sound 1204	Special Price	76·95
DECCA COMPACT 2	Sp. Price	79·95
DECCA Compact 3	Special Price	102·35
DECCA 403	Special Price	47·75
ELIZABETHAN LZ101	58·33	41·85
FERGUSON 3450 with Radio	70·45	53·95
FERGUSON 3451 with Radio	96·80	75·95
FIDELITY UA2 Music Master	43·50	30·95
UA1 Music Master with Radio	100·23	71·95
Stereo nine	38·50	24·95
GOODMANS Module 80 compact system FM/35 watts. RMS (Less L/S)	165·00	125·75
HMV 2404/5/6 with Radio	194·40	151·95
HMV 2451	115·95	89·95
HMV 2452	63·90	47·95
HMV 2450 with Stereo Radio	130·60	98·95
KB1025 with 657 speakers	48·25	37·95
McDONALD MP60 complete with base, cover and Goldring G800 cartridge, Amstrad 2000 MP amplifier, 2 Wharfedale Denton speakers	113·96	74·25
MURPHY 902 Studio 1, AM/VHF Radio	84·50	65·95
MURPHY 903	84·42	65·95
MARCONI 4452	73·95	56·50
PHILCO FORD M1500	97·96	66·75
PHILIPS 808	93·50	71·95
PHILIPS GF824	65·30	49·65
PHILIPS 825	49·50	38·95
PHILIPS 826	75·00	52·95
PHILIPS 835	69·50	49·55
PHILIPS 836	95·00	69·95
PYE black box unit stereo 1022	90·93	68·25
RIGONDA party time	27·50	21·95
STEEPLETONE stereo system	41·75	29·95
TELETON STP 8 track stereo system	57·50	38·95
TELETON R800 Tuner/Amplifier with stereo decoder. Garrard 2025 TC turntable and one pair of Teleton 8000 speakers	87·95	47·80

Full range of headphones available at discounted prices.

HI-FI STEREO SYSTEMS—*continued*

	Rec. Retail Price	Comet Price
ULTRA 6028	58·15	44·95
ULTRA 6450	70·45	53·95
ULTRA 6454	38·85	29·95
ULTRA 6455	41·35	31·95

TAPE RECORDERS AND TAPE DECKS

	Rec. Retail Price	Comet Price
AKAI 1720L 4-track Stereo	87·36	59·95
AKAI 4000D 4-track stereo deck	93·65	64·95
AKAI CR80D 8-track stereo deck	85·02	58·45
AKAI CR80 8-track stereo recorder	106·39	74·00
AKAI CR80T 8-track stereo recorder and tuner amplifier	149·84	89·95
AKAI X200D	157·93	100·45
AKAI 1800SD	162·79	102·30
AKAI 2000SD	289·07	223·30
AKAI GXC 40D Cassette Tape Deck	92·26	68·25
AKAI GXC 40 Cassette recorder	111·75	83·85
BUSH Discassette DC70	20·62	16·55
BUSH TP 66 Batt./Mains Cassette Recorder	28·18	21·95
BUSH TP70 Cassette, battery/mains tape recorder	28·13	21·95
CARLTONE LCR500 Cassette	Sp. Price	11·95
DECCA 2000 Cassette Recorder (battery/mains)	Sp. Price	22·95
DECCA CR1000 Cassette Recorder with VHF Radio	Sp. Price	32·95
EKCO 350 Battery/Mains Cassette VHF/MW Radio	37·42	28·75
EKCO 351 Battery/Mains Cassette	23·23	18·45
FERGUSON 3240 cassette with case	24·90	15·95
FERGUSON 3245 Twin track	36·70	25·95
FERGUSON 3246 4-track	42·55	30·95
FERGUSON 3247 4-track	47·95	34·95
FERGUSON 3248 4-track	53·75	39·95
FERGUSON 3252 4-track	100·52	74·95
FERGUSON 3253	43·55	31·95
FERGUSON 3258 4-track	72·40	53·95
FERGUSON 3262	30·15	23·95

TAPE RECORDERS—*continued*

	Rec. Retail Price	Comet Price
FERROGRAPH 702/4 DOLBY	264·38	224·95
FERROGRAPH 702H DOLBY	274·95	233·95
FERROGRAPH 722/4 DOLBY	301·98	255·95
FERROGRAPH 722H DOLBY	312·55	264·59
FERROGRAPH 702 2-track tape deck	224·43	170·65
FERROGRAPH 704/W 4-track deck	224·43	170·65
FERROGRAPH 722	262·03	190·15
FERROGRAPH 724	262·03	190·15
GRUNDIG C200 De Luxe Cassette	37·55	27·95
GRUNDIG C210 batt/mains cassette	46·90	34·95
GRUNDIG TK 121 twin track	56·25	39·95
GRUNDIG TK 141 4-track	62·10	45·75
GRUNDIG TK 146 4-track Auto	66·95	49·95
GRUNDIG TK 147 4-track Auto	93·05	71·95
GRUNDIG C410 Cassette recorder	42·50	32·95
GRUNDIG C418 (4-track auto 2 speed)	71·30	53·95
HARVARD elite cassette with AM/FM radio batt./mains	42·00	32·95
PHILIPS R.R. 692 MW/VHF Radio and Cassette Recorder	49·95	36·55
2202 cassette	22·85	17·95
2204 cassette, battery/mains	29·10	22·90
3302 cassette	20·35	15·95
4303 Twin-track	39·46	29·95
4307 4-track	48·65	34·95
4308 De luxe 4-track	56·85	41·45
4404 4-track stereo recorder	89·25	65·95
4407 4-track stereo recorder	108·50	73·95
4418 4-track stereo	189·75	139·95
4450 4-track stereo	272·50	199·95
4500 4-track stereo tape deck	124·30	91·65
2400 stereo cassette less L/S	66·10	51·95
PYE 9109 cassette	20·37	16·95
PYE 9116 Stereo cassette	66·10	51·60
PYE 9118	29·11	22·95
TANDBERG 2000	125·61	103·95
TANDBERG 1841 4-track stereo tape deck	66·09	48·75
TANDBERG 3021X twin track stereo	104·00	80·85
TANDBERG 3041X 4-track stereo	104·00	80·85
TANDBERG 4021X twin track stereo	169·12	135·50
TANDBERG 4041X 4-track stereo	169·12	135·50
TANDBERG 6041X 4-track stereo	182·73	145·25
TANDBERG 6021X twin track stereo	182·73	145·25
TELETON TRC 130 cassette with VHF/AM radio battery/mains	42·50	28·00
TC110 cassette battery/mains	27·50	18·50

COMPLETE HI-FI SYSTEMS

Completely wired mounted and ready for used

	Rec. Retail Price	Comet Price
THORENS TD 150AB Mk. II with TX11 dust cover, SHURE M55E Cartridge, LEAK Delta 70 Amplifier, 2 Wharfedale Dovedale Speakers	229·96	167·90
PHILIPS 790 tuner/amp 20 watts RMS per channel. FM/MW/LW/SW & Stereo decoder. Electronic touch tuning. Goldring G275 turntable on plinth with cover and G800 magnetic cartridge, fully wired. 2 Mezzo III speakers	269·19	158·80
GARRARD AP76 with base cover and Shure M55E cartridge. Arena 2600 AM/FM and SW Tuner/Amp and 2 Goodmans Havant speakers	214·95	138·15
GOODMANS Module 80 Tuner/Amplifier, Garrard AP76 Turntable with Goldring G800 Cartridge and 2 Goodmans Havant Speakers	192·97	135·65
LEAK Delta 30 amp in teak case. 15 watts RMS per channel. Garrard AP76 transcription deck with plinth, cover and G800 magnetic cartridge, fully wired. 2 Ditton 15 speakers	189·36	129·70
PHILIPS RH 802 Stereo Tuner/Amp. player. 2 x 15 watts LW/MW1/MW2/SW/FM. GP400 magnetic cartridge, speakers extra	155·00	118·95
PHILIPS RH 811 System, Stereo Tuner/Amp/Cassette recorder, with 2 RH411 L/S.	117·00	89·95
GARRARD 2025/TC deck with plinth and cover, and Sonotone 9TAHC cartridge to suit above.	Sp. Price	13·90
LINTON System with Wharfedale Linton Amplifier, Linton Turntable with Shure M44-7 Cartridge and pair of Linton Mk. II Speakers	143·50	104·15
AMSTRAD L.C. 2000 integrated circuit 20 watts RMS into 8 ohms per channel amp., Garrard SP25 turntable with plinth, cover and Goldring G800 magnetic cartridge, fully wired. 2 Wharfedale Denton Speakers	114·95	75·00
AMSTRAD 8000 Mk. II Amplifier, 7 watts RMS per channel, Garrard SP25 with G800 cartridge including base, plinth and cover and pair of Amstrad 138 13" × 8" twin cone teak finish Speakers	86·95	48·40
GOLDRING 705P Turntable, fully wired complete with Goldring 850 cartridge. Amstrad stereo 8000 amplifier and 2 Amstrad 138 13" × 8" twin cone Speakers	79·95	40·85

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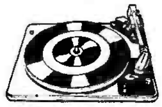
Garrard Record Players



SP25 Mk. III
Deck Only

4 speed
Automatic Single Player

Lasky's price **£11·50**

Garrard SL95B Deck	£35·00
Add £9·00 for Garrard Base & Cover. C & P	£1·50
Garrard AP76 deck only	£23·00
Garrard 40B deck only	£9·50
complete with stereo cartridge ...	£11·50
Garrard SL55B deck only	£9·00
Garrard 2025TC deck only	
complete with KS40A stereo ceramic cartridge...	£7·95
Garrard ZERO 100 Automatic	£47·50
C & P	£1·50
Garrard ZERO 100S Single Player ...	£43·50
C & P	£1·50

Garrard Plinths & Covers

WB4 Mk. II Plinth...	£5·45
SPC4 Mk. II cover...	£4·25
Price together	£8·70
WB1 Plinth	£3·70
SPC1 cover	£3·60
Price together	£6·50

SP 25 Package

SP25 Mk. III Single player ...	List	£15·85
AD76K stereo magnetic cartridge	List	£4·35
Lasky's teack plinth & cover ...	List	£4·75
Total List Price		£24·95

Package Price £20·50

AP 76 Package

AP76 Single Player	List	£29·26
SHURE M44E Cartridge	List	£8·59
Lask's Base and Cover	List	£5·95
Total List Price		£43·80

Package Price £35·00

CARRIAGE—all units
DECK ONLY 50p. PLINTH & COVER ONLY 25p.
DECK WITH PLINTH AND COVER 75p.

FANTAVOX CAR RADIO

W1/700
MW/LW

Two waveband all transistor car radio that covers full Medium and Long wavebands with slide switch wave change. Large easy to grip controls. Illuminated dial with "easy to read" scale. Externally adjustable aerial trimmer. Powerful output through either one or two speakers. Operates on 12 volt D.C. Negative or positive earth. Standard size 6⅛in (W) x 4⅞in (D) x 2in (H). Black with chrome trim. **Complete with speaker, baffle, leads, mounting brackets.**

LASKY'S PRICE **ONLY £7·50** C & P 25p

NEW DIGITAL CLOCK

NOW WITH ILLUMINATED DIAL EXCLUSIVELY FROM LASKY'S

The clock measures 5¾ W x 2¾ H x 3in D (overall from front of drum to back of switch). SPEC.: 210/240V a.c. 50Hz operation; switch rating 250V, 3A. Complete with instructions. ● COMPLETE WITH KNOBS. FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER

SPECIAL QUOTES FOR QUANTITIES LASKY'S PRICE **£6·75** C & P 25p

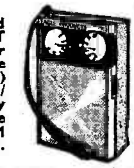
SINCLAIR PHASE LOCK LOOP STEREO FM TUNER

Incorporates varicap diodes, printed circuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to be mounted into any cabinet you choose. It may be used with any High Fidelity Amplifier. Power requirements 25/30V DC. Size 8½" x 1½" x 3½".

LIST PRICE £25·00 LASKY'S PRICE **£16·95** C & P 25p

PZ5 power supply £4·15 extra.

EAGLE AM/FM POCKET TRANSISTOR RADIO



This super compact two-band radio **ORIGINALLY COST £9·81!** The ideal pocket set for all ages. Receives all Med. wave and FM stations (local news, etc.)—separate tuning scales. Grey/chrome trim cabinet with carry strap. Excellent tone. Uses single PP3 type battery. Telescopic FM aerial. Size: 4½ x 2½ x 1⅛in. comp. with battery and ear-piece.

LIST PRICE £9·81 LASKY'S PRICE **£4·75** C & P 15p

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Type	Single	5	10	15
C60	28p	£1·37	£2·70	£3·99
C90	38p	£1·86	£3·67	£5·42
C120	48p	£2·35	£4·63	£6·84

Each cassette individually boxed in Philips, type plastic library.
C & P: each 7p, 5—25p, 10—40p, 20—68p.

INTERNATIONAL

MAGNETIC RECORDING TAPE FROM THE U.S.A. AT LASKY'S RECORD LOW PRICES

3in.	RT.20 Message Tape 225ft ...	19p
3¼in.	RT.21 Triple play, 600ft. Mylar ...	50p
5in.	RT.23 Double play, 1,200ft. ...	75p
5in.	RT.18 Long play, 900ft. Acetate ...	50p
5in.	RT.17 Standard play 600ft. ...	43p
5¾in.	RT.15 Double play, 1,800ft. Mylar...	£1·13
5¾in.	RT.16 Long play 1,200ft. Acetate...	75p
5¾in.	RT.24 Standard play 900ft. P.V.C.	68p
5¾in.	RT.14 Long play 1,200ft. Mylar ...	75p
5¾in.	RT.25 Triple play, 2,400ft	£1·31
7in.	RT.22 Standard play, 1,200ft Acetate	63p
7in.	R.T.10 Standard play, 1,200ft. Mylar	63p
7in.	RT.12 Long play, 1,800ft. Mylar ...	95p
7in.	RT.13 Double play, 2,400ft. Mylar	£1·25
7in.	RT.11 Long play, 1,800ft. Acetate	75p
7in.	RT.19 Triple play, 3,600ft. Mylar ...	£2·50
3¼in.	RT.22 Quad play, 1,100ft.	£1·02

P & P 5p extra per reel, 4 reels and over Post Free.
Special quotes for quantities.

Leak Speaker "Scoop"

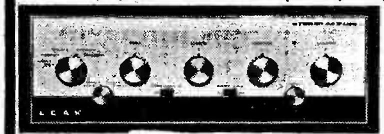
Leak 150 Speakers
List price £49·90
Lasky's Price **£38·95** C & P £2·00

Leak 250 Speakers
List price £65·00
Lasky's Price **£48·95** C & P £2·00

Leak 600 Speakers
List price £99·00
Lasky's Price **£68·75** C & P FREE

LEAK BARGAINS

STEREO 30 PLUS amplifier (cased)



List Price £62·50 PRICE **£45·00** C & P £1·00

STEREO 70 amplifier (cased)

List Price £75·00 LASKY'S PRICE **£55.00** C & P £1·00

LEAK CASES

Rosewood cases for Stereo 30 or Stereo 70.
List Price £7·37 LASKY'S PRICE **£2·75** C & P 35p

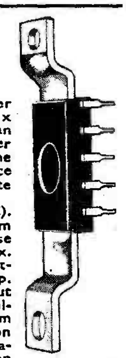
Teak case for Stereofetic tuner only.
List Price £7·37 LASKY'S PRICE **£2·50** C & P 35p

Teak double case for 30 or 70 and stereofetic tuner.
List Price £10·37 LASKY'S PRICE **£4·95** C & P 35p

LEAK TRUSPEED

2 speed belt drive turntable comp. with plinth, cover and SHURE cartridge.
LIST PRICE £69·50
LASKY'S PRICE **£47·50** C & P £1·50

LASKY'S IC-403 INTEGRATED CIRCUIT



Originally developed for computer and space projects—size only 25 x 10 x 5 millimetres. The IC-403 is an integrated power and preamplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output. SPECIFICATION (ratings at 25 C). Output power typically 3W from 250mV. Input frequency response 20Hz to 80KHz plus 3dB Max. operating voltage 21V. Min. operating load 7·5 ohms. Pre-amp imp. 2M/ohms Preamp. D.C. Input current 50mA. The IC-403 is available from stock exclusively from Laskys—complete with instruction data and suggested circuit applications. Free instruction leaflet on request.

LASKY'S PRICE **£1·50** EACH 2 FOR **£2·85** C & P 5p EACH

TRIO KA2000A STEREO AMP

KA2000A 16 + 16W Stereo Amplifier 10½ x 4½ x 9¾in. TEAK SLEEVE as illustrated £3·25 extra.

LASKY'S PRICE **ONLY £37·50** C & P FREE

KA2000A PACKAGE

TRIO KA2000A Stereo amplifier ...	£37·50
2 LASKY'S Criterion Mk X speakers	£28·00
BSR MP.60 turntable...	£15·20
LASKY'S Plinth and cover	£4·75
AD76K stereo magnetic cartridge ...	£4·35
Total Recommended List Price ...	£89·80

LASKY'S PRICE **£79·00** C & P £3·50

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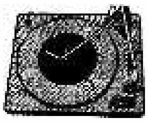
BSR LATEST SUPERSLIM
STEREO AND MONO



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 13¼ × 11¼in. Above motor board 3¼in. below motor board 2¼in. with STEREO and MONO XTAL **£8·75** Post 25p.
MONO-COMPATIBLE Plays all records **£7·75** Post 25p.

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made tested. Printed circuit. Pentode valve EL84. 3 watts output. Tone and volume controls. Metal rectifier. Complete with two knobs, output transformer and high performance loudspeaker. Response 50-12,000 cps. Sensitivity 300mV. **£4** Post 25p

R.C.S. PORTABLE PLAYER CABINET

Really smart appearance with space for R.C.S. Amplifiers and most modern autochangers. Size 18 × 15 × 8in. Metal fittings. Carrying handle. Popular colours. Two-tone rexine covered. **£4** Post 25p.

GARRARD DISCO DECK TA MKII

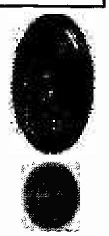
4 speeds. Plays all sizes of records. 4 pole heavy duty motor. 9in. steel turntable. Plug in head complete with stereo/mono cartridge. Adjustable stylus pressure. Autostop. Brown and Cream finish. AC mains 110/240V. Base plate size 12in. × 8in. Operating area 14in. × 12½in. Above motor board 3in., below motor board 2¾in. Ideal for Home Hi-Fi or Discotheque. **£10** Post Free

GARRARD AUTOCHANGERS with Sonotone Cartridges Stereo Diamond and Mono Sapphire. Model 1025 £10. Model 3500 Stereo and Mono Autochanger £14. Post 25p.

BSR JUNIOR SINGLE PLAYER Turntable. 4-speed motor and separate pick-up **£4·50**

HI-FI PICK-UP CARTRIDGES. Diamond LP/Stereo Stereo/Mono 9TA £2·50; GP94 £2·50; GP93 £2·00; Sapphire Mono GP91 £1·50; Power-point LP/78. 60p.

E.M.I. WOOFER AND TWEETER KIT
£5·75 Post 25p



Comprising a fine example of a Woofer 10½ × 6½in. with a massive Ceramic Magnet, 44oz, Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser supplied.

Impedance Standard .... 8 ohms
Maximum Power.......... 12 watts
Useful Response.... 35 to 18.000 cps
Base Resonance .... 45 cps

SUITABLE ENCLOSURE 20 x 13 x 9in, £9 POST 25p MODERN TEAK DESIGN

WEYRAD P50—TRANSISTOR COILS

RA2W Ferrite Aerial..	72p	Spare Cores	3p
Osc. P50/1AC.........	38p	Driver Trans. LFDT4 .	58p
I.F. P50/2CC 470 kc/s.	36p	Printed Circuit, PCA1 .	58p
3rd I.F. P50/3CC......	36p	J.B. Tuning Gang.....	65p
P51/1 or P51/2	36p	Weyrad Booklet	10p
P50/3V	36p	OPTI	58p

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

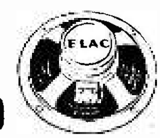
VOLUME CONTROLS

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.

8in ELAC HI-FI SPEAKERS



Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts music power. **£4·80**

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32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	43p
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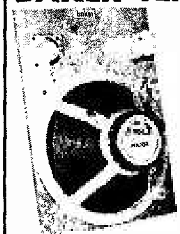

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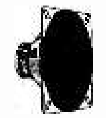

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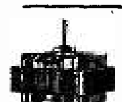

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100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
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100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	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
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·33	0·57	0·75	—

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T5	8	2G382T	OC82
T6	8	2G344B	OC44
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Q32	3	PNP sil. trans. 2 × 2N1131, 1 × 2N1132	0·50
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Q34	7	Sil. NPN trans. 2N2369, 500MHZ	0·50
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Q49	4	NPN trans. 2 × BFY51, 2 × BFY52	0·50
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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
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AD161 *NPN*
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M/P COMP GERM TRANS. OUR LOWEST PRICE OF 55p *PER PAIR*

SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/IT 5MHZ. OUR PRICE EACH :

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2N3055
115 WATT SIL POWER NPN 50p EACH

SILICON 50 WATTS MATCHED NPN/PNP BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/ IC 10A. HFE type 100/ft 3mHZ. OUR PRICE PER PAIR :

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OC22	30p	OC29	40p	AL102	85p	BD132 80p	BD140 85p
OC23	33p	OC35	33p	AL103	85p	BD135 70p	BD155 75p
OC24	45p	OC36	40p	BD121	60p	BD136 80p	BU105 £3
OC25	25p	AD140	40p	BD123	75p	BD137 70p	2N3054 45p
OC26	25p	AD142	40p	BD124	70p	BD138 80p	

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F.E.T.'S

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TSO 16 ,, ,,	35p	32p	30p

LOW COST No.			
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BPS 16	16p	14p	12p

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Check our 74 Series List before you buy any I.C's. Our prices are the lowest possible. All devices ex-stock. Full spec. guaranteed

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BP00=SN7400	0·15	0·14	0·12
BP01=SN7401	0·15	0·14	0·12
BP02=SN7402	0·15	0·14	0·12
BP03=SN7403	0·15	0·14	0·12
BP04=SN7404	0·15	0·14	0·12
BP05=SN7405	0·15	0·14	0·12
BP07=SN7407	0·18	0·17	0·16
BP08=SN7408	0·18	0·17	0·16
BP09=SN7409	0·18	0·17	0·16
BP10=SN7410	0·15	0·14	0·12
BP13=SN7413	0·29	0·26	0·24
BP16=SN7416	0·43	0·40	0·38
BP17=SN7417	0·43	0·40	0·38
BP20=SN7420	0·15	0·14	0·12
BP30=SN7430	0·15	0·14	0·12
BP40=SN7440	0·15	0·14	0·12
BP41=SN7441	0·67	0·64	0·58
BP42=SN7442	0·67	0·64	0·58
BP43=SN7443	1·95	1·85	1·75
BP44=SN7444	1·95	1·85	1·75
BP45=SN7445	1·95	1·85	1·75
BP46=SN7446	0·97	0·94	0·88
BP47=SN7447	0·97	0·94	0·88
BP48=SN7448	0·97	0·94	0·88
BP50=SN7450	0·15	0·14	0·12
BP51=SN7451	0·15	0·14	0·12
BP53=SN7453	0·15	0·14	0·12
BP54=SN7454	0·15	0·14	0·12
BP60=SN7460	0·15	0·14	0·12
BP70=SN7470	0·29	0·26	0·24
BP72=SN7472	0·29	0·26	0·24
BP73=SN7473	0·37	0·35	0·32
BP74=SN7474	0·37	0·35	0·32
BP75=SN7475	0·47	0·45	0·42
BP76=SN7476	0·43	0·40	0·38
BP80=SN7480	0·67	0·64	0·58
BP81=SN7481	0·97	0·94	0·88
BP82=SN7482	0·97	0·94	0·88
BP83=SN7483	1·10	1·05	0·95

BI-PAK Order No.	Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP86=SN7486	0·82	0·30	0·28
BP90=SN7490	0·67	0·64	0·58
BP91=SN7491AN	0·87	0·84	0·78
BP92=SN7492	0·67	0·64	0·58
BP93=SN7493	0·67	0·64	0·58
BP94=SN7494	0·77	0·74	0·68
BP95=SN7495	0·77	0·74	0·68
BP96=SN7496	0·77	0·74	0·68
BP100=SN74100	1·75	1·65	1·55
BP104=SN74104	0·97	0·94	0·88
BP105=SN74105	0·97	0·94	0·88
BP107=SN74107	0·40	0·38	0·36
BP110=SN74110	0·55	0·53	0·50
BP111=SN74111	1·25	1·15	1·00
BP118=SN74118	1·00	0·95	0·90
BP119=SN74119	1·35	1·25	1·10
BP121=SN74121	0·67	0·64	0·58
BP141=SN74141	0·67	0·64	0·58
BP145=SN74145	1·50	1·40	1·30
BP150=SN74150	1·80	1·70	1·60
BP151=SN74151	1·00	0·95	0·90
BP153=SN74153	1·20	1·10	0·95
BP154=SN74154	1·80	1·70	1·60
BP155=SN74155	1·40	1·30	1·20
BP156=SN74156	1·40	1·30	1·20
BP160=SN74160	1·80	1·70	1·60
BP161=SN74161	1·80	1·70	1·60
BP164=SN74164	2·00	1·90	1·80
BP165=SN74165	2·00	1·90	1·80
BP181=SN74181	2·75	2·60	2·40
BP182=SN74182	0·97	0·94	0·88
BP190=SN74190	3·50	3·25	3·00
BP191=SN74191	3·50	3·25	3·00
BP192=SN74192	2·10	1·95	1·75
BP193=SN74193	2·10	1·95	1·75
BP195=SN74195	1·10	1·05	0·95
BP196=SN74196	1·80	1·70	1·60
BP197=SN74197	1·80	1·70	1·60
BP198=SN74198	5·50	5·00	4·00
BP199=SN74199	5·50	5·00	4·00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442.

LINEAR I.C's—FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	63p	53p	45p
BP701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP709—72709	53p	45p	40p
BP 709P—μA709C	53p	45p	40p
BP 710—72710	53p	45p	40p
BP 711—μA711	58p	50p	45p
BP 741—72741	75p	60p	50p
μA703C—μA703C	43p	34p	27p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

S.G.S. EA1000 2·63

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
RP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

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

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

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AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5amps at 35volts. Size: 63mm × 105mm × 30mm.

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DTL & 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.		
UIC930	= 12 × μA 930 ..	50p	UIC948	= 8 × μA 948 ..	50p
UIC932	= 12 × μA 932 ..	50p	UIC951	= 5 × μA 951 ..	50p
UIC933	= 12 × μA 9₀3 ..	50p	UIC961	= 12 × μA 961 ..	50p
UIC935	= 12 × μA 935 ..	50p	UIC9093	= 5 × μA 9093 ..	50p
UIC936	= 12 × μA 936 ..	50p	UIC9094	= 5 × μA 9094 ..	50p
UIC944	= 12 × μA 944 ..	50p	UIC9097	= 5 × μA 9097 ..	50p
UIC945	= 8 × μA 945 ..	50p	UIC9099	= 5 × μA 9099 ..	50p
UIC946	= 12 × μA 946 ..	50p	UICX9	25 Assorted 930 Series	£1·50

Packs cannot be split but 25 Assorted Pieces (our mix) is available as Pack UICX9
Data Booklet available for the BP930 Series, PRICE 13p

UIC00=12×7400N	50p	UIC46= 5×7446N	50p	UIC81= 5×7481N	50p
UIC01=12×7401N	50p	UIC47= 5×7447N	50p	UIC82= 5×7482N	50p
UIC02=12×7402N	50p	UIC48= 5×7448N	50p	UIC83= 5×7483N	50p
UIC03=12×7303N	50p	UIC50=12×7450N	50p	UIC86= 5×7486N	50p
UIC04=12×7404N	50p	UIC51=12×7451N	50p	UIC90= 5×7490N	50p
UIC05=12×7405N	50p	UIC53=12×7453N	50p	UIC91= 5×7491N	50p
UIC10=12×7410N	50p	UIC54=12×7454N	50p	UIC92= 5×7492N	50p
UIC13= 8×7413N	50p	UIC60=12×7460N	50p	UIC93= 5×7493N	50p
UIC20=12×7420N	50p	UIC70= 8×7470N	50p	UIC94= 5×7494N	50p
UIC40=12×7440N	50p	UIC72= 8×7472N	50p	UIC95= 5×7495N	50p
UIC41= 5×7441AN	50p	UIC73= 8×7473N	50p	UIC96= 5×7496N	50p
UIC42= 5×7442N	50p	UIC74= 8×7474N	50p	UIC121=5×74121N	50p
UIC43= 5×7443N	50p	UIC75= 8×7475N	50p	UICX1=25×Asst'd 74's	£1·50
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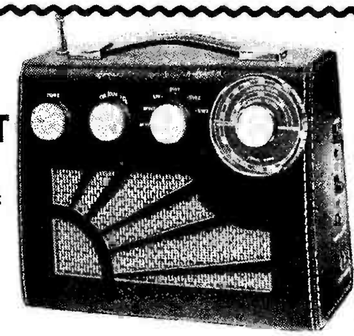
NEW! ROAMER 10 WITH VHF INCLUDING AIRCRAFT



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

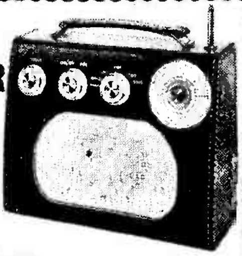
Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated Telescopic Aerial, for peak short wave and VHF listening. Push Pull output using 600mw Transistors. Car Aerial and Tape Record Sockets. Switched Earpiece Socket complete with Earpiece. 10 Transistors plus 3 Diodes. 8" × 2½" Speaker. Air 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

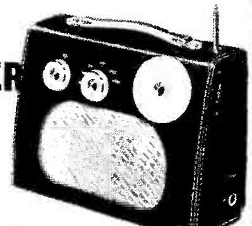


NOW WITH VARIABLE TONE CONTROL

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. 8" × 2½" 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)

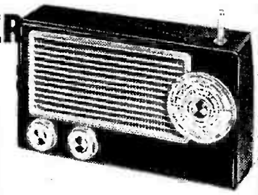
ROAMER SEVEN MK IV



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. 8" × 2½" 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)

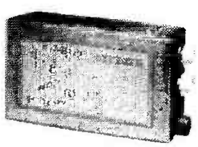
ROAMER SIX



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)

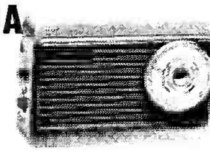
POCKET FIVE



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

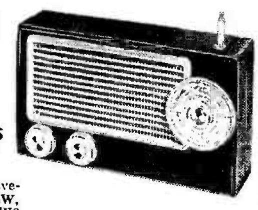


5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial. tuning condenser volume control, fine tone 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



8 TRANSISTORS and 3 DIODES

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
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2N1305	PNP	,,	26p
2N2646	Sil. UJT	Oscillator, SCR driver	47p
2N2926	NPN	Small sig. amp	11p
2N3055	NPN	High power	50p
2N3702	PNP	Low power	10p
2N3704	NPN	Low power	10p
AC126	Ger. PNP	Small sig./driver	23p
AC128	PNP	Low power	20p
AC176	NPN	Low power	16p
AD149	PNP	High power	58p
*AD161	NPN	Med. power	33p
*AD162	PNP	Med. power	36p
BC108	Sil. NPN	Small signal	11p
BC109	NPN	Low noise	12p
BC168	NPN	Small signal	10p
BC169	NPN	Low noise	11p
BF194	NPN	RF amp.	14p
BFY51	NPN	Med. current	20p
OA90	Ger. diode	RF detector	6p
OA91	,, ,,	General purpose	5p
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WO2		Silicon bridge 1 amp	30p

Sil.=Sillicon. Ger.=Germanium. *Matched pair AD161/AD162 60p

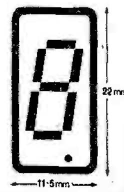
RESISTORS 10%—5%—2%

Code	Power	Tolerance	Range in ohms	Values	1 to 9	10 to 99 (see note below)	100 up
C	1/8W	5%	4·7-470K	E24	1	0·8	0·7
C	1/4W	10%	4·7-10M	E12	1	0·8	0·7
C	1/2W	5%	4·7-10M	E24	1·2	1	0·9
C	1W	5%	4·7-10M	E12	2·5	2	1·9
MO	1/2W	2%	10-1M	E24	4	3	2 nett
WW	1W	10% +1/20 Ω	0·22-3·9	E12	7	7	6
WW	3W	5%	1Ω-10K	E12	7	7	6
WW	7W	5%	1Ω-10K	E12	9	9	8

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

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 72, 91 and their decades. **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).*

MINITRON DIGITAL INDICATOR



TYPE 3015F Seven segment indicator compatible with standard logic modules and power supplies. Figs. 0–9 from well illuminated filament segments to give character of 9mm height plus decimal point. Power requirement 8mA from 5V D.C. per segment. A limited number of alphabetical symbols also available.
In 16 lead DIL case **£2.00**

Suitable BCD decoder driver type FLL121T **£1.36**

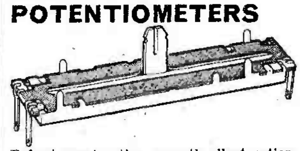
DIL Socket: 16 lead **30p.**

No. 3015G showing + or − and fig. 1 and decimal point £2·00.

RIVLIN PRECISION RESISTORS

0·1% to 0·01% tolerance. Prices and delivery details on request. Example—values up to 100K, between £1 and £2 nett.

SLIDE POTENTIOMETERS



Robust construction, smooth silent action. In values from 4K7 to 1 megohm, linear or log, each 26p. Light grey escutchon, 10p. Knobs flat, grip type in black/Red/Green/, Yellow/Blue/Lt. Grey/Dark Grey or White each 5p.

We are official distributors for SOLDERSTAT SOLDER IRONS

As appointed distributors for well-known Elremco-Wolf "Solderstat" irons we offer this light weight model HMS in 16 or 24 watt, ratings 220/240V a.c. nett **£1·87**

INFINITELY VARIABLE TEMPERATURE CONTROLLED SOLDER IRON

Designed essentially for micro-miniature and printed circuit board assemblies. Temperature is adjusted as required by control on base and remains constant whether idling or on load. Although for working to very delicate standards, the iron is of rugged construction and is exceptionally reliable.
Price, complete with base, nett **£9·20**

DE-SOLDER BRAID

The efficient money saving way to de-solder solder joints, per 6 ft. length, nett **50p**

TYGAN 36"×27" £1·58;18"×27" 83p.
VYNAIR 36"×25" 93p. 15"×25" 50p
(Pattern Book 3p & S.A.E.)

SIEMENS TTL INTEGRATED CIRCUITS

FLH101	(7400)	20p	FLJ121	(7473)	45p
FLH201	(7401)	20p	FLJ141	(7474)	45p
FLH191	(7402)	20p	FLJ151	(7475)	45p
FLH291	(7403)	20p	FLJ131	(7476)	45p
FLH211	(7404)	25p	FLH221	(7480)	68p
FLH271	(7405)	25p	FLH231	(7482)	87p
FLH381	(7408)	25p	FLH241	(7483)	1·32
FLH391	(7409)	25p	FLH341	(7486)	33p
FLH111	(7410)	20p	FLJ161	(7490)	80p
FLH351	(7413)	35p	FLJ221	(7491 AN)	1·28
FLH121	(7420)	20p			
FLH131	(7430)	20p	FLJ171	(7492)	85p
FLH141	(7440)	24p	FLJ181	(7493)	80p
FLL101	(7414)	1·22	FLJ231	(7494)	1·13
FLH281	(7442)	1·16	FLJ191	(7495)	87p
FLH361	(7443)	1·45	FLJ261	(7496)	1·48
FLH371	(7444)	1·45	FLJ301	(74100)	1·64
FLH151	(7450)	20p	FLJ281	(74104)	43p
FLH161	(7451)	20p	FLJ271	(74107)	52p
FLH171	(7453)	20p	FLK101	(74121)	48p
FLH181	(7454)	20p	FLJ201	(74190)	1·80
FLY101	(7466)	20p	FLJ211	(74191)	1·80
FLJ101	(7470)	45p	FLJ241	(74192)	1·74
FLJ111	(7472)	32p	FLJ251	(74193)	1·74

BAXANDALL SPEAKER

As designed by P. J. Baxandall and originally described in "Wirless World". Complete kit inc. spkr. equaliser and special cabinet kit (18" × 12" × 10") cut to size. 10 watt RMS/15 Ω loading. Part cost of carr. and ins. in U.K. 60p Nett **£13·81**

Speaker unit and equaliser kit post free nett £4·81. Pack flat cabinet assembly (all cut to shape) natural teak finish £9·00 nett. Part cost of carr. in U.K. 60p.

