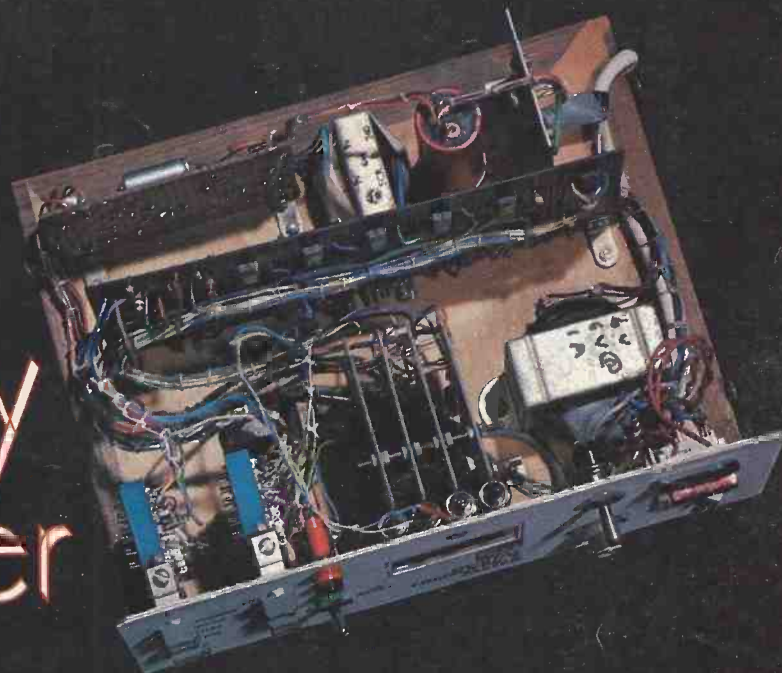
PRACTICAL WIRELESS

JUNE 1976

35p

Digital Frequency Meter



ALSO: TALKING TRANSISTORS

RECEIVER CALIBRATION AID

FAULT-FINDING GUIDE Continued

PRACTICAL WIRELESS

VOL. 52 NO. 2
ISSUE 832
JUNE 1976

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

Advertisement correspondence and enquiries to the Advertisement Manager, Roy Smith, Practical Wireless, Kings Reach Tower, Stamford Street, London, SE1 9LS

Published by IPC Magazines Ltd., Fleetway House, Farringdon Street, London EC4A 4AD. Tel. 01-634 4444

BINDERS
Binders (£2·10 from May 1st) and indexes 45p (inc. VAT) can be supplied by the Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London, SE1 0PF.

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We regret that we are unable to supply back numbers of Practical Wireless. Readers are recommended to enquire at a public library to see copies. **Requests for specific back numbers of** *Practical Wireless* **and** *Television* **can be published in our CQ Column.**

● NEWS & COMMENT

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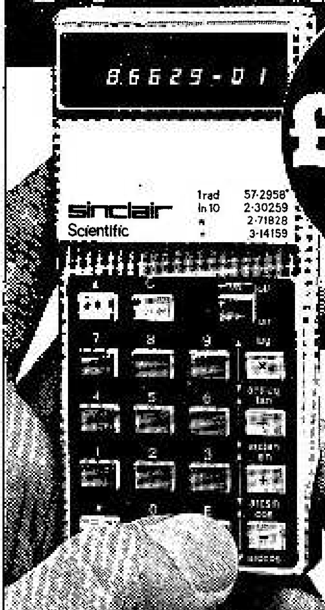
sinclair SCIENTIFIC KIT

ONLY £6·50 +50p p&p



LASKYS now offer this Sinclair Scientific Calculator for a fraction of the original cost. All parts are supplied – all you need provide is a soldering iron and a pair of cutters, complete step-by-step instructions. Assembly time is about 3 hours. The Sinclair Scientific performs logs, trigs and arithmetic at the touch of a button.

FEATURES OF THE SINCLAIR SCIENTIFIC

Functions summary Four arithmetic functions: (+, —, ×, ÷). Sin and Arcsin. Cos and Arccos. Tan and Arctan. Automatic squaring. Automatic doubling. Log10 and Antilog10, giving quick access to xy (including square and other roots). **Scientific notation.** Display shows 5-digit mantissa and 2-digit exponent, both signable. **200 decade range.** —9.9999 x 10-99 to 9.9999 x 1099. **Post-fixed operators.** Post-fixed operators (reverse Polish notation): allow chain calculations of unlimited length. **'Upper and lower case' operation.** Basic arithmetic keys each have two extra functions. **Pocket-sized.** 4⅛" × 2" × 11/16". Weight: 4oz. Trim-fit plastic carrying case.

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RSC 100 WATT DISCO SYSTEM AT FANTASTIC LOW PRICES!

DISCOMAJOR Mk. 2 POWER DISCO CONSOLE with integral Power Amp. Twin Jack output sockets. **TWIN BSR** turntables. Cartridges with Diamond Styli. Separate volume controls each t/table. *Full Headphone Monitoring Facilities.* **PAIR OF 50 WATT SPEAKERS:** Black Vynide covered cabinets approx. size 18" × 18" × 8". **PAIR OF HI-FI HEADPHONES and MATCHING 'MIKE': STEREO VERSION £209·95**
PACKAGE PRICE (including VAT) Carr. £4.
OR DEPOSIT £31·99 and 12 mthly. payments **£12·48** (Total **£181·75**) **£159.95**

FANE DISCO 60C SPEAKER UNITS
Fabulous 'Specialist' range Speaker in heavy Vynide covered cab. fitted protective corner pieces **£45** ea. PRICES INC. VAT
A pair can be supplied in lieu of RSC Speakers with the above system for £25 extra.