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.

ZENER DIODES 5% full range E24 values: 400mW: 2·7V to 36V, **14p each**; 1W: 6·8V to 82V, **27p each**; 1·5W: 4·7V to 75V, **48p each.**
Clip to increase 1·5W rating to 3 watts (type 266F) 4p.

MINIATURE TOGGLE SWITCHES
2A/250V. DP/DT, 48p.

MAINLINE AMPLIFIER KITS
70 watt power amp. module kit, **£12·60 nett.** Power supply kit, **£6·00 nett.** Matching pre-amp kit, **£3·30 nett.** (Above prices for mono.) **Stereo Kit.** 2 power amps. pre-amp kit, power supply kit and matched controls for building your own cabinet, **£38·40 nett.**

Q.E.D. High quality amplifier systems. Built to your personal specifications. Enquiries invited. Please quote P.W.8.

SIEMENS CAPACITORS

POLYCARBONATE—5% TOLERANCE

250V. up to 0·1μF: 100V/0·1μF and above
0·01; 0·012; 0·015; 0·018; 0·022; 0·027; 0·033; 0·047; 0·056 **each 3p.**
0·068; 0·082; 0·1; 0·12; 0·15 **each 4p.**
0·18; 0·22; **each 5p.**
0·27; 0·33; **6p**; 0·39 **7p**; 0·47 **8p**; 0·56 **10p**; 0·68 **11p**; 1μF **13p**

ELECTROLYTIC CAPACITORS (values in μF/V)
0·47/100; 1/100; 2·2/63; 4·7/35; 10/25; 22/16; 47/10; 47/25; 100/10; 22/3—**each 5p.**
10/63; 22/35; 47/35; 100/16; 100/25; 220/6; 220/10; 220/16; 470/3 **each 6p.**
47/50; 47/63; 100/35; 470/10 **each 7p.**
100/50; 220/35; **each 9p**; 100/63; 470/25; 100/10 **each 10p.**
220/63; 470/35; 1000/16; **each 14p.**
1000/25—**16p**; 470/63; 1000/35 **each 19p**; 2200/25—**30p.**
1000/63; 2,200/35; 4,700/16—**each 33p.**
Tantalum and other capacitors etc.—see latest 1972 Catalogue—issue No. 6.

1972 ELECTROVALUE CATALOGUE (NO.6)

Now enlarged to 96 pages plus cover. More items, more information, more diagrams then ever. Post free in U.K. —10p.

NEWMARKET LINEAR I.Cs

LIC 709C/14 Dual in line—**34p** | 709C/5, TO5 **39p**
LIC 741C/14 Dual in line—**40p** | 741C/5, TO5 **42p**

CARBON TRACK POTENTIOMETERS

Long spindles. Double wipers for low noise.
SINGLE GANG P.20 lin. 100 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, 22K, 47K, 1M Ω only **42p**, Dual antilog, **10K** only, **42p.** Any type with 2A D.P. mains switch, **12p** extra.
Only decades of 10, 22 & 47 available in ranges quoted.
DUAL CONCENTRIC in any combination of P.20 values as above, **60p**; with switch, **72p.** Knobs, pair **24p.**

DISCOUNTS

10% on orders £5 to £15.
15% on orders over £15. *No discount on items marked Nett. **Prices** subject to alteration without notice.*

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FREE unless otherwise stated. Handling surcharge 10p on mail orders under £2.
Overseas orders: carr. & Insurance charged at cost.
U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore, PA 19081.
ENQUIRIES FROM TRADE AND OTHER LARGE QUANTITY USERS INVITED.

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(Dept. P.W. 872) 28 ST. JUDES ROAD., ENGLEFIELD GREEN, EGHAM, SURREY, TW20 OHB
Hours: 9—5.30: Sat. 1 p.m. Tel.: Egham 3603 (STD 0784-3) Telex 264475
ELECTROVALUE LTD—AN INDEPENDENT COMPANY SINCE ITS ESTABLISHMENT ORIGINALLY IN 1965

RSC HIGH-FIDELITY STEREO PACKAGE OFFERS

Four fully wired units ready to 'plug in'.
★ SUPER 30 AMPLIFIER (15 + 15 watt) in veneered housing
★ GARRARD SP25 MK III Turntable on Plinth with cover
★ GOLDRING G850 Magnetic cartridge with diamond stylus
★ PAIR OF STANWAY II Speaker Units

Special Total Price **£86·95** Carr. £1·50

Terms: Deposit £11·95 and 9 monthly payments £9·37 (Total £96·28).

★ Super 30 Amplifier (15 + 15 watt) in veneered housing
★ Goldring GL69 II Transcription Turntable on Plinth as illustrated
★ Goldring Magnetic P.U. Cartridge.
★ Pair of Stanway II speaker units.

Special Total Price **£98·63** Carr. £1·50

Terms: Deposit £13·63 and 9 monthly payments £10·62 (Total £109·21).

ATTRACTIVE TEAK OR AFRORMOSIA VENEERED CABINETS AND PLINTHS

Send S.A.E. for coloured brochure showing other money saving offers.

Matching as recommended for optimum performance.

★ TA12 AMPLIFIER 6·5 + 6·5 watt in veneered housing
★ GARRARD SP25 MK III Player unit on Plinth
★ GOLDRING CS90 Ceramic P.U Cartridge with diamond stylus
★ PAIR OF DORCHESTER Loudspeaker Units

Special Total Price **£58·33** Or Deposit £8·33 & 9 mthly payments £6·25 (Total £64·58). Carr. £1·25

Trans. Plastic Cover £3·15 extra.

PACKAGE AS ABOVE but with Garrard 3000 Autochanger and Sonotone 9TA Ceramic Cartridge in lieu of SP25 and CS90 Carr. £1·25 **£51·20**

Or Deposit £7·45 and 9 monthly payments £5·58 (Total £57·67)

Trans. Plastic cover £3·15 extra.

'YORK' HIGH-FIDELITY 3 SPEAKER SYSTEM

★ Moderate size only 25×14×10in. approx.
★ Response 30-20,000 c.p.s. Impedance 15 ohms

COMPLETE KIT **£23** Carr. 65p

★ Performance comparable with units costing considerably more.

Consists of (1)12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system (3) 8×5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Handsome Teak veneered cabinet. (7) Circuit and full instructions. Terms: Dep. £4·60 and 9 monthly payments £2·47 (Total £26·83).

DEMONSTRATIONS AT ALL BRANCHES

HIGH FIDELITY LOUDSPEAKER UNITS

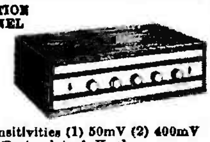
Cabinets latest style Satin Teak veneer. Acoustically lined or filled acoustic damping. Ported where appropriate. Credit terms available.

DORCHESTER (Illustrated) Size 16×11×9in. appr. Range 45-15,000 c.p.s. Rating 8-10 watts. Fitted High flux 13×8in. Dual Cone speaker. Imp. 3 or 15 ohms. **£9.45** Carr. 40p.

STANWAY II Size 20×10½×9½in. approx. Rating 10 watts. Inc. 13×8in. speaker with highly flexible cone surround, long throw voice coil and 10,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 35-20,000 c.p.s. Imp. 8 ohms. Gives smooth realistic sound output. See 'package offers' for illustration **£17·85**

R.S.C. TA12 MKIII 6·5+6·5 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION
HIGH FIDELITY OUTPUT OF 6·5 WATTS PER CHANNEL



Designed for optimum performance with any crystal or ceramic Gram. P.U. cartridge, Radio tuner, Tape recorder etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3-15 ohms ★ For 200-250v. A.C. mains ★ Frequency Response 20-20,000 c.p.s. −2dB ★ Harmonic Distortion 0·3% at 1,000 c.p.s. Hum and Noise −70dB ★ Sensitivities (1) 50mV (2) 400mV (3) 100mV. Output rating I.H.F.M. ★ Handsome finish Facia plate & Knobs.

COMPLETE KIT OF PARTS WITH FULL WIRING DIAGRAMS & INSTRUCTIONS. **£15·50** Carr. 40p. Factory built with 12 mths. guarantee **£19·50**

Deposit £3 and 9 mthly pymts £2·15 (Total £22·35). Or in Teak veneer housing Dep. £3 & 9 mthly payments £2·55 (Total £25·95). Send S.A.E. for leaflet. **£23**

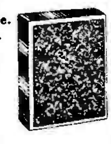
Individual Ganged Controls: Bass, Treble, Volume and Balance. Printed circuit construction employing 10 Transistors plus Diodes. Output rating I.H.F.M. Frequency range 20-20,000 c.p.s. Bass Control ± 12db. Treble Control ± 13db. Selector switch for P.U. or Tape/Radio. For loudspeaker output impedances of 3 to 15 ohms. For standard 200-250v. A.C. mains operation. Attractive Black and Silver finished metal facia plate and matching control knobs.

COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and comprehensive wiring diagram and instructions **£11·50** Carr. 40p

Or FACTORY BUILT IN TEAK VENEERED CABINET as illustrated £14·99 or dep. £2·20 and 9 monthly payments £1·70 (Total £17·50).

HI-FI SPEAKER ENCLOSURES MODERN DESIGN

Teak veneer finish. Acoustically lined. Sizes approx. Carr. 35p. per enc.



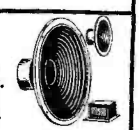
JE8 Size 16 × 11 × 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·35**

SE8 For optimum performance with any 8in. Hi-Fi spkr. Size 22 × 15 × 9in. **£6·47**

SE10 For outstanding results with 10in. Hi-Fi spkr. Size 24 × 15 × 10in. P'td. **£6·74**

SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter Size 25 × 16 × 10½in. **£7·87**

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. **£5·95** Carr. 30p

OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£6·95** Carr. 35p

AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticised 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.

HF808T	8"	10W	£2·88	HF120D	12"	15W	£4·75
HF102D	10"	10W	£3·40	HF126	12"	15W	£5·50
HF120	12"	15W	£4·25	HF126D	12"	15W	£5·90

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1. An all-dry battery eliminator. Size 5½×4½×2in. approx. Completely replaces batteries supplying 1·5v and 90v, to battery radio where A.C. mains 200/250v. 50c/s is available.

COMPLETE KIT WITH DIAGRAM **£3·25** ASSEMBLED READY FOR USE **£3·75**

FANE 807T HIGH FIDELITY SPEAKER

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 15 KHz. Gauss 10,000. Impedance 3 or 8-15 Ω.

PLEASE STATE IMPEDANCE WHEN ORDERING **£3·85**

R.S.C. TA6 6 Watt HI-FI 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, 9½×2½×5½in. Attractive brushed silver finish facia plate 10½×3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£7·75** Carr. 40p

OR FACTORY BUILT WITH 12 MONTHS' GUARANTEE £10·95

R.S.C. MkIII SUPER 30 HIGH FIDELITY STEREO AMPLIFIER

A COMPLETELY NEW DESIGN FURTHER IMPROVED IN BOTH APPEARANCE and PERFORMANCE. REPRESENTING VALUE FAR HIGHER THAN THE PRICES SUGGEST.

Only high grade components by leading manufacturers.

COMPLETE KIT OF PARTS **£25** Carr. 65p

Or FACTORY BUILT with 12 months guarantee. Dep. £5·75 and 9 monthly payments £3·50 (Total £37·25.) **£33·75**

Or FACTORY BUILT in cabinet as illustrated. Dep. £7 and 9 monthly payments £3·99 (Total £42·91) **£38·75**

PRINTED CIRCUITRY
TWENTY SILICON TRANSISTORS.
FOUR DIODES.
FOUR RECTIFIERS

★ SATIN SILVER METAL FACIA with black lettering. Black edged knobs with bright silver centres.
★ PUSH-BUTTON SELECTOR SWITCHING
★ NEON INDICATOR
★ JACK SOCKET FOR HEADPHONES
★ CABINETED MODEL VENEERED IN SATIN TEAK. SUITABLE FOR ANY MODERN PICK-UP CARTRIDGE CERAMIC or MAGNETIC, REGARDLESS OF PRICE. WE RECOMMEND USE WITH THE BEST ANCILLARY EQUIPMENT THAT CAN BE AFFORDED.

OUTPUT: 15 watts R.M.S. (Continuous) into 8 ohms. 10 watts R.M.S. (Continuous) into 15 ohms.

TECHNICAL DETAILS (Applying to each channel where appropriate)

CONTROLS: PUSH-BUTTON SELECTOR (1) Disc (2) Radio (3) Tape (4) Mono L (5) Mono R (6) SPEAKER DIS. (7) Mains on/off. Bass, Treble and Balance. Plus Ceramic Mag P.U. Switch.

HUM & NOISE −75dB Min. Vol. −65dB Full Vol. **HARMONIC DISTORTION** 0·1% at 1000 Hz 10 Watts
FREQUENCY RESPONSE: −3dB 7Hz to 70kHz
TREBLE CONTROL: +16dB to −12dB at 14kHz
BASS CONTROL: +17dB to −16dB at 40Hz **CROSS TALK** −58dB
SENSITIVITIES: Disc Mag. 2·5 mV. Ceramic 35mV. Radio 120mV. Tape 120mV.
REAR PANEL SOCKETS ARE FOR 3 PAIRS OF INPUTS (1) P.U. (2) Radio. (3) Tape Amp. Plus pair for tape recorder signal take off and 2 pairs for speaker connections.

RSC GROUP/DISCO UNITS

UNITS ILLUSTRATED

FAL FG1/2A Console £67·10. Carr. £1·25.
100W Power Amplifier £31·80. Carr. 50p.
Pair High Quality Headphones Matching Dynamic (Moving Coil) Microphone fitted to Headphones. £6·95.
Pair 50W Speakers black rexine covered. Size approx. 18″ × 18″ × 8″. £33·90. Carr. 75p.
TOTAL COST OF INDIVIDUAL UNITS **£139·75**
Terms on Amp., Speakers and H/phone/Mike. Deposit £15 and 18 monthly payments of £3·94 (Total £85·92)
FG1/2 Terms etc., next column

SEND S.A.E. FOR DISCO LEAFLET

FAL

F.G.1/2A DISCO CONSOLE

Incorporating twin Garrard SP25 Mk.III turntables and Ceramic Cartridges with diamond stylii. Separate Vol. controls for each turntable. Also MONITORING FACILITIES, plus Treble and Bass Controls. Separate input for 'mike' with vol. control switch. Black Rexine covered Cabinet with lid.

Carr. £1·25 **£67·10**
Or Deposit £15 and 18 monthly payments £3·58 (Total £79·08)

R.S.C. COLUMN SPEAKERS

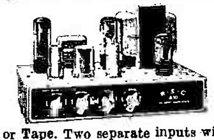
IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

All types 15 Ohms covered in Rexine and 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 × 10 × 5in. **£17·75**
Terms: Dep £3 and 9 monthly payments £2 (Total £21) Carr. 50p.

TYPE C412S 50 WATTS
Fitted four 12″ 11,000 line 15 watt speakers: Overall size approx. 56 × 14 × 9in **£31**
Terms: Dep. £4 and 9 monthly payments £3·37 (Total £34·33) Carr. 75p

TYPE C4100 100 WATTS inc. four 12″ 50 watt speakers for conservative rating. Extra heavy construction. Size approx. 58 × 16 × 10″ Acoustically filled and pressurised. Terms: Dep. £11 and 9 mthly. pyts. £6·75 (Total £71.75). **£65** Carr. £1



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 Contrrols. 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, 200-250v. 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 £1·90. 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.

R.S.C. TRANSFORMERS, L.F. CHOKES & RECTIFIERS

FULLY GUARANTEED. Impregnated and Interleaved where necessary.

Primaries 200-250v. 50c/s. Screened
MIDGET CLAMPED TYPE $2\frac{1}{2} \times 2\frac{5}{8} \times 2\frac{1}{4}$in.
250v., 60mA, 6·3v. 2a 99p
250-0-250v., 60mA 6·3v 2a .... £1·05
FULLY SHROUDED UPRIGHT MOUNTING
250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a. £1·40
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
300-0-300v. 130mA, 6·3v. 4a. c.t., 6·3v. 1a. For Mullard 510 Amplifier .... £2·65
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·65
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a. £4·95
425-0-425v. 200mA, 6·3v. 4a., 6·3v. 3a., 5v. 3a .... £5·10
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a. £5·50
TOP SHROUDED DROP-THRO' TYPE
250-0-250v. 70mA, 6·3v. 2a., 0-5-6·3v. 2a. £1·35
250-0-250v. 100mA, 6·3v. 3·5a. .... £1·55
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
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
300-0-300v. 130mA, 6·3v. 4a., c.t. 6·3v. 1a. Suitable for Mullard 510 Amplifier...... £2·60
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. £2·20
350-0-350v. 150mA, 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..
CHARGER TRANSFORMERS 0-9-15v. 1½a. 99p; 2½a. £1·10; 3a. £1·25; 5a. £1·45; 6a. £1·65; 8a. £2·00
AUTO (Step UP/step DOWN) TRANSFORMERS 0-110/120v. 200-230-250v. 50-80 watts £1·10, 150 watts, £1·90 250 watts £2·75; 500 watts £5·75
OUTPUT TRANSFORMERS
Standard Pentode 5,000 Ω or 7,000 Ω to 3 Ω 50p
Push-Pull 8 watts EL84 to 3 Ω or 15 Ω.. 83p
Push-Pull 10 watts 6V6, ECL86 to 3, 5, 8 or 15 Ω .... £1·37
Push-Pull EL84 to 3 or 15 Ω 10·12 watts.. £1·35
Push-Pull Ultra Linear for Mullard 510, etc. £2·20
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω .... £1·99
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15 Ω £3·30
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.

CREDIT TERMS AVAILABLE ON PURCHASES OVER £8 (Kits Excepted)
INTEREST CHARGES REFUNDED ON CREDIT SALES Settled in 3 months

FANE ULTRA HIGH POWER LOUDSPEAKERS

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

'POP' 100	'POP' 60	'POP' 50
18″ 100 Watt	15″ 60 Watt	12″ 50 Watt
14,000 gauss	14,000 gauss	13,000 gauss
8/15Ω **£22·95**	8/15Ω **£12·90**	15Ω **£10·90**
Dep: £6 and 9 mthly payments £2·20 (Total £25·80)	Dep. £3·30 and 9 monthly payments. £1·30 (Total £15).	Dep £2 and 9 monthly payments £1·20 (Total £12·80)
		PAIR SUITABLE ALL PURPOSES

FOR BASS GUITAR, ELECT. ORGAN. ETC.

FANE SPEAKERS 'POP' 25/2 12 in. 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).

GROUP/DISCO EQUIPMENT PACKAGE OFFERS

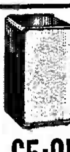
F.A.L. PHASE 50 MK.III AMPLIFIER £34·95
PR. FANE POP 25/2 25W L/SPEAKERS £13·50
£48·45
Terms: Deposit £6.50 and 9 monthly payments of £4.72 (Total £48.98)
PACKAGE PRICE **£45** carr. £1

F.A.L. PHASE 50 MK.III AMPLIFIER £34·95
PR. FANE POP 50 L/SPEAKERS £21·80
£56·75
Terms: Deposit £10 and 9 monthly payments of £5·25 (Total £57.25)
PACKAGE PRICE **£52** carr. £1

F.A.L. PHASE 50 MK.III AMPLIFIER £34·95
PAIR L12/25 25W L/S in cabinets £23·90
£58·85
Terms: Deposit £10 and 9 monthly payments of £5·50 (Total £59·50)
PACKAGE PRICE **£54** carr. £1·25

F.A.L. PHASE 100 AMPLIFIER £61·95
4 FANE POP 50 L/SPEAKERS £43·60
£105·55
Terms: Deposit £15·95 and 9 monthly payments of £10·50 (Total £110·45)
PACKAGE PRICE **£99·95** carr. £2

HIGH QUALITY LOUDSPEAKER UNITS



ALL TWO TONE REXINE AND VYNAIR FINISH
L125 50 WATT Fitted pair of 12″ 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Carr. £1·50 **£33·50**
Or deposit £4·50 and 9 monthly payts. of £3·62. Total £37·08

L12/25 12″ 25 WATT 10,000 lines 15 ohms. Carr. 50p. **£11·95**

L13 13″ × 8″ 10 Watt 10,000 lines 3 or 15 ohms. State impedance required. Carr 40p **£5·25**

FAL PHASE 50 MkIII 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 to 30 ohms. Size 17″ × 7″ × 7½″. 200-250v. A.C. mains. Output 50 watts music rating. Or deposit £7·25 & 9 monthly payments £3·50. Total £38·75. **£34·95** Carr. 75p.

R.S.C. Branches listed below open all day Sats.
BRADFORD 10 North Parade (Half-day Wed.). Tel. 25349
BLACKPOOL (Agent) O & C Electronics 227 Church Street
BIRMINGHAM 30/31 Great Western Arcade, Tel. 021-236 1279 (Half-day Wed.).
DERBY 26 Osmaston Rd., The Spot (Half-day Wed.). Tel. 41361
DARLINGTON 18 Priestgate (Half-day Wed.). Tel. 68043
EDINBURGH 101 Lothian Rd. (Half-day Wed.).
GLASGOW 326 Argyle St. (Half-day Tues.). Tel. 248 4158
HULL 91 Paragon Street (Half-day Thurs.). Tel. 20505.
LEICESTER 32 High Street (Half-day Thurs.). Tel. 56420
LEEDS 5–7 County (Mecca) Arcade, Briggate (Half-day Wed.). Tel. 28252
LIVERPOOL 73 Dale Street (Half-day Wed.). Tel. 236 3573
LONDON 238 Edgware Road, W.2. (Half-day Thurs.). Tel. 723 1629
MANCHESTER 60A Oldham Street, (Half-day Wed.). Tel. 236 2778
MIDDLESBROUGH 106 Newport Rd. (Half-day Wed.). Tel. 47096
NEWCASTLE UPON TYNE 41 Blackett Street (Half-day Wed.). Tel. 21469
NOTTINGHAM 19/19A Market Street (Half-day Thurs.). Tel: 48068
SHEFFIELD 13 Exchange Street (Castle Market Blds.) (Half-day Thurs.). Tel. 20716
SUNDERLAND 5 Market Square Opp. W. H. Smiths

NOW TWO NEW BRANCHES

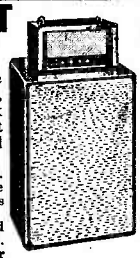
19/19A MARKET STREET
NOTTINGHAM
Also 5 Market Square
SUNDERLAND
Opening late July

AND NEW MUCH LARGER PREMISES AT 101 LOTHIAN ROAD, EDINBURGH

RSC HI-FI CENTRES LTD.

MAIL ORDERS & EXPORT ENQUIRIES TO:— AUDIO HOUSE, HENCONNER LANE, LEEDS, 13. Tel: Pudsey (09735) 77631.
TERMS C.W.O. or C.O.D. No C.O.D. under £1. POSTAGE 25p EXTRA UNDER £2. 30p EXTRA OVER £2 OR AS QUOTED. TRADE SUPPLIED. S.A.E. PLEASE WITH ENQUIRIES. SUPPLIERS TO GOVERNMENT DEPARTMENTS, EDUCATION AUTHORITIES, SCHOOLS, HOSPITALS, H.M. FORCES ETC.
MAIL ORDERS MUST NOT BE SENT TO SHOPS

RSC 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.
★ Two extra heavy duty 12in. Loudspeakers.
★ Four Jack inputs and two Volume Controls for instant use of up to four pick-ups or "mikes". Bass and Treble controls.
Credit Terms: Deposit £16 & 9 monthly pyts of £6·08 (Total £70·72) Carr. £1·50 **£63** Send S.A.E. for leaflet.

RSC GP30 HI-FI AMPLIFIER

For Guitar, Vocal or Instrumental Group.

A 4 input, 2 vol. control HI-FI 30 watt 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 £4·30 and 9 monthly payments of £2·30 (Total £25·00). **£22·50** Carr. 65p

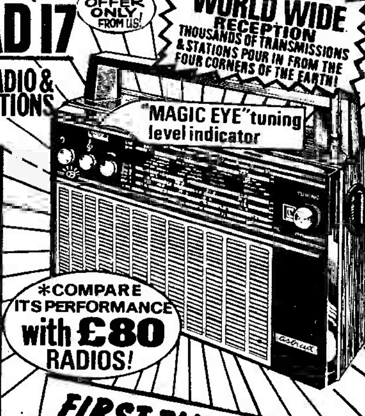
JUST ARRIVED! THIS YEAR'S NEW RUSSIAN MIRACLE! *"COMPUTERISED"?

BRAND NEW "SPACE AGE" model —SO FAR AHEAD OF ITS TIME IT WILL STILL BE MAKING MANY LOOK OUT OF DATE IN 1984!

THE FABULOUS **ASTRAD 17** PORTABLE RADIO & COMMUNICATIONS RECEIVER

This OFFER ONLY FROM US!

WORLD WIDE RECEPTION THOUSANDS OF TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH!



28 TRANSISTORS AND DIODES!

WAVEBANDS: STANDARD LONG and MEDIUM *Plus* 5 SHORT WAVEBANDS *Plus* ULTRA SHORT WAVES (V.H.F. AM. FM. MW. LW. USW.)

*COMPARE ITS PERFORMANCE with £80 RADIOS!

WE COULDN'T EVEN MAKE THEM FOR THIS PRICE!

BATTERY MODEL **£20·75** BOX POST ETC. 50p

MAINS/BATTERY ELIMINATOR £1·48 extra

FIRST TIME EVER! *NOW AVAILABLE WITH fabulous "COMPUTERISED" WORLD TUNING GUIDE! NO MORE GUESSWORK— INSTANT DATA at your fingertips— enables you to TUNE IN A FLASH to transmissions the world over!

ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic ASTRAD 17 and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! THIS ONE SUPERSEDES ALL EARLIER MODELS! It will probably make your present radio seem like a "crystal set"!** Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £20·75—**a mere fraction of even today's Russian miracle price!** We challenge you to compare performance and value with that of £80 radios! *You can't lose, we'll refund instantly if you are not astounded! **Elegant black and chrome finish facia, set in fabulous Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures purer and sweeter tone than ever!** Volume controlled from a whisper to a roar that would fill a hall! **Much wider band spread, for absolute "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity!** Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spaceship and satellite communications. **Yes, EVERY WAVEBAND** instantly at your fingertips **including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth 24 hours a day, including all normal transmissions, VHF, AM, FM, MW, LW, USW, plus local and new stations not yet operational and messages from all over the world! Expensive TURRET TUNER** side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! **Press-button dial illumination! Take it anywhere**—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240v AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39ins approx. **It's also a fabulous CAR RADIO. Can also be used through extension amplifier, tape recorder or public address system. SIZE 14ins x 10½ins x 4½ins** overall approx. Magnificently designed, made to give **years of perfect service.** (U.K. service facilities and spares available for years and years to come, if ever necessary!). With WRITTEN GUARANTEE manual with simple operating instructions and circuit diagram. **ONLY £20·75** (with mains/battery eliminator £1·48 extra). **BOX, POST, ETC. 50p. *BUT WAIT,** for only 55p extra you get the sensational **"COMPUTERISED" WORLD TUNING GUIDE** (it enables you to time, pinpoint and get transmissions the whole world over—even a child can do it in a flash—**it even lets you know when to tune into the U.K. when abroad.** NO GUESSING! NO MESSING!) **PLUS** Standard 'longlife' batteries **PLUS ultra sensitive earphone for personal listening.** (Sorry—We cannot change these new radios for any earlier model purchased.) HURRY! Send today or call at either store. It's a chance of a lifetime that nobody can afford to miss.

MOTORING SENSATION! **SAVE £24·50!**

LIST PRICE £39·97!

8-TRACK CAR STEREO PLAYER

Plus **2 MATCHED SPEAKERS** FOR ONLY £1·25 EACH!

ONLY **£12·97** CARR. ETC 33p

Plus ALL CONNECTIONS and FITTINGS!

FANTASTIC "BANK BUSTING" OFFER! ASTRONOMICAL REDUCTION! Frustrated import order must be turned into cash! Brand New, from first-class makers—we must not mention name. Absolutely the ultimate in luxury car equipment. The sort of offer that you only dream about, but **THIS** is true! Yes, for the incredible price of **£12·97 carr. etc. 33p** you can have this magnificent complete 8-track Stereo Player. Beautifully made—so compact, overall size 6¾in. x 6¼in. x 2¾in. approx. for easy mounting in any car, boat or truck—or even in the home. (Runs off 12V. battery.) Just 'slap-in' your favourite recordings (obtainable everywhere) and you get hours of continuous playing **and experience rich true-fidelity stereo sound!** Autoplay, automatic track-changer, plus manual programme selector. Separate thumbwheel volume and treble/bass tone controls, sliding balance control. Outstanding 80-10,000 c/s frequency response! Circuit—10Tr OTL system! Playback system—8 track, 4 channels! Speaker impedance—4-8 ohms each channel! Output power—5 watts (2·5 watts per channel), plus all leads, connections, fitments, etc. Designed for fast, easy mounting. Complete with simple instructions & WRITTEN GUARANTEE. **BUT WAIT!** For only £2·50 extra (£1·25 each) you get the option to buy **TWO SUPERB COMPACT MATCHED SPEAKERS**—each 4½in. diam. approx.—to give you a **COMPLETE MAGNIFICENT 8 TRACK CAR STEREO SYSTEM! Everything for £15.47 carr. 33p.** (SAVING YOU £24·50), but please hurry! We don't want to disappoint a single reader! **Refund guarantee**

THIS FANTASTIC OFFER ONLY FROM US!

SAVE £20·25 NOW!

fabulous BRAND NEW **SOLID STATE**

This equipment's got EVERYTHING!

BATTERY/MAINS AC

Combined **V.H.F AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER**

WITH REMOTE CONTROL MICROPHONE

RECOMMENDED RETAIL PRICE £44

OUR PRICE **£23·75** CARR. ETC. 35p

Shopertunities 'thunder' ahead with an offer that's FANTASTIC (even by our standards!) We've snapped up 500 magnificent machines. **Latest sensation in the world of sound!** First-class makers! Fabulous **VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined and it also runs off standard batteries or mains.** (Simply plug in the 220/240v. AC line cord. Record and play back **anything, anywhere! Even tape direct from the Radio as you listen! RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE!** Wonderful features: ★ **Press-button Keyboard, Control Panel or latest MASTER SWITCH CONTROL!** ★ **"MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller!** ★ **Separate ON/OFF and HI-LO volume controls!** ★ **Heavy duty built-in speaker!** ★ **Earphone** (for personal listening or "monitoring") **and extension speaker sockets!** ★ **Remote control microphone!** ★ **Built-in swivel telescopic extension aerial (24in. approx)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.)** Takes standard 30, 60, 90 or 120-minute Philips Cassette Tapes obtainable everywhere. **The amazing built-in full circuit VHF, AM/FM Radio** gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus B.B.C. National, VHF. Picks up dozens of foreign stations. **Fabulous in your car!** You could pay £ £ £'s more for a Car Radio or Car Cassette player ALONE! **£23·75, CARR, ETC. 35p. Complete with simple instructions, remote control microphone with on/off switch and microphone stand. WITH WRITTEN GUARANTEE.** *Send today or call at either store.*

BONUS OFFER: Batteries and Cassette Tape 25p extra if required.

SHOPERTUNITIES LTD.

Dept. WP/21, 164 UXBRIDGE RD., LONDON, W12 8AQ (Thurs. 1, Fri. 7) (*facing Shepherd's Bush Green*). **Also 37 High Holborn, London W.C.1 (Thursday 7 p.m.). Both Mon. to Sat. 9 a.m.–6 p.m.**

PRACTICAL WIRELESS

VOL 48 NO 4

Issue 786

AUGUST 1972

Hope for VHF

If we are honest, the VHF (Band II) services have largely been a failure. It is 17 years since these transmissions started but even now the number of people listening to them compared to the AM stations is very small. We have tried to get hold of some figures to prove the point but they do not seem to exist. Most informed sources tend towards a figure of less than 10 per cent. We don't blame the BBC for this; they have given plenty of information on the availability of the service but they (quite rightly) cannot force people to change over.

The main reason for this failure must be that until recently there have been no extra services on VHF, a situation rather different from that elsewhere, in Europe and the United States, where additional programmes have been available on this band for several years.

There is hope however. Recently the Sound Broadcasting Bill was given the Royal Assent and within about a year the first commercial stations will take to the air. Plans on frequencies etc. have yet to be finalised but it would seem that both medium waves and VHF will be used during daylight while transmissions after dark will be confined to VHF. This situation could bring about a listening revolution; people will have reason to change the waveband switch to VHF and it will not be long before they become convinced that the reception is better. If this *does* happen, everyone will gain. The set makers will be well pleased, the BBC local stations will have a much higher potential audience and the BBC networks will be able to justify an expansion of stereo transmissions, something which is difficult now with so few taking advantage of the service. It will be the listeners however that have the most to gain.

It will be a very long time before the medium waves become redundant, in fact they will probably continue indefinitely, even if all domestic services are duplicated on VHF, but we can foresee a swing away from AM and this must be welcomed.

We must remember however that the introduction of the BBC local stations was predicted as being the saviour of this band, a hope that has only been realised to a small extent. The number of people who have even *heard* of the existence of these stations seems to be small, largely due to the tiny budgets available to these stations for publicity. The commercial operators on the other hand will have a vested interest in popularising this band if they are confined to it for part of their transmission time. We can only hope that they will succeed.

W. N. STEVENS—*Editor*

NEWS AND COMMENT

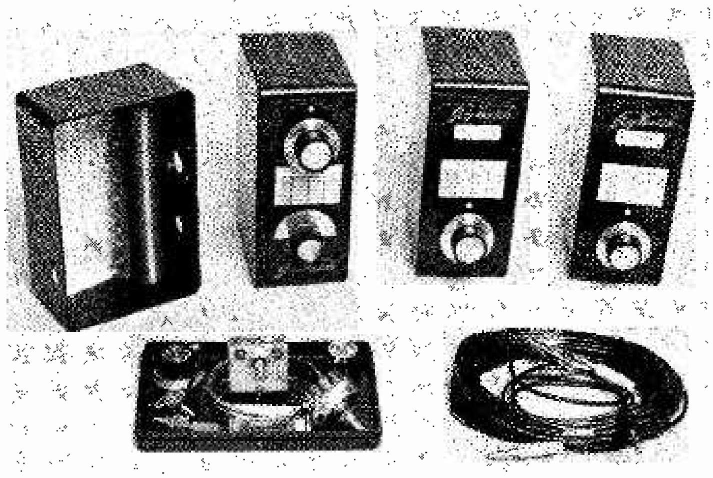
CONSTRUCTIONAL

OTHER FEATURES

SEPTEMBER ISSUE WILL BE PUBLISHED ON AUGUST 4th

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

Partridge add to their range



Partridge Electronics Ltd. of Broadstairs in addition to their brand new range of "Joystick" and "Joymatch" export aerial equipment; have introduced a range of novel very reasonably priced items they describe as "The Partridge Budget Line." These items illustrated from left to right are: (1) Versatile transmit or receive ATU kit; (2) Assembled kit; (3) Indoor artificial earth; (4) Complete aerial system comprising aerial and ATU.

Not illustrated is the new "Joystick" VFA which measures 7ft. 6in. assembled (or 2·28m for E.E.C. area readers).

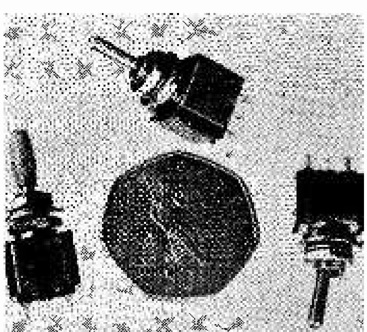
Mini toggles

A new range of low cost miniature toggle switches, the 5500 series is now available ex-stock from Guest International Limited.

Utilizing 6m.m. threaded bush fixing, they are supplied in single or double pole versions. The standard version offers a changeover action, but both types can be supplied in momentary switch and centre off versions.

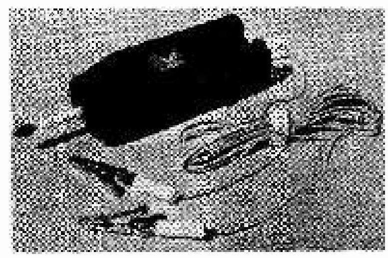
The switches are rated at 250V a.c. at 2A and have solid silver contacts terminating in solder tags.

Coloured plastic hoods are available which snap over the tapered dolly thus providing effective coding. For further information contact Mr. E. S. Tingay, Manager, Industrial Components Division, Guest International Limited, Nicholas House, Brigstock Road, Thornton Heath, Surrey.



The mini toggle switches

Grinder



Peter Kwasny GmbH & Co., of West Germany market a small battery-operated grinder which has many applications in the home constructor field of radio/electronics. It is ideal for example, for smoothing off holes that have been drilled in chassis and really comes into its own when cabinets have to be drilled or a nice finish has to be put on a unit and rough edges smoothed down.

The carborundum tip cuts metals, plastics or wood and runs at 11,000r.p.m. A toggle switch is provided to switch the unit on and off and power supply is 6-12V. The sole UK agents are *TIS Products Limited, 39 St. James's Street, London, S.W.1*, and the price of the unit is £2·50.

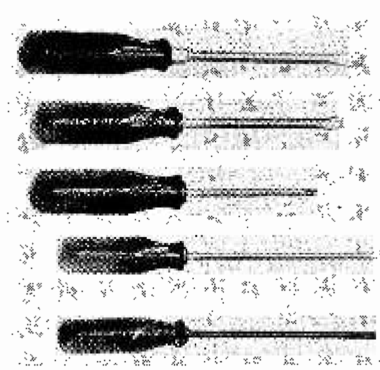
PARS rally

Preston Amateur Radio Society Mobile Rally will be held on Sunday, August 27th at Kimberley Barracks, Deepdale Road, Preston, from 12 noon to 5 p.m.

Talk in stations on 160 metres and 2 metres. Ample parking, refreshments and bar. Further details from G. W. Earnshaw, G3ZXC, 12 Withy Parade, Fulwood, Preston.

Screwdrivers

Wittekind screwdrivers have chrome vanadium in their blades and the Standard range has fluted plastic handles. The Top Ten range has a unique three-sided handle design which gives even better turning power while each face is textured to improve the grip even more. Wittekind screwdrivers are distributed in the UK by: *L. J. Hydleman & Co. Ltd., 197/215 Lyham Road, London, SW2 5PZ.*



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

Seminar of 1972

Texas Instruments Ltd. presented "The Seminar of 1972" on June 6th, 7th and 8th, at the Talk of The Town. The programme was specifically chosen to meet the needs of design engineers working on original equipment.

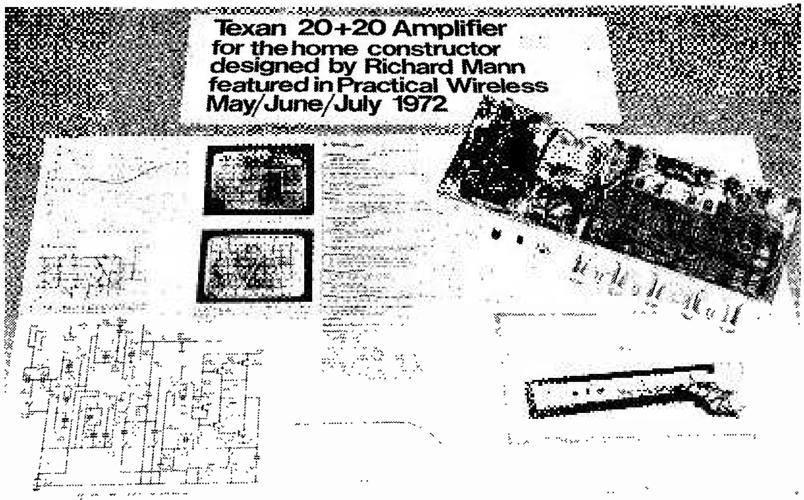
The themes discussed were: New Digital and Linear Bipolar I.C.'s, M.O.S., Audio and Consumer Design Techniques, Power Control and Opto Electronics.

A Seminar Slide Book was given to everyone attending the day's presentation. This contained a reproduction of all relevant slides, together with a comprehensive data pack containing a selection of collateral material to support the day's presentation.

A new feature for this year's Seminar was a specially prepared text book worth £5. Its contents are relevant to the presentations, and it is intended as supplementary reading to the day's Seminar.

The Text Book plus the four course lunch, plus a full day's presentation was all covered by an inclusive charge of £8·50 per delegate.

"The Seminar of 1972" was a comprehensive applications coverage of tomorrow's semiconductor products. It provided a useful day's education for delegates, and equipped them with knowledge, which they can apply to the design of end equipment that will be marketable throughout the world.



The "Texan" Amplifier display on view at the Seminar.

Bi-Pak components

Bi-Pak have opened their first electrical component and Hi-Fi supermarket at 18 Baldock Street, Ware, Herts (continuation of Ware High Street).

In addition to their Mail Order lines there is a vast selection of Hi-Fi equipment, transistor radios, cassette and tape recorders, car radios, record playing decks, loudspeakers and enclosures, cartridges and stylus, etc., electronic equipment and accessories.

Customers are also able to hear the popular System 12 Stereo kit which is on display.

The shop is trading under the name of "BI-PAK Components" and is open 9.15 a.m.-6 p.m. Tuesdays to Saturdays with late night shopping till 8 p.m. on Fridays. Telephone: Ware 61593.

Use anywhere soldering instrument

Adcola have introduced a lightweight thermally controlled soldering iron operating from a standard car battery.

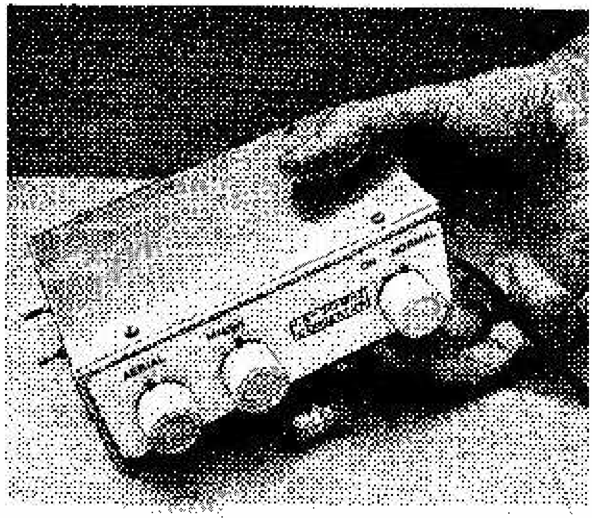
The new model is an addition to the Invader range of mains operated soldering instruments mentioned in NEWS ... last year, and features a simple plug-in element which can be replaced in 90 seconds.

Two models are available with soldering bit diameters of $^3/_{16}$in and $^1/_4$in, rated at 23 and 27 watts respectively to provide an operating bit temperature of 360°C.

Crocodile clips are provided at the end of 12ft. of p.v.c. cable—impervious to oil, grease and water—for connection to the battery terminals. The tool is supplied with a fire-resistant tubular sleeve which fits over the element and bit. This allows the user to safely replace the soldering instrument in a tool box after use without having to wait for the tip to cool—the sleeve also protects the element in transit.

The Invader $^3/_{16}$in. diameter bit model BL 646 retails at £2·37 and the larger model BL 1076 for £2·47. Both are available with a red or blue handle. A wide range of standard copper and iron plated long-life bits are also available.

top band CONVERTER



F. G. RAYER G3OGR

THIS converter may be used with a valve or transistor receiver, bringing the 1800kHz to 2000kHz amateur "Top Band" range into the 600kHz to 800kHz section of the receiver's medium wave band. Actual frequency coverage extends somewhat outside the 1·8-2·0MHz range.

Conversion is by means of an oscillator working at about 2·6MHz, the oscillator being h.f. of the signal frequency. As an example; to receive a signal on 1800kHz, the converter output is 2600−1800, or 800kHz, while to receive a signal on 2000kHz, the converter output is 2600—2000kHz, or 600 kHz. The receiver thus functions as a tunable i.f. amplifier, covering 1800-2000kHz when tuned from 800-600kHz. It will be noted that the new frequency range is inverted, the high frequency end of this band coming towards the low frequency end of the receiver's medium wave range.

Circuit

This is shown in Fig.1. When the 3-pole switch is in the "off" position S1A and S1C take the aerial connection directly to the receiver, which then works in the usual manner. When the switch is "on" S1B connects the 9V battery supply and signals pass through the converter.

Tr1, an OC170, is the r.f. amplifier, the aerial circuit being peaked up by the panel trimmer VC1. Output from this stage passes to L2, trimmed by VC2, which

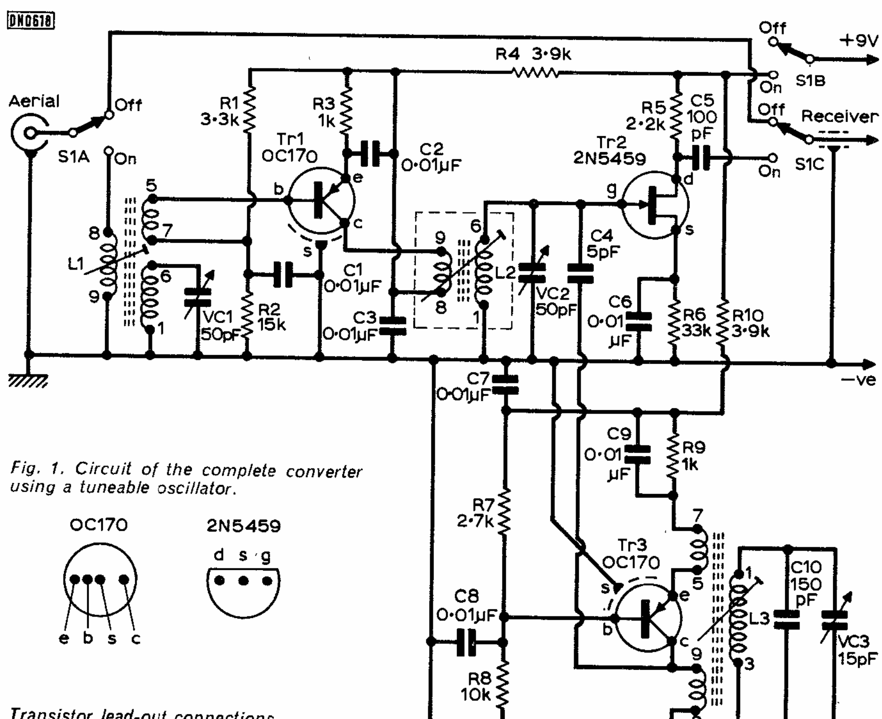
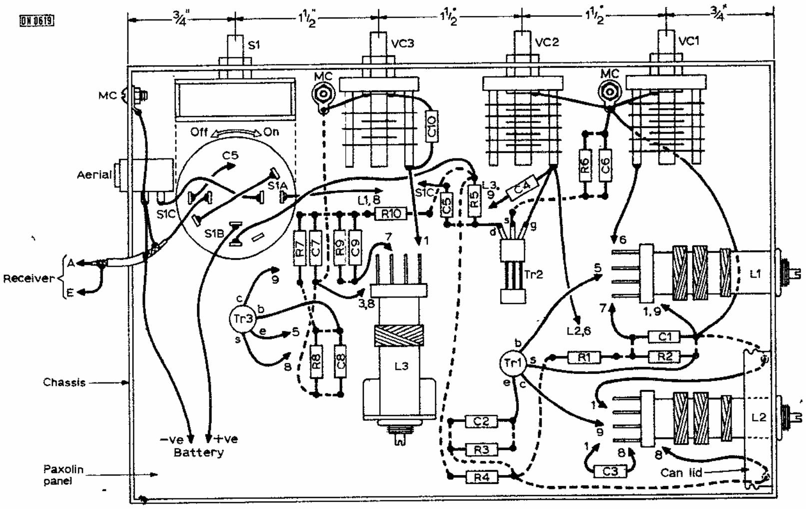


Fig. 1. Circuit of the complete converter using a tuneable oscillator.

Transistor lead-out connections.



◀*Fig. 2. Layout of the tuneable version of the converter. Tuning capacitor VC3 and associated components are not required in the crystal controlled version, shown in heading photograph.*

forms the input circuit of the f.e.t. mixer Tr2, a 2N5459.

Tr3, an OC170, is the 2·6MHz oscillator, coil L3 having a fixed capacitor C10 in parallel together with the trimmer VC3. Mixer injection is via C4, while the output to the receiver is by means of a screened lead.

Crystal Control

The oscillator stage Tr3 in Fig. 1 may be replaced by a crystal controlled oscillator, as described later. In this case, VC3 and some other items here will not be required, as this part of the circuit conforms to Fig. 3.

Construction

The converter is completely screened in a 6×4×2in. aluminium box made from two 6×2in. universal chassis members, two 4×2in. members and two 6×4in. flat plates secured with self-tapping screws.

Holes for capacitors, switch and coils are punched as in Fig. 2. The can in which L2 is supplied is used as a screen by securing the lid under the bush of L2. Drill holes clear of the threaded portion of the lid, for the leads from pins 1, 6 and 8.

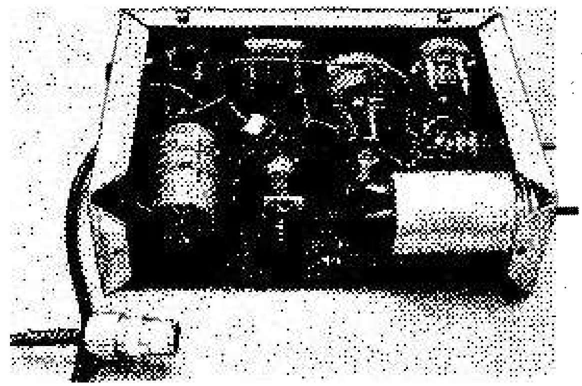
A piece of $\frac{1}{16}$in. paxolin about $5\frac{1}{4}$in.×$3\frac{3}{4}$in. is cut and fixed inside the flanged members by countersunk 6BA bolts through the flanges and paxolin. Place washers between the flanges and paxolin, to give about $\frac{3}{16}$in. clearance for wires which will be under the paxolin. If this is not done, it will be impossible to fix the bottom 6×4in. plate in position. Secure 6BA tags under the bolts near VC1 and the switch, for earth return connections.

It is easier to wire the converter with only the front 6×2in. and side 4×2in. members in place. After testing, bolt on the back 6×2in. member, and fix top and bottom 6×4in. plates.

L3 is mounted on a small bracket cut from scrap metal but leads should be soldered to its pins before actually fixing it.

Wiring

Resistors and other components are fixed to the paxolin board by drilling small holes and putting the wire ends through them, Fig. 2.



▼*General view of completed converter based on Fig. 1 and 2.*

Coil pins should be scraped or cleaned with abrasive paper before soldering, since undue heating will soften the material in which the pins are moulded.

(Because of the ease with which the coils can be damaged by excessive heat applied to the pins it is suggested that constructors may wish to use a valveholder for each coil. Wire the valveholders in such a way that they can be pushed on to their respective coils, keeping the leads as short as possible.—Ed.)

When wiring L2, leave an insulated wire projecting from pin 9.

Drill a hole in the centre of the screening can and also cut off some of the threaded section, so that when the can is screwed on it does not cut into the leads from pins 6 and 8. The can is then screwed on, with the lead through the hole, the collector lead of Tr1 being soldered to the lead. Note that C3 is across pins 1 and 8, inside the can.

A 3-socket transistor holder is used for Tr2 and this can be cemented in position, or held with stout leads through the paxolin.

Check that switch connections are correct. In the "off" position the converter is not in use. With the switch "on" S1A takes the aerial to 8 on L1, S1B connects the battery positive, and S1C connects the receiver to C5.

The aerial socket fitted is a miniature item for a small jack plug, outer going to chassis, and inner to S1A. The output lead employed was small co-axial cable with the outer soldered to a tag bolted to the chassis and the inner conductor running to S1C. This was to suit associated equipment. There is adequate space for ordinary co-axial connectors or sockets, for both input and output purposes, if preferred.

An elastic band through holes in the paxolin holds the internal battery. The internal battery supply allows the converter to be connected to a car radio in a vehicle having either positive or negative earth.

Alignment

If the converter is used with a portable or table transistor receiver, run a reasonably short screened lead to the aerial input socket of the receiver, the co-axial outer conductor going to the receiver earth or chassis in the usual way. This can also be done with mains receivers where the receiver chassis is earthed and isolated from the mains. **The converter must not be used with any ac/dc type receiver having a live chassis.**

Plug in Tr2, making sure the lead-out wires are in the correct sockets. Adjust L1 and L2 so that about 15 threads of the adjusting screw protrude. L3 has about 10 threads protruding.

Tune in any Top-Band signal with the receiver tuning around 700kHz. Place VC1, VC2 and VC3 about half closed and rotate the cores of L1 and L2 for best volume. The core of L3 can be moved to alter coverage, if necessary, and then locked with a nut. It should be found that VC1 and VC2 peak up signals throughout the band; if not, adjust L1 and L2 cores for suitable coverage. In the event of a wanted Top-Band signal falling on the frequency of a medium wave signal thus causing interference, alter VC3 and re-tune the receiver. VC3 also acts as a fine tuner if the receiver is not equipped with a suitably slow tuning drive or dial.

Alternative Crystal Control

The LC oscillator tuned circuit L3 with C10 and VC3 can be replaced by a crystal controlled oscillator stage with a frequency of about 2600kHz. The circuit for this is shown in Fig. 3 and the layout in Fig. 4.

Crystal control gives much greater oscillator stability and Top Band frequency readings transferred to the receiver m.w. scale will remain unchanged, which can be useful for logging and tuning purposes. On the other hand, it is impossible to shift the m.w. tuning point in the manner previously described, in order to dodge m.w. interference. So crystal control is only suitable when the receiver is not subject to m.w. breakthrough.

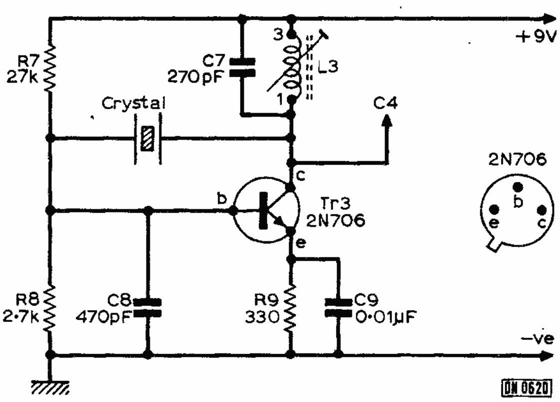


Fig. 3. Modified oscillator circuit for crystal control.

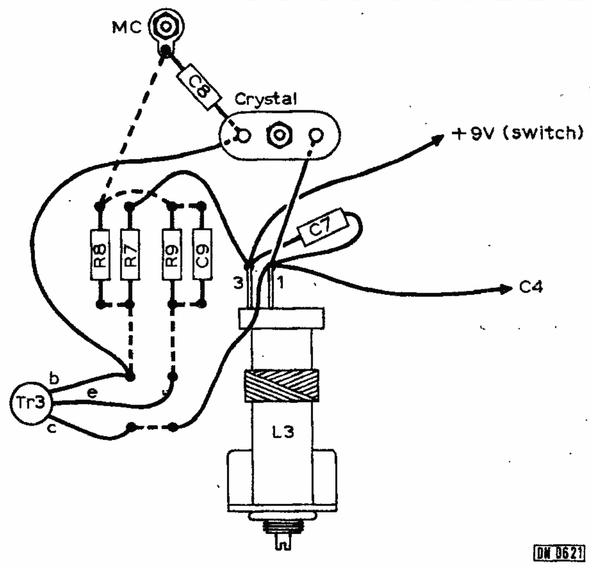


Fig. 4. Layout of components around oscillator inductor L3, when using circuit of Fig. 3.

★ components list

Resistors:
R1 3·3kΩ R5 2·2kΩ R9 1kΩ
R2 15kΩ R6 33kΩ R10 3·9kΩ
R3 1kΩ R7 2·7kΩ
R4 3·9kΩ R8 10kΩ All ¼W 10%

Capacitors:
C1 0·01μF disc ceramic C6 0·01μF disc ceramic
C2 0·01μF ,, ,, C7 0·01μF ,, ,,
C3 0·01μF ,, ,, C8 0·01μF ,, ,,
C4 5pF SM C9 0·01μF ,, ,,
C5 100pF SM C10 150pF SM
VC1-2 50pF variable (Jackson C804)
VC3 15pF variable (,, ,,)

Semiconductors:
Tr1 OC170 Tr2 2N5459 Tr3 OC170

Miscellaneous:
L1, Range 2, Blue, L2, Range 2, Yellow. L3, Range 3, Red, all miniature, transistor (Denco). Case, Universal Chassis members, 6 x 2in. flanged (2), 4 x 2in. flanged (2), 6 x 4in. flat plates (2) (Home Radio). Transistor holder, for 2N5459. 3-pole 2-way rotary switch. Screened lead, knobs, aerial socket.

Crystal Oscillator: (Fig. 3)
R7 27kΩ R8 2·7kΩ R9 330Ω
C7 270pF SM C8 470pF SM C9 0·01μF disc
Tr3 2N706 L3 See text
Crystal: 2600kHz and holder, see text

L3 can be that used for the circuit in Fig. 1, or any similar inductor which can be adjusted to about the crystal frequency by moving its core. Set the core so that the oscillator starts immediately when the converter is switched on.

Aerials

If no Top Band aerial is available a long outdoor wire will give good general results. Some 50 to 150ft of wire would do well. Bends in the run of the aerial will not matter too much, if they cannot be avoided, but the wire should not turn back on itself.

Various resonant and other aerials are used by Top-Band enthusiasts which can greatly increase signal strength. If a very short aerial is used, it should be brought to resonance by a tuner.

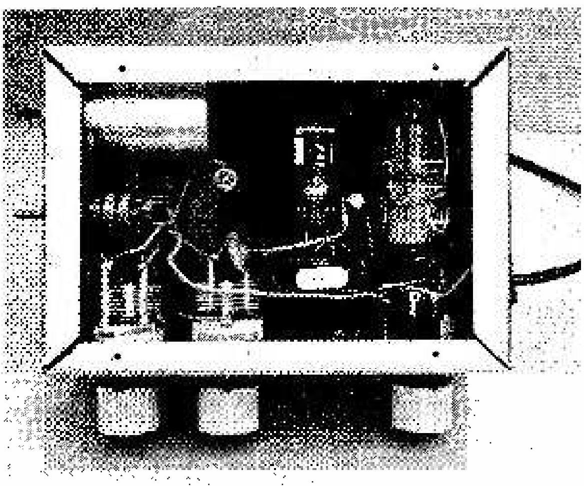
Connecting a reasonably effective earth can also greatly increase the strength of Top-Band signals.

If there is particularly troublesome interference from a m.w. transmission breaking through, this can be reduced with a wavetrap.

Tuning

With a receiver such as a car radio or older type of domestic receiver intended for use with an external aerial, there is very little pick-up of medium wave transmissions in the 600-800kHz sector when the aerial is disconnected or the converter in use. It is then only necessary to peak signals with VC1 and VC2 on the converter and tune the receiver through the 600-800kHz range.

With other receivers, and particularly portables with ferrite rod aerials, there is considerable pick-up of medium wave transmissions, so that a number of broadcast stations will be heard in the 600-800kHz range. As it is scarcely practicable to eliminate this,



Underside view of modified converter.

interference to reception in the 1·8-2·0MHz range is avoided by means of the small trimmer VC3, which allows the converter oscillator frequency to be shifted a little, so that if necessary a wanted Top Band signal can be moved off the channel occupied by a broadcast station in the m.w. range. With the aid of VC3 it was found practicable to use the converter with a portable receiver having an internal ferrite rod aerial, and provision for connecting an external aerial, and to obtain Top Band signals without m.w. broadcast interference.

VC1 and VC2 were each 50pF, but on test it was apparent that 25pF capacitors would be adequate. A pre-set, adjusted when first testing the converter, may be used instead of VC2, but with a slight falling off of results towards the extreme ends of the band. VC3 could also be omitted if the receiver does not give troublesome break-through of medium wave signals. VC1 is better retained as a panel control, to allow peaking up L1 with any aerial. ■

Electronotes..

S. GINSBERG

Calculators have been in existence for quite some time. Probably the earliest was a hand which gave a crude visual indication. The left hand fingers were worth one, going from one to five. From five to ten individual numbers were recognised by a bent finger. Once ten was reached, a finger on the other hand was raised. The abacus came with its beads enabling counting to be carried out with comparative ease. Most modern day school children have used a slide rule. These can be bought for less than £1 and offer quick means of making a calculation. Accuracy is often not very good, but is usually near enough for most practical purposes.

In this modern technological age even the slide rule is considered by many to be crude, and electronic calculators are beginning to move in. Simple machines which add, subtract, divide and multiply are readily available, some for less than £50.

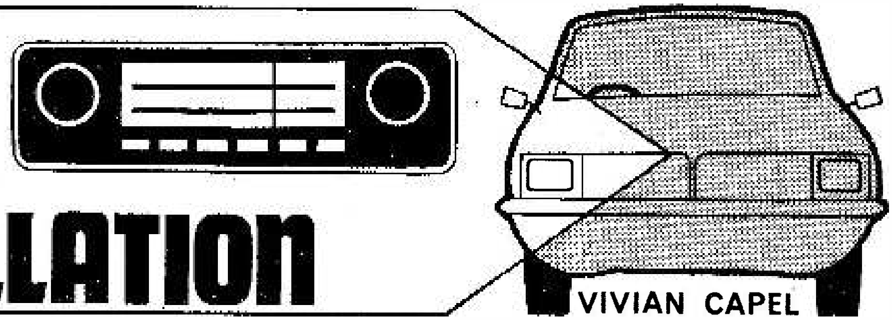
Beauty of the electronic slide rule or calculator is that it is accurate and very easy to read. It is only a matter of pressing clearly labelled push buttons for the simple operations. The answer is clearly readable from illuminated digital readouts.

An electronic calculator which aroused a great deal of interest when it was launched recently, is the HP-35. This unit fits snugly into the palm of your hand, weighs only nine ounces and gives a readout from quite complex functions in less than 0·5 second. The display goes to ten digits, so accuracy is excellent. Some 30,000 transistors are employed in the m.o.s. chips which are manufactured using ion implantation. Besides adding, subtracting, multiplying and dividing, the unit also handles square roots plus a whole range of trigonometrical functions such as Sin x, Cos x, Tan x, Arc sin x, Arc cos x, and Arc tan x. Logarithmic functions include $\log_{10}$ x, $\log_e$ and e^x. Other functions are x^y, 1/x, data storage and positioning keys.

The calculating range covers 10^{-99} to 10^{99} which is equal to 200 decades. If any improper operations are involved, such as the square root of a negative number, a light will flash. Readouts are l.e.d's, which save power compared to other readout systems, and the unit also has a memory which will remember a figure for you and display it as and when you call it up on the readout.

Just in case you are a hardened cynic and reckon you could back your conventional slide rule against this device, try working out a square root. The HP-35 takes 110 milliseconds to do this—to ten digit accuracy too. Of course, logarithmic and exponential functions are more difficult and the HP-35 takes a full 200 milliseconds before displaying these answers.

CAR RADIO INSTALLATION



VIVIAN CAPEL

PART 1

INTEREST in mobile radio has never been greater. Recently a boost to car radio ownership was given when the radio licence fee was abolished. This had been a damper for some time, and the requirement for a separate licence for the car radio resulted in many technical dodges. The simplest was the provision of a car aerial socket on the ordinary transistor radio, but in most cases it proved unsatisfactory for one reason or another. Next, came the car-portable, which was a cradle fixed in the usual dashboard position into which a detachable transistor radio could be slid. A set of contacts in the cradle and the radio automatically connected an external speaker, car aerial and in some cases the car battery to save the internal ones. Although widely used these actually were illegal from the point of view of operating without a licence because the criterion was not detachability, but whether the radio was run from the car battery.

All this is over now of course, and we can go ahead with a proper installation without consideration of how to save the licence fee. The large number of radios currently offered by the makers is proof that large numbers are doing just that, and the car-portable which had many problems of its own, is now dying a natural death.

The four main operations in installing a car radio are: mounting the radio; mounting the loudspeaker; fitting the aerial, and making the electrical connections including interference suppression.

Mounting the radio

In the days of valve radios, mounting was always a problem due to the bulk and the weight. Often the power unit consisting of the vibrator to turn the car-battery d.c. voltage into a.c., and the step-up transformer together with the output stage were contained within a separate case. This helped with space and mounting problems for the radio, but of course room had to be found for the power unit.

Modern transistorised car radios are small, compact and light thus greatly facilitating mounting. The weight of the earlier models meant that one or two securing struts had to be bolted between the back of the radio and some point behind the dashboard of the car. These were extremely difficult to fit in many cars, and just as bad to remove if the radio needed repair. It usually meant lying in some unbelievable positions, and getting entangled with gear levers and handbrakes. Nowadays, the radio can be fixed only by a pair of brackets on either side, and although these are not always easy to secure, generally things are much easier.

In most cars there is a blank plate on the instrument panel which can be removed to reveal the space to accommodate the radio. Incidentally when removing this plate make sure it is kept safely because you may want to remove the radio if ever you change cars. In the aperture will be found, with many models, brackets already fitted as part of the car body. Many have four brackets, one pair at the rear and a pair near the front of the radio, however it is not always necessary to secure the back as mentioned before. It may, though, be desirable as a thief-deterrent to do so. The brackets have slotted holes and can be bent to suit different sized radios.

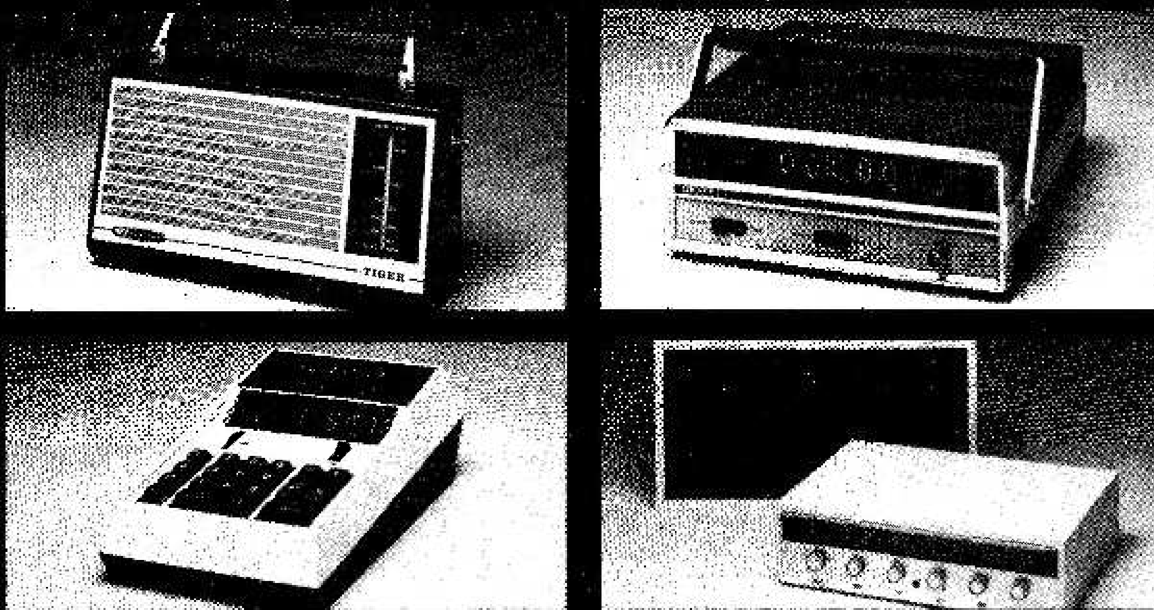
The fixing bolts usually have plain hexagonal heads, and where access may be rather limited a selection of spanners, box and ring, may be needed to reach the bolts. Sometimes the brackets may be too far from the fixing holes in the radio, and a metal mounting-strut may have to be used. These are usually supplied as part of the mounting kit with the radio.

The finishing touches

To finish off the mounting, an escutcheon will be needed to fill in the space between the edge of the radio and the instrument-panel aperture. In some cases where the radio is a good fit and the radio scale overlaps the panel, an escutcheon can be dispensed with. A range of escutcheons is often available from the radio makers to suit most modern car models. Sometimes though, the correct escutcheon or even one close to it is not available because of an unusual style, curvature or size of the instrument-panel. One way to overcome this snag is to make one up from leather or leatherette material obtained from a handicraft shop. A colour can be chosen that will match with the interior trim of the car. Holes are cut in the material for the knob spindles and an aperture for the station scale. The edge of the piece can be either tucked inside the aperture of the instrument-panel or it can be left on the outside. If it is on show, the edge must be cut very neatly and the corners can be rounded off to prevent curling. It can then be secured by fitting self-tapping screws, one in each corner and one halfway along each long side, which will screw into the metalwork of the instrument-panel. The screws should be small, semi or totally countersunk.

Occasionally one may encounter a car, especially an older model where there is no provision or space for a radio in the instrument-panel. In this case it will have to be slung underneath the panel. A central position is best as this will then not interfere with

You can make any of these just as well as we can. And save yourself money into the bargain.



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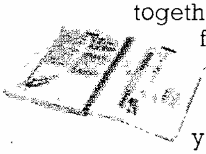

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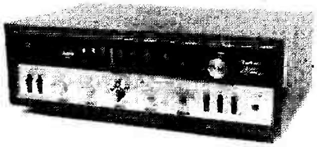

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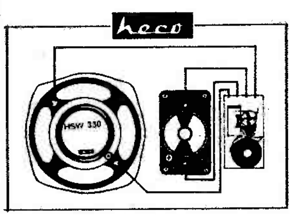

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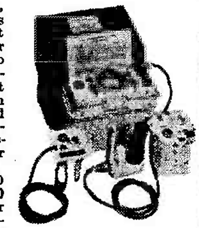

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the leg-room of either driver or passenger. In some car models though, this space is already occupied by heating equipment, so some other position will have to be found by experiment.

Once the position of an underslung mounting has been decided upon, the actual fitting can be accomplished by using the metal struts mentioned previously. These are screwed to the fixing points on the radio, and then secured by large, self-tapping screws to convenient places on the car body, usually in inconspicuous positions underneath the instrument panel. The struts may have to be cut to size and bent into a suitable shape.

Loudspeaker fitting

Now we have to determine where to fit the loudspeaker. There is normally no difficulty here. A common place is underneath the instrument-panel on the passenger side facing downward. Space on the driving side will already be occupied with the steering wheel. Another position favoured by some is in the rear parcel-shelf. The speaker in this case is actually in the boot facing upward. Grilles and escutcheons are available for mounting a speaker in this manner.

A baffle board is usually supplied for the front-mounting position, ready cut for the speaker, so it is just a case of screwing the baffle in position. Some cars have a ready made forward facing position as part of the instrument panel in which case the baffle board can be discarded and the speaker mounted directly in position.

Some people like to have two speakers in the car, one at the rear for the rear passengers, and one at the front. A changeover switch can be fitted to silence either one or the other, or parallel them so that both are on at the same time. One thing that must be watched here is that paralleling halves the load, and many transistor output circuits are not happy when working into a lower impedance than that intended, in fact the output transistors can be damaged. To prevent this, a series resistor can be included in the circuit, which should be half the value of the impedance of one speaker, this will bring the impedance up to that of a single speaker when the two are paralleled. Alternatively matters can be arranged without loss of power in the resistor, by connecting the speakers in series. The changeover switch can then merely short one or the other speaker out.

It is sometimes found that where two speakers are used, one seems louder than the other. This can be due to the efficiency of the baffle, the speaker itself or the resistance of the cable to the back speaker, although this should have little effect if the wire is not too thin. In such a case, a resistor can be included in series with the loud one to reduce it to about the same level as the other. Of course a variable resistor can be used to give volume control if required.

Aerials

Next comes the aerial fitting. There are a variety of positions possible, the considerations being good signal pickup, avoidance of interference, practical mounting and accessibility factors, and appearance. Some of the possible ones are shown at Fig. 1. As fitting involves drilling the bodywork it must be right first time, no second thoughts are possible unless one is prepared to make good a large body hole!

Detachable aerials are available that can be clipped on to the window, but these are more nuisance than they are worth and cannot be considered as a proper installation. Their only value is for occasional use with a portable radio with car-aerial socket.

It must be remembered that strong interference fields are radiated from the distributor and ignition-coil, as is well known from the early days of television reception. Therefore, the aerial should not be mounted on the same side of the car as these components. It is true that they will be suppressed, but background noise can still be picked up if the aerial is in close proximity, especially if weak stations are being received.

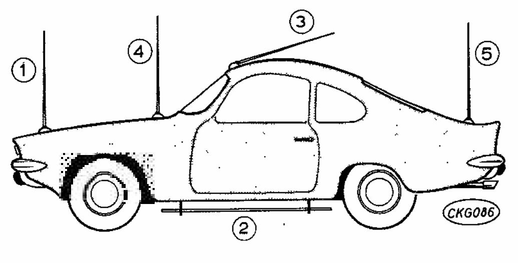


Fig. 1: The various possible positions for the car radio aerial.