MOBILE DISCO CONSOLE **£59·95** Carr. £3

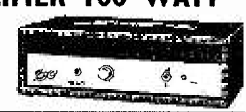
MIC., JACK. PHONE. JACK. MONITOR VOL. CONTROL. MONITOR SELECTOR DECK (1) Vol. Control. DECK (2) Vol. control. Mic. Vol. Control. Treble Control. Bass Control. ON/OFF Switch. Neon Indicator. Twin Turntables. Terms: Dep. **£7·95** and 18 fortnightly paymts. £3·33. Total **£67·89.**

40W DISCO SYSTEM

Inc. Mobile Disco Console with O/P stage (£79·95) & pr. 12" Speakers **£99·95**

POWER (SLAVE) AMPLIFIER 100 WATT

Suitable for use with above or other DISCO-Consoles. Also for increasing output of lower-powered Amplifiers. Terms: Dep. £9·00 and 8 mthly payments of £5·22 (Total £50·76) carr. £1 **£45·00**



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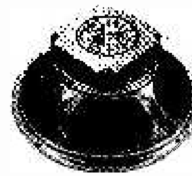
GUARANTEED FOR 5 YEARS



Imp.8-15 Ω

	Rec. Price	RSC Price
T12/35 12" 35w	£14·00	**£10·95**
T12/60A 12" 60w	£21·00	**£14·95**
T12/100 12" 100w	£36·00	**£23·95**
T15/60 15" 60w	£27·00	**£17·99**
T15/70 15" 70w	£28·00	**£19·95**
T15/100 15" 100w	£39·50	**£28·95**
T18/100 18" 100w	£44·00	**£29·95**

TERMS MODEL	MONTHLY PAYMENTS DEPOSIT		TOTAL
Model T12/35	(Pr) **£4·90**	& 8 at **£2·62**	**£25·86**
Model T12/60A	(Pr) **£6·90**	& 8 at **£3·37**	**£33·86**
Model T12/100	(Ea) **£4·99**	& 8 at **£3·00**	**£28·95**
Model T15/60	(Ea) **£3·99**	& 8 at **£2·25**	**£21·99**
Model T15/70	(Ea) **£4·95**	& 8 at **£2·37**	**£23·91**
Model T15/100	(Ea) **£6·00**	& 8 at **£3·37**	**£32·96**
Model T18/100	(Ea) **£6·95**	& 8 at **£3·37**	**£33·91**

SPECIAL OFFER

FOR ONE MONTH ONLY

FANE CRESCENDO

12 BASS 12" Super Bass Guitar Speaker

Our Price Carr. Free **£33·95**

Rec. Ret. Price **£49·30**

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

FULLY GUARANTEED. Impregnated and Interleaved where necessary. Primaries 200-250v. 50c/s. Screened ALL PRICES INCLUDE VAT

MIDGET CLAMPED TYPE
250v. 60mA 6·3v. 2a. **£1·75**
250-0-250v. 60mA 6·3v. 2a. **£1·85**

FULLY SHROUDED UPRIGHT MOUNTING
250-0-250v. 60mA 6·3v. 2a. 0-5-6·3v. 2a. **£2·60**
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300-0-300v. 130mA 6·3v. 4a. C.T. 6·3v. 1a. for Mullard 510 Amplifier **£5·20**
350-0-350v. 100mA 6·3v. 4a. 0-5-6.3v. 3a. **£4·35**
350-0-350v. 150mA 6·3v. 4a. 0-5-6·3v. 3a. **£5·20**
425-0-425v. 200mA 6·3v. 4a. C.T. 5v. 3a. **£9·85**
425-0-425v. 200mA 6·3v. 4a. 6·3v. 4a. 5v. 3a. **£10·00**
450-0-450v. 250mA 6·3v. 4a. C.T. 5v. 3a. **£10·45**

TOP SHROUDED DROP-THROUGH TYPE
250-250v. 70mA 6·3v. 2a. 0-5-6.3v. 2a. **£2·60**
250-0-250v. 100mA 6·3v. 3·5a. **£2·90**
250-0-250v. 100mA 6·3v. 2a. 6·3v. 1a. **£3·20**
350-0-350v. 80mA 6·3v. 2a. 0-5-6·3v. 2a. **£3·20**
250-0-250v. 100mA 6·3v. 4a. 0-5-6·3v. 3a. **£4·35**
300-0-300v. 100mA 6·3v. 4a. 0-5-6·3v. 3a. **£4·35**
300-0-300v. 130mA 6·3v. 4a. 0-5-6·3v. 1a suitable for Mullard 510 Amp. **£5·20**
350-0-350v. 100mA 6·3v. 4a. 0-5-6·3v. 3a **£4·35**
350-0-350v. 150mA 6·3v. 4a. 0-5-6·3v. 3a. **£5·20**

FILAMENT OR TRANSISTOR POWER PACK
Type: 12v. 1a. **£1·10**, 6·3v. 1·5a **£1·06**, 6·3v. 2a. **£1·10** 6·3v. 3a **£1·70**, 6·3v. 6a. **£2·60**, 12v. 3a. or 24v. 1·5a. **£2·60** 0-9-18v. 1½a. **£2·26**, 0-12-25-42v. 2a. **£3·19**

AUTO (STEP UP/STEP DOWN) TRANSFORMERS
0-110/120v. 200-230-250v. 50-80w. **£2·90** 150 watts **£5·20**, 250 watts **£6·37**, 500 watts **£9·84**

CHARGER TRANSFORMERS
0-9-15v. 1½a. **£2·03**, 2½a. **£2·26**, 3a. **£2·32**, 5a. **£2·84**, 6a. **£3·19**, 8a. **£3·48**