Normally, the distributor is on the same side of the engine as the plugs, but if this is not so, it is better for the aerial to be near the plugs than the distributor, because although plugs can generate interference, they are buried to a considerable extent in the engine-block and so are at least partially screened. It is the distributor that is the worst culprit, as far as interference goes.

Aerial siting

We shall now consider the features of the various positions. A forward position on the wings is fairly easy to fit, as access to the underneath can be obtained from the front wheel-arch. However, the aerial lead will then have to pass through the engine compartment on its way back, and although screened, may pick up a certain amount of interference. It must be remembered that screening does not completely eliminate pickup, it only reduces it to small proportions, and it is when one is a long distance from the nearest BBC transmitter, or well shielded by hills so that the signal is weak, that interference previously unnoticed becomes prominent. Another snag with this position is that the bottom of the aerial and its cable connection is exposed to mud and wet thrown up by the wheel. Even though it may be enclosed, moisture can seep in. This results in a leakage between the aerial and the bodywork. It is quite enlightening to measure the resistance from the aerial to the body with a meter during a wet spell, very often leakage can be found. The effect of this is a reduction of signal and an increase of interference. In fact a number of car radios returned to one manufacturer, were found to be working perfectly and subsequently the trouble was traced to aerial leakage.

Another position that was very popular at one time but seems to have faded out is the under-car aerial. These are very good from the interference angle as they are well away from the main causes, but signal pickup is not so good. There is also the probability of damage from wet and corrosion from the road. Certainly the under-car aerial has room to be longer and more complex than a simple vertical rod, which to some extent compensates for its otherwise poorer signal pickup. It is also unobtrusive and doesn't mar the appearance of the car. This probably was a reason for its losing popularity, as the car aerial became something of a status symbol. However, in these days of vandalism and the wanton destruction of car aerials in many areas, it may again become popular.

Roof aerials

As a complete contrast we have the roof position. Because of garage height and other considerations, roof aerials are not of the vertical-rod type, but have a swept-back configuration, or are circular. This position is well away from the engine and interference sources and the elevation is good for signal pickup, although there may be some loss due to the small physical dimensions. Fitting may pose a few problems. A hole must be drilled in a centre position above the windscreen, and with wider cars it may not be too easy to reach this without standing on the bonnet; then the trim must be removed from the inside to feed the cable down to the radio.

A very good position is on the body close to the windscreen. This is remote from the engine and distributor, and the aerial feeder does not have to enter the engine compartment. Provided the exact spot for drilling is well chosen, fitting is quite easy. The cable will emerge from behind the instrument panel, so there will be no need for the removal of trim and refitting. There is one thing that must be carefully checked before drilling. Many car bodies employ a box construction at certain places to impart extra strength. If one inadvertently drills into one of these, there will be no access to the underside of the aerial to pass the cable through and fit the securing nuts. So make quite sure that there is access to the inside before drilling.

Rear mounted aerials

The final position is on the body at the rear of the car near to the back window. One advantage with this position is that there will be no wind-noise at high speeds which can arise with forward positions, nor any obstruction of the forward view however slight.

Access to the underside is very straightforward, because this point usually lies directly over the boot. Here the aerial is at maximum distance from the engine and so this gives maximum rejection of interference. In fact while with most forward mounting positions, there will be residual interference with the volume up high on weak stations, back positions are usually completely silent. In fact it seems to have all the advantages, but there is one snag. A long cable-run is needed from the aerial to the set. Apart from practical cable-run problems, a high capacitance will be introduced into the aerial circuit. Also the cable supplied with the aerial will in most cases be too short and extra will be needed.

Adding cable

Taking this last problem first, any extra cable will need to be special car-radio aerial type. It must be screened, but not the ordinary audio screened-cable which has far too high a capacitance between conductor and screen. Television co-ax cable is better and can be used for short runs, but even this imposes too great a capacitance for a long run from the back of the car. The special cable, which incidentally seems not too easy to come by, consists of a very fine centre conductor running in a tube which is then covered with metal braiding. This construction gives a low capacitance.

If the existing cable is too short, the best plan is to scrap it and fit a new length. If for any reason this is not practicable, the additional length should be soldered to the existing one to ensure a trouble-free joint. After joining the inner conductor, insulate and then join the screened braids around the inner joint if possible, to maintain the screening throughout.

Cable routing

The route taken by the cable will depend on the car, but usually it can be passed behind the back seat to emerge on the floor and run along the corner between wall and floor. Often, the wall trim is glued down to the floor level with some overlap onto the floor. If this can be peeled back to the corner and the cable laid along, then the trim glued back into place, an inconspicuous run will be achieved.

Make sure that the cable does not foul the handbrake if this is on the right of the driver's seat and therefore in the way of the run. Finally it can pass behind the side foot-panel to come up behind the front parcel shelf and thence to the radio. An alternative is to pass the cable through a hole in the floor and then along underneath the car to come back inside at the front. If drilling down from the back, take care not to drill into the petrol tank!

Even with low-capacitance cable, a long run from the back may introduce too much capacitance into the circuit. Most car radios have an aerial trimmer mounted so that it can be adjusted without removing the case. The receiver is aligned in the usual way by means of the internal trimmers, with the aerial trimmer near maximum, and with a dummy aerial giving the capacitance of an average car aerial.

Aerial trimmers

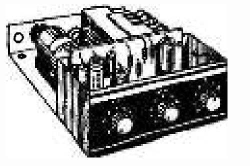
When the radio is being installed, before it is screwed into place, it must be switched on and tried. The aerial trimmer is then adjusted to give the maximum output with that particular aerial, which it does by compensating for the differences between the aerial and the dummy one used in the alignment. If the capacitance of the aerial lead is too great the trimmer will not be able to compensate and it will be found that maximum gain will not be reached even with the trimmer fully unscrewed.

One way of tackling this problem is to realign the internal aerial circuits with a capacitance across the aerial socket to simulate the extra capacitance of the aerial. This may not always work satisfactorily, as tracking may be affected and optimum alignment not be attainable at all points of the scale.

There is another quite effective way of dealing with this difficulty, and that is to simply wire a small-

—continued on page 342

SUPERSOUND 13 HI-FI MONO AMPLIFIER



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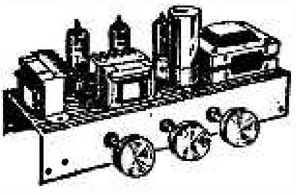

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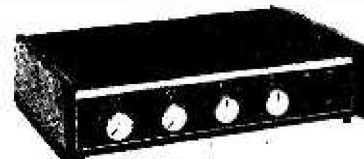

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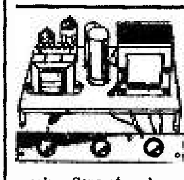

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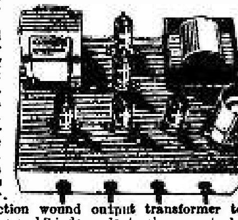

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TAKE 20

JULIAN ANDERSON

No. 39
I.C. AUDIO AMPLIFIER

IN *"IC of the Month"* in September 1970, Mr. Ireland said that the particular IC being dealt with should more appropriately come into the sphere of *Take 20*. At the time this was a bit optimistic as the cost of the device was about £1·25 and there were of course a number of ancillary components. Times change, however, and once again we are able to incorporate components in our circuits that would have been too expensive even a few months ago.

The IC involved is a remakable one, the MFC4000P. For an IC it is not particularly complex; it contains six transistors together with a few resistors and diodes. It now retails for only 55p from at least two advertisers in this magazine and even with the discrete components, we are within our price limit though the loudspeaker will have to be considered as an extra.

The MFC4000P is an audio amplifier, designed for use with a 9V battery, a 15Ω speaker and with an output up to 250mW. This output may not sound very much until you consider that the outputs from pocket transistor radios which can be as low as 50mW and rarely reach the level provided by this little package. Distortion is claimed by the makers to only 0·7 per cent and with this low figure, together with the spec mentioned above, you will agree that this IC has a lot to recommend it.

The package itself has only four connections: input, output, positive and negative supply points. Both the input and the output have to be d.c. blocked and we need a volume control of course. Other than these items only one resistor and two capacitors are needed. R1 provides both a.c. and d.c. feedback from the output to the input. For greater gain it is possible to apply only d.c. feedback by using the alternative arrangement instead of this single resistor. This considerably increases the distortion but for certain applications this does not matter. The IC in this arrangement is being rather overrun and it can get very hot and almost certainly it is being run outside the manufacturer's ratings, but providing that some form of heatsink is fitted, I have found no problems in this. I have included this alteration only as an idea for an experiment and unless you know what you are doing it would be best to stick to the basic circuit.

The package itself is very small, under ¼in. square, and the other components need not be large. One way of constructing this circuit is to glue the IC to the volume control-cum-on-off switch and mount the other components around it. The complete amplifier will then be little larger than the volume control itself. It is as well to use a double pole switch; only one pole need be used but the other tags can be used as a firm anchoring point for the output. If this is not done the whole strain of the loudspeaker lead would be taken by the small tag on the body of the IC—not very good practice!

The amplifier has a very high frequency response and to prevent h.f. instability a small capacitor, C2, is wired from the negative line to the input. This may or may not be needed but if problems are encountered it should certainly be included.

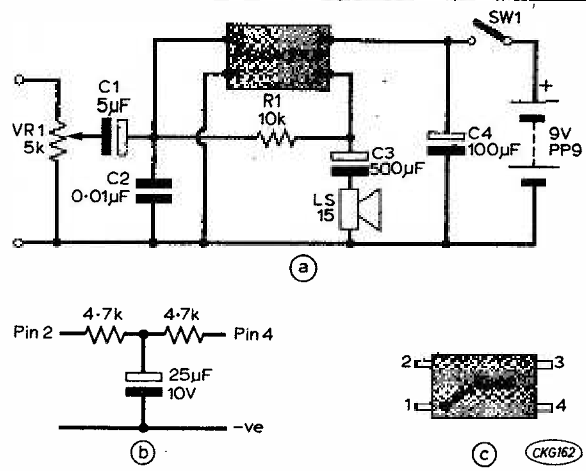


Fig. 1: (a) The complete circuit of the amplifier, (b) an alternative arrangement to replace R1 but see text, (c) the lead identification viewed from the top.

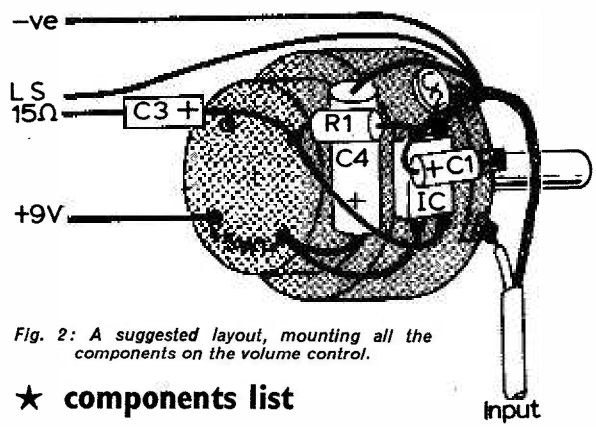


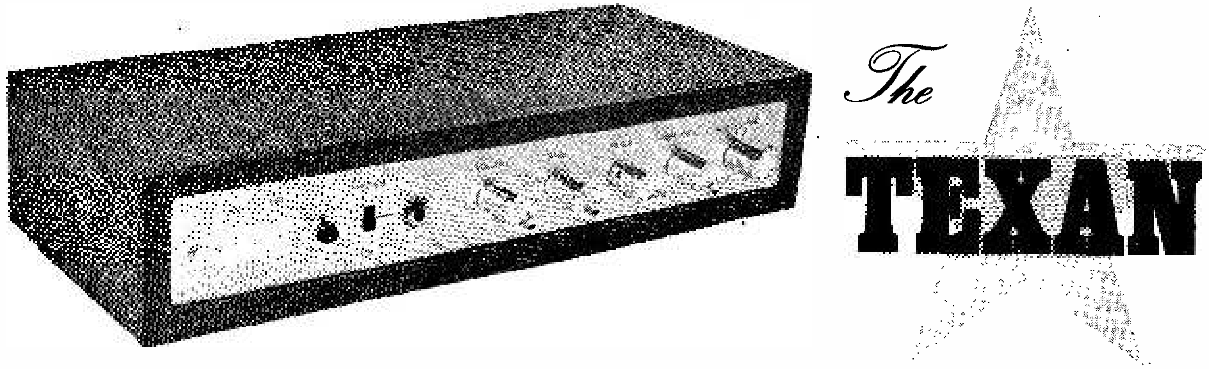
Fig. 2: A suggested layout, mounting all the components on the volume control.

★ components list

MFC4000P	Henry's Radio or G. W. Smith	55p
R1	10kΩ ¼W, 5%	1p
C1	5μF 10V min.	5p
C2	0·01μF Mylar or ceramic	3p
C3	500μF 10V min.	7p
C4	100μF 10V min.	5p
VR1	10kΩ log pot with D.P. switch	24p
		£1·00p

Prices are those recently advertised in Practical Wireless and may have changed. No allowance is made for minimum order costs or for postage and packing and these points should be checked carefully before ordering.

Quiescent current drain is only about 3·5mA, though this rises to 60mA or more on peaks and a substantial battery such as a PP9 is needed to drive the unit. The power supply described in the last *Take 20* can also be used. ■



20+20 WATT I.C. STEREO AMPLIFIER

PART 4

RICHARD MANN

Continued from the July issue.

(10) Place capacitors C22 and C23 (*these will have insulating sleeves*) in position and fix down with the capacitor clip. The capacitors rely largely on a snug fit between the transformer and the dividing plate to keep them from slipping around but a thin piece of foam rubber under the clip helps to make the anchoring more positive.
(11) Assemble the mains switch and neon indicator on the front panel.
(12) Fit the jack socket for the headphones to the sub-front panel and use as many of the fibre spacing washers as are necessary to fill the space between the sub-front panel and the front panel.
(13) Feed the leads from the neon indicator through the sub-front panel and screw the front panel to the upper pair of chassis hank bushes with spacers between the panels so that the front panel clears the nuts and washers on the potentiometers. Bright headed fixing screws are recommended since the heads shown on the front panel.
(14) Finally screw in the fixing nut of the jack socket. The control knobs can now be fitted and the final wiring completed.
Illustrations of the final wiring are given in Figs. 44 and 45. These should be followed, carefully, particularly whenever earth wiring is concerned.

Setting up

If a fixed resistor has been used for R24 it should be possible to wire up the *Texan* and switch on! However I know from bitter experience that p.n.p. transistors sometimes get swapped with n.p.n. transistors and joints are not always as wet as they might be. So a few precautions are worth while:
(1) First the obvious—check all joints and component positions with particular care in the output stage. This is where mistakes can be expensive.
(2) To be on the safe side temporarily replace F2 and F102 with 250mA fuses and turn the volume control to minimum and selector to Radio.
(3) Switch S5 to the loudspeaker position but do not connect the loudspeakers.
(4) If you have an Avometer (or other suitable test meter) available, check the power supply voltages. Across C22 and C23 there should be +32V and −32V respectively and across C20 and C21 there should be +15V and −15V. These voltages could well vary by about 10% due to the tolerance on the quiescent current. Also check the output voltage at the collectors of Tr4 and Tr5 which should be less than 10mV.
(5) If all is well so far, disconnect fuse F2 and measure the current flowing into the output stages. This should be in the region of 30 to 100mA.
(6) Assuming this checks correctly the loudspeakers can now be connected and a few tests made of the volume and tone controls. Even with the amplifier input circuit open the output should be completely stable at all frequencies and all settings of the controls.
(7) Assuming no problems are encountered up to this point then it safe to put back the 2A fuses and do some full power listening tests.

If a variable resistor has been used instead of R24 for setting up the current this should be turned down to a *minimum* resistance (fully anti-clockwise) before switching on.

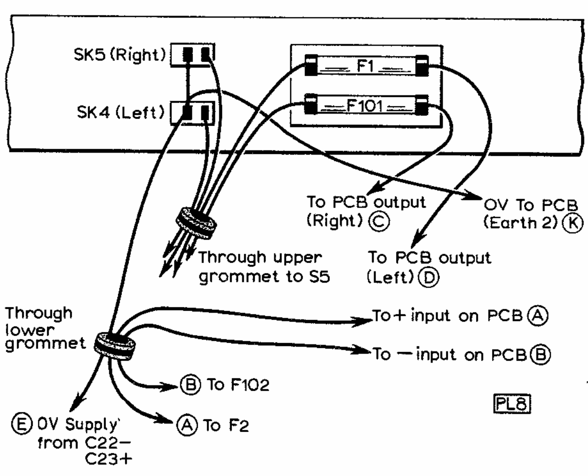


Fig. 44: Details of sockets SK4, SK5 and loudspeaker fuse mounting.

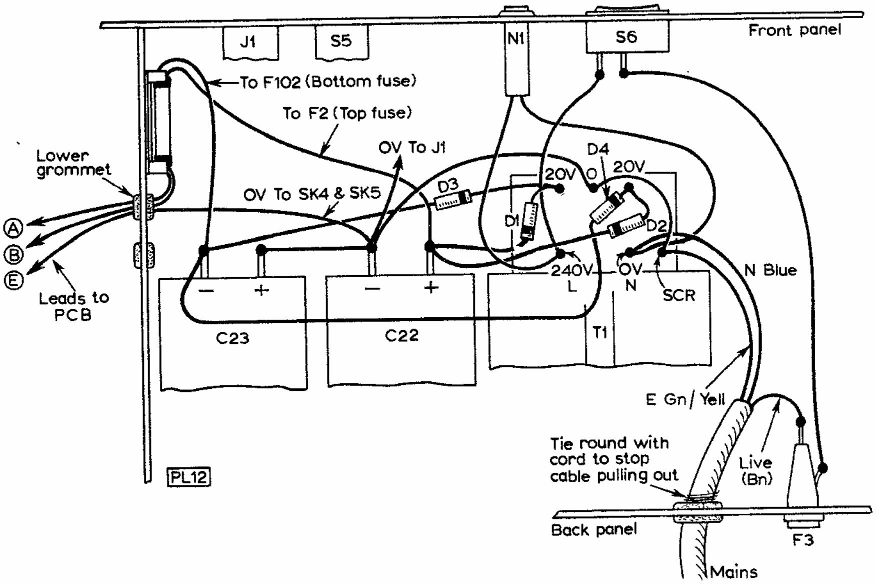


Fig. 45: Power supply wiring details and component positioning.

Proceed with tests 1-4 above then break the wire link to the emitter of Tr4 and insert a milliameter. The variable resistance can then be turned up (clockwise) until the current is set to 20mA. This procedure is then repeated for the second channel. The wire links must of course be replaced when the meter is removed.

A word of warning to anyone with facilities for more elaborate testing of the amplifier: do be careful with the earthing arrangements of the oscilloscope, pulse generator or whatever equipment you happen to be using. It is quite easy to introduce an extraneous earth loop into the system by connecting an oscilloscope probe across the load and an audio generator across the input resulting in a proportion of the load current flowing through the input stage earth track on the P.C.B. This will not damage the board itself, but it may well introduce low frequency instability, causing some components to "cook" as well as general alarm and despondency. My own technique is to remove the mains earth connections from all the test equipment (groans from RoSPA!) and to clip the 'scope probe earths to the earth link on the input DIN sockets (SKI-3).

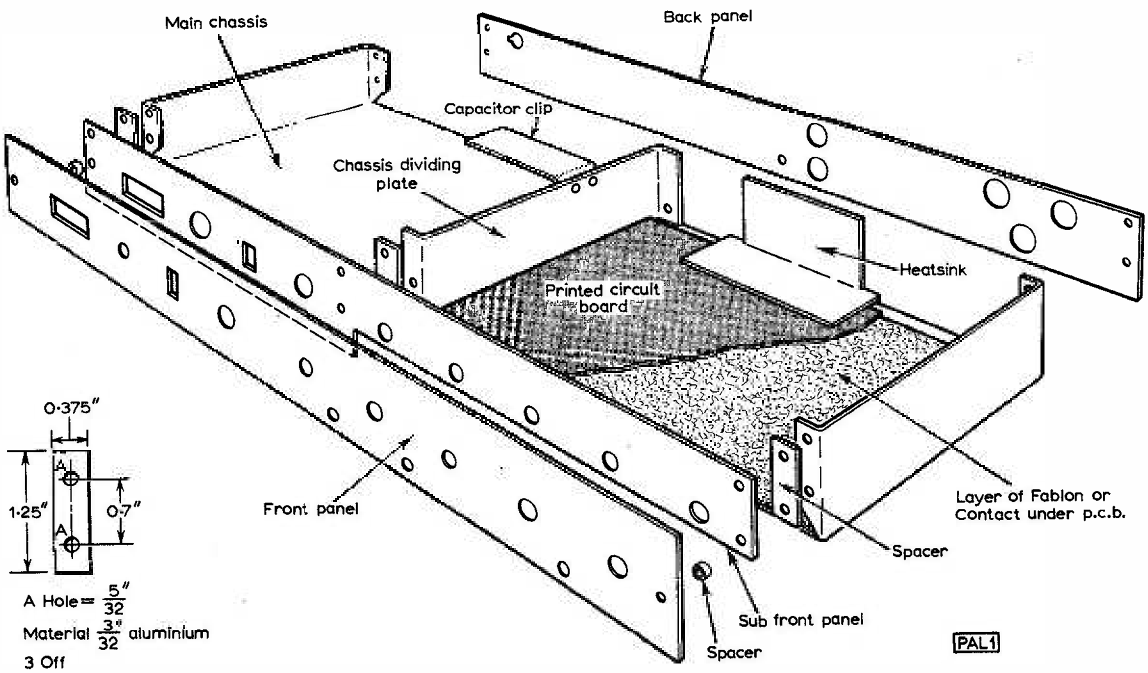


Fig. 46: Exploded view of the metalwork. Note the addition of the three metal strip spacers introduced between the sub front panel and chassis. These have been introduced to facilitate easier mounting of the printed circuit board.

Heatsink

In the interests of size, economy and simplicity the *Texan* was designed with normal domestic operating conditions in mind rather than for extended tests on continuous sine wave inputs. This mainly affects the power supply and heatsink since the basic amplifier is quite capable of supplying a continuous 25 watt from both channels simultaneously.

In the prototype it was found that the heatsink ran at about 30-35°C with a moderately deafening output of Simon and Garfunkel. It will also cope with full power sinusoidal outputs for a period of ten minutes without reaching a temperature which is dangerously high for the output transistors. However, if particularly arduous conditions are anticipated the heat dissipation can be improved by adding a U-shaped bracket to the back panel of the amplifier. If this is made the width of the heat sink so that it projects about two inches away from the back of the amplifier it will fit quite neatly between the D.I.N. plugs and give a useful reduction in temperature.

Since the first article of this series was published, I have had letters from as far apart as Norway and South Africa which shows how *P.W.* gets around. The most recurrent query concerned the loudspeaker impedances, which can be used with the Texan so some reiteration may be in order.

Basically the amplifier is suitable for use with 4Ω, 8Ωor 15Ω loudspeakers. If 15Ω speakers are used there will be a reduction in the maximum continuous sine wave output power from 16+16W to 15+15W (see Specification, Part 1). However, on speech and music there is virtually no audible difference between 8Ω and 15Ω power outputs since the voltage of the unregulated power supply tends to rise with 15Ω loads, due to the smaller peak load currents thereby giving a higher power capability on intermittent inputs. There is an added bonus in that the total harmonic distortion is reduced. With 15Ω loads it is a good idea to drop the rating of fuses F1 and F101 to 1A.

At the other end of the scale, the higher currents required by 4Ω loads do tend to push up the distortion (see Table 2, part II) but not to a level which would be objectionable or, indeed, audible to the great majority of listeners. It is possible to obtain full output power (i.e. equivalent to 8Ω loading) when using 4Ω loudspeakers. It may be necessary to increase F1 and F101 to 3A rating, but I would be inclined to leave in the 2A fuses unless they blow persistently. It all depends how loud you like your music.

When it comes to actual *sound* output power the most significant factor is the design of the loudspeaker itself. Some designs are notoriously inefficient—particularly some of the infinite-baffle bookshelf systems. This is not to say they are bad designs —some are really excellent—but they do often need a bit more power to drive them. If you are buying new loudspeakers, the best thing is to go along to a good HiFi supplier with your slim-line Texan in hand and demand to hear the complete system before you part with any cash.

If during normal operation of the amplifier it is considered that the output transistors are running rather hot, the values of R24 and R124 may be changed to 270Ω. This will reduce the quiescent current in the output transistors. Alternatively the "purists" may use the potentiometer method outlined earlier.

Finally, I should like to acknowledge the assitance received from Derek Skinner, who was involved in the design of the original B80 Amplifier and of Alistair Manley and Brian Howarth for their contributions to the Texan.

The Texan was originally designed in the Bedford Applications Laboratory of Texas Instruments Limited and was subsequently modified for the present series of articles with the co-operation of this magazine and Henry's Radio Limited. Several advertisements have since appeared for "complete Texan kits" and while these may be to specification, it is emphasised that to date neither Texas Instruments nor *Practical Wireless* have had any liaison concerning the Texan with any kit suppliers other than Henry's Radio Limited.

Henry's Radio Limited are supplying the complete kit for the Texan—to the Texas specification—at £28·50 (plus postage and packing). The teak cabinet will now be given free with all orders for complete kits. This applies also to all existing orders. The cabinet will still be available separately at £2·75 plus 20p P&P. ■

Hi-Fi and Electronic retailers amalgamate prior to public flotation

The Lasky Group and G. W. Smith announce that a merger agreement was concluded on Tuesday 13 June.

The merger has been effected through Audiotronic Holdings Limited, a new company which has been formed to amalgamate the Lasky's group of companies with the G. W. Smith business.

Amalgamation of the two companies has been carried out prior to a flotation on the Stock Exchange in the autumn. An Offer for Sale to the public of shares in Audiotronics Limited is being arranged through merchant bankers Singer & Friedlander.

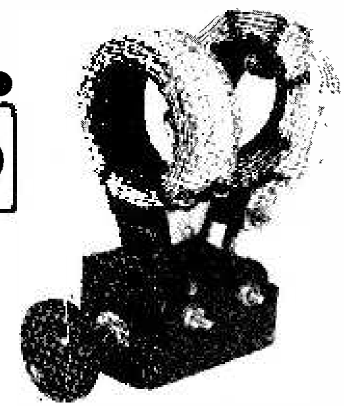
Under the merger agreement Audiotronics will acquire the entire capital of Lasky's Holdings Limited (parent company of the Lasky group) and Barnet Factors Limited (parent company of the G. W. Smith group).

Apart from operating 14 hi-fi and electronic stores and a mail order division comprising a mailing list of 250,000, the combined group also run a wholesale division, handling hi-fidelity and electronic equipment, components, accessories and test equipment.

Following the merger it is the intention that the two companies shall continue to trade under their separate names and maintain their individiual identities.

Profits of the combined companies last year totalled £677,000 before depreciation and tax and a substantial increase in turnover and profit is expected during 1972.

GOING BACK...



COLIN RICHES
ARTHUR DOW

The ST200—Again and Finally

FOR some time now in "Going Back" we have been publishing snippets of information and comment on the ephemeral ST200 receiver, the main theme being—did it ever exist? We were, therefore, highly delighted to get the following letter from the great man himself, which explains all and which we hope will now end the discussion to the satisfaction of all concerned:—

Dear Sirs,
In your January 1972 "Going Back" feature, which has just come to my notice, a reader suggested that one of the ST series of set designs was withdrawn from the market because of a mistake. As he admits he cannot recollect the facts, may I say that no set design of mine contained a mistake or was withdrawn. The word "market," in any case, is inappropriate. I simply wrote articles in the technical press and readers built sets with components sold by a wide variety of firms.

There appears to have been some suggestion of a mystery about the ST200. My books of circuits went up to ST151. I then confined myself to centuries. The ST300 set of 1932 was the first of a series that ran to ST900. It was called ST300 because I had produced the popular ST100 in 1923 and, somewhat later, a little-publicised circuit labelled ST200. The ST200 was born in and remained in obscurity, but that hardly amounts to a mystery.

Yours faithfully,
John Scott-Taggart
F.I.E.E., F.I.Mech.E., F.Inst.P.

S.T.—A Retrospective Look

Anyone who was constructing receivers in the early days of wireless was well acquainted with the name of John Scott-Taggart and the stream of progressive designs that he produced. The designs were generally free of "gimmicks" and the home constructor, using standard components, could follow the constructional articles with complete confidence.

Wing Commander John Scott-Taggart, M.C., F.I.E.E., F.I.Mech.E., F.Inst.P., far better known as "S.T.", is 75 this year. It is appropriate on this occasion to give an account of some of the pioneering activities of one who has contributed so much to the amateur movement but even more to the development of electronics.

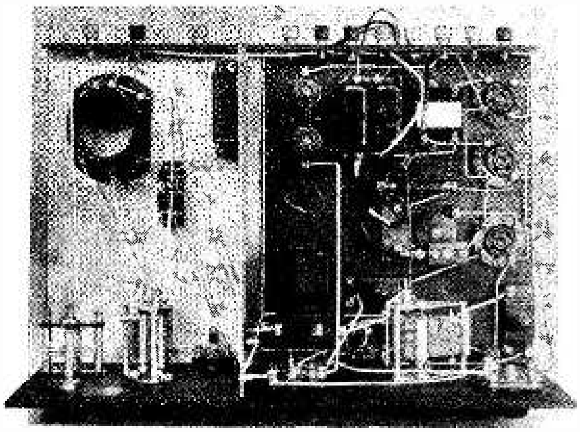
Our personal knowledge of his work dates from 1932 when he designed the S.T.300, the first of a highly popular annual set designs. But this was his second-wind activity. What was he up to before 1932? There are many sources of information, most of them printed, some of them on television and some we have dug up out of "S.T.'s" own half-forgotten archives. We shall call him "S.T." throughout. He was so well known that in 1926 a letter from abroad addressed simply "S.T., England" reached him at once. He calls this notoriety rather than fame and growls that it has smothered his far more important work as a professional radio engineer.

Let's see what he's done for the amateur and serious experimenter first. He became an amateur himself in 1911. He acquired a transmitting licence (call-sign UX, later LUX!) and figured in the Gamage directory of 1913. His name first appeared in print when he showed his equipment at a school exhibition in Bolton in July 1912. In July 1913 the account of a school camp radio station appeared in the national press. In the December 1914 issue of *Wireless World* he described his first receiver design. It was the first

Amateur radio station LUX, designed, built and operated by S.T., after being licensed in 1911.

of some 800 articles in British and foreign journals. In December 1914, as a boy of 17, he joined the Army and was a sergeant-instructor of signalling at just 18. He went to France as an infantryman but after going to a Wireless School at G.H.Q. he was given a commission in the Royal Engineers. He was privileged to work in the laboratory of Major Stanley and learnt, as he has said, "all about valves"—then a development practically unknown to the general public.

The rest of the war he spent as a wireless officer at the front, gaining the Military Cross and a Mention in Despatches for gallant and distinguished service. In spite of his active service, he contributed —starting in 1917—a series of "excellent articles" on valve techniques. The description appears in the preface to a book by Fleming—the father of the valve.



Top view of one of the famous series of receivers designed by S.T., the ST300 of 193?.

His compulsion to write and explain has lasted "S.T.'s" whole radio career. In 1921 appeared a monumental book "Thermionic Tubes in Radio Telegraphy and Telephony" with its 460 pages and nearly as many illustrations. Some dozen textbooks have come from his pen, excluding manuals written for the Royal Navy in later years.

On demobilisation in 1919 S.T. got his first civilian job—as head of valve manufacture in the Ediswan Company. He designed for them the first valves made expressly for the amateur experimenter. These were marketed in the period 1919/1920 and the types were called ES2 and ES4.

From 1918 onwards, S.T. patented many valves and valve circuits. Some thirty patents were sold to Marconi's, Radio Communication Company, Telefunken (Germany), La Radio Technique (largest makers of valves in France), Ediswan, Canadian Marconi Company, Commercial Cable Company (USA), Hazeltine Corporation (USA) and other concerns. His expert knowledge of patent work led to his becoming, in May 1920, Head of the Patent Department of the Radio Communication Company—then Marconi's great rivals; he also occupied the same position simultaneously with Mullard's. When Mullard's were sued by Marconi's for alleged infringement of their valve patents, S.T. was involved up to the neck in a legal battle that ended in a Mullard victory. The valve was free. As a patent expert, he advised many leading companies in the world—especially those in competition with Marconi companies. He was later chief radio patent consultant to HMV, now part of EMI.

But what of his interest in the wireless amateur? He was a very active member of the Wireless Society of London (which at the end of 1922 became the Radio Society of Great Britain) and was made a member of its Committee in 1920. In 1922 he was one of the committee that extracted from the Postmaster-General permission for the Marconi Company to broadcast from Writtle (near Chelmsford) half-an-hour a week! Half-an-hour! Such was the opposition both to broadcasting and the amateur. This was the start of broadcasting as we know it. That it was due to amateur pressure is proved by the Postmaster-General's official statement that this broadcasting was "for the benefit of the wireless societies". But, meanwhile, in the USA broadcasting had begun in earnest and Britain followed. The British Broadcasting Company was formed and the flood-gates that the amateur had prized open a few inches were flung wide open. There followed a boom—but it was led by the 30,000 amateur experimenters. Without them to act as a lever, the general public would have taken far longer to get round to broadcasting.

S.T., in 1972.

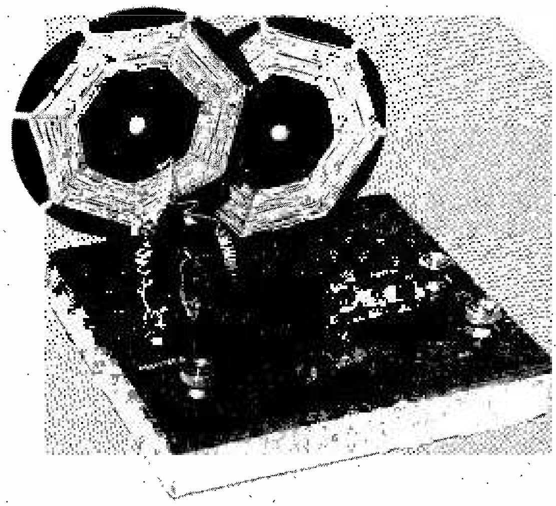
John Scott-Taggart, amongst others, was there at the right moment to instruct the growing public. He formed his own publishing organisation Radio Press Limited, which published five radio journals. The first appeared on 9th January 1923—*Modern Wireless*, a monthly magazine. It was in the June 1923 issue that the ST100 circuit was published and 100,000 sets are known to have been built to this design.

The battle for the amateur movement was not over. There was much hostility from set manufacturers and the Post Office. S.T. offered a large sum to the Radio Society of Great Britain to fight for the legal rights of the experimenter. Later there were threats of patent actions against those who built their own sets. S.T. publicly undertook to defend at his company's expense any experimenter who was sued for patent infringement. The scare died down.

At the end of 1926 S.T. retired—at 29 years of age! He was called to the Bar in June 1928 but never used his wig and gown. In 1932 he was asked to design sets for Amalgamated Press Limited, the company to which he had sold his periodicals. The "Return of John Scott-Taggart" went with a bang and the first explosion was the ST300.

continued on page 350

IN NEXT MONTH'S PRACTICAL WIRELESS

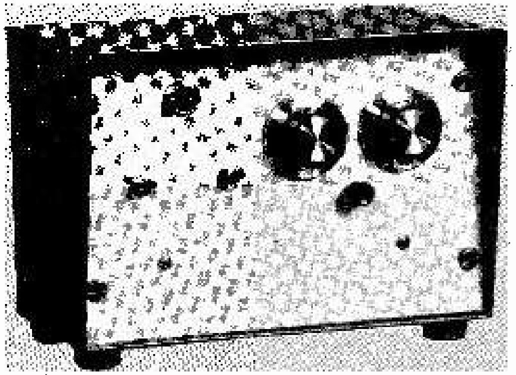


Reproduction crystal set

Our nostalgia special! Few of our readers will remember the techniques used in the early twenties for receiving wireless telegraphy (as radio was then called) but the crystal sets of those days *did* work and the materials can still be obtained. This crystal set duplicates *exactly* the circuits and techniques used in the very earliest days of radio. And who knows, you may be able to hear the 50th anniversary broadcasts on the BBC in November on our Reproduction Crystal Set!

4-Band Radio

For our valve enthusiasts—a relatively simple but efficient receiver intended to cover the short wave bands but additional coils permit reception on medium and long waves. A high i.f. of 1·6MHz gives good second channel selectivity while the associated crystal filter will provide adequate selectivity whether the mode of reception is a.m., c.w. or s.s.b. The use of easily obtainable and standard components greatly facilitates the alignment procedure once the receiver is completed.



Enlarger Timer

A high precision enlarger timer is essential for good printing from negatives and this one is truly a "Rolls Royce" version with a range from 1 to 110 seconds in switched 1 second intervals and with an accuracy of 5 per cent. It has excellent "repeatability" and the stability is first class.