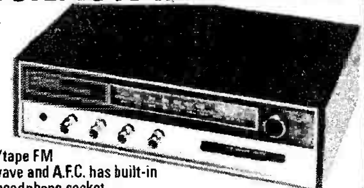
OUTPUT TRANSFORMERS
Standard Pentode 5000 to 3 ohm, or 7000 ohm to 3 ohm **£1·12.** Push Pull 8 watts EL84 to 3 ohm or 15 ohm **£1·68**; Push Pull 10-12 watts 6v, 6 to 3 ohm or 15 ohm **£2·61**; Push Pull 10-12 watts to match 6v. 6 to 3, 5, 8 or 15 ohm **£2·72**; Push Pull EL84 to 3 or 15 ohm 10-12 watts **£2·61**; Push Pull Ultra Linear for Mullard 510 etc. **£4·35**; Push Pull 15-18 watts, sectionally wound 6L6 KT66 etc. from 3 or 15 ohm. **£3·71p.** Push Pull 20 watt high quality sectionally wound EL34 6L6 KT66 etc. to 3 or 15 ohm, fully shrouded. **£6·37p.**

SELENIUM RECTIFIERS
F.W. (Bridged)
All 6/12 v. D.C. output. Max. A.C. input 18v. 1a **45p**, 2a **57p**, 3a **65p**, 4a **95p**, 5a **£1·15.**

L.F. CHOKES 150mA, 7-10H, 250 Ω **£1·28**; 100mA, 10H, 200 Ω **£1·10**; 60mA, 10H, 400 Ω **41p.**

RTVC

ELIZABETHAN STEREO TUNER AMPLIFIER



This compact Tuner Amplifier gives you full medium wave and V.H.F. coverage and FM stereo. With inputs for your turntable and tape recorder. It has rotary tuning. Volume. Balance. Bass and Treble controls and push button selection switches for Phono/tape FM Stereo, FM mono,, Medium wave and A.F.C. has built-in stereo beacon and switched headphone socket.
Technical Specifications 15 transistors, 11 diodes, integrated circuit. Power output 8 watts. Size of tuner amplifier: 4" x 10" x 15½" approx. Finished in selected rosewood veneer with brushed aluminium front panel and matching controls. Output into 15 ohms speakers only.

£29.00 + p&p £1.50

*STEREO 21

COMPLETE ONLY
£23.20 + p&p £4.00

INCORPORATING A GARRARD DECK

Garrard 3 speed Deck automatic, manual facilities together with stereo cartridge and cueing device.

Stereo 21, easy to assemble audio system kit. No soldering required. The unit is finished in Sim Teak . and the acrylic top presents an unusually interesting variation on the modern deck plinth. Includes – **3 speed deck**, automatic manual facilities together with stereo cartridge and cueing device.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications – For the technically minded.
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8-15 ohms. Stereo headphone socket with. automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs.
Overall Dimensions. Speakers approx 12" x 9" x 5". Complete deck and cover in closed position approx. 15½" x 12" x 6".
Extras if required. Optional Diamond Styli **£1.60.**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance **£5.80.**

BSR DECKS WITH PLINTHS AT FANTASTIC REDUCTIONS

MP 60 Type *(illustrated)* *Less Cartridge*	**£16·00** p&p £2·00
C141 *(not illustrated)* *Auto. with Cue Fitted Stereo Cartridge*	**£12·00** p&p £1·50

All plinths finished in matching Teak veneer.

EASY TO BUILD SPEAKER KITS

These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" x 8" woofer, 3½" tweeter and matching crossover.
Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20-20,000 Hz. Size 20" x 11" x 9½" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£22.00 pair complete + £5.20 p&p
Complete with crossover Components and circuit diagram.

THE 'COMPACT' EASY BUILD SPEAKER KIT

A compact bookshelf speaker system giving a high electro accoustic efficiency for the low powered amplifier.
The professional finish can be obtained with the minimum of tools, the infinite baffle type enclosures come ready mitred and professionally finished, and fix together with masking tape till glue dries.
The cabinet measures 12" x 9" x 5" deep approx finished in simulated teak, incorporating a quality 7" x 4" elliptical speaker, power handling 4 watts, flux density 30,000 maxwells, impedance 8-15 ohms nominal, voice coil dia ¾" magnet size 2⅞" approx.

£6.00 + p&p £1.70
PAIR INCLUSIVE

EMI 350 KIT

£7.25 + £1.20 p & p.
Complete with crossover Components and circuit diagram

System consists of a 13" × 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

VISCOUNT IV STEREO AMP

NOW AVAILABLE IN KIT FORM! 30 x 30 WATTS RMS

£27.50 + p&p £1.50

COMPLETE 20 x 20 SYSTEMS

SYSTEM 1A £69.00

The new 20 + 20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls – volume, bass, treble, balance mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear – for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion at 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. – 3 millivolts at 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. – 50 millivolts at 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. – 140 millivolts at 50 K ohms (flat frequency response); 5. Microphone – 3 millivolts at 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response:** 25 Hz to 25 kHz at full rated output. **Signal to noise ratio:** better than –50 dB on all inputs. **Tone control range:** Bass ±15 dB at 50 Hz; Treble ±12 dB at 10 KHz. **Power requirements:** 250V A.C. mains at 60 watts.
Approx size: 15¼" x 3" x 10". **MP60 type deck** with magnetic cartridge, de luxe plinth and cover. **Two Duo Type IIa matched speakers** – Enclosure size approx. 19½" x 10¾" x 7¾" in simulated teak. Drive unit 13" x 8" with 3" tweeter. 15 watts handling. 30 watts peak.

Complete System with these speakers
£69.00 + £6.50 p&p.

SYSTEM 2 £85.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers – Enclosure size approx. 27" × 13" × 11½". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range – 20 Hz to 18,000 Hz.
Complete System with these speakers £85.00 + £7.60 p & p.

PRICES: SYSTEM 1a

Viscount IV R103 amplifier	£27.50 + £1.90 p & p.
2 Duo Type IIa speakers	£30.00 + £6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover	£22.00 + £3.30 p & p.
Total if purchased separately:	**£79.50**
Available complete for only:	**£69.00** + £6.50 p & p.

PRICES: SYSTEM 2

Viscount IV R103 amplifier	£27.50 + £1.90 p & p
2 Duo Type III speakers	£46.00 + £7.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover	£22.00 + £3.30 p & p.
Total if purchased separately:	**£95.50**
Available complete for only	**£85.00** + £7.60 p & p.

Scotland and the Orkneys P & P Surcharge
System 1a £1.75 System 2 £3.50

Note: 30 x 30 kit available only as a separate item.

PUSH BUTTON CAR RADIO KIT–THE TOURIST *

* IF YOU CAN SOLDER CORRECTLY ON A PRINTED CIRCUIT BOARD YOU CAN BUILD THIS KIT CORRECTLY.

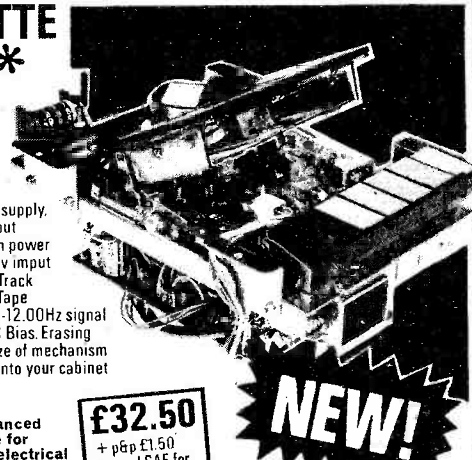
NOW YOU CAN BUILD YOUR OWN PUSH-BUTTON CAR RADIO! This construction kit comprises a fully built and aligned R.F. I.F. module; Printed circuit board, with ready, mounted integrated circuit output stage and all other components. The push button tuning mechanism is fully built and tested ready to mate with the printed circuit board. (once it is assembled) **NOTE:** No test equipment is required for alignment, but remember you must have the ability to solder on a printed circuit board.

TECHNICAL SPECIFICATION:
(1) Output 4 watts RMS output. For 12 volt operation on negative or positive earth. (2) Integrated circuit output stage, pre-built three stage IF Module. Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7" wide 2" high and 4¾" deep approx. Speaker including baffle and fixing strip **£2·00** + 45p. p. & p. **Car Aerial Recommended**—fully retractable **£1·60** + 40p. p. & p.
Price **£8·20** + £1·05 p. & p.

SPECIAL OFFER

The Tourist I Kit
Complete with speakers, fixing kit and fully retractable aerial. **£10·50** + p. & p. £1·50

STEREO CASSETTE TAPE DECK KIT*



Kit comprises of ready built cassette tape transport mechanism. Featuring pause control, solenoid assisted auto-stop. 3 digit tape counter, belt-driven balanced fly wheel. DC motor with electronic speed control, ready built and mounted record/replay PC board, and two VU meters, power supply, PC board, mains transformer. Input and output sockets and two level controls. Specification power source 240 AC 50Hz. Output more than 0.5v imput mike −65dB.10KΩ. DIN −47dB.100KΩ. Track system 2 channel stereo record play-back. Tape speed. 4.8CM/SEC. Frequency response 50-12.00Hz signal to noise ratio −42dB. Recording system AC Bias. Erasing system AC erase. Bias frequency 57KHz. Size of mechanism 8" x 5" x 3½" approx. unit easy to mount into your cabinet 3" required to clear base of mechanism approx.

* **This is an advanced kit not suitable for those without electrical knowledge and those unable to solder.**

£32.50 + p&p £1.50 or send SAE for complete details.

*DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Output 20 watts RMS into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls. *Separate bass and treble controls common to all 4 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State circuitry. *Attractive styling.
INPUT SENSITIVITIES – Input – 1). Crystal mic. guitar or moving coil mic. 2 and 10mV. (Selector switch for desired sensitivity.) – Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation. Size approx: 12½"×6"×3½" **£20.00** +£1.35 p & p.

8 TRACK HOME CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system. Compatible with Viscount IV system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV.

Yours for only
£14.00 +£1.70 p & p.

SPECIAL OFFER

As above but complete with build yourself Unisound Amplifier Kit (see opposite panel) + 2 'Compact' easy to build speaker kits (see opposite page) **£25.00** + p & p £2·00

BUILD YOUR OWN STEREO AMPLIFIER*

For the man who wants to design his own stereo – here's your chance to start, with Unisound – pre-amp, power amplifier and control panel. No soldering – just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

Also available with 2 speakers (7"x4") £10 + £1.75 p & p. **£8.95** £1.05 p & p.

Also available with the 'Compact' (see opposite page) easy build speaker kit £13.50 + £2 p & p

PORTABLE DISCO CONSOLE*

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables. Two B.S.R. MP60 type single play professional series decks, fitted with crystal cartridges.

TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K. 240 volt operation. **Turntables capacity** – 7", 10" or 12" records. **Rumble, wow and flutter** Rumble Better than −35dB. Wow Better than 0.2%. Flutter Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size –
Unit Closed – 17¾"×13¾"×8¾"(app.)
Unit Open – 35¾"×13¾"×4¾" (app.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only
£49.00 +£6.50 p & p.

All prices include VAT at current rates

BARCLAYCARD
Buy it with Access

DO NOT SEND CARD
Just write your order giving your credit card number

Mail orders to Acton. Terms C.W.O. All enquiries stamped addressed envelope. Goods not despatched outside U.K.