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THE OSCILLOSCOPE

THE oscilloscope is probably one of the most versatile electronic testing instruments in existence, for it will not only measure amplitudes of a.c. or d.c. voltage but will display for visual examination the waveforms or fluctuations associated with them i.e., variations in amplitude over a period of time and at repetition frequencies ranging from zero (d.c.) to the high Megahertz ranges.

It is not intended to explain how the oscilloscope itself operates as many articles have been devoted to this and there are a number of text books which deal admirably with the subject. It should be mentioned, however, that commercial oscilloscopes are usually designed for specific applications, ranging from general workshop use for audio and television servicing, to highly sophisticated and expensive laboratory instruments with bandwidths extending to 4GHz and beyond. There are also 'd.c.' 'scopes which directly measure and display stationary or slowly fluctuating voltages from a few millivolts to 1000V or more as well as alternating voltages of very slow repetition rate or up to very high frequencies.

The various applications described and illustrated are confined to the lower frequencies e.g., audio amplifier testing, audio frequency comparison and modulation, etc., and so will exclude any that apply to video which are dealt with in *Television* and in text books such as 'Servicing with the Oscilloscope' by Gordon J. King. Even so there are a large number of audio and other applications that cannot be mentioned or illustrated because of space limitation. It is hoped that the examples given will at least prove helpful to those new to the oscilloscope whilst others may simply serve to illustrate the versatility of the instrument and provide a few new ideas for those already well practised in the art of oscillography.

All the photographs are real oscillograms; they are not redrawn. Some have been taken by direct projection of the display onto bromide photographic paper, hence the 'black on white' illustrations, whilst the rest are by normal film and print photography (white on black). Oscillogram photography is in itself quite a fascinating subject but there is not room to deal with it here.

OSCILLOSCOPE ESSENTIALS

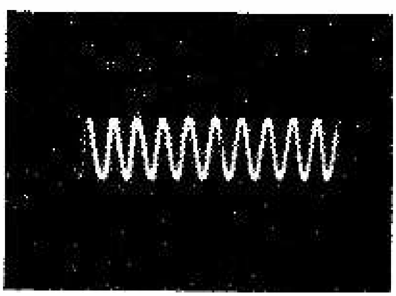


Fig. 1: A 1kHz sine wave illustrating good linearity.

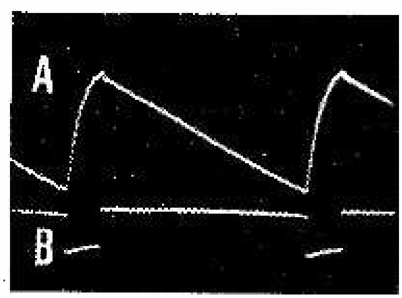


Fig. 2: The timebase waveform (above) and the flyback suppression (below) in the PW Workshop Oscilloscope.

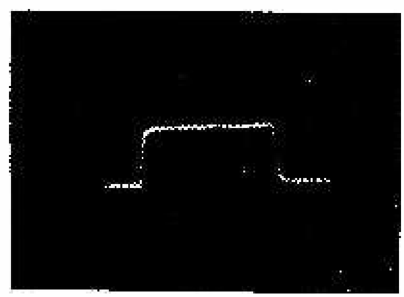


Fig. 3: Half a cycle of a 10kHz square-wave applied direct to a 'scope.

General purpose servicing oscilloscopes are not all that expensive when one considers their usefulness and have many applications in audio work, as well as television. The "P.W. Workshop Oscilloscope" described in *Practical Wireless* April and May 1971 issues (which unfortunately are no longer available) has been used for some of the examples shown; the rest have been taken from a Cossor Model 1049 Mk III double beam d.c. 'scope. Good secondhand double beam and d.c. instruments can be obtained at quite reasonable prices and have many applications beyond the usual display of a.c. waveforms as will be shown.

It is important with any oscilloscope that the amplifiers and timebase generator perform correctly and that some form of calibration is available, i.e., that the controls are calibrated or that there are calibration marks on the c.r.t. screen. The latter are usually contained on a thin perspex or celluloid graticle placed over the screen. For examination of repeating waveforms, i.e., sine and square-waves, etc., it is essentital that each timebase produces a linear X (horizontal) deflection. The example given in Fig. 1 is a 1kHz sine wave displayed on the *P.W.* Workshop Oscilloscope. Note the equal spacing between each cycle. This is because the timebase voltage itself is linear; actual timebase waveform (Fig. 2A) and flyback suppression pulse (Fig. 2B).

F. C. Judd

at work

Wide frequency response in the Y (vertical) amplifier is also an essential feature and the example given in Fig. 3 shows a little over one half cycle of a 10kHz square-wave displayed on the P.W. Workshop 'Scope with the highest but one timebase range. It is equally important when using an oscilloscope not to overload the Y amplifier input. The result of doing so is shown in Fig. 4 in which positive clipping of a sinewave is occurring. If the input signal is too large it should first be attenuated.

Two common faults that can occur, particularly with home constructed 'scopes, are hum pick-up in the Y amplifier as shown in Fig. 5 and crosstalk between the Y amplifier and timebase amplifier and generator as shown in Fig. 6. The first fault, hum pick up, might make it difficult to synchronize the timebase and also ascertain any hum level in the signal being checked. The second fault simply produces distortion in the display of the waveform being examined.

Fig. 6: Crosstalk between the timebase and Y amplifier.

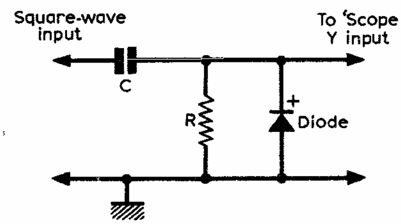


Fig. 7: Simple differentiating circuit for obtaining marker pips from a square-wave.

CALIBRATION

With a.c. coupled 'scopes, calibration of the Y

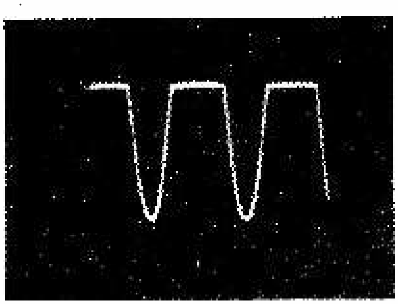


Fig. 4: Result of overloading the Y amplifier showing positive clipping.

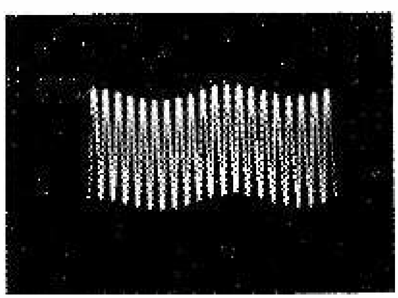


Fig. 5: The result of hum in the Y amplifier.

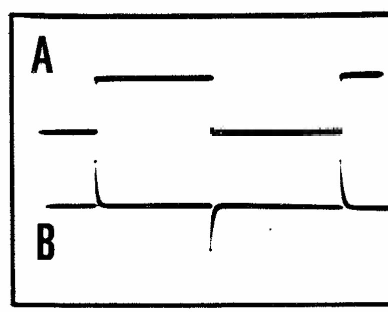


Fig. 8: Waveform A shows a square-wave while B shows the differentiated output.

amplifier can be carried out by using a combination of screen graticule markings and gain control settings to denote different peak-to-peak amplitudes of signals fed to the Y amplifier.

Time-base calibration is a little more difficult but can be obtained by means of marker pips derived from square-waves of known frequency. First the square-wave must be differentiated by the simple circuit shown in Fig. 7, with the C (usually small) and R (usually a few thousand ohms adjusted to produce the positive and negative going pips as in Fig. 8B. Either the positive or negative pips can be rectified out with a diode across R leaving defined single pips as in Fig. 9A.

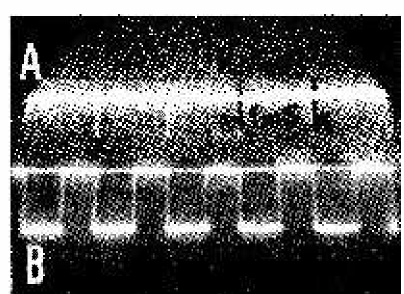


Fig. 9: 1mS marker pips from a 1kHz square-wave.

The next procedure is to mark the screen with dots (with indian ink) as in Fig. 10.

The setting of the timebase controls must be noted, or left set, as any alteration of the timebase speed will render the calibration inaccurate. This method is more suitable for short term testing, for example, to find the rise time of a square-wave as shown in Fig. 11 in which 10µS markers are derived from a 100kHz square-wave. The rise time of the square-wave shown from the 10 per cent to 90 per cent points on the leading edge is approximately 1µS.

FREQUENCY COMPARISON

The Lissajous method for frequency comparison may well be a technique unknown to those who have never used an oscilloscope but is a simple enough way of determining, for example, the frequency of an oscillator. A calibrated oscillator and oscilloscope are required but the 'scope must have inputs to both

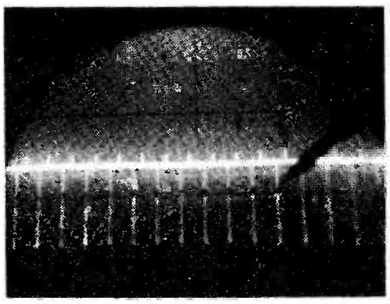


Fig. 10: By putting indian ink marks over the pips, the screen can be calibrated.

Fig. 11: 10µS marker pips used for measuring the rise time of a square-wave.

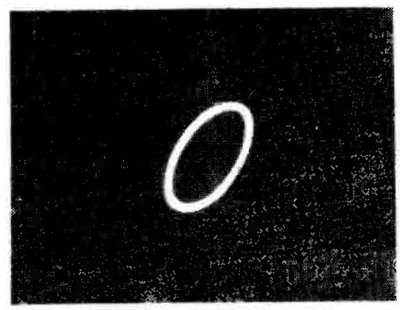


Fig. 12: A Lissajous circle.

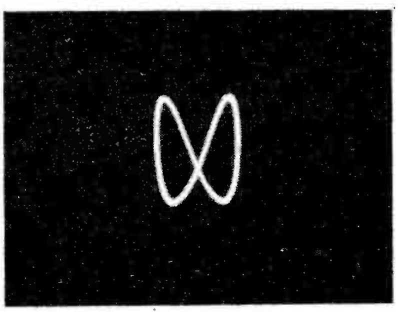


Fig. 13: A two-to-one Lissajous pattern.

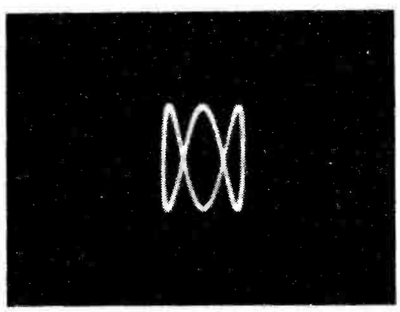


Fig. 14: A three-to-one pattern.

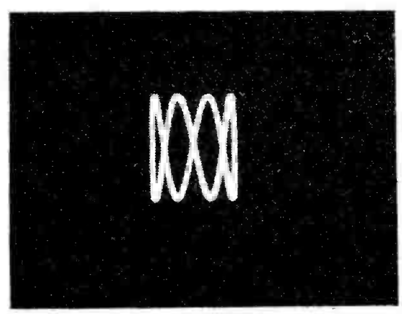


Fig. 15: A four-to-one frequency ratio.

the X and Y plates, either directly, or via X and Y amplifiers. The timebase must be switched off (the P.W. Workshop Oscilloscope has these facilities). The calibrated oscillator can be connected to, say, the X input and its output set to produce a short horizontal trace. The signal of unknown frequency is connected to the Y input to produce about the same amount of vertical deflection.

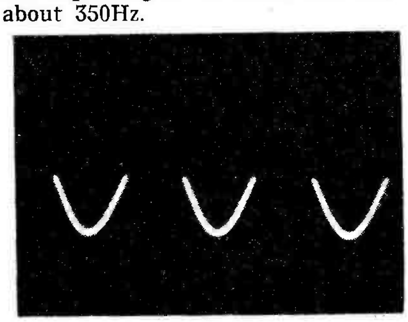
The calibrated oscillator is now slowly adjusted around the expected frequency of the unknown until a circle is produced as in Fig. 12. When the circle is stationary, or nearly so, the frequency of both signal sources will be the same, i.e., the unknown will be that of the calibrated. It may happen that the frequency of the unknown is outside the range of the calibrated source in which case multiples of the circles can be used to determine frequency. In Fig. 13 two loops are visible and in this case the known frequency was 50Hz and the unknown twice that frequency (100Hz). If the loops were lying sideways (turn the page round) then the unknown would have been the known frequency divided by two or 25Hz.

Further examples are shown in Figs. 14 and 15 which display 3 and 4 loops respectively. The three loop display is vertical and the known frequency 50Hz. The unknown is therefore the known frequency times three or 150Hz. The four loop display will then be 200Hz.

BRILLIANCE MODULATION

If pulses applied to the c.r.t. grid are directly related in frequency to signals coupled to the Y input, the result will be blanked out portions of the display as in Fig. 16. The pulses to the grid must be of sufficient intensity and in the case of Fig. 16 the Y display is a 50Hz sine-wave and as each half cycle is missing the pulses to the c.r.t. grid are also 50Hz. Remember that only the negative going half cycles of the signals to the c.r.t. grid will produce the blanking effect. A further example is shown in Fig. 17 in which the Y input signal is 50Hz and the blanking pulses about 350Hz.

Fig. 16: Brilliance modulation with a one-to-one ratio.



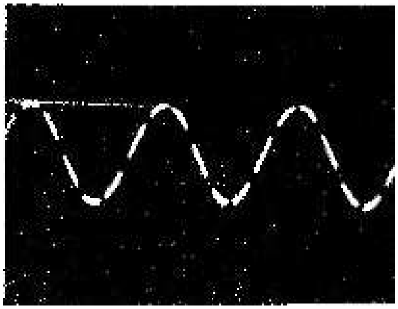


Fig. 17: Brilliance modulation with about a seven-to-one ratio.

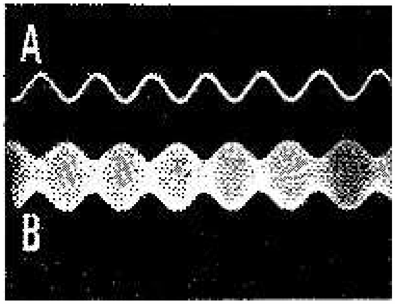


Fig. 18: A shows a sine-wave, B shows the same signal modulating an r.f. carrier to about 50 per cent.

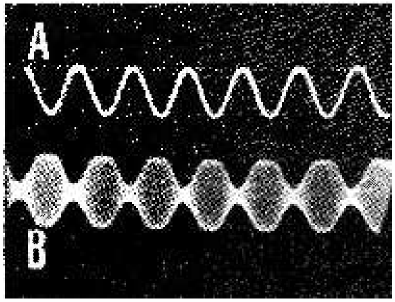


Fig. 19: 80 per cent modulation with some clipping.

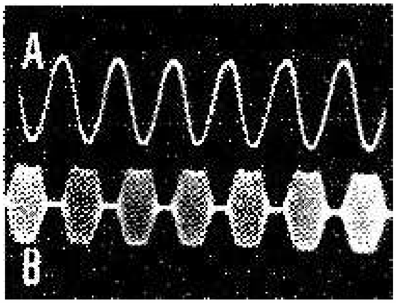


Fig. 20: Greater than 100 per cent modulation resulting in top and bottom clipping.

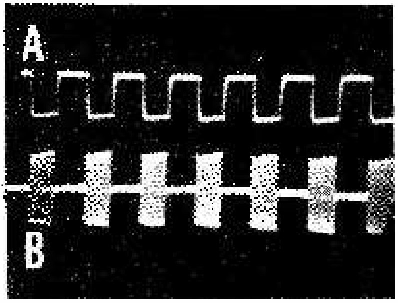


Fig. 21 : Gross over modulation resulting in squared pulses. Such a signal will produce severe harmonics.

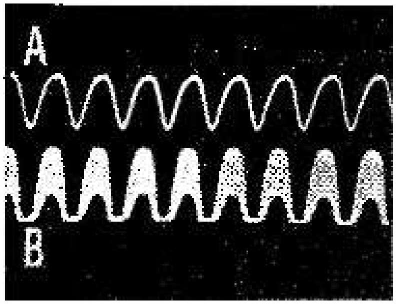


Fig. 22: A complex waveform due to stray coupling.

RF MODULATION

Amplitude modulation of radio frequency signals by audio frequency signals is well known by amateur radio enthusiasts but, judging by the side band splatter frequently heard on the amateur transmitting bands, it is pretty obvious that few ever monitor the modulation level. Modulation can be displayed in two ways but if the 'scope has a Y amplifier with a sufficiently wide bandwidth (the P.W. 'scope will cope with 1·8MHz) then it may be simply a case of coupling some of the modulated r.f. signal to the Y input, taking care not to overload it.

The first example shown in Fig. 18 displays the modulating audio sine-wave at 1kHz and the modulation at approximately 50 per cent (Fig. 18B). In Fig. 19 modulation is at approximately 80 per cent but there is slight clipping which could be due to insufficient r.f. drive power or limiting in the modulator itself. Another example is given in Fig. 20 which shows modulation at well over 100 per cent plus top and bottom clipping. The r.f. amplifier is also failing to maintain power on positive peaks. Gross over modulation is shown in Fig. 21 in which the audio signal is squared resulting in squared pulses from the transmitter. Speech modulation, allowed to square in this fashion, would produce spurious side bands all over and outside any amateur radio band allocation.

Finally, don't be fooled by a display like that shown in Fig. 22 in which the modulation is 100 per cent but phase shift, due to stray coupling, external to the 'scope, is producing the distorted positive going modulation envelopes as well as distortion in the modulating audio signal.

SQUARE-WAVE TESTS

The so-called square-wave test is commonly used to check the performance of high fidelity amplifiers and the method is to feed a square-wave of known quality to a linear input of the amplifier and then examine the amplified version with an oscilloscope. An example is given in Fig. 23 in which trace A is the input square-wave at 1kHz with a 1:1 mark-space ratio and a rise time of less than $1\mu S$. It is important that a square-wave of this quality is used. The output from the amplifier, with tone controls neutral and filters, etc., out of circuit, is shown in trace B. Slight loss of rise time and rounded tops on the leading edges indicate some small loss of frequency response but nevertheless show that the amplifier itself still has a wide response which, in the case of the example shown, was almost flat from 15Hz to 100kHz. Severe rounding on the leading edge would indicate poor h.f. response whilst downward sloping to the top (left to right) and upward sloping (left to right) of the bottom, would indicate poor l.f. response.

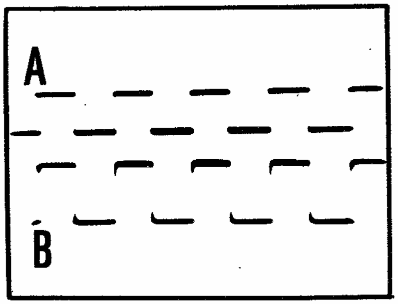


Fig. 23: A 1:1 square-wave as applied to an amplifier (A) and as seen at the output (B). The fast rise time on the verticals means that this part of the waveform cannot be seen.

This latter test is supported by Fig. 24 which shows that the bass control has been turned to full bass cut thus reducing the l.f. response. The square-wave is still at 1kHz and trace A is the input. On the other hand bass lift is shown by sloping in the opposite direction as in Fig. 25, trace B, which shows

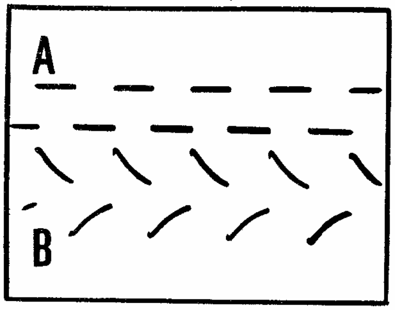


Fig. 24: The applied signal (A), with the output (B), showing poor l.f. response.

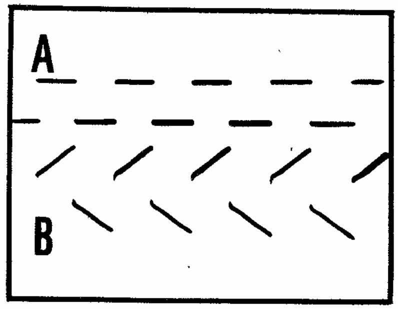


Fig. 25: Boosted l.f. response. A poorer amplifier may show some rounding of waveform B under similar conditions.

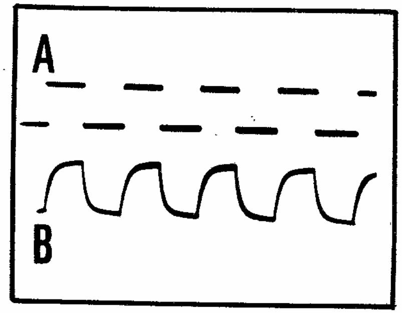


Fig. 26: Poor h.f. response or full treble cut.

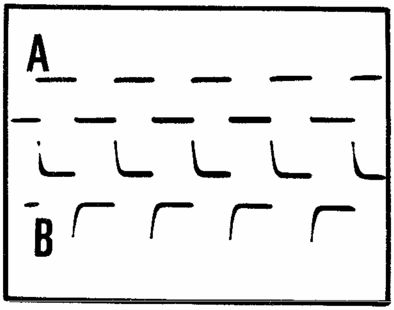


Fig. 27: Boosted h.f. response resulting in overshoot

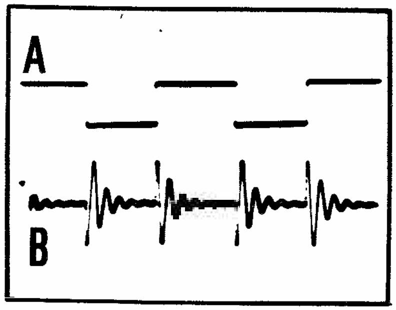


Fig. 28: Severe ringing in an amplifier.

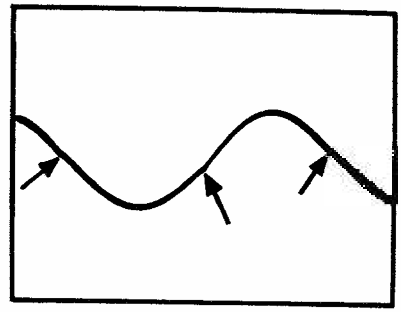


Fig. 29: Crossover distortion indicated by the arrows.

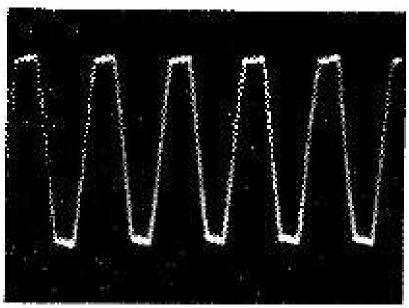


Fig. 30: Symmetrical clipping.

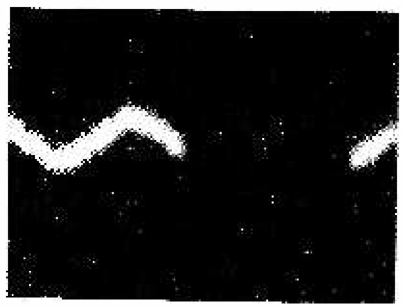


Fig. 31: Noise and hum from an amplifier.

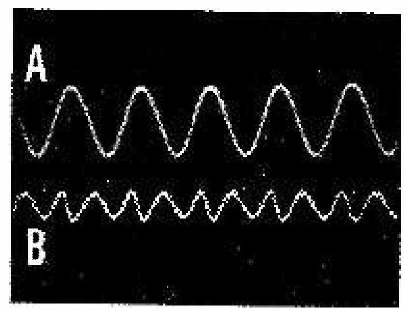


Fig. 32: Harmonic distortion. A shows the input while B shows the output with the fundamental signal removed.

the effect of turning the bass control to full lift, i.e., about plus 12dB. Again the input square-wave is 1kHz as in trace A.

The response of the treble controls can be determined in much the same way. Fig. 26 trace B shows the effect of full treble cut, i.e., by about 12dB, whilst Fig. 27, trace B, shows the effect of full treble lift, also by about 12dB.

The square-wave test can also show if ringing is occurring on transients; a good amplifier should not produce these. A severe case is shown in Fig. 28 in which trace A is the input at 1kHz and trace B the amplifier output with ringing due to inductive elements within the amplifier circuitry, e.g., coupling transformers.

Another form of distortion common to audio amplifiers with complementary pair output stages is crossover distortion whereby the point of take-over between one transistor and the other does not coincide. The effect can be seen by applying a sine-wave input and is a small 'step' half-way between the positive and negative peaks. The step is often hard to detect and then only at low power levels. Listening tests might fail to reveal a small amount of crossover distortion. The example shown in Fig. 29 is typical but is only a small amount. The steps are just visible where shown by the arrows.

Another test applied to audio amplifiers, also with a sine-wave input, is a check that symmetrical clipping can be obtained at just beyond the rated r.m.s. power output. A good example is shown in Fig. 30 in which both top and bottom have become clipped uniformly. Clipping at either top or bottom only indicates unbalance in the output stages.

The oscilloscope will also show the hum and noise content of an amplifier which, if related in terms of r.m.s. voltage to the r.m.s. voltage obtained at full power from a 1kHz sine-wave, can be expressed in decibels as a level below the rated output. The example given in Fig. 31 shows the combined hum and noise from an amplifier (the missing portion is due to the fast camera shutter speed and the slow timebase speed). Note that the hum amplitude is greater than the noise amplitude but it is usual to measure the r.m.s. voltage of both together. For example a combined hum and noise level of 12mV

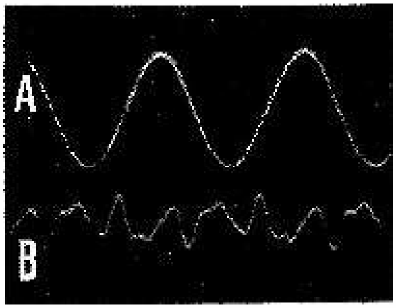


Fig. 33: The distortion seen on the 50Hz mains.

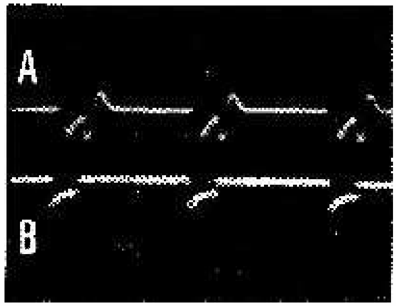


Fig. 34: The effect of a voicing network in an electronic organ.

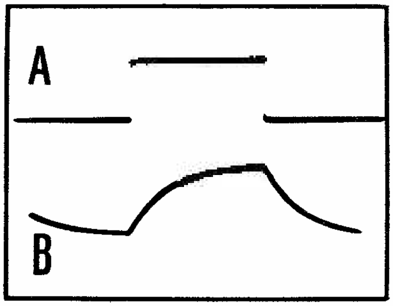


Fig. 35: The integration of a square-wave signal.

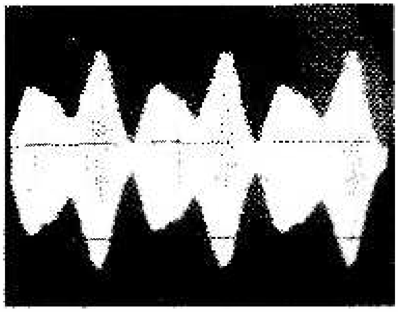


Fig. 36: Waveform from a rotating tremulant loudspeaker.

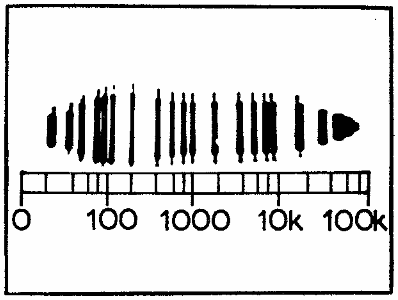


Fig. 37: Permanent record of the frequency response of an amplifier.

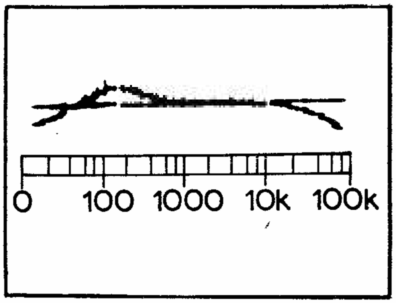


Fig. 38: An alternative method of displaying the frequency response.

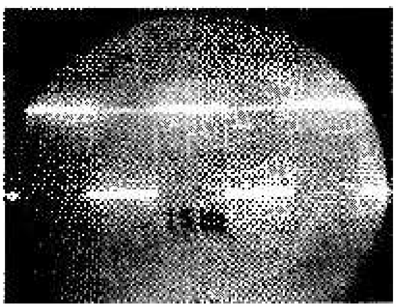
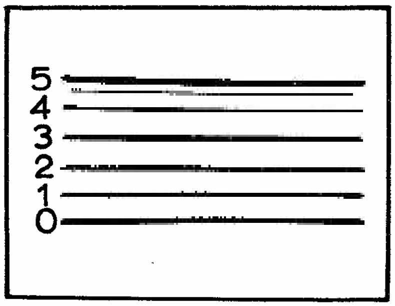


Fig. 39: (left) A good low frequency square-wave. Such a display is only available on a d.c. coupled 'scope.

Fig. 40: (right) Using a d.c. 'scope as a voltmeter—the numbers represent volts.



related to an amplifier output of 12V both across a load of say 8Ω, would be 60dB, i.e., the hum and noise would be 60dB below the rated power output.

One other form of distortion is shown in Fig. 32. This is THD or total harmonic distortion but to be seen requires a THD bridge. However, it is shown for the sake of interest and the upper trace A is a 1kHz sine-wave signal after passing through an amplifier. The lower trace B is the total harmonic distortion produced by the amplifier and in this case is about 0·3 per cent and contains mostly second harmonics. A further example, again one of interest, is that given in Fig. 33 in which trace A is ordinary 50Hz domestic mains supply. The THD shown below in trace B looks formidable but amounts to only about 1 per cent. However, the harmonic content is complex and no doubt accounts for the fact that mains hum and its harmonics are so difficult to get rid of in amplifiers!

MISCELLANEOUS

The double beam oscilloscope allows one to examine both input and output signals simultaneously, as in the case of amplifiers when the square-wave test is applied, or when it is desired to compare the effect of a particular circuit on a given waveform. In Fig. 34 for instance the lower trace B shows the waveform being fed into an electronic organ voicing circuit whilst trace A shows the output from that circuit. A further example is given in Fig. 35 in which trace A is a square-wave and trace B the effect of integration by passing the square-wave through a CR network.

One of the advantages of any oscilloscope is that the timebase can be locked to the signal input, thus producing a stationary display of rapidly occurring waveforms. The display shown in Fig. 36 is an unusual one in that the signals had to be picked up by a microphone, amplified and then fed to the 'scope. The waveform is that produced by a rotating termulant loudspeaker (Leslie speaker) on an electronic organ. The modulation envelope is approximately 6Hz per second.

It is not difficult to obtain a permanent record of the frequency response of an amplifier by a photographic method as shown in Fig. 37. In this case an a.c. coupled 'scope can be used in conjunction with an illuminated frequency response (log) scale which is placed over the c.r.t. screen. The signal level at each test frequency is displayed as a vertical deflection which is the peak-to-peak amplitude. The timebase is switched off and the X shift control used to move each vertical trace to coincide with the frequency scale. The example shown is the response from a Hi-Fi amplifier.

A similar technique can be used with a double beam d.c. 'scope but in this case the signals being measured are rectified to produce a d.c. voltage to deflect the trace. No timebase is used and the scan is carried out by manual X shift control. In Fig. 38 the straight line is the output from the signal generator (0dB) and the curving line the amplifier response from 10Hz to almost 100kHz.—the same amplifier as used for Fig. 37 in fact.

An a.c. coupled 'scope will not normally display accurately a square-wave of very low frequency although the wave may be very symmetrical, i.e., perfectly flat top and bottom. An a.c. 'scope will usually display it with the top and bottom sloping quite considerably. A d.c. coupled 'scope, however, will display a low frequency square-wave accurately as shown in Fig. 39 which is the 15Hz square-wave from a good audio signal generator.

A d.c. coupled 'scope can also be used as a d.c. voltmeter because d.c. voltages applied to the input will produce direct deflection of the trace. In Fig. 40 each line is the trace deflected upward from 0V to 5V by 1V intervals. ■

THE Medium Wave Column

CHARLES MOLLOY

MR. ROY TOOMBS who lives in Knowle near Birmingham has been active on the medium waves with his Pye 1400 broadcast receiver. He reports reception from the Mediterranean area of Oujda, Morocco on 593kHz; Nicosia, Cyprus 602kHz; El Gawarsha, Libya 674kHz; Sebaa Aioun, Morocco 701kHz; Corfu 1007kHz; Sebaa Aioun, 1043kHz. Many local broadcasters from this part of the world are audible during the evening. Listen for Oran, Algeria on 548kHz; Cairo 773kHz; Tartus, Syria on 782kHz; Beirut, Lebanon 836kHz; Algiers 890kHz; Tunis 962kHz; Algiers 980kHz; El Beida, Libya 1124kHz; The Voice of Morocco, Tangiers on 1232kHz; Tripoli, Libya 1250kHz. Stations further east that are worth looking for are Baghdad, Iraq on 760kHz; Radio Teheran, Iran 841kHz; Kermanshah, Iran 985kHz; Riyadh, Saudi Arabia 1183kHz.

From **Seamas Davey** of Collooney, Co. Sligo comes information about the new low-power local radio service in the West of Ireland. Programmes are in the Irish language and are on the air daily from 1800hrs until 2000hrs GMT on 529kHz and 1250kHz. Reception reports should go to Radio na Gaeltachta, Casla, Connemara, Eire.

Richard Coyle of Glasgow has a Lafayette KT340 and a medium wave loop antenna. Between 0100hrs and 0300hrs GMT he has logged CJON St John's, Newfoundland on 930kHz; CBA Moncton, N.B. Canada on 1070kHz; Radio Sutatenza, Colombia on 960kHz; Radio Margarita, Venezuela 1020kHz; Radio Globo 1180kHz and Radio Tupi 1280kHz, both located in Rio de Janeiro, Brazil. South Americans are at their best in summer, those in Brazil being particularly prominent during the hour before sunrise. The cities of Sao Paulo and Rio de Janeiro have a number of commercially owned outlets that are heard regularly in the U.K. Portuguese is the language and call signs, although allocated, are seldom used. Try for Radio Record 1000kHz; Radio Tupi 1040kHz; Radio Nacional 1100kHz; in Sao Paulo. From Rio de Janeiro there are Radio Mundial 860kHz; Radio Journal 940kHz; Radio Nacional 980kHz; Radio Globo 1180kHz; Radio Tupi 1280kHz.

Two high power outlets in Buenos Aires, Argentina can nearly always be heard. These are LR1 Radio el Mundo on 1070kHz and LR3 Radio Belgrano on 950kHz. Others to look for when conditions for reception from this area are good, include CX12 Radio Oriental Montevideo, Uruguay on 810kHz; CX16 Radio Carve, Montevideo 850kHz; LR4 Radio Splendid, Buenos Aires 910kHz; CX28 Radio Imparcial, Montevideo 1090kHz; LT2 Radio Splendid, Rosario 1230kHz; LS6 Radio America, Buenos Aires 1350kHz.

Send logs and information about the Medium Waves to the writer at 132 Segars Lane, Southport, PR8 3JG.

Audio Test Trio No.2&3

COMPACT SIGNAL GENERATOR

ATTENUATOR

J.N.WATT

This month we describe a simpler and smaller version of the comprehensive audio signal generator dealt with in the July issue of PW. A discussion on the design of audio attenuators is followed by constructional details of a practical unit with switchable attenuation from 0 to 39dB.

Specification

Frequency ranges: 30 – 300Hz
300 – 3kHz
3 – 30kHz
with some range overlap.
Output level, sine wave: 1V continuously variable.
Output impedance: 600Ω
Output amplitude held to ± ¼dB (sine wave)
Power supply: 18V from two self contained batteries.
Power consumption: 5mA

THE full audio generator described last month is thought to be a very suitable one for a large number of applications, but despite its relatively small size, it occurred to the author that an even smaller design, almost of pocket size, would be found extremely useful to service engineers etc. who prefer to work on audio equipment away from their main workshop.

Accordingly, a second instrument was constructed omitting the square wave generator and coarse level output attenuator. This enabled the generator to be built in a box only half the size of the previous design. With no coarse attenuator now available, for levels of signal below 100mV, it is desirable to use an external attenuator, rather than attempt to set the instrument's fine level control for such very small output.