* **Leaflets available for all items listed thus * Send stamped addressed envelope. All items subject to availability. Prices correct at 1st April 1976 and subject to change without notice.**

● Minimum order on ACCESS/BARCLAYCARD–£11

R T V C

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1mA	5V DC	10A AC*
1-0-1mA	10V DC	20A AC*
5mA	15V DC	30A AC*
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* Moving iron (all others are moving coil).

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25µA	£3·95 each
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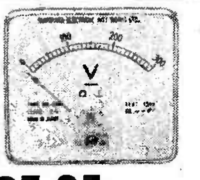

Dimensions: Front 110mm x 120mm wide
Panel Hole: 85mm
Accuracy ±2·5%

RANGES

50µA	10mA	50V DC
100µA	50mA	150V DC
200µA	100mA	300V DC
500µA	500mA	15V DC
50-0-50µA	1A DC	300V AC
100-0-100µA	5A DC	1A AC*
500-0-500µA	15A DC	5A AC*
1mA	30A DC	10A AC*
1-0-1mA	10V DC	20A AC*
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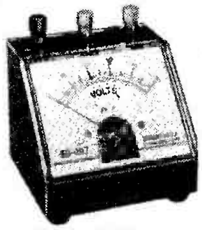

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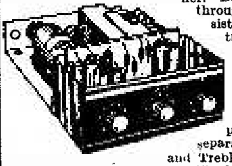
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. **PRICE £13·75.** P. & P. 85p.

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A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:- 2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built & tested to a high standard. **£12·40.** P.&P. 95p.

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P. & P. 85p BARGAIN PRICE **£5·00**

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QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. wide × 3in. deep × 6in. high. Ready built and tested. PRICE £6·20, P. & P. 90p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £7·30, P. & P. £1.

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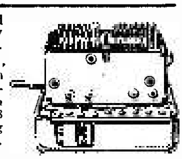

Pye VHF/FM Tuner Head covering 88-108 M/Hz. 10·7 M/Hz I.F. output 7-8 Volt + earth. Supplied pre-aligned, with gang full circuit diagram and connection details supplied. Beautifully made with precision-geared FM and 323 Pf + 323Pf A.M. Tuning Gauge only £3·50 + P. & P. 35p.

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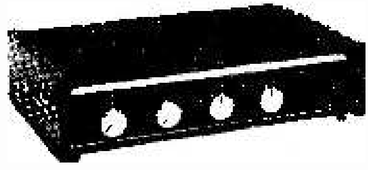
HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise, level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metalwork high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification; Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp. Overall Size 12"w. × 8"d. × 2½"h.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£13·50	P. & P. 55p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·85	P. & P. 85p
CABINET	£4·85	P. & P. 75p

SPECIAL OFFER—only £22·50 if all 3 items ordered at one time including p. & p.

Full after sales service

Also available ready built and tested £29·25. P. & P. £1.

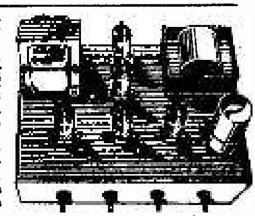
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc. and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £7·80. P. & P. 85p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc £7·00 P. & P. 85p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p + SAE (Free with parts)' All parts sold separately. ONLY £11·25 P. & P. £1·25. Also available ready built and tested £15·20 P. & P. £1·20.

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Fitted with Phase Lock-loop Decoder

★ FET Input Stage
★ VARI-CAP diode tuning
★ Switched AFC
★ Multi turn pre-sets
★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20–30v at 90 Ma max.

OUR PRICE ONLY

£19.95

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461.**
The S450 is supplied fully built, tested and aligned.
The unit iseasily in stalled using the simple instructions supplied.

STEREO PRE-AMPLIFIER PA100

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response ± 1dB 20Hz–20KHz.
Sensitivity of inputs:
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
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P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply 20-35V at 20mA. Dimensions—[illegible]mm × [illegible]mm × 35mm.

£13.50 p & p 45p

MK60 AUDIO KIT:
Comprising: 2 x AL60's 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27·55** *plus 62p postage.*
TEAK 60 AUDIO KIT:
Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9·20** *plus 62p postage.*

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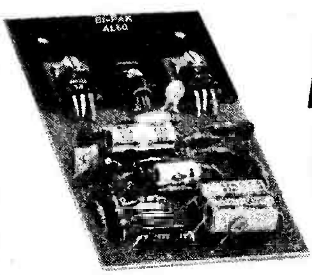
AL 60



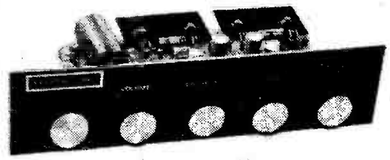
25 Watts (RMS)

● Max Heat Sink temp. 90C. ● Frequency response 20Hz. ● Distortion better than 0·1 at 1kHz. ● Supply voltage 15-50v. ● Thermal Feedback. ● Latest Design Improvements. ● Load—3,4,5, or 16ohms. ● Signal to noise ratio 80db. ● Overall size 63mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

ONLY **£3.95**

STEREO 30 COMPLETE AUDIO CHASSIS



7 + 7 WATTS R.M.S.
The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins.).

TRANSFORMER £2·45 plus 62p p & p
TEAK CASE £3·65 plus 62p p & p.

£15.75 *P & P 45p.*

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1·5A at 35V. Size: 63mm, 105mm, 30mm. Incorporating short circuit protection.

INPUT VOLTAGE	33-40V. A.C.
OUTPUT VOLTAGE	33V. D.C. Nominal
OUTPUT CURRENT	10mA-1·5 amps
OVERLEAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm
TRANSFORMER BMT80	£2·60 + 62p. postage

£3.00

TRANSFORMERS

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Wide range of Audio accessories & semiconductors.

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SEC. 120/240
CENTRE TAP WITH SCREEN

Ref.	VA (Watts)	£
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149	60	5·84
150	100	6·67
151	200	10·43
152	250	12·67
153	350	14·99
154	500	17·21
155	750	23·69†
156	1000	33·01†
157	1500	37·68†
158	2000	42·03†
159	3000	66·40†

*115V or 240V Sec. only.

30 VOLT RANGE
Prim. 200-240V
Sec. 0-12-15-20-24-30V

Ref.	Amps	£
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79	1·0	3·38
3	2·0	4·85
20	3·0	5·99
21	4·0	6·92
51	5·0	8·32
117	6·0	9·33
88	8·0	12·38
89	10·0	12·71

60 VOLT RANGE
Prim. 200-240V
Sec. 0-24-30-40-48-60V

Ref	Amps	£
124	0·5	3·46
126	1·0	4·75
127	2·0	6·67
125	3·0	9·58
123	4·0	11·45
40	5·0	12·41
120	6·0	14·56
121	8·0	17·01†
122	10·0	20·95†
189	12·0	21·87†

12 and or 24 Volt
PRIMARY 240-250 VOLTS

Ref.	Amps 12v	Amps 24v	£
111	0·5	0·25	1·97
213	1·0	0·5	2·64
71	2	1	2·80
68	3	–	4·60
18	4	2	3·98
85	5	–	4·91
70	6	3	5·56
108	8	4	6·41
72	10	5	6·86
116	12	6	7·42
17	16	8	9·13
115	20	10	13·52
187	30	15	16·86
226	60	30	19·08†

HIGH VOLTAGE
Mains Isolating
Prim. 200/220 *or* 400/440
Sec. 100/120 *or* 200/240

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350	247	13·33
1000	250	28·41†
2000	252	47·65†

AUTO TRANSFORMERS

Ref	VA (Watts)	Auto Taps	£
113	20	0-115-210-240	2·44
64	75	,, ,,	4·07
4	150	0-115-200-220-240	5·45
66	300	,, ,,	7·51
67	500	,, ,,	11·46
84	1000	,, ,,	17·25
93	1500	,, ,,	20·54†
95	2000	,, ,,	27·44†
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240 to 110V ·500VA to 2KVA
(to BS3535) Send for details

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Prim. 200-240V
Sec. 0-19-25-33-40-50V

Ref. No.	Amps	£
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103	1·0	4·61
104	2·0	6·26
105	3·0	7·63
106	4·0	9·83
107	6·0	15·08
118	8·0	16·46
119	10·0	19·17†

SCREENED MINIATURES

Ref	mA	Volts	£
238	200	3-0-3	1·98
212	1A, 1A	0-6, 0-6	2·71
13	100	9-0-9	1·96
235	330, 330	0-9, 0-9	2·04
207	500, 500	0-8-9, 0-8-9	2·73
208	1A, 1A	0-8-9, 0-8-9	3·94
236	200, 200	0-15, 0-15	1·95
214	300, 300	0-20, 0-20	2·82
221	700 (DC)	20-12-0-12-20	4·28
206	1A, 1A	0-15-20, 0-15-20	4·70
203	500, 500	0-15-27, 0-15-27	4·18
204	1A, 1A	0-15-27, 0-15-27	5·14
S112	500	12, 15, 20, 24, 30	2·68

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100V	6A	1·03
200V	1A	0·60
200V	2A	0·72
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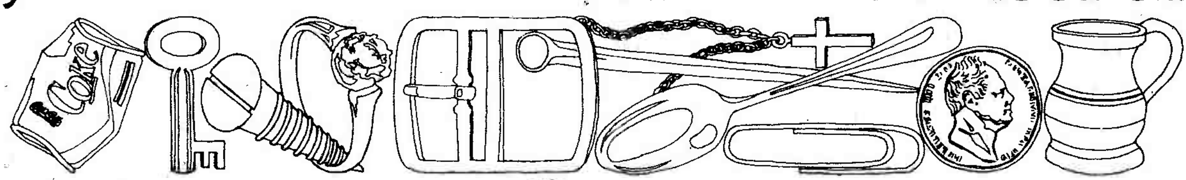
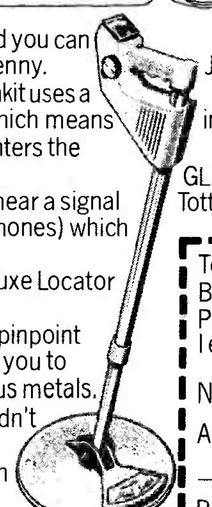
A few interesting (and not so interesting) things you could find with a Heathkit Metal Locator.





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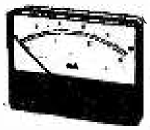
ME9 =0 to 1 m/a Full Scale
ME10=0 to 5 m/a Full Scale
ME11=0 to 10 m/a Full Scale
ME12=0 to 50 m/a Full Scale
ME13=0 to 100 m/a Full Scale
ME14=0 to 500 m/a Full Scale
ME15=0 to 1 amp Full Scale
ME16=0 to 50 volts
ME17=0 to 300 volts A.C. Full Scale
ME18="S" Meter
ME19="VU" Meter



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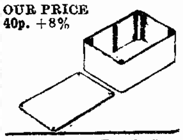
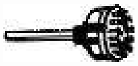


WAFER SWITCHES

1 Pole 12 Way
2 Pole 2 Way
2 Pole 3 Way
2 Pole 4 Way
2 Pole 6 Way
3 Pole 4 Way
4 Pole 3 Way



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All £1·30 each

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We supply a MW—LW—FM—Stereo Tuner fully wired and aligned on a 6" × 4" × 1½" printed board, plus the Ferrite Aerial and switch which you connect following our complete instructions.
Now you only need a 9-12 volt D.C. supply and you can feed this tuner into any Stereo Amplifier.