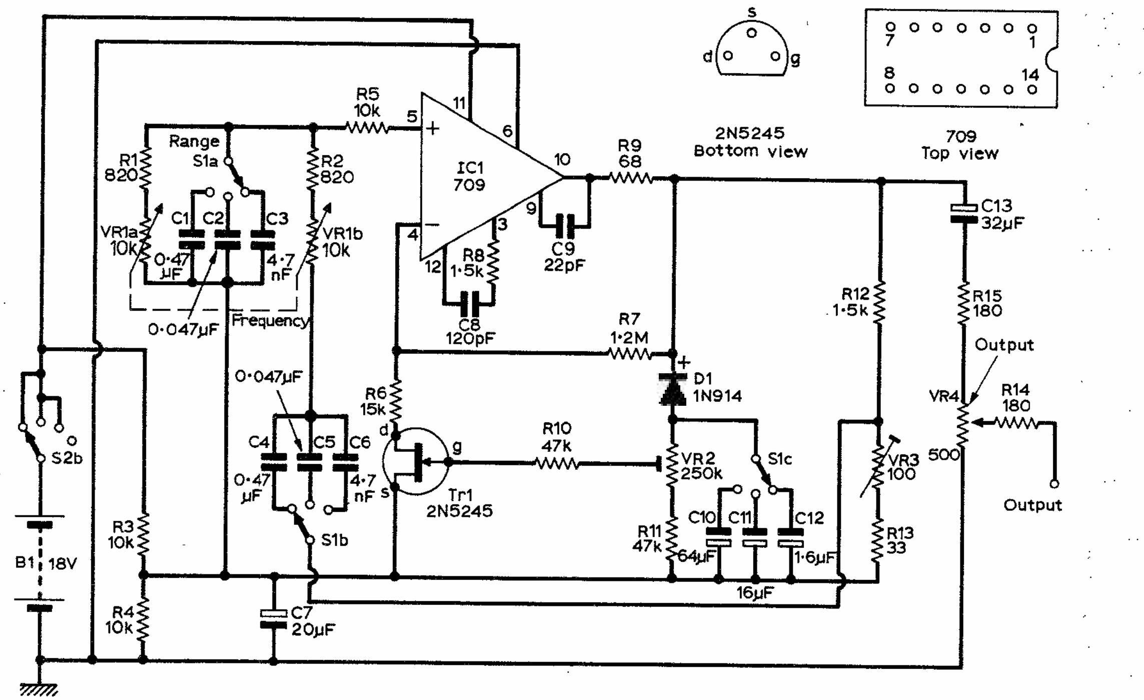
With a little ingenuity, an even smaller unit could no doubt be made, perhaps only 1½in. in depth, the generator then resulting could truly be called pocket-size but would still retain the excellent stability and purity of waveform of the original.

CIRCUIT

The simpler oscillator circuit Fig. 1 follows, in principle, that of the larger instrument described last month, that is, amplitude stabilisation is provided in the same way, using the voltage variable resistance characteristic of the 2N5245 f.e.t. as a means of controlling the gain of IC1. Frequency determination is provided by VR1 together with the appropriate capacitor C1 to C3 and C4 to C6, as selected by two poles of S1, while the time constant of the amplitude stabilising circuit is similarly selected by the third pole of S1.

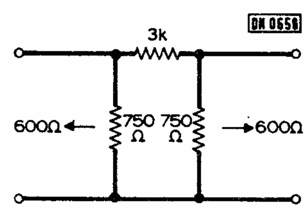
As with the larger unit, any temporary increase in the sine wave output of IC1 results in a larger negative d.c. voltage appearing across C10 to C12; a proportion of this latter voltage is impressed on the gate of the f.e.t. so increasing its effective resistance. This has the effect of increasing the amount of negative feedback around IC1, which of course reduces the gain of that amplifier, so counteracting the increase in sine wave output originally noted. The actual level of this output is determined by the particular values of all the circuit elements employed. The f.e.t. especially is liable to vary from sample to sample and so VR2 is used to set the output to the required level.

The variable resistor VR3 is adjusted to give sufficient, and only just sufficient, positive feedback for the circuit to oscillate reliably, and is set up so that a constant output is obtained at all settings of VR1, without distortion of the output waveform.



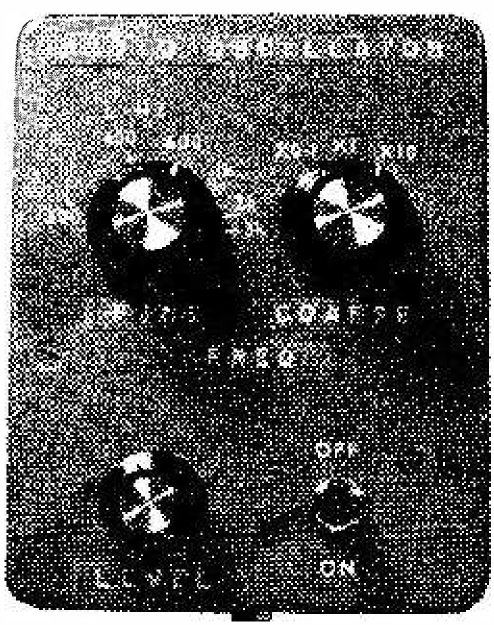
▲ *Fig. 1. Circuit of the simplified audio signal generator.*

▼*Fig. 2. Circuit of a 20dB 600Ω attenuator suitable for use with almost any signal generator.*



Once set, the range of control of the negative feedback is sufficient to ensure stability.

Only a straightforward potential divider attenuator is provided in this simpler oscillator, so that when the output level is varied, so then is the output impedance varied also. For very low levels of output an external attenuator is best employed and this should also be done if the output impedance is required to be kept constant for any reason. A suitable 20dB 600Ω attenuator is shown in Fig. 2.



In other respects the smaller oscillator will be found to be as effective as its larger companion, as well as being a very portable source of audio frequency signals.

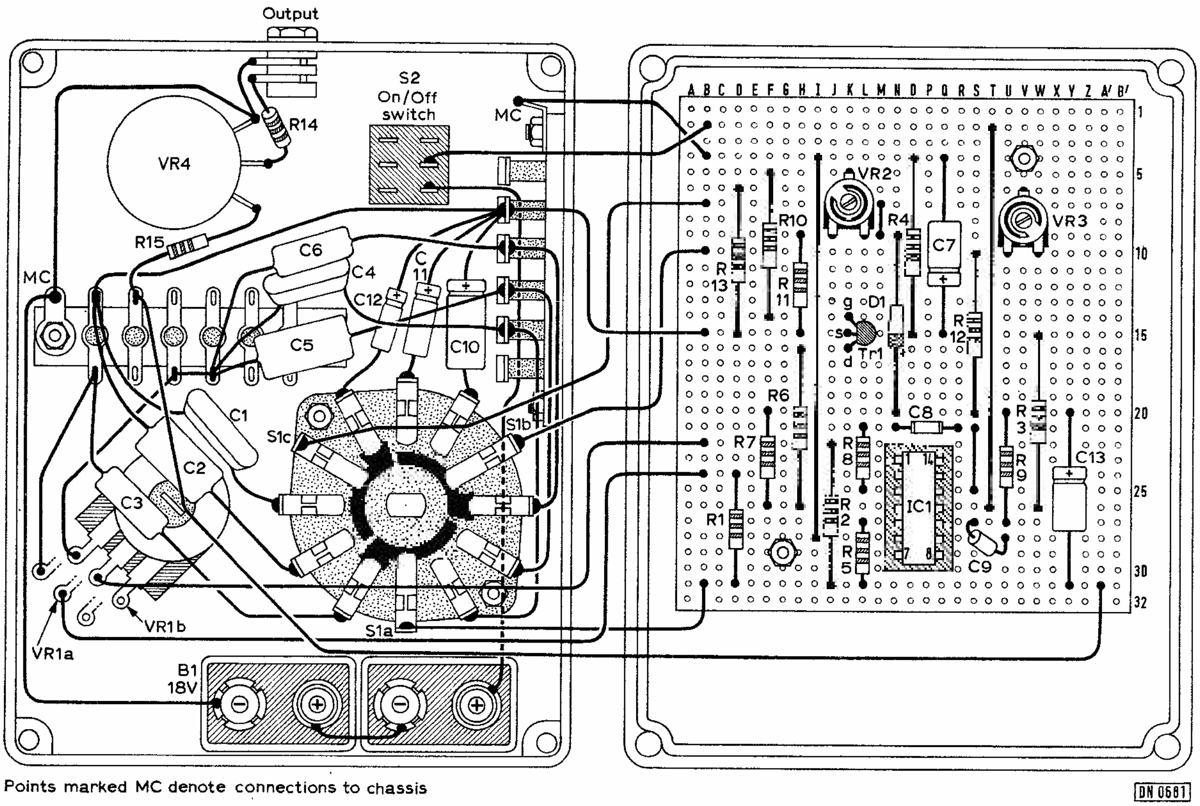
CONSTRUCTION

The general method of construction is similar to that used in the larger model of the generator except that the die cast box now measures only $4\frac{5}{8}$ x $3\frac{5}{8}$ x $2\frac{1}{4}$in. The circuit board, Fig. 4, is attached to the lid while the remainder of the components are fitted in the box itself, Fig. 3.

TESTING

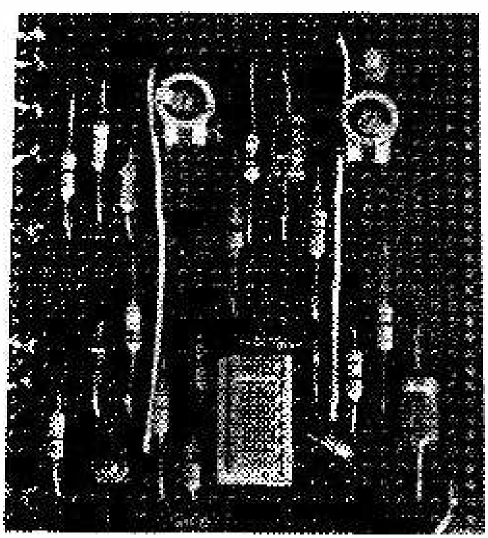
The setting up of the generator follows the same procedure as described last month for the sine wave part of the circuit. However the essentials of the alignment are given again.

With construction complete, before plugging in the i.c., use a voltmeter to check that, at each of the input pins of the holder, i.e. pins 4 and 5, there is half supply volts. These readings should with two new batteries, be +9V or so, relative to battery negative (chassis). Any large departure from this value indicates the presence of a fault of some



Points marked MC denote connections to chassis

Fig. 3. The larger components are fitted in the die cast box, left, with the remaining components mounted on the lid, right.



The completed circuit board is mounted using a piece of thin foam plastic as insulator.

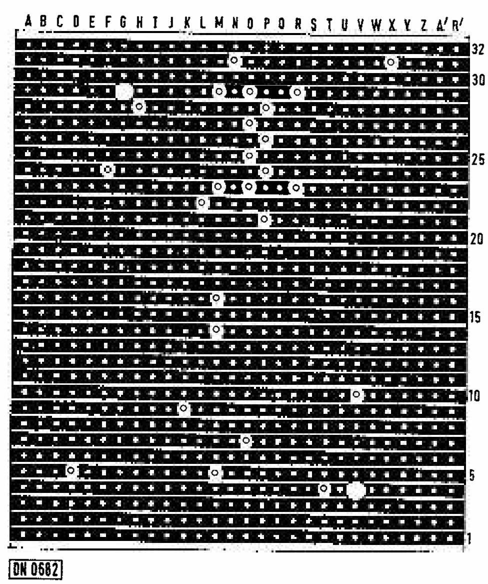


Fig. 4. Reverse of the circuit board indicating breaks required in the copper rails.

kind; correction must be carried out before insertion of the i.c.

Now fit IC1 and check its output potential at pin 10. It should lie close to +9V relative to chassis. If all is well, VR3 can be adjusted for optimium performance.

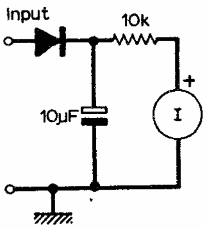
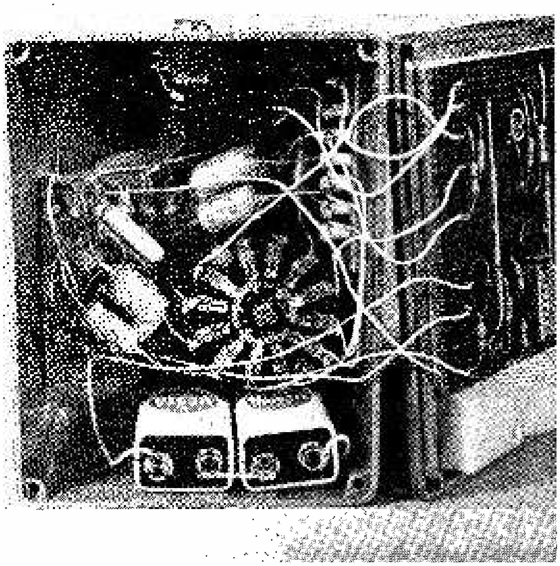


Fig. 5. A meter capable of giving a clear indication of about 100µA is required in the test set-up.

To do this, the test set-up of Fig. 5 is required to monitor the output of IC1. S1 is set to the middle range and VR1 to mid travel. With VR3 in its extreme anti-clockwise position, advance it slowly until the meter starts to indicate. Further advancement will give a rising meter reading which will start to level off as VR3 is rotated further; stop at this point.

Now swing VR1 over its total range whilst continuing to monitor IC1 output. The reading should be constant, indicating a good setting of VR1 but if the meter reading is not constant, slight re-adjustment of VR3 is called for. The specification calls for the output level to be within ½dB either way which amounts to a total permitted variation in meter reading of about 11% as VR1 is swung from one end to the other.

The actual level of the output signal depends on the particular values of the components employed, especially the specimen of f.e.t. used. Accordingly, transfer the test set-up to the output terminals, which should be loaded with 600Ω. Set VR4 to maximum output and S2 to the 1V range; adjust VR2 for a reading of 80µA indicating a level of 1V r.m.s. With some specimens of the f.e.t. called for, it may not be possible to obtain 1V r.m.s. in this way, in which case a slight alteration in the value of R15 should enable the correct level to be arrived at.



★ components list

Resistors

R1 820Ω	R6 16kΩ	R11 47kΩ
R2 820Ω	R7 1·2MΩ	R12 1·5kΩ
R3 10kΩ	R8 1·5kΩ	R13 33Ω
R4 10kΩ	R9 68Ω	R14 180Ω
R5 10kΩ	R10 47kΩ	R15 180Ω*

All resistors ¼W 5% * see text

VR1 10kΩ + 10kΩ linear	VRs 100Ω pre-set
VR2 250kΩ pre-set	VR4 500Ω lin.

Capacitors

C1 0·47µF 10%	C8 120pF
C2 0·047µF 10%	C9 22pF
C3 4700pF 10%	C10 64µF 10V
C4 0·47µF 10%	C11 16µF 10V
C5 0·047µF 10%	C12 1·6µF 25V
C6 4700pF 10%	C13 32µF 10V
C7 20µF 16V	

Miscellaneous

ICI, Type 709 integrated circuit with holder.
Tr1, 2N5245. D1, 1N914. S1, 3 pole 3 way wafer switch. Die cast box 4⅝ x 3⅝ x 2¼in.
Veroboard, 0·1in matrix 3¼ x 2⅞in.
Headphone socket. Knobs.

With IC1 functioning correctly, an oscilloscope can be used, if available, to examine the output sine wave. It should be excellent at all settings of the controls.

Lack of output, or a large rise in output, at any setting of VR1, other than that used when setting up VR3 probably indicates a fault in the amplitude stabilisation circuitry.

Calibration of the frequency scale can be done by comparison with an existing audio signal generator, either by means of a Lissajou figure on an oscilloscope or by listening simultaneously to both generators. It is possible to determine when both signals are at the same frequency by this latter means, especially if the operator has some musical appreciation.

Audio signals of a very high degree of frequency accuracy are available to everyone with a radio or TV set.

ATTENUATORS

A glance inside the workroom of any enthusiastic amateur constructor in the field of electronics will reveal the presence of a number of items of test equipment, the quantity and complexity of them depending largely on the experience and depth of knowledge of the owner.

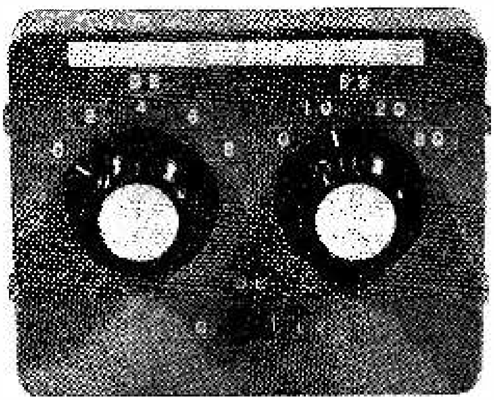
Thus, from a multi-range testmeter likely to be found belonging to even the rawest beginner, we move to the laboratory-like instruments of the advanced constructor, probably including signal generators, a valve voltmeter and perhaps an oscilloscope, along with other items depending on the owner's special interests. However, how often do we see a calibrated attenuator?

No professional laboratory would dream of being without an accurate attenuator, so why is it that the amateur constructor seems to think differently?

Is it a question of the lack of availability of commercially manufactured units at reasonable prices, coupled with the lack of information for home construction? If the latter, this article seeks to put that right, with an outline of the simple theory, how to calculate component values, constructional details of a 0-39dB attenuator, followed by an example of its use in a typical audio measurement.

Specification

Attenuation: 0 to 39dB in 1dB steps.
Impedance: 600Ω.
Frequency Range: DC to at least 80kHz.
Input: from either 10kΩ or 600Ω source
Output: to either 5kΩ or more or 600Ω load.
Input level: at 600Ω input; up to 8·6V r.m.s. at all settings but greater at low settings, e.g. 10V r.m.s. at 6dB.
Input level: at 10kΩ input; up to 35V r.m.s. at all settings.



The die cast box carries all the components. The three switches provide any attenuation between 0 and 39dB.

BASIC CIRCUITS

First, just what is an attenuator? In its simplest form, it consists of just two resistances arranged as in Fig. 1, so that:—

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

This very simple attenuator has the merit of simplicity but the disadvantage that the impedance seen by the signal source (to the left in Fig. 1) is different from the impedance seen by the load (to the right in Fig. 1). Accordingly, since the input and output impedances of this attenuator are necessarily different, accurate matching is impossible. Moreover, as the ratio of V_o to V_i is altered, by altering the values of R1 and R2, these input and output impedances change, so further disturbing matching.

A much better arrangement is that given in Fig. 2, where the impedances seen at both the input and output are equal, provided that the resistor values are calculated according to the following equations:

$$R_1=R_3=Z\left[\frac{N+1}{N-1}\right] \text{ and } R_2=Z\left[\frac{N^2-1}{2N}\right]$$

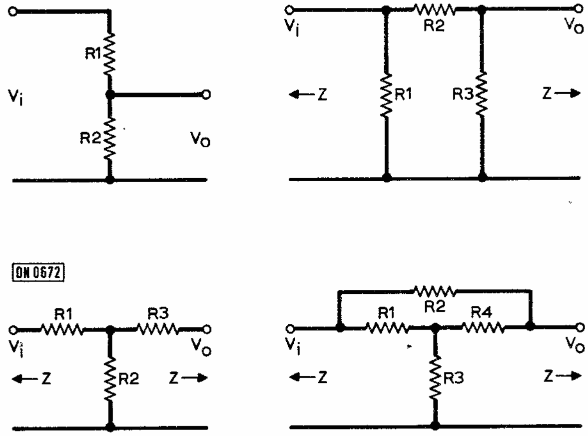


Fig. 1, top left, shows the simplest form of attenuator. Fig. 2, top right the π pad provides a better match of impedances. Fig. 3, bottom left is a T network while Fig. 4, bottom right, is the alternative bridged-T network.

where Z is the input and output impedance and N is V_i/Vo.

Note that if the attenuation is quoted in dB (as is usual) then $D=20\log N$.

Such a network, or **pad,** is known as a π pad.

An alternative solution to the problem of providing a known loss at a fixed impedance is the **T** pad, see Fig. 3. Here:—

$$R_1=R_3=Z\left[\frac{N-1}{N+1}\right] \text{ and } R_2=Z\left[\frac{2N}{N^2-1}\right]$$

Either a π or a T pad may be used in any particular case; the choice of which to use would normally depend on the values of resistance that had been calculated, one pad perhaps having more suitable or standard values than the other. Resistors of 5% tolerance are usually adequate, any departure from the calculated value then giving rise to no more than a 5% mis-match, and only a very small attenuation difference.

One other type of attenuator working between constant impedances is the bridged-T, Fig. 4, where:—

$$R_1=R_4=Z \text{ and } R_2=Z\,(N-1) \text{ and } R_3=\frac{Z}{N-1}$$

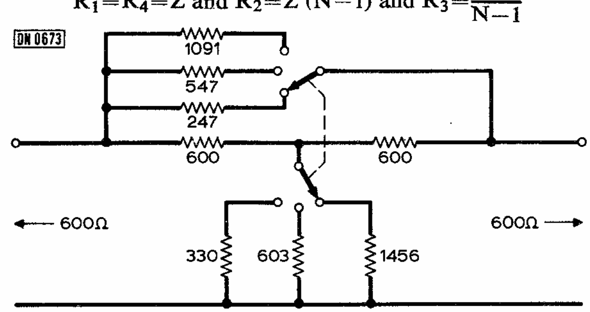


Fig. 5. Switched attenuator for 3, 6 or 9dB. A practical circuit would use preferred value resistors.

This type of pad can have some very inconveniently low values for R3 and very large values for R2 when N is large, and uses one more resistor compared to the π and **T** pads, but note that only two of these resistors need to be altered to alter the attenuation, which is sometimes an advantage, see Fig. 5. Here, a choice of 3, 6 or 9dB is available,

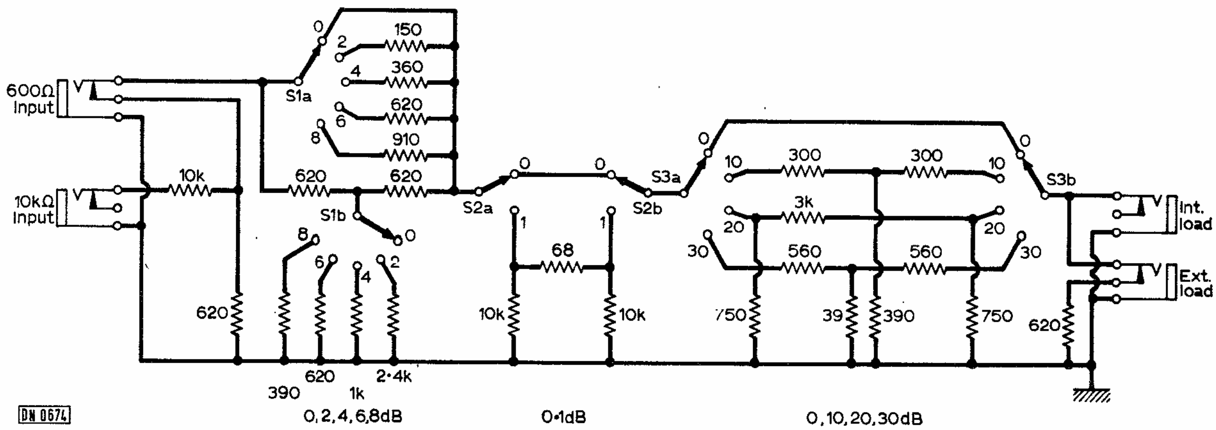


Fig. 6. Practical design for the attenuator illustrated, incorporating π and T pads.

using eight resistors and a switch of only two poles.

The practical design for an attenuator, presented below, takes advantage of this simplification, compared to the use of π and T pads, although this is done only for the lower values of attenuation. Resistor values called for in the larger attenuation section would be rather larger, using a bridged-T, and the stray capacities associated with such resistors could tend to modify the response of the attenuator at the higher frequencies. Accordingly, π and T pads are used, see Fig. 6.

The total attenuation available, at an impedance of 600Ω, is 39dB, made up as follows. The first pad is a bridged-T, with a two pole rotary switch used to select 2, 4, 6 or 8dB of attenuation. This is followed by a 1dB π pad, either selected or by-passed by the slide switch. Finally, there are three separate pads, of 10, 20 and 30dB attenuation respectively, with a second two pole rotary switch employed to bring in one complete section at a time.

Note that while the 10 and 30dB pads are T section, a π section is used for the 20dB pad. This was done in the present design as the resistor values calculated for a 20dB T pad turned out to lie exactly mid-way between two preferred 5% values; to eliminate any errors from the use of resistors either 5% too high or 5% too low in value, a change to a π section was made. As noted earlier, T and π sections are interchangeable.

Two input circuits are provided, one connecting directly to the pads for 600Ω inputs, the other being used for signals fed from an impedance of 10kΩ e.g., the output of some signal generators. The simple matching pad used to connect this high impedance input to the 600Ω attenuator presents an impedance of 10kΩ to the signal source and 600Ω to the pads which follow. Of course, a loss occurs in this matching process amounting to some 18dB. Because of the change of impedance, this represents a reduction in voltage by a factor of 17·4.

The output circuits are also duplicated, in that one is arranged to have a dummy load connected, the other having no such load provided.

CONSTRUCTION

The actual form of construction employed can depend, to a large extent, on the availability of a suitable housing for the attenuator, but in any event it should be a metal box of some kind that can be earthed, via the input and output jacks, for screening purposes. The author's prototype uses a robust die-cast box, $4\frac{3}{4} \times 3\frac{3}{4}$ in. The layout of the front panel and position of the four jacks (two for input and two for output) is clear from the photographs and drawings, Fig. 7.

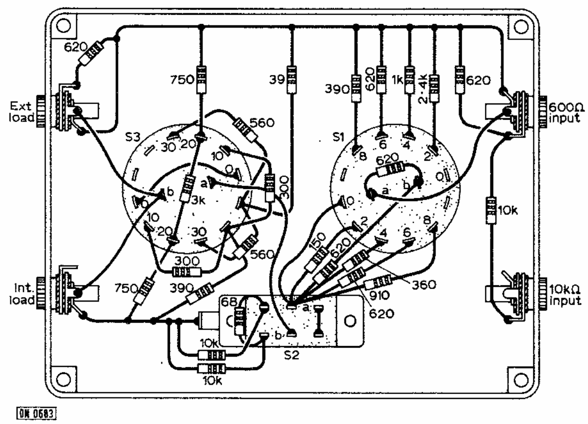


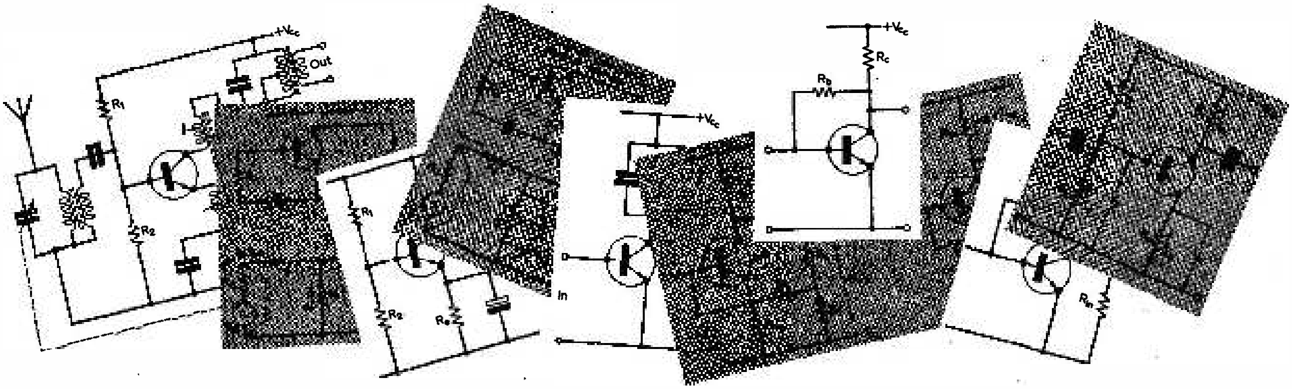
Fig. 7. Component layout. All resistors are ¼W 5%, S1 is 2-pole 5-way, S2 is a 2-pole 2-way slide switch and S3 is 2-pole 4-way.

With this external layout, the disposition of the resistors in the interior, using the switch terminals where possible, is fairly straightforward. A tagstrip may be used, if found to be convenient, for mounting some of the resistors.

As for the resistors themselves, the use of 1/8W components of as tight a tolerance as practicable is recommended. The author used 5% resistors, which most likely gives rise to about 3% overall mis-match and a very small attenuation error, say ¼dB, so that the use of, say, 2% tolerance resistors at greater expense is hardly justified. As the specification shows, using 1/8W resistors limits the maximum input signal (at the 600Ω input) to 8·6V r.m.s. If the constructor envisages that he will require to apply a greater signal level, ¼W or ½W resistors can be used, as appropriate.

Inputs and outputs to the attenuator are by 3·5mm. jacks, with some use made of the contacts which are opened by the insertion of the jack plug. At the 600Ω input this contact is arranged to remove the 620Ω resistor which forms part of the high impedance matching network, for if this component

—continued on page 350



TRANSISTOR CIRCUITRY for beginners

PART 9

H.W. HELLYER & MICHAEL HOLLIER

E and O not E

Part 8 of this series was held over from the May issue of *PW*, partly through illness which delayed the contribution, and partly because perceptive readers had jumped swiftly on one or two errors, a few omissions, and some arguable propositions. It would be expedient, if shaming, to begin this article with an attempt to put matters right.

Those readers who wrote, and are champing at the bit for an answer, please read on. . . .

Mr. Sharples, of Widnes, Lancs, hits upon one very common cause of complaint. "Most books on electronics I have locked at", he says, "contain mostly mathematics, with very little explanation of the operation of circuits." He wants a recommendation of specific books to meet his needs. Many other readers voice this plea, but all give different outlines of their needs. There just are not enough specific books on the market to satisfy such narrow requirements. Authors set out, quite honestly, to appeal to as wide a readership as they can, while giving all the information they are able in the space that is available. It is no easy task: believe me, I speak with feeling. *(Mr. Hellyer is the author of "Tape Recorders" and "Radio Technician's Bench Manual", published by Fountain Press, as well as "Questions and Answers on Radio and Television", published by Butterworths, and "Tape Recorder Servicing Manual", now out of print, originally published by Newnes.)*

There have been a number of books published on transistor circuitry, with hardly any mathematics, but Mr. Sharples and others ask for "books on electronic circuit design" and this cannot be done without some recourse to arithmetic.

I will not deign to call it mathematics, for none of the formulae used in this series of articles should be beyond the resources of a twelve-year old; and in all cases, we have "worked" the examples through, leaving very little to be taken for granted.

But on one score, I agree wholeheartedly with Mr. Sharples. There is very little "explanation of circuits" in the literature available. Poor Michael beat his brains out when preparing his piece on bootstrapping, which will follow. Between us, we combed the libraries of Bristol and could not find a satisfactory explanation that tallied with our own findings. So may I anticipate any challenge to our text by asking critics to supply supporting chapter and verse?

Input resistance

Next we come to the redoubtable *Mr. Skidmore*, of Gatley, Cheshire, and, to some extent on the same subject, *Mr. Fletcher* of Kingston, Surrey. Both find faults with Part 6, which appeared in the March 1972 issue of *PW*.

Factually, both are right in challenging Fig. 31. In the preparation for publication, the caption for this diagram, and the designation of the X axis, became mixed with another drawing. This unpardonable crime, more easily understood if you look at Pax's cartoon at the foot of Page 70, May issue, should be corrected as follows:—

X axis of Fig. 31 should be h_{fe} and not H_{FE}. Caption should read "Typical variation of small signal forward current ratio with collector current".

We should also point out that we are interested in the curve for a BC109 at a VCE of 5V. In the

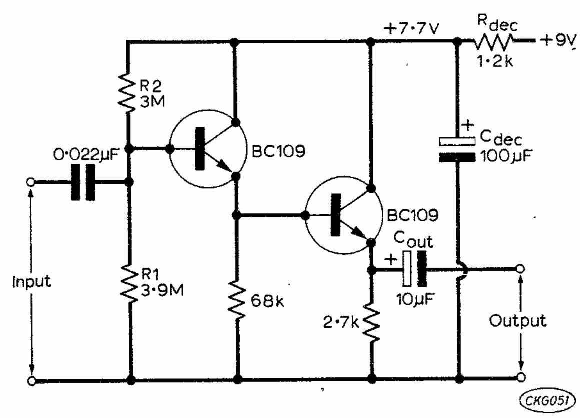


Fig. 45. Reproduction of Fig. 30, p.1008 of March PW, showing a Darlington pair, as previously described, with special attention in the text to the effect of the 68kΩ emitter resistor of the first transistor.

diagrams of the last part and in subsequent diagrams, we hope to avoid this misunderstanding by omitting extraneous detail, concentrating only on the basic information we want to impart.

However, one message we tried to impart, and signally failed to do, it seems, is on the subject of input resistance. Referring back to page 1009 of the March issue, we should point out that all the calculations deliberately ignored the effect of Re1. In Fig. 30, this emitter resistor is 68kΩ, and both our aforementioned correspondents take us to task for not including it in our calculations. We have said that providing Re1 is many times larger than Re2, its shunting effect on the input of Tr2 will be negligible, but that is not good enough for Messrs Fletcher and Skidmore. They have done us the honour of digging more deeply into the subject, bless them!

Quotation

A clearer idea of the objections raised by our two perspicacious readers may be gained if I quote them verbatim, and then leave Michael to provide his personal answer. *(That's one way of getting yourself off the hook! Ed.)*

Quoting Mr. Fletcher: ". . . the resistance seen at the emitter of Tr1 is 68kΩ in parallel with the resistance looking into the base of Tr2. This latter is current gain of Tr2 times Tr2's emitter load resistor, i.e., 440×2·7kΩ or 1·2MΩ approximately.

It is clear therefore that the 68kΩ is the governing factor as regards the input resistance of Tr1. Its current gain being 240, this gives us a value of 16·8MΩ, quite different to the 285MΩ quoted but still unimportant compared to the lower value of the two base-biasing resistors in parallel."

Now let's go on to Mr. Skidmore, who is a little more hard-hitting.

He says "$R_{in} = h_{fe(1)} \times h_{fe(2)} \times RE(2)$ is quite satisfactory when applied to the circuit of Fig. 26 where the two transistors can be imagined as a single transistor with a high current gain . . . but the author has applied this formula to the circuit of Fig. 30 and has completely ignored the effects of the 68kΩ resistor Re1." This emitter resistor cannot be ignored, he asserts, because it changes the circuit to two emitter followers in cascade.

"All the transistor books I have read give the input resistance of an emitter follower as approximately equal to the emitter load times the current gain, where the emitter load is equal to the combination of the emitter resistors plus any external load added to it."

Mr. Skidmore's meaning is clear, if his language is falling short of the scientifically precise. Perhaps he should have a go at the 1972 Cup (see Editorial in the May issue of *PW*). But his figures clash with Mr. Fletcher's. If $h_{fe(1)}$ is 240; $h_{fe(2)}$ 440; R_{e1}, 68kΩ and R_{e2} 2·7kΩ, he says, then $R_{in(1)} = h_{fe(1)} \times R_{e(1)} =$ 240×68kΩ=16·3MΩ.

He calculates the input impedance at 1·54MΩ which is ultimately not far short of our calculated *and measured* result. I think it should be remembered that we are trying to be practical (that's what it says on the cover). We build and measure, after initial calculations. Quite often, as we have already demonstrated, the empirical method gives surprising results: obviously some factor has been omitted from the calculation. So *was* Re1 left out?—let's see.

Michael answers: We must take things step by step in arriving at these input resistances of direct coupled transistors. First, we ignore Re1 for the reasons already given, so $R_{in} = h_{fe(1)} \times h_{fe(2)} \times RE2$, 240×440×2,700, which is 285·12MΩ.

It is then shunted by the input base bias network R1 and R2, giving the *stage* input resistance as:—

$$\frac{1}{R_{IN}} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R_{in}}$$

$$= \frac{1}{3{\cdot}9M\Omega} + \frac{1}{3M\Omega} + \frac{1}{285M\Omega} = 1{\cdot}6M\Omega \text{ approx.}$$

A more accurate calculation for R_{IN} would take into account RE1, previously ignored, giving a marked difference in the calculation of R_{in}.

Remember that the input resistance R_{in} is mainly controlled by R1 and R2 in parallel. This has already been used as a main argument by our readers, so let's go on from there.