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Ideal for domestic record players, etc. A Bargain at £5+12½% VAT.

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12-0-12 volt 500m/a

240 volt primary transformer bargain.
approx size 60mm x 40mm x 50mm
fixing centres 75mm
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Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels. Fitted with 1mm front panels.
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1006=150mm × 75mm × 47mm=72p
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All types are screened and Centre tapped to earth.

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100	4·53	70					
200	7·26	80					
250	8·30	1·10					
350	10·59	1·18					
500	12·18	1·34	23·25	1	—	O.A.	1·20
750	18·65	O.A.	30·80	1	—	O.A.	1·20
1000	26·00	O.A.	37·77	2	—	O.A.	2·40
1500	29·65	O.A.	44·30	3	—	O.A.	3·60
2000	35·00	O.A.	51·85	1	1	O.A.	2·70
3000	55·00	O.A.	75·35	3	1	O.A.	5·10

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Primary 240V
Please state which voltage

AMPS 12V	AMPS 24V	PRICE £	P & P p
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1	·5	1·58	45
2	1	2·05	45
4	2	2·52	62
6	3	3·76	62
8	4	4·30	85
10	5	4·67	85
12	6	4·93	98
16	8	6·35	1·20
20	10	9·27	1·20

MINIATURE TRANSFORMERS
Primary voltage 240V

Sec. volts	mA	PRICE £	P & P p
3-0-3	200	1·37	25
0-6 x 2	1A	1·80	45
0-9 x 2	330	1·34	26
0-9 x 2	500	1·83	45
0-9 x 2	·1A	2·60	52
0-15 x 2	200	1·30	25
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EBF80	0·63
EBF83	0·66
EBF89	0·50
EC86	0·82
EC88	0·86
EC90	0·94
EC97	0·69
ECC81	0·70
ECC82	0·70
ECC83	0·70
ECC84	0·63
ECC85	1·02
ECC88	1·22
ECC189	0·77
ECF80	0·63
ECF82	0·90
ECF86	0·76
ECH81	1·73
ECH83	1·06
ECH84	1·50
ECL80	1·02
ECL82	0·69
ECL83	0·93
ECL86	0·82

EF80	0·62
EF83	1·10
EF85	0·70
EF86	1·78
EF89	1·73
EF91	1·35
EF92	1·51
EF95	1·63
EF183	0·93
EF184	0·98
EH90	1·22
EL34	1·40
EL36	1·50
EL84	0·70
EL86	1·40
EL95	1·02
EM81	1·24
EY51	0·89
EY86	0·50
EY86/87	0·70
EY88	0·81
EZ80	0·84
EZ81	0·70
GY501	1·73
GZ34	1·22
OC83	0·60
PC86	1·40
PC88	1·40
PC97	0·70
PC900	0·84

PCC84	0·84
PCC85	1·02
PCC88	0·98
PCC89	0·97
PCC189	1·22
PCF80	0·84
PCF82	1·37
PCF86	0·97
PCF200	1·50
PCF201	1·50
PCF801	0·97
PCF802	1·02
PCF806	0·97
PCH200	1·73
PCL82	0·84
PCL83	0·97
PCL84	0·93
PCL85	0·72
PCL86	0·97
PCL805/85	0·97
PD500	2·62
PFL200	1·23
PL36	1·40
PL81	1·23
PL81A	1·40
PL82	0·48
PL83	1·78
PL84	1·02
PL500	1·40

PL504	1·40
PL508	1·73
PL509	2·33
PL802	2·33
PY33	0·73
PY81/800	0·72
PY82	0·70
PY86/7	70p
PY88	0·84
PY500A	1·50
PY800	0·56
PY801	0·72
U26	1·22
U191	1·17
U193	0·56
UABC80	1·01
UBC81	0·80
UBF89	0·65
UCC85	0·66
UCH81	1·73
UCL82	1·02
UCL83	1·02
UL84	1·23
UY85	0·73
6/30L2/ECC804	1·20
6F23/EF812	1·16
30C1/PCF80	0·84

30C15/PCF800	1·22
30C17	1·29
30C18/PCF805	1·29
30F5/PF818	1·35
30FL1/PCE800	0·98
30FL2	1·02
30FL12	1·44
30FL14	1·20
30L1/PCC84	0·63
30L15/PCC805	1·35
30L17	1·12
30P4MR	1·63
30P12/PC801	1·22
30P19/PC802	1·06
30PL1/PCL801	1·35
30PL13/PCL800	1·47
30PL14/PCL88	1·72
30PL15	1'44

NEW VALVES

Individually boxed and guaranteed but of European or other origin at greatly reduced prices. Quotations for any valve not listed. Send SAE for lists.