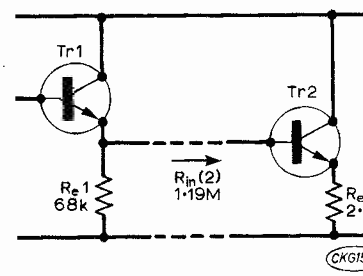


Fig. 46. Input resistances separately calculated for each section of a combined stage. This is not really a true picture, see text.

The input resistance to the second transistor, $R_{in(2)}$ is $h_{fe(2)} \times Re_{(2)}$ approximately, which works out to 1·19MΩ *approximately*. Fig. 46 sets out what we have already learned in the preceding paragraphs. But in interpreting this we should hark back to John Donne's reminder, "No man is an island". Paraphrasing, no transistor is a self-contained entity when in a circuit.

In Fig. 46, $R_{in(2)}$ is shunting the first transistor emitter resistance, the bone of contention, that 68kΩ component. Now, 1·19MΩ is large, so large compared with 68kΩ that the *effective* emitter resistance is only very little below the nominal 68kΩ, certainly with component tolerances and transistor spreads.

But let's look at $R_{in(1)}$, using our nominal figure.

$$R_{in(1)} = 240 \times 68k\Omega = 16{\cdot}3M\Omega$$

This is a far different figure from 285MΩ, granted, but take another look at the Stage Resistance, which is what we want to know, practically. Let's insert our new figure of 16·3MΩ in this formula. We now get:—

$$\frac{1}{R_{IN}} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R_{in}}$$

$$= \frac{1}{3{\cdot}9M\Omega} + \frac{1}{3M\Omega} + \frac{1}{16{\cdot}3M\Omega} = 1{\cdot}53M\Omega$$

As we can see, not such a different value from the original 1·6MΩ.

We have to thank our correspondents for making us add to our explanation of Input Resistance and hope other readers will bear with us when we appear to be labouring a minor point. It can be important in practice.

One red-faced author wishes to apologise for a slip of the typewriter: in the April issue, talking about the "practice" of using transistor circuits, allowing for gain spreads, etc., I said (and underlined, Heaven help me!) "Stage input resistance is primarily controlled by the base bias transistors," and, of course, I should have said *resistors.*

Again, in the final paragraph of this contribution, headed "Normalising", it would have been more explicit to say: "For example, our I_C is 1mA, which gives us around 0·24V, so we multiply the quoted minimum h_{FE} at 100mA Ic, 20,000 by 0·24, getting 4,800. The last sentence of this article should then be ignored.

Biasing

In our previous circuits, we have relied upon the potential divider method of biasing, i.e., R1 and R2 in Fig. 45, and the effect of the emitter resistor has, rightly been pointed out to us. We now come to the next step in circuit design, taking account of this component as the prime biasing factor—which may now explain why we were rather reticent about its effect before.

If we have a single transistor, as in Fig. 47, taking a silicon type, for ease of calculation, and we require this to have the collector current of 1mA. If, also, we want the collector to emitter voltage to be around half the supply (see previous articles for the reasons underlying these choices), we can anticipate the maximum voltage swing at the output, all being well.

Beginning with the collector resistor, R_c, let's calculate:

$$R_c = \frac{VR_c}{I_c} = \frac{6V}{1mA} = 6k\Omega$$

All right, you don't have one of those in your spares box—but just stick with us a moment, while we continue to calculate, using "ideal" rather than practical values. (I remember an old steam radio engineer who used to say "stick a point one in" whenever a capacitor, sorry, condenser to him, had gone. Surprising how often it was successful.)

Let's typify the circuit by saying the h_{ie} is around 6kΩ and the h_{FE} is between a minimum of 200 and maximum of 800, typically 400. Take it from there . . .

Let us now use just one resistor to bias the base, as in Fig. 48. Regard the base-emitter junction as a conducting diode: right then, the base-to-emitter voltage will be around 600mV for our silicon semiconductor. Taking this away from the supply voltage, we get

$$VR_b = V_{cc} - V_{bc} = 12 - 0{\cdot}6 = 11{\cdot}4V.$$

Calculating the current which will flow through R_b, which is, of course, the base current of the transistor, I_b, we take into account the d.c. current gain which will give us the required collector current. Hence our previous insistence on those graphs. It is no use sticking in something similar and hoping it will work: the right way is to check your curves and do these simple calculations. Or ask your twelve-year old nipper to do them for you!

We know that the base current is multiplied by the d.c. current gain—yes we do, for we spent some time previously, explaining why!—and this gives us a certain collector current.

To write this in basic mathematics, $I_c = I_b \times h_{FE}$. If we juggle this formula, we can see that the base current required to attain a given collector current with a known d.c. current gain will be

$$I_b = \frac{I_c}{h_{FE}}$$

If we take a typical example, our figure of 400 for h_{FE}, then I_b becomes $\frac{1mA}{400}$ or 2·5μA.

Simple Ohms Law can now be called into play.

$$R_b = \frac{VR_b}{IR_b} = \frac{11{\cdot}4}{2{\cdot}5 \times 10^{-6}} = 4{,}560{,}000, \text{ i.e. } 4{\cdot}56M\Omega.$$

If we fitted a resistor of this value (if we could find one, that is), plus the input and output coupling capacitors, we could get a working circuit with an input impedance of around 6kΩ, and we could expect the output impedance to be similar.

In practical terms, a 6kΩ input impedance is low. Remember what we have said before: low to high is the golden rule for matching. In this case, we could increase the input resistance by inserting an unbypassed emitter resistor. Easy, you say, but there is always a snag, that's Henry's First Law. The snag is that inserting this resistor immediately affects the biasing, and we are back where we began.

h_{FE} spreads

There is an even more subtle pitfall, and this could be called differences in d.c. current gain. There can be variations of as much as 4:1 in h_{FE} in any given batch of transistors. So instead of being able to expect a collector voltage swing of between the V_{cc} and the "zero" line with a collector voltage of 6 volts, in the case given, we must allow for h_{FE} spreads between 200 and 800. Let's take a look at what this means, practically.

First, the base current is fixed, so the voltage drop across that base resistor will be 11·4 volts *in the little circuit of Fig. 48.* As the resistor does not change its value we can expect the current through it to be 2·5μA.

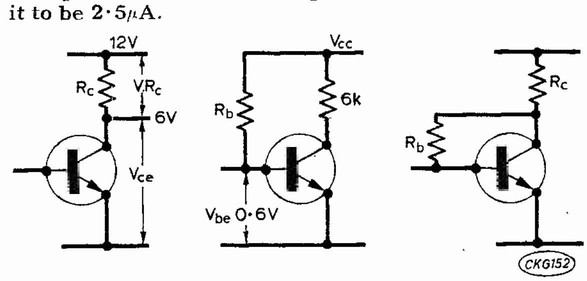


Fig. 47, left. Biasing, the first steps: determining collector voltage. Fig. 48, centre, the effect of the base bias resistor. Fig. 49, right, returning the "upper" end of R_b to the collector considerably alters conditions.

Let's begin with the minimum h_{FE} of 200. The collector current will be:

$$I_c = I_b \times h_{FE} = 2{\cdot}5\mu A \times 200 = 500\mu A$$

In other words, half the calculated I_c. And even worse, in these circumstances, the voltage across the collector resistor will be $I_c \times R_c$, or 3V which makes the collector voltage 12−3=9V.

The serious effect of this is that instead of our collector having a swing of almost plus and minus 6 volts we are now limited to a nominal 3 volts plus and 9 volts minus. Lop-sided waveforms are anathema to good amplifiers, so we would have to waste a lot of potential capability by limiting the swing to ±3V to allow for the h_{FE} spread.

If you would care to pursue the same argument, you will find that an h_{FE} of 800 would give a collector current of 2mA and a collector voltage of, believe it or not, zero volts, or very nearly.

The solution? In this type of circuit we would use selected transistors. Even gain grouped types have spreads of 2:1 or so, and an alternative way of ensuring precision is to employ selected resistors for the base bias, or, better still, have a preset resistor.

In practice, what's to be done? We have already seen that resistor choice is precise, and transistor selection can be, to say the least a chancy business. Yet we find this type of circuit in use throughout commercial gear. So where do we, as constructors, take our guideline?

We, that is, Mike and I, suggest you always take the *maximum* h_{FE} into account. We do not want to end up with zero collector voltage, so if we design the circuit around maximum d.c. current gain, this eventuality, at least, can be avoided. But we must always remember that the reliability of this type of circuit depends on the peak-to-peak signal swing being smaller than the maximum spreads likely to be obtained in transistors of similar design, and, oh boy; do these vary!

Another biasing method

Let us now get on to another type of biasing. A subtle difference, with the base bias resistor taken to the collector instead of the supply line, Fig. 49.

Consider the case of a transistor with a high h_{FE} fitted into this circuit. As we have seen, this would cause the collector voltage to be less. The base current is controlled by R_b, as has already been noted, but it is also controlled by the voltage "feeding it", so to speak, at its upper end.

So, if the collector voltage is lower than normal, then the current feed, via R_b to the base will be less, and let us not forget that we are dealing with a current-sensitive device. Reduction of base current will cause reduction of the collector current, so there will be less voltage drop across the collector resistor and the collector voltage will go up.

From this, we can see that taking the base bias resistor to the collector instead of the supply makes the simple circuit more tolerant of transistor variations.

The signal source

It has already been stated that we cannot regard a transistor circuit in its isolated state. What came before and what comes after is relevant to its operation. Take Fig. 50a as an example.

Here, we have a signal source, with, presumably, a definable resistance. The a.c. signal at the collector of the transistor is phase reversed with respect to the base. As R_b is connected from collector to base, some negative feedback will take place. The amount of negative feedback depends on the ratio of R_b to the resistance of the signal source.

Let's take the source resistance of the previous stage to be 1kΩ. In our diagram, this is shown in series with a hypothetical generator, a convenient way of indicating a signal source. If R_b is 100kΩ and the source 1kΩ, then 1/100th of the signal source is being fed back to the base.

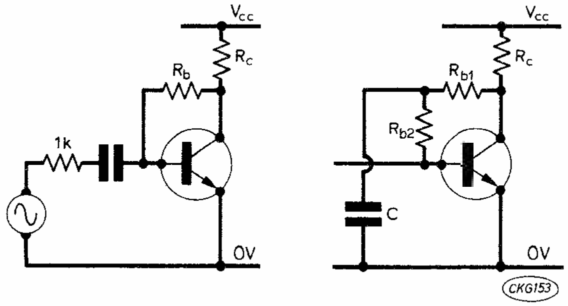


Fig. 50a, left, shows why the input resistance must be accounted for. Here the source is shown as a voltage generator with its resistance in series. Fig. 50b, right, shows how by "splitting" R_b and decoupling the junction point, we can modify the feedback.

We can modify the amount of feedback by effectively splitting the feedback resistor, as in Fig 50b. But note that the junction of the two resistors is decoupled to the zero volts line. This is to ensure that although for d.c. purposes, R_b consists of R_{b1} and R_{b2}, for a.c. purposes, it is merely R_{b2}, because the "bottom" end of C is effectively taken to V_{cc} via the power supply. The nearer C is to the collector, the more it shunts R_c and reduces the a.c. gain of the stage.

Substitutes

In the May issue of *PW* there was some excellent semiconductor guidance, both in Mr. Longland's useful supplement and in the article (The Texan Stereo Amplifier) by Richard Mann. But the sort of thing you will not always see in these articles and supplements, and which is daily hammered home to those of us in the service industry, is that substitutes are not always what they seem—despite published specifications.

In circuits of the type of our Fig. 48, some substitutes may not work at all, even those of the same type number. Not all makers indicate gain groups satisfactorily.

Summing bias

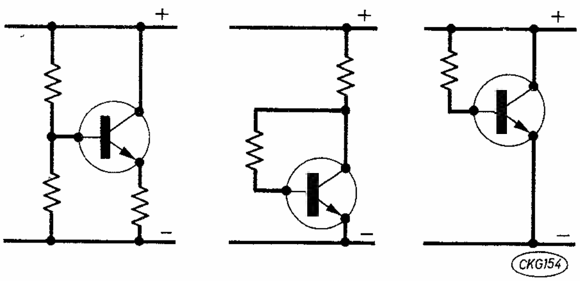
We have looked at the two-resistor method of base biasing in previous articles; have considered the effect of the emitter resistor, and in this article we have noted two distinct methods of base bias with a single resistor to the collector, or the supply line. All are common practical methods, and to sum them up, we show a direct comparison, with parameter variations, in Fig. 51.

For this purpose, we are again indebted to Mullard Ltd. You know, if they didn't exist, they would have had to be invented! This figure is a direct crib from Chapter 3 of the Mullard Transistor Handbook. The only change we have to note is their use of V_S instead of our V_{cc}. The table shows the effect on emitter current when h_{FE}, V_{BE} or V_S is varied. We can see that in the potential divider type of circuit, the spreads in h_{FE} have little effect on the emitter current. But an emitter voltage of 3V or more is needed if current variations are to be small when the supply voltage changes.

Thus, it can be seen that variation of the base-to-emitter voltage causes only a very small percentage change in the emitter current. So we can regard V_{BE} variations as of negligible consequence.

Variations of h_{FE}, however, depend on the circuit arrangement. They are greater with the "direct" arrangement of R_b to V_S.

In all cases, the really drastic operational change is caused by a variation in supply voltage. Change in V_S has a marked change effect on emitter current. This underlines more than ever the need for a stable power supply. Both Mike and I feel so strongly about this, having had so much bother with amplifiers and other pieces of transistorised equipment, that we intend to deal with stabilised power supplies, to build and describe one for general use, as soon as a pretty busy life will allow us.



Parameter variation	I_E variation		
h_{FE} ±50%	+1, −1·6%	+23, −35%	±49%
V_{BE} ±7%	±1·7%	±0·95%	±0·86%
V_S −50%	−62%	−55%	−56%

Fig. 51. Comparison of biasing arrangements, showing the effect of spreads of emitter current that can result from changes in h_{FE} and V_{BE} for alternative supply voltages. Nominal values of parameters are: $V_S = 7V$, $V_{BE} = 0{\cdot}7V$, $h_{FE} = 100$, $I_E = 1mA$ (approx.).

For now, bear with us, again having spent our allotted space in theoretical discussion. Next month, constructors can get their teeth into a useful project again.

TO BE CONTINUED

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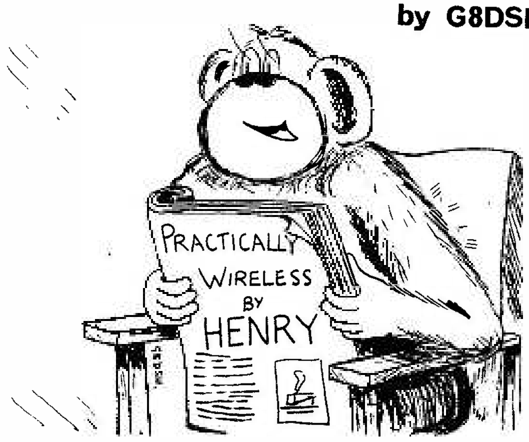

"I'll bet he hasn't the nerve to make a monkey out of me"!

Car Radio Installation — *continued from page 314*

value capacitor say around 50pF, in series with the aerial. This should be done inside the receiver, hence it should be in series with the aerial socket, so that it will be fully screened. The reason for this is that we are putting two capacitances in series, the capacitor, and that of the aerial and its feeder. Capacitances in series are always less in value than either one, hence the capacitance seen by the receiver aerial circuits is less than that of the aerial. There will be slight attenuation resulting from the reactance of the capacitor, but this will be little compared with the extra gain resulting from proper alignment of the aerial circuits.

An aerial trimmer should come to a definite peak, if it doesn't, it shows that alignment is not at its optimum and most likely too much capacitance is the cause. The series capacitor is always worth a try.

Finally in the matter of fitting the aerial, it is a good practice to make a small indentation with a centre-punch at the point of the body where you are going to drill. If this is not done, the drill may wander, or worse still slip and make a nasty scratch on the paintwork.

Power supplies

The power supply is the next step. It is essential first to ascertain the polarity of the car and that of the radio. Many radios are easily converted from one polarity to the other by means of a plug and socket or similar switching device, others can be converted by internal wiring changes described in the maker's service manual, while yet others are non-convertible.

Having made sure of the correct polarity, next comes the connecting up. Each radio has a power lead connected to it which incorporates a series fuse-carrier. This too should be checked to see if the fuse is present and of the correct value.

There is usually a large grommet in the bulkhead through which various cables pass. The power lead can pass through this, retaining the fuse-carrier on the inside of the car. The lead is brought to the fuse and distribution-box which will usually be found on the bulkhead in the engine compartment. There are generally two fuses for auxiliary equipment, one which is live when the ignition is switched on, and the other which is live all the time. As the radio will no doubt be required when the car is stationary, the one that is permanently on is the one to connect in to. The car handbook will identify which is which, but if a manual is not available, use a meter to discover which is still alive with the ignition switched off.

Interference

The radio should now work, and the aerial trimmer can be adjusted as before described, then the radio screwed into place. However, the installation is not yet finished, steps must be taken to suppress interference. Actually, the principal difficulties in achieving a satisfactory installation arise from suppressing interference. There seems to be a certain element of chance involved in this, some cars are quite docile and give no trouble at all, while others seems to be 'rogue' models producing several different types of interference that prove difficult to eradicate.

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AF239	40p
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ASY27	30p
ASY28	25p
ASY29	30p
ASZ21	55p
BA100	15p
BA102	30p
BA110	25p
BA115	7p
BAX13	5p
BAX16	7p
BAY31	7p
BAY38	15p
BC107	10p
BC108	10p
BC109	10p
BC109C	12p
BC113	10p
BC114	20p
BC115	20p
BC116	20p
BC116A	25p
BC117	20p
BC118	20p
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7450	Expand dual 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
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7460	Dual 4-input expanders	20p	18p	16p	14p	12p
7470	Single J-K flip-flop (gated inputs)	30p	27p	25p	22p	20p
7472	Single J-K flip flop (gated inputs)	30p	27p	25p	22p	20p
7473	Dual J-K flip flop	40p	37p	35p	33p	30p
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7475	Quadruple bistable latch	45p	42p	40p	38p	35p
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7484	16-bit RAN with gated write inputs	90p	85p	80p	75p	71p
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7490	BCD decade counter	75p	70p	65p	60p	55p
7491	8-bit shift register	£1·00	95p	90p	80p	70p
7492	Divide twelve counter	75p	70p	65p	60p	55p
7493	4-bit binary counter	75p	70p	65p	60p	55p
7494	Dual entry 4-bit shift register	80p	75p	70p	65p	60p
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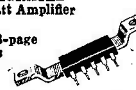

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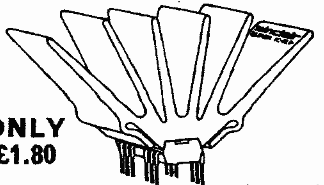

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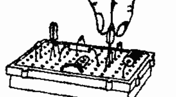

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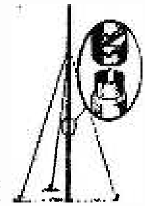

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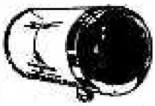

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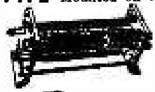

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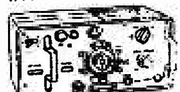

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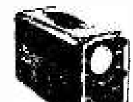

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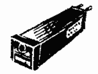

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ON THE SHORT WAVES
MONTHLY NEWS FOR DX LISTENERS

THE BROADCAST BANDS
Malcolm Connah

Frequencies in kHz • Times in GMT

THE various electronic methods of determining the frequency of a station were discussed last month and, as promised, I will now describe a method which requires no additional electronic apparatus.

The main requirement for this method is that the receiver has a bandspread dial, if this is not fitted it can be done very simply—several articles on this subject have been published. The other requirement is graph paper, the best kind has markings every tenth of an inch with major markings every ½in.

The vertical axis of the graph is marked with the frequencies of interest. As an example I shall describe the calibration of my Lafayette HA63 receiver on the 11MHz. band. The lowest frequency of interest is 11700kHz. and this is written at the bottom of the vertical axis. The scale is chosen so that ½in. represents 25kHz. The first mark up is therefore 11725kHz., the second is 11750kHz. and so on up to 12000kHz.

The horizontal axis is marked with the graduations on the bandspread control. The scale on my receiver is marked from 0 to 100. The left hand end of the axis is marked 100 and every ½in. corresponds to 2 on the dial. The graph markings are, therefore, 100, 98, 96 etc.

In order to draw the graph a certain amount of listening has to be done. The Main Tuning is set to a point where the Bandspread Control covers the whole of the band of interest, this point is then marked on the dial so that the tuning can be reset to this position at any time. During a short period of listening several stations will be heard of which the frequency is either known or announced during the broadcast. The positions of these stations on the bandspread dial are noted.

Typical results of this are, for instance, 11710 kHz. at 66 on the dial, 11800 at 70, 11880 at 74, 11940 at 78 and 11990 at 82. These points are marked on the graph and a smooth curve is drawn joining all the points.

Once the graph has been drawn it is very easy to determine the frequency of any station. Before listening the Main Tuning is moved to the set point, the position of the station on the Bandspread dial is noted and the corresponding frequency is determined from the graph.

The first report this month comes from **Richard Coyle** in Glasgow. Richard's equipment consists of a Lafayette KT340 receiver and a 200(?) foot loft aerial.

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4970 *R. Rumbos,* Venezuela at 0400.
4980 *Ecos del Torbes,* Venezuela at 0345.
4990 *R. Barquisimeto,* Venezuela at 0400.
11710 *RAE, Argentina* in English at 0045.
11720 *R. Nacional,* Brazil at 0200.
11795 *R. Afghanistan* in English at 1820.
11805 *R. Globo,* Brazil at 0110.
11865 *R. Pernambuco,* Brazil at 0005.
11880 *R. Splendid,* Argentina at 0100.
11925 *R. Bandeirantes,* Brzail at 0010.
11955 *FEBA,* Seychelles at 1800.

Philip Sokell has recently added a 50 foot long-wire aerial to his equipment and has heard:

6000 *Hanoi,* N. Vietnam at 2000.
6050 *HCJB,* Quito, Ecuador at 0630.
7125 *Conakry,* Guinea Rep. at 0530.
7170 *Beirut,* Lebanon at 0200.
7205 *Beira,* Mozambique at 0625.
9645 *Karachi,* Pakistan at 0225.
9545 *Ulan Bator,* Mongolia at 2330.

Michael Berry of Dewsbury has used his Eddystone EB35 receiver and 15 foot vertical antenna to hear some interesting stations including:

3240 *R. Baghdad,* Iraq in Turkish at 2005.
3380 *Blantyre,* Malawi in English at 2100.
3905 *AIR,* Delhi in English at 2310.
4915 *Nairobi* Kenya in Swahili at 1730.
4940 *R. Yaracuy,* Venezuela in Spanish at 0130.
4940 *Abidjan,* Ivory Coast in French at 2300.
4975 *Dushanbe,* USSR at 0000.
15435 *Dar-es-Salaam,* Tanzania, English at 1905.
15480 *R. Portugal* Libre, Portuguese at 1840.

Ian Howes of Lowestoft used his R209 MKII receiver and TV antenna to good effect hearing:—

3260 *R. TV Congolaise,* Kinshasa in French at 1920.
3295 *Ghana* B.C. in English at 2205.
3380 *Malawi* B.C. in vernacular. at 1945.
4755 *R. Dif. do Maranhao,* Brazil at 0020.
4915 *Voice of Kenya* at 1750.
4945 *SABC,* Commercial Service at 2205.
9630 *VOA, Philippines* at 1700.
14992 *R. Liberation,* S. Vietnam at 2000.
15180 *WINB,* Red Lion in English at 2200.
15265 *R. Afghanistan* in English at 1800.

Chris Bruckshaw of Stockport has a Trio 9R59DS receiver and a 30 foot long-wire antenna enabling him to hear:—

4940 *R. Abidjan,* Ivory Coast at 1940.
4945 *SABC,* Commercial Service at 2015.
4980 *R. Accra,* Ghana noted at 2100.
4990 *R. Nigeria,* Lagos at 2010.
5010 *R. Garoua,* Cameroon in French at 2115.
5047 *R. Lome,* Togo with African Music at 2000.
9020 *R. Teheran,* Iran in English at 2000.
15015 *R. Hanoi,* N. Vietnam, English at 2025.
15345 *R. Kuwait* in English at 1800.

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

ON THE SHORT WAVES

THE AMATEUR BANDS

David Gibson, G3JDG

Frequencies in kHz • Times in GMT

EVERYONE has their pet moans. Many people appear to select the 'JDG shoulder to weep openly and unashamedly on when it comes to writing in about happenings on the Amateur bands. While it would be nice to dismiss these wailings with a single statement, unhappy experience not only backs these complaints but lends considerable weight to their argument.

The most common one is European lids who appear to be smitten with both lack of intelligence and cloth ears at the same time. The other night, on twenty, an OH station called UK1ZFI with the rest of the gang standing by. Numerous other European stations then began frantically calling the OH station who spent most of the evening politely asking people to wait since he was specifically calling the UK1. Definitely an award for the most patient and polite Amateur in the face of persistent and wanton liddery must go to OH1XX.

This incident, of course, is similar to the ones where lids call DX stations on their own frequency despite a clear statement from the DX operator that he is listening 5kHz (or whatever) up or down the band. One solution might be that any s.w.l. hearing a lid at work, should drop him a line pointing out the error of his ways. The R.S.G.B. has an "Intruder Watch", how about a "Lid Watch"?

Award for the greenest (with envy) amateur of the month goes to your scribe. My miserable 40ft. end fed overheard 9Y4T telling of his 1kW to a 3-element beam at thirty feet (Hallelujah!).

FB8XX is on 7·001MHz practically every night according to **Karl Muller** (Mbabane, Swaziland). He also mentions ZD9BM as being on the loose on forty. Log from Karl for this band includes; A2CAK, CR7EY, CR7IZ, DJ1ZN, DJ6EN, DM2ATD, DU1HB, DU1OR, FB8XX, JA1VKC, JA3BG, JA8CSR, JA9BE, JH3OZL, JR1FCT, K2IG, K3PKL, LZ1KNB, OH5UX, PY2AAT, PY5AAB, PY7BBF, SP6BKL, SV0WOO, VE2NV, VK6RU, W1AW, W1LP, W2JBL, W5QU, YU1BCD, ZD9BM, 5R8BD, 7P8AF, 9L1VR, 9M2CN, 9V1QK. All these on c.w. using a Philips BC receiver, homebrew b.f.o. and a G5RV antenna at 15ft. Who says there's nothing but noise and commercials on forty?

Another 40 metre addict is **John Moxham** (Glastonbury) who is shortly moving QTH (the things they'll do just to get a better aerial up). Receiver is a Drake 2B, antenna an inverted V, all stations 7MHz s.s.b.; HP3ML, HR1KAS, KZ5JF, LU2ER, TR8VE, VK2AVA, VK3ZL, VK5PB, YV4TV, YV4UF, ZL2AFA, ZL3GQ, 4Z4AQ/MM. On ten metres, John logged; FM7AA, KG6SL, WA2BVU/3D6, 3B8CR, 5X5NK, 7Q7AA.

Pieter Jacobs keeps a sharp pair of ears at the ready from his QTH in the Transvaal, South Africa. Gear is an HE-30 connected to a wire which is fed "off-centre." Results on 7MHz read; CR6EO, CR6TP, CX2AX, DL8PC, LU1AEP, LU3AK, OZ5KF, PY2EYO, PZ1CU, TR8VE, YV5CY, 4U1ITU.

Some sharp-eyed sleuths will exclaim that although one or two of these stations are DX to British listeners, they are not DX in S. Africa. Point is that if you examine this log, and that of Karl Muller, you will see that some European stations are logged. So, the DX is there, and "they" can hear Europe. If "you" can't hear any DX on forty . . . Hm, see what I mean?

"I still prefer top band," says **Graham Armstrong** (Jedburgh, Scotland). Just the same, Graham slaved over a hot 20 metre segment of the r.f. spectrum to provide heiroglyphics on the following; CP6EL, CN8CG, DU2DB, EL2CY, FY7AP, HC1MC, HP3FA, IT9LPP, JA4BBQ/MM, JW2IK, KP4BAL, KV4AB, KZ5UM, LU5DJD, OD5ES, PZ9AA, SV1GA, TI1FCD, VE3BNZ, VK4CX, VK6KJ, VK9AR/MM, WB2AQC/P/5T5, XV2IAW, ZL3AAA, ZF1GC, 4X4AE, 6Y5MH, 8P6AN, 8R1P, 8R1Q, 9Y4VV, 9G1NC. These were s.s.b. logged on a 9R-59DS and a 200ft. long wire.

Large parcel from **Adrian Barnes** (Abingdon) turned out to be a 20 metre log of goodies heard on his CR150/2 plus quarter wave vertical. Impossible to print it all, so here's an abridged volume; BV3VRG, CE0AB, CP1OW, CR7CH, EL8I, EP2MH, ET3DF, FP6VC, FY7AS, HC2MV, HP1KC, IS0CCQ, JA1WDF, JW8IL, KH6HIH, KP4CLV, KS6DV, KW6PWH, LU3IO, M1D, OD5GT, OY9LVW, W5ALR/P/TF, TF3EB, TU2DD, TU2DO, 12 VE stations, 81 VK's, VO1CV, VP2GDI, VP2KA, VP2LU, VP8FM, VP8MM, VR1AC, VR6TC, 60 W stations, YA2AGU, YB0ABB, ZD8KO, 10 ZL stations, ZM6LJ, ZS1SP, 4X4OC, 4Z4BL, 5B4BGM, 5U7AK, 5W1AB, 7X2BK, 8P6EK, 9H1DH, 9L1MF, 9K2CI, 9Y4KJ.

Malcolm Bell admits to squandering a whole £3·20 on his receiver which is a one valve t.r.f. This feeds a three-valve amplifier. Malcolm claims the following on twenty; CN8GG, CR7CH, DU1DBT, EA6BM/M, ET3DS, HC2ML, HK3AUE, HL1BSM, HP1KC, HR2WTA, JA3NHL, JX6RL, JW7FD, K6OU, KP4DAL, KZ5LZ, OD5EP, OY9LV, PY1ADR, ST2SA, TF3SV, VE1AFY, VK3AAO, VK5AZ, VP8MM, VR6TC, WA6JZL/TF, YA1OS, YV1AQE, ZD8RR, ZE1CU, ZL1AA, 4U1ITU, 5J5FW, 5X5NK, 5Z4KV, 9J2LL, 9Y4RB. Think what he'd do with two valves!

Richard Osborne (Weaverham, Cheshire) has a pair of homebrew headphones " . . . containing coat-hanger wire and foam draught excluder." Presumably the DX stations can hang their coats up but are prevented from sneezing in his earholes. Gear is a dipole into a preselector feeding the P.W. General Coverage Receiver (March/April, 1970). Stations which arrived at the "cans" include; CP1DN, CR7GJ, K9PAJ, LU4QM, PY2DVH, VK4AS, VP2DAJ, VQ9R, VU2OMR, 3V8AF, 9K2CI, 9L1MF, 9Y4VV. All heard on 14MHz s.s.b. Incidentally OM, do you plug the phones into the receiver, or vice versa?

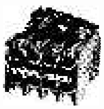
Logs, in alphabetical order please, to arrive by the 15th of the month to:

12 Cross Way, Harpenden, Herts.

DRILL CONTROLLER
NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available. **£2·25** plus 13p post & p.

MAINS OPERATED CONTACTOR

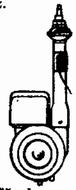


220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. **£1** each.

NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. **6p** each, **60p** doz. Plastic push-rod suitable for operating, **5p** each, **45p** doz.

AUTO—ELECTRIC CAR AERIAL



with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12v. positive or negative earth. Supplied complete with fitting nstructions and ready wired dashboard switch. **£5·75** plus 25p post and ins.

TOGGLE SWITCH

3 amp. 250v. with fixing ring **7½p** each, **75p** doz.

MICRO SWITCH

5 amp changeover contacts, **9p** each, **£1** doz. 15 amp Model **10p** each or **£1·05** doz.

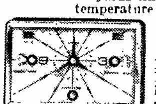
MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole. 12 way. All at **20p** each, **£1·80** for ten, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. **50p** post free

15A ELECTRICAL PROGRAMMER



Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£1·95** + 20p p & p or with glass front chrome bezel **75p** extra.

TREASURE TRACER MARK II

Complete Kit (except battens) to make the metal detector similar to the circuit in Practical Wireless August issue. **£3·95** plus **20p** post and insurance.

QUICK CUPPA

Mini Immersion Heater, 350w 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **£1·25**, post and insurance 14p. 12v. car model also available same price. Jug heater **£1·50** plus p. & p. 14p

SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. **5p** each, **10** for **45p**.

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN. 3, Price **£1·45** each. 10 for **£13**.

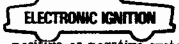
12 WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in. thick. Price **20p** per yard.

LIGHT CELL

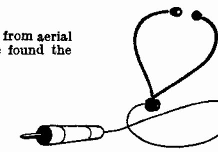
Almost zero resistant in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ⅛in. thick. Rated at 500 MW, wire ended. **43p** with circuit. Also ORP 12 light cell **45p**.

CAPACITOR DISCHARGE CAR IGNITION



This system which has proved to be amazingly efficient. We offer a kit of parts as PW circuit **£5·95** + 20p. De-luxe model with prepared circuit boards **£6·95**. When ordering please state whether for positive or negative systems. Also available, ready made ignition systems for 6v vehicles. **£5·95** plus 20p.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **£2**—twin stethoset instead of earpiece **75p** extra post and ins. 20p.

STANDARD WAFER SWITCHES

Standard size 1¼″ wafer—silver-plated 5-amp contact, standard ¼″ spindle 2″ long—with locking washer and nut.

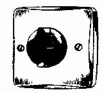
No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10way	12way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

THIS MONTHS SNIP

13 AMP TWIN GANG SOCKETS

Offered at less than wholesale price your opportunity to replace those dangerous adaptors—brown bakelite flush mounting—standard fitting. Unswitched **20p** each, separately switched **30p** each. Separately switched and with neon on/off indicators **45p** each. Single sockets unswitched **10p** each. Less 10% ten or more +20p postage if order under £5.

THYRISTOR LIGHT DIMMER



For any lamp up to 200 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price **£2·50** plus 20p post and insurance.

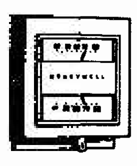
MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up 9V battery operated. Size 2in long × 1¼in wide × 1in high. SPECIAL SNIP PRICE **60p** each. 10 for **£5**.

HORSTMANN "TIME & SET" SWITCH

(A30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **£1·50** Post and ins. 23p.

HONEYWELL THERMOSTAT



Made by Honeywell for normal air temperatures 40°-80°F (5-25°C). This is a precision instrument with a differential which can be adjusted to better than 1·5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below-size approx 3·8″ × 3·2″ × 1·4″ deep—can be mounted on conduit box or directly on wall. Price **£1·25** each or ten for **£11·25**.

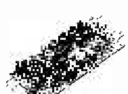
24-HOUR TIME SWITCH

Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 25p. Additional time contacts **50p** pair.

INTEGRATED CIRCUIT BARGAIN

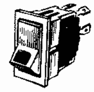
A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over £5. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices **25p** upwards with circuits and technical data of each. Complete parcel only **£1** post paid. *DON'T MISS THIS TERRIFIC BARGAIN.*

MULLARD IF MODULE



This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. **75p** each. 10 for **£6·75**. 100 for **£62·50p**. With connection dig.

ROCKER SWITCHES



3 new types to offer this month, all snap in fixing into oblong holes. **Type 1** S.P. on/off 10 amp 250V. Size approx. 1⅛″ × ⅝″. Made by Arrow electric. (93 series). Price **12p** each. 10 for **£1·08**.

Type 2 D.P. on/off 10 amp 250V with neon indicator in the lever. Again Arrow 93 series. Price **25p** each or 10 for **£2·25**.

Type 3 Double pole change over spring return, made by the French Russenberg Company. Size approx. 1″ × ⅝″. Price **15p** each. 10 for **£1·35**.

CARD OPERATED SAFE

All electronic parts to make this **£4·50**.

AMPLIFIER CASE

Teak veneer on ⅝″ ply, modern appearance and design. Size—front 13″ × 4½″ deep × 8½″. Limited quantity **£1·25** each plus 25p post and insurance.

MUSIC ON TAPE

A further buy enables us to offer these at an even lower price—namely **65p** each or 5 for **£2·50**. Send for list of titles. We can't repeat when sold out.

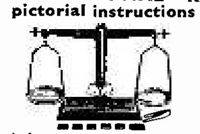
PRESSURE SWITCH

Made by Bailey and Macaey Ltd., Type 108R. Adjustable up to 15lb. per square inch. (Instructions included). Set to trip at 8lb. per square inch. Changeover switch rated at 5amp 250V A.C. with re-set button. Electrical connections in box with conduit entry. Price **£1·50** each plus 20p post and insurance.

20 WATT INVERTER

Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½″ × 2″ × 1½″. Price **£6·50** complete with lamp holders and tube clips.

EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT FREE Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **40p** each post paid. Special price for all 7 kits **£2·50** with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA6—2-Pole Motor Kit. Twenty-four parts, including enamel wire, armature and pole piece, etc. Motor operates from 1½ volt battery. Illustrates and teaches how electro-magnetism operates a motor.

KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

PULSE GENERATORS

Sectronic, made by Smiths. Operated by single 1·5 volt battery or transformer and rectifier. Two models, one gives 10 pulses per second the other gives 8. In plastic enclosures, size approx. 2″ × 1⅞″ × 1¼″ deep. Price **£2** each 10 for **£18**.

AMPLIFIER IN CASE & SPEAKER. Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9½″ × 6½″ × 3½″ deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9v battery or an external 110v source Speaker is an R-A eliptical 6″ × 3½″ 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3·50** each, 10 for **£31·50**. Post and insurance 20p.

MAIN TRANSFORMER SNIPS

Mains Transformer. Primary 240v. tapped 220v. Secondary 20v. ½ amp. Price **60p** each or 10 for **£5·40**.

Transformers. Primary 230-240v. Secondary 6·5-0-6·5 1 amp. With fitted primary screen **65p** each or 10 for **£5·85**.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p Semiconductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. P.W.), 7 Park Street, Croydon CRO IYD

Callers to: 102/3 Tamworth Road, Croydon.

All prices in pounds and new pence

VALVES

1A7GT	45	6BA6	25	6J6	20
1CP31	£7·00	6BE6	30	6J7M	45
1D5	50	6BH6	75	6J7G	30
1H5	50	6BJ6	50	6J7GT	45
IN5GT	55	6BQ7A	45	6K6GT	60
IR5	40	6BR7	90	6K7M	35
IS4	30	6BR8	70	6K7G	35
IS5	30	6BS7	£1·30	6K7GT	35
IT4	30	6BW6	85	6K8M	60
3A4	40	6BW7	80	6K8G	40
3Q4	50	6C4	33	6K8GT	50
3Q5	50	6C5G	35	6K25	75
3S4	35	6C6	25	6L6G	50
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5V4G	45	6D6	35	6SA7M	40
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6AK5	35	6F11	40	6SL7GT	35
6AM5	35	6F13	45	6SN7GT	35
6AM6	33	6F14	70	6SQ7GT	40
6AQ5	38	6F23	85	6U4GT	65
6AS7G	85	6F24	75	6U5G	40
6AT6	35	6F25	£1·00	6V6M	60
6AU6	25	6F28	65	6V6G	30
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		6H6	23	6X5G	40
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7C5	£1·13	12SR7	40	37	40
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9BW6	60	20P5	£1·20	78	45
10C2	63	25A6	35	80	55
10F1	75	25L6GT	50	85A2	50
10F3	90	25Y5	65	150B2	60
10F9	60	25Z4	30	150C4	60
10F18	50	25Z5GT	55	801	60
10LD11	65	25Z6	65	807	50
10P13	60	30C1	30	813USA	£3·75
11E3	£4·00	30C15	80	866A	75
12AT6	30	30C17	90	954	60
12AT7	35	30C18	80	1625	55
12AU6	35	30F5	85	4022AR	£5·50
12AU7	30	30FL1	75	5763	70
12AX7	30	30FL12	£1·20	7193	30
12BA6	40	30FL14	85	7475	50
12BE6	40	30L15	85	A61	48
12C8GT	35	30L17	80	ATP4	45
12E1	£2·20	30P4	£1·12	ATP5	60
12J5GT	30	30P12	80	ATP7	60
12J7GT	50	30P19	85	AU2	£4·00
12K7GT	40	30PL1	75	AU5	75
12K8GT	50	30PL13	93	AZ1	55
12Q7GT	40	30PL14	90	AZ31	55
12SA7GT	50	35A5	75	CBL31	£1·00
12SG7	35	35L6	50	CCH35	75
12SH7	35	35W4	35	CL33	£1·30
12SJ7	40	35Z3	70	CY30	63
12SK7	50	35Z4GT	60	CY31	43
		35Z5	50	DAC32	50

DAF91	30	EBL31	£1·50	EL41	60
DAF96	45	EC90	33	EL42	65
DCC90	£1·35	ECC81	35	EL84	25
DF33	55	ECC82	30	EL95	35
DF70	45	ECC83	30	ELL80	£1·00
DF91	20	ECC84	30	EM80	45
DF92	20	ECC85	40	EM81	60
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DK32	45	ECH42	75	EZ35	40
DK91	40	ECH81	30	EZ40	50
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EB91	20	EF91	33	KTZ41	50
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OZ4	40	PX4	£2·50	UBC81	40
PC86	60	PX25	£2·50	UBF80	40
PC88	60	PY33	63	UBF89	35
PC97	50	PY81	30	UCC84	43
PCC84	40	PY82	35	UCC85	40
PCC89	50	PY83	38	UCF80	55
PCC189	55	PY500	£1·00	UCH42	70
PCF80	30	PY800	40	UCH81	40
PCF82	35	PY801	50	UCL82	35
PCF84	60	R2	75	UCL83	60
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2N697	15	AC128	20	GET102	30	OAZ224	45	ZS178	P on A
2N706	10	ACY20	20	GET882	25	OAZ241	22	ZTX107	15
2N1132	25	ACY39	50	GJ7M	37	OAZ242	23	ZTX108	12
2N1305	22	AD140	50	KS100A	20	OAZ246	23	ZTX300	12
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2N2444	£1·91	BC107	10	NKT223	33	OC59	65		
2N2646	45	BC108	10	NKT251	24	OC71	12		
2N2904	20	BC109	10	NKT713	25	OC72	20		
2N2926	10	BC169C	15	OA70	10	OC81	20		
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7406	30	7433	70	7451	20	7483	£1·00
7407	30			7453	20	7484	90
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7409	45			7460	20	7490	75
7410	20			7470	30	7491AN	£1·00
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7412	42						
7413	30						
7416	30						
7417	30						
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7422	48						

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74110	80	74155	£1·55	74195	£1·85
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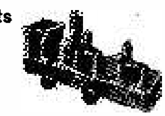

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I.C. OF THE MONTH

L.A.J. IRELAND

Number 32 — L.E.D. Readouts

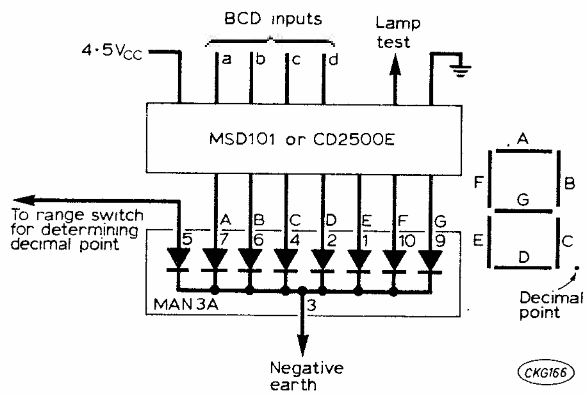
THE advances made in the design and fabrication of Light Emitting Diodes over the past few years coupled with the huge demand in industry and elsewhere for these fascinating devices has resulted in a considerable price reduction of these components making them now well within the economic reach of most constructors. Their advantages as light sources over the conventional filament or gas filled bulb parallel those of the transistor over the well established valve. However, like any new discovery, they were not without their teething problems and it is only now that their full potential is being realised. Already in these notes reference has been made to the suitability of l.e.d's as the readout element in digital display devices, making them ideal for use in applications where ruggedness and reliability are of prime importance since failure due to shock, vibration or similar ill-usage is almost completely prevented.

Developments

Just as it was only a matter of time towards the end of the Fifties when it would be technologically feasible to integrate transistors, resistors, etc., on a single monolithic silicon chip producing the now very familiar integrated circuits, the same trend is evidenced in the current production of l.e.d. arrays and from being the laboratory curiosities of a few years ago they are now making an important impact on the digital display industry. As recently as 1969 the incandescent seven segment low voltage readout tubes had gradually begun to replace the old Nixie tubes as they were more compatible for use in transistor circuitry, yet these very same devices are suffering the same fate of being superceded by the seven segment and matrix l.e.d. arrays and the present article reviews a number of these units; but first a brief explanation of how the l.e.d. functions.

Operation

In an ordinary silicon or germanium diode a potential barrier of about 0·2 to 0·5 volts exists between the p-n junction. Consequently when current flows through the diode the electrons injected across the barrier must overcome this counteracting voltage and they dissipate most of their energy in the form of heat when they drop from their excited states into the valancy bands of the crystal atoms. However the electrons usually go through a number of intermediary stages before finally reaching their lowest energy level and this gives rise to a broad band of electromagnetic radiation. Due to the existence of so many intermediary energy levels in the case of silicon and germanium these materials proved unsuitable for light generation so a direct band gap material such as gallium arsenide is used. Here the injected electrons do not pause at intermediary stages when they recombine with "holes" and so liberate most of their energy at one specific frequency thereby giving rise to very efficient light production.

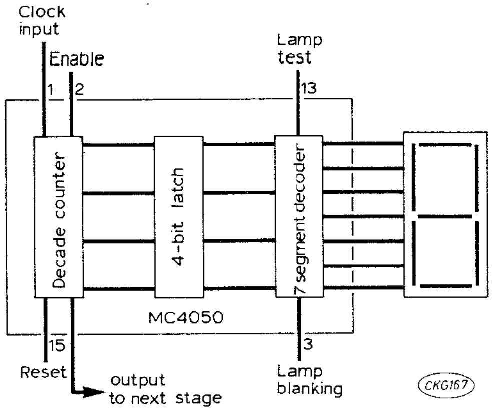


Decoder and driver functional diagram for operating the Monsanto MAN3A alpha-numeric display.

An obvious development from this, seeing that the light production area was confined to a minute space, was to integrate a number of these diodes in a seven segment "figure of eight" pattern. The Monsanto Company, in particular, manufacture a wide range of seven segment readout l.e.d's and one of these the MAN3A at present retails at £3·40. (The American parent company has recently indicated that it hopes soon to reduce the price by about half.) A suitable seven-segment decoder such as the MSD101 manufactured by the same company is needed to decode the BCD outputs of an ordinary decade counter or alternately the RCA type CD2500E (reviewed in the April 1971 issue of P.W.) could be used.

Recent progress

Motorola with the release of their MC4050 i.c. have gone one step further in integrating the decade counter and decoder. This MSI device requires merely the addition of a power supply and seven segment readout device such as the MAN3A to form a complete decade counter, and the only logical step left in developments along this line is to integrate the readout l.e.d. on the same chip as the counter and decoder and no doubt this will shortly be accomplished.



Block diagram of Motorola MC4050 i.c. which requires only the addition of a power supply and seven segment readout display for a complete decade counter.

Monsanto also produce a 5×7 dot matrix array of l.e.d's type MAN2, which is capable of displaying 64 different characters but the price at present (£8·96) is a bit on the dear side. Nevertheless if the present trend in the optoelectronics industry continues we can expect to see further reductions in the price of these specialised i.c's and their associated address systems.

MAN3A and MSD101 are available from Semicomponents Ltd., No. 5 Northfield Estate, Beresford Avenue, Wembley, Middlesex. ■

GOING BACK *—continued from page 322*

At the end of 1937 S.T. retired again. War threatened and in May 1939 he was commissioned in the RAFVR. He was sent to France on the second day of the war and commanded a radar station there until Dunkirk. He obtained a Mention in Despatches for gallant and distinguished service. At the end of 1940 he became the Staff Officer at Air Ministry responsible for all radar training in the RAF. He was also responsible for the technical vetting of would-be officers and was Chairman of the radar synthetic training scheme.

In 1943 he became, as a Wing Commander, the Senior Technical Officer of 73 Wing and was responsible for installation, maintenance and operation of all RAF radar stations (including the Navy's coastal stations) in two-thirds of England and Wales. He was again Mentioned in Despatches.

Between 1951 and 1959, S.T. now well out of the public eye, served at the Admiralty Signal and Radar Establishment. In 1959 he retired from radio but followed his developing interest in art—not only as a collector but as an author of three books on the subject. In 1963 the President of Italy appointed him a Knight Officer of the Order of Merit for his services to art.

S.T. says he is now just a has-been of radio and electronics. But we who have benefited from his activities, whether we are amateurs or professionals, are not likely to forget him or feel anything but grateful to him. ■

AUDIO TEST TRIO*—continued from page 336*

were left connected, too low an impedance would be presented at the 600Ω input.

At the output, when a jack plug is inserted in the "External load" output, the 620Ω load is thereby switched out; it remains connected when the "Internal load" output is used.

The reason for the provision of two jacks and a dummy load is that for the levels of attenuation quoted to be accurately obtained, the pads used must be fed from, and loaded by, a resistance of 600Ω. When the attenuator is being used to feed, say, an amplifier of 10kΩ input impedance, then the "Internal load" jack must be employed to preserve this state of affairs.

TYPICAL APPLICATION

As an example of the use of the attenuator, consider the difficulty usually encountered in plotting the response of tone control circuits, for very few of the popular signal generators available have accurately calibrated attenuators.

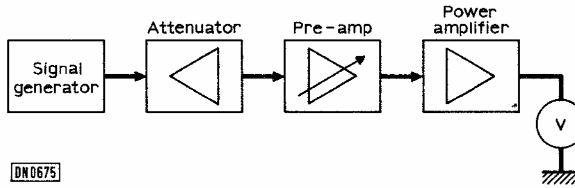


Fig. 8. Typical set-up for plotting response curves.

Using the set up of Fig. 8, the problem is easily overcome. The voltmeter can be any a.c. instrument sufficiently sensitive to indicate the output voltage at the loudspeaker. The signal generator's output level is first set, at 1kHz, to give a reasonable output from the power amplifier with, say, 20dB set on the attenuator, and the voltmeter reading noted. The input frequency is then varied in steps, and, at each step, the attenuator is adjusted to give the same voltmeter reading as originally, so enabling a response curve to be drawn. Remember that, in this example, an increase in attenuator setting to say 26dB to give the original voltmeter reading means that the overall response has increased by 6dB at that frequency, relative to 1kHz.

Different settings of the tone controls and a repetition of the procedure soon enable a picture of the effect of varying such controls to be drawn. It is as well to use the voltmeter to check that the output of the signal generator is the same at all frequencies; setting the attenuator at a fairly high level of attenuation, so requiring the generator output to be large, will assist this if the voltmeter is not very sensitive. ■

BACK NUMBERS

We regret that the back numbers department of P.W. has now closed and consequently we are unable to supply these. Requests for specific back issues can usually be included in our 'CQ' section; there is no charge for this but it is a service between readers and P.W. is unable to meet any of these requests.

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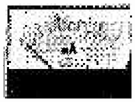

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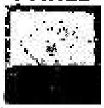

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Type MR.52P. 2½in. square fronts.

50μA	£3·10	10V. D.C.	£2·00
50-0-50μA	£2·60	20V. D.C.	£2·00
100μA	£2·60	50V. D.C.	£2·00
100-0-100μA	£2·50	300V. D.C.	£2·00
500μA	£2·30	15V. A.C.	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3½in. × 3¼in. fronts.

50μA	£3·37	10V. D.C.	£2·20
50-0-50μA	£2·75	20V. D.C.	£2·20
100μA	£2·75	50V. D.C.	£2·20
100-0-100μA	£2·65	150V. D.C.	£2·20
200μA	£2·65	300V. D.C.	£2·20
500μA	£2·40	15V. A.C.	£2·30
500-0-500μA	£2·20	50V. A.C.	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	S Meter 1mA	£2·37
100mA	£2·20	VU Meter	£3·37
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp.	£2·20	1 amp. A.C.*	£2·20
20 amp.	£2·20	5 amp. A.C.*	£2·20
30 amp.	£2·30	10 amp. A.C.*	£2·20
50 amp.	£2·50	20 amp. A.C.*	£2·20
5V. D.C.	£2·20	30 amp. A.C.*	£2·20

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Type MR.38P. 1 21/32in. square fronts.

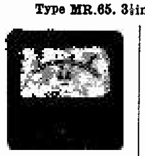
		200mA	£1·60
		300mA	£1·60
		500mA	£1·60
		750mA	£1·60
		1 amp.	£1·60
		2 amp.	£1·60
		5 amp.	£1·60
		10 amp.	£1·60
50μA	£2·10	3V. D.C.	£1·60
50-0-50μA	£1·90	10V. D.C.	£1·60
100μA	£1·90	15V. D.C.	£1·60
100-0-100μA	£1·75	20V. D.C.	£1·60
200μA	£1·75	100V. D.C.	£1·60
500μA	£1·65	150V. D.C.	£1·60
500-0-500μA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1-0-1mA	£1·60	750V. D.C.	£1·60
2mA	£1·60	15V. A.C.	£1·70
5mA	£1·60	50V. A.C.	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1·60	S Meter 1mA	£1·70
150mA	£1·60	VU Meter	£2·10

Type MR.45P. 2in. square fronts.

50μA	£2·25	5 amp.	£1·70
50-0-50μA	£2·10	10V. D.C.	£1·50
100μA	£2·10	20V. D.C.	£1·50
100-0-100μA	£1·87	50V. D.C.	£1·50
200μA	£1·87	300V. D.C.	£1·50
500μA	£1·75	15V. A.C.	£1·80
500-0-500μA	£1·70	300V. A.C.	£1·80
1mA	£1·70	S Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp.	£1·70	30 amp. A.C.*	£1·70

"SEW" BAKELITE PANEL METER

Type MR.65. 3½in. square fronts.

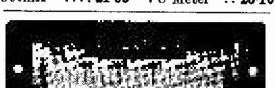


		1 amp.	£1·95
		2 amp.	£1·95
		5 amp.	£1·95
		15 amp.	£1·95
		30 amp.	£1·95
		50 amp.	£1·95
		5V. D.C.	£1·95
		10V. D.C.	£1·95
		20V. D.C.	£1·95
		50V. D.C.	£1·95
		150V. D.C.	£1·95
25μA	£3·50	300V. D.C.	£1·95
50μA	£2·75	30V. A.C.*	£1·95
50-0-50μA	£2·35	50V. A.C.*	£1·95
100μA	£2·35	150V. A.C.*	£1·95
100-0-100μA	£2·25	300V. A.C.*	£1·95
500μA	£2·20	500mA A.C.*	£1·95
1mA	£1·95	1 amp. A.C.*	£1·95
1-0-1mA	£1·95	5 amp. A.C.*	£1·95
5mA	£1·95	10 amp. A.C.*	£1·95
10mA	£1·95	20 amp. A.C.*	£1·95
50mA	£1·95	30 amp. A.C.*	£1·95
100mA	£1·95	50 amp. A.C.	£1·95
500mA	£1·95	VU Meter	£3·10

SEW EDUCATIONAL METERS

Type ED.107. Size overall 100mm × 90mm × 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50μA	£5·00	20V d.c.	£4·80
100μA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c.	£4·40
50-0-50μA	£4·65		
1-0-1mA	£4·40	Dual range	
1A d.c.	£4·40	500mA/5A d.c.	£4·65
5A d.c.	£4·40	5V/50V d.c.	£4·65
10V. d.c.	£4·40		



EDGWISE METERS

Type PE.70. 3 17/32in. × 1 15/32in. × 2½in. deep

50μA	£3·10	500μA	£2·75
50-0-50μA	£3·00	1mA	£2·45
100μA	£3·00	300V. A.C.	£2·45
100-0-100μA	£2·90	VU Meter	£3·40
200μA	£2·90		

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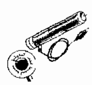
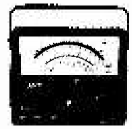
ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



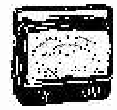
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0·20K ohms. ONLY £1·97 P. & P. 13p

SKYWOOD SW-500



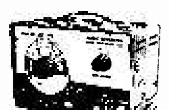
50K Ω/Volt. Mirror scale DC Volts 0·6/3/12/30/300/600. DC current 20uA/6/600mA Resistance 10K/100K/1 Meg/10 Meg. Decibels −20 to +57 db. £7·50. P. & P. 15p.

TMK LAB TESTER.



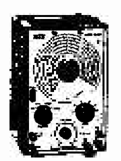
100,000 O.P.V. 6½in. Scale Buzzer Short Cir. cuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K/Volt A.C. D.C. Volts: ·5, 2·5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100μA, 10, 100, 500mA, 2·5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG Ω. Decibels: −10 to +49 db. Plastic Case with Carrying Handle. Size: 7½in. × 6¾in. × 3¼in. £18·90. P. & P. 25p

TE22 SINE SQUARE WAVE AUDIO GENERATORS



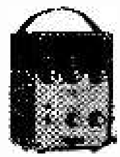
Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms, 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £17·50. Carr. 37½p.

TE-20D RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120 Kc/s-500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £15. Carr. 37½p. Size 140 × 215 × 170 mm.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



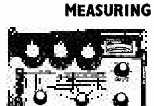
New high quality portable instrument. Sine 1 Hz to 100 kHz. Square 20 Hz to 20 kHz. Output max +10 dB (10 K ohms). Operation 220/240v. A.C. Size 215mm × 150mm × 120mm. Price £27·50. Carr. 25p

240° Wide Angle 1mA Meters

MW1-6 60mm square	£3·97½
MW1-8 80mm square	£4·97½

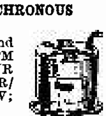
P. & P. extra

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω–11·1 meg Ω 6 Ranges ±1% L.1 μ H - 111 HENRYS 6 Ranges 2 = %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 7¾ × 5 × 2in. £20. P. & P. 25p

230V/240V SMITHS SYNCHRONOUS GEARED MOTORS



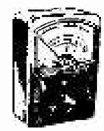
Built in gearbox. All brand new and boxed. 60 RPM CW; 30 RPH CW; 2R/HR ACW; 2R/HR CW; 8R/DAY CW; 10 RPM CW; 20R/HR ACW. 50p each Post 12p.

HIOKI MODEL 720X

20,000 O.P.V. Overload protection 5/25/100/500/1000 VDC. 10/50/250/1000 VAC. 50uA/250mA. 20K/2 meg-ohm. −5 to + 62db. £4·97. P. & P. 15p.

ModelS-100TRMULTIMETER/TRANSISTOR TESTER. 100,000o.p.v. mirror scale/overload protection. 0/·12/·6/3/12/30/120/600 VDC. 0/6/30/120/600 VAC. 0/12/600μA/12/300mA/12 AMP DC. 0/10 K/1MEG/100MEG. −20to+50 db. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.

MODEL 500 30,000 O.P.V with overload protection

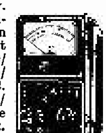


mirror scale 0/·5/2·5/10/25 100/250/500/1,000v. D.C 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω. £8·87½. Post paid.

MODEL 5025 57 Ranges,

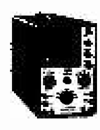
Giant 5¼in. Meter, Polarity Reverse Switch. Sensitivity: 50K/Volt D.C. 5K/Volt A.C. D.C. Volts: ·125, ·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.C. Current: 25, 50IA, 2·5, 5. 25, 50, 250, 500mA, 5, 10 amp. Resistance: 2K, 10K, 100K, 1MEG, 10 MEG. Decibels: −20 to +85 dB. £12·50. P. & P. 17½p.

RUSSIAN 22 RANGE MULTIMETER



Model U437 10,000 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. 2·5/10/50/250/500/1000v A.C. DC Current 100 wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £5·97 P. & P. 25p.

TO-3 PORTABLE OSCILLOSCOPE



3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps–800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p.

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0·2. ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5⅝in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. £49·97½. Carr. 50p.

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2N696	15p
2N697	15p
2N698	25p
2N699	30p
2N706	10p
2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
2N1090	22p
2N1091	22p
2N1131	25p
2N1132	25p
2N1302	17p
2N1303	17p
2N1304	22p
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2N1307	25p
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2N1507	17p
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2N1639	27p
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2N1711	24p
2N1889	32p
2N1893	37p
2N2147	72p
2N2160	57p
2N2193	40p
2N2193A	42p
2N2194	27p
2N2194A	30p
2N2217	25p
2N2218	20p
2N2219	20p
2N2220	25p
2N2221	25p
2N2222	20p
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2N2297	30p
2N2368	15p
2N2369	15p
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2N2484	32p
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2N2905A	20p
2N2906	20p
2N2906A	25p
2N2907	23p
2N2923	15p
2N2924	15p
2N2925	15p
2N2926G	10p
2N2926O	10p
2N2926Y	10p
2N3011	20p
2N3014	32p
2N3053	18p
2N3054	46p
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2N3133	30p
2N3134	15p
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2N3414	22p

2N3415	22p
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2N3564	17p
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2N3569	25p
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2N3572	97p
2N3605	27p
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2N3607	22p
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2N3638A	20p
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2N3644	25p
2N3645	25p
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2N3692	18p
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2N3694	18p
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2N3704	11p
2N3705	10p
2N3706	9p
2N3707	11p
2N3708	7p
2N3709	9p
2N3710	9p
2N3711	12p
2N3713	187p
2N3714	200p
2N3715	123p
2N3716	130p
2N3773	240p
2N3791	206p
2N3819	34p
2N3820	55p
2N3823	50p
2N3854	27p
2N3854A	27p
2N3855	27p
2N3855A	30p
2N3856	30p
2N3856A	35p
2N3858	25p
2N3858A	30p
2N3859	27p
2N3859A	32p
2N3860	30p
2N3866	150p
2N3877	40p
2N3877A	40p
2N3900	37p
2N3900A	40p
2N3901	97p
2N3903	20p
2N3904	25p
2N3905	30p
2N3906	25p
2N4058	12p
2N4059	10p
2N4060	12p
2N4061	12p
2N4062	12p
2N4244	47p
2N4248	15p
2N4249	15p
2N4250	18p
2N4254	42p
2N4255	42p
2M4284	17p
2N4285	17p
2N4286	17p
2N4287	17p
2N4288	15p
2N4289	17p
2N4290	12p
2N4291	15p
2N4292	15p
2N4303	47p
2N4964	15p
2N4965	18p
2N5027	52p
2N5028	57p
2N5029	47p
2N5030	42p
2N5172	12p
2N5174	52p
2N5175	52p
2N5176	45p
2N5232A	30p
2N5245	45p
2N5246	42p
2N5249	67p
2N5265	325p
2N5305	37p
2N5306	40p
2N5307	37p
2N5308	37p
2N5309	62p
2N5310	42p
2N5354	27p
2N5355	27p
2N5356	32p
2N5365	47p
2N5366	32p
2N5367	57p
2N5457	30p

2N5458	35p
2N5459	40p
2S102	25p
2S103	25p
2S104	25p
2S301	50p
2S302	50p
2S303	60p
2S304	75p
2S501	32p
2S502	35p
2S503	27p
3N83	40p
3N128	70p
3N140	77p
3N141	72p
3N142	55p
3N143	67p
3N152	87p
40050	55p
40250	50p
40251	32p
40309	32p
40310	45p
40311	35p
40312	47p
40314	37p
40315	37p
40316	47p
40317	37p
40319	55p
40320	47p
40323	32p
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40344	27p
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40528	72p
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AC154	22p
AC176	20p
AC187	25p
AC188	25p
ACY17	27p
ACY18	24p
ACY19	24p
ACY20	20p
ACY21	20p
ACY22	10p
ACY28	17p
ACY39	47p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	47p
AD149	47p
AD150	62p
AD161	35p
AD162	35p
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AF114	25p
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AF179	45p
AF180	50p
AF181	40p
AF186	39p
AF239	30p
AF279	47p
AF280	47p
AFZ11	32p
ASY26	25p
ASY27	30p
ASY28	24p
ASY29	27p
ASY50	25p
ASY51	32p
ASY54	25p
ASY67	45p
ASY86	32p
ASZ21	51p
AUY10	150p
BC107	10p
BC108	10p
BC109	10p
BC113	10p

BC114	15p
BC115	15p
BC116	15p
BC118	15p
BC119	30p
BC121	20p
BC122	20p
BC125	15p
BC126	20p
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BC137	15p
BC138	20p
BC140	35p
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BC148	10p
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BC169B	11p
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BC187	27p
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BC213L	12p
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BFX89	62p
BFX93A	70p
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BFY21	42p
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BFY50	20p
BFY51	20p
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BFY53	15p
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BSX26	45p
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BSX28	32p
BSX60	82p
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NKT215	22p
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OC84	25p
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SN7492	87p
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SN7496	87p
SN74107	52p
SN74153	135p
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ECC81	10p	PL81	17p	20D1	10p
ECC82	12p	PY81	8p	30P4	20p
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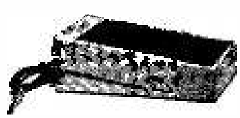

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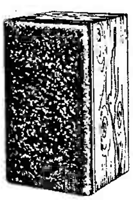

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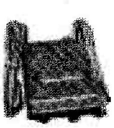

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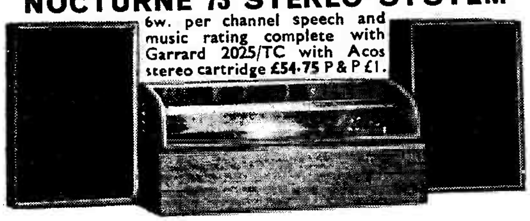

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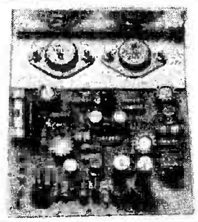

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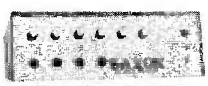

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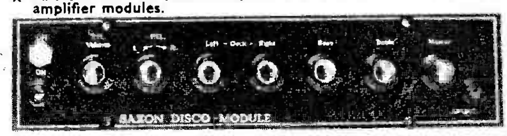

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SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108MHz. **Sensitivity:** 7µV for lock-in over full deviation. **Squelch level:** Typically 20µV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10Hz – 15KHz (±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. maximum **Operating voltage:** 25–30VDC. **Indicators:** Stereo on; tuning. **Size:** 93 x 40 x 207mm.

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Typical Project 60 applications

System	The Units to use	together with	Units cost
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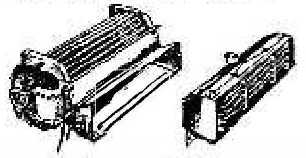

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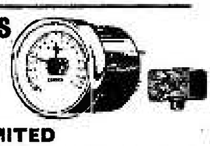

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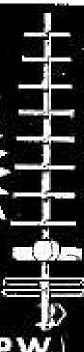

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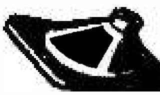

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2N3702	0.12	BC149	0.15	OC81	0.25
2N3703	0.12	BC152	0.15	OC81D	0.15
2N3704	0.17	BC158	0.15	OC83	0.20
2N3707	0.15	BC175	0.20	OC139	0.30
2N3709	0.12	BC186	0.25	OC140	0.35
2N3710	0.12	BCY30	0.25	OC141	0.60
2N3819	0.35	BCY31	0.40	OC170	0.25
2N3906	0.20	BCY33	0.25	OC171	0.25
2S702	0.50	BCY34	0.30	OC200	0.30
2S746	0.25	BCY72	0.20	OC201	0.60
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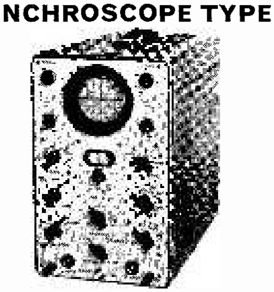

3-in tube fitted with telescopic viewing hood, giving bright display in full daylight. Sensitivity 10mV/mm (narrow band) to 30mV/mm (wide band).
Bandwidth 10 c/s—10 mc/s. Triggered sweep pre-set at 1-2-5-10-30-100-300-1000-3000 μsec per stroke. Free-running time base 20 c/s to 2000kc/s with built-in crystal calibrator providing timing marks at .05-.2-1-5-20-100 μ sec.
Amptitude calibrator directly calibrated in volts.
Input attenuator 1-10-100.
Power supplies 127/230v AC.

PRICE £39.00. Packing and carriage 1.50

INTEGRATED CIRCUITS

TAA263 Direct coupled 3-stage amplifier up to 600kc. Supply voltage 6-8V output 10mW TO72 outline .. .. 0·75
TAA293. Medium frequency amplifier up to 600kc. Supply voltage 6V. output 10mW TO74 outline .. .. 0·95
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TAA570. Four-stage limiter-amplifier with F.M. quadrator detector and remote D.C. volume control facility. Nominal supply voltage 12V. TO74 outline .. .. 0·95
TAD100. AM receiver circuit containing all active components (except output stage) required to build a complete receiver .. £1·95
SL403D PLESSEY 3-Watts Audio Amplifier £1·50
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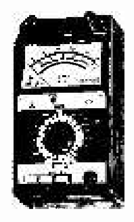
MULTIMETERS

WITH TAUT BAND SUSPENSION MOVEMENT

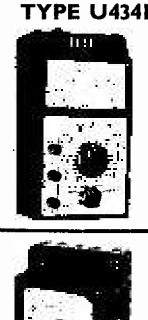


TYPE U4312

Low sensitivity (667 ohms per volt), 1% accuracy DC and 1·5% AC. 9 DC current ranges 300μA to 6A. 8 AC current ranges (1·5mA to 6A). 9 AC/DC voltage ranges 0·3-900V. Resistance 0·2-30K.
£9·75

TYPE U4313. High sensitivity 20 Kohms/volt DC and 2 Kohms/volt AC. Accuracy 1·5% DC and 2·5% AC. 8 DC current ranges 60μA to 1·5A. 6 AC current ranges 0·60mA to 1·5A. 9 AC and DC Voltage ranges 1·5 to 500V. Resistance ranges 0·5-500 Kohms. £10·50

TYPE U4341 MULTIMETER AND TRANSISTOR TESTER



With taut band suspension movement.
8-DC voltage ranges 0·3-900V
6-AC voltage ranges 1.5-750V
5-DC current ranges 0·06-600mA
4-AC current ranges 0·3-300mA
4-resistance ranges 0·5-500 Kohms
Transistor cut-off current 60μA max
Transistor DC current gain 10-350
Sensitivity: 16700 Ω/V DC; 3300 Ω/V AC PRICE £10·50

TYPE U435

With taut band suspension movement.
Sensitivity 20 Kohms/volt DC and 2 Kohms/volt AC.
7 DC current ranges 50μA to 2·5A.
5 AC current ranges 5mA to 2·5A.
7 AC/DC Voltage ranges 2·5 to 1000V.
3 Resistance ranges 0-300 Kohms
Capacity range 0·5μF. £9·00

All instruments are supplied with steel carrying case and leads.
No protection is incorporated. As the movement can withstand overloads up to 100 times, only basic precautions should be taken to prevent damage through misuse

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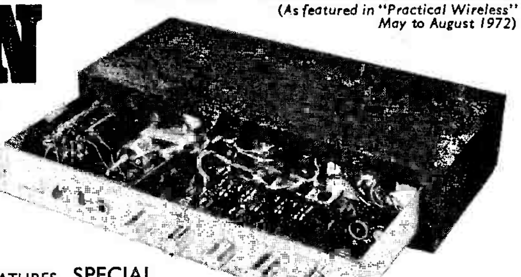
BUILD THE TEXAN

(As featured in "Practical Wireless" May to August 1972)



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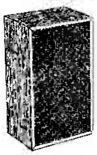

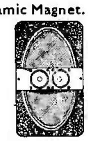

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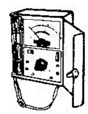

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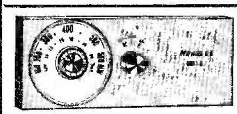
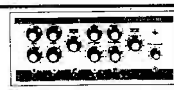
NEW MW/LW TUNER to BUILD ML-3



Uses Mullard Module. Slow motion tuning. Built in battery. Ferrite aerial. Overall size 7" x $2\frac{1}{4}$" x $3\frac{1}{4}$". TOTAL COST TO BUILD £4·85, Post 15p. All parts sold separately. Leaflet No. 6

PA-Disco-Lighting



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Miniature Amplifier
5 transistor. 300mW o/p. Fitted volume and sensitivity control
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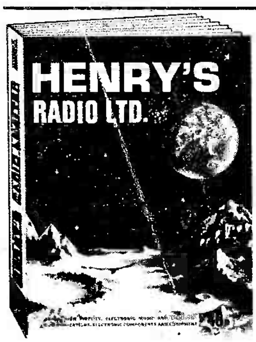

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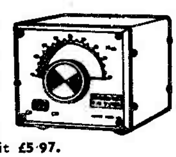

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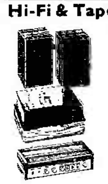

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