AZ1	1·00
AZ31	1·00
CBL31	1·40
CL33	1·50
CY31	1·00
DAF91	0·40
DAF96	0·60
DCC90	1·35
DF91	0·40
DF96	0·60
DK91	0·50
DK92	1·00
DK96	0·75
DL92	0·50
DL94	0·48
DL96	0·55
DY86	0·45
DY87	0·45
DY802	0·47
EABC80	0·38
EAF42	0·70
EB91	0·30
EBC33	1·00
EBC41	0·75
EBC81	0·40
EBF80	0·40
EBF83	0·40
EBF89	0·32
EBL31	2·00
ECC81	0·45
ECC82	0·38
ECC83	0·38
ECC84	0·35
ECC85	0·45
ECC88	0·50
ECH35	1·50
ECH42	0·85
ECH81	0·35
ECH83	0·50
ECL80	0·60
ECL82	0·42
ECL83	0·75
ECL86	0·55
ECLL800	3·50

EF37A	1·50
EF39	1·25
EF80	0·35
EF85	0·45
EF86	0·50
EF89	0·35
EF91	0·40
EF92	0·50
EF95	0·45
EF98	0·80
EF183	0·40
EF184	0·40
EL32	0·60
EL33	8·00
EL34	0·70
EL36	0·60
EL37	3·40
EL41	0·90
EL42	1·65
EL84	0·35
EL95	0·60
EM80	0·55
EM81	0·60
EM84	0·40
EM85	1·00
EM87	1·00
EY51	0·45
EY86	0·50
EZ40	0·60
EZ41	0·75
EZ80	0·30
EZ81	0·31
GY501	0·90
GZ30	0·65
GZ32	0·65
GZ34	0·75
HN309	1·50
KT61	3·00
KT66	3·40
KT81(7C5)	2·00
KT81	1·75
KT88	3·65
KTW61	1·50
MU14	1·00

N78	5·00
OA2	0·45
OB2	0·45
PC86	0·65
PC88	0·65
PC97	0·55
PC900	0·55
PCC84	0·45
PCC88	0·62
PCC89	0·55
PCC189	0·65
PCF80	0·40
PCF82	0·42
PCF86	0·65
PCF801	0·60
PCF802	0·55
PCF805	0·90
PCF806	0·80
PCF808	1·00
PCL82	0·45
PCL83	0·70
PCL84	0·50
PCL85	0·60
PCL86	0·50
PCL805/85	0·60
PD500	1·50
PEN45	0·85
PL36	0·63
PL81	0·55
PL82	0·50
PL83	0·50
PL84	0·50
PL500	0·85
PL504	0·85
PL508	0·90
PL509	1·55
PL802	2·00
PX25	3·50
PY33	0·63
PY81	0·50
PY82	0·45
PY83	0·50
PY88	0·63

PY500	1·10
PY81/800	0·50
PY801	0·55
SP41	3·00
SP61	0·85
T41	1·50
U14	0·75
U25	1·00
U26	0·85
U191	0·75
UABC80	0·40
UAF42	0·75
UBC41	0·60
UBC81	0·50
UBF80	0·50
UBF89	0·50
UCC85	0·50
UCH42	0·80
UCH81	0·50
UCL82	0·40
UCL83	0·70
UF41	0·75
UF89	0·50
UL41	0·85
UL84	0·50
UY41	0·55
UY85	0·45
VR105/30	0·40
VR150/30	0·45
1R5	0·50
1S5	0·40
1T4	0·40
3S4	0·50
3V4	0·85
5R4GY	1·20
5U4G	1·25
5U4GB	0·70
5Y3GT	0·65
5Z4G	0·95
6/30L2	0·90
6AK5	0·45
6AM5	2·00
6AQ5	0·50
6AS7G	1·00
6AT6	0·60
6AU6	0·40
6BA6	0·38
6BE6	0·45
6BH6	0·75
6BJ6	0·75
6BQ7A	0·55
6BR7	1·20
6BS7	1·40
6BW6	1·00
6BW7	1·00
6C4	0·40
6CD6G	1·60
6CH6	2·20
6CW4	3·00
6F23	0·90
6F25	1·00
6F28	0·75

6J5M	0·65
6J5G	0·45
6J6	0·35
6J7G	0·30
6J7M	0·65
6K6GT	0·80
6K7G	0·35
6K7M	0·45
6K8G	0·45
6K8M	0·70
6K25	1·00
6L6G	1·25
6L6GC	0·80
6Q7G	0·40
6Q7M	0·60
6SL7GT	0·55
6SN7GT	0·55
6SQ7GT	0·40
6U5G	1·50
6V6G	0·30
6V6GT	0·60
6X4	0·45
6X5G	0·45
6X5GT	0·55
7B6	0·80
7B7	0·80
7C5	2·00
7C6	1·00
7H7	0·80
7R7	0·80
7S7	2·25
7Y4	0·80
12AT6	0·45
12AT7	0·45
12AU6	0·50
12AU7	0·38
12AX7	0·38
12BA6	0·50
12BE6	0·60
30C1	0·40
30C15	1·00
30C17	1·00
30C18	0·90
30F5	1·00
30FL1	1·00
30FL2	1·00
30FL14	1·00
30L15	0·95
30L17	0·95
30P4MR	1·30
30P12	1·00
30P19	0·95
30PL1	0·95
30PL13	1·10
30PL14	1·10
35W4	0·60
35Z4GT	0·70
50CD6G	1·20
807	1·00
813ITT	17·50
813USSR	7·00
866A	2·00

TRANSISTORS-INTEGRATED CIRCUITS

EXPRESS POSTAGE
12p per order in UK

All transistors, I.C's offered are new and branded. Manufactured by Mullard, Texas, RCA, Ferranti, Motorola, ITT, Fairchild, Lucas, etc. Quantity discounts on application. Send SAE for full lists.

AA119	0·07
AAZ13	0·12
AAZ15	0·10
AC107	0·51
AC126	0·25
AC127	0·25
AC128	0·15
AC176	0·25
AC187	0·21
AC188	0·20
ACY21	0·35
ACY39	0·75
AD140	0·50
AD149	0·75
AD161	0·44
AD162	0·44
AF115	0·25
AF116	0·25
AF117	0·24
AF186	0·48
AF239	0·44
ASY27	0·40
ASY28	0·25
BA102	0·25
BA115	0·10
BC107	0·14
BC108	0·13
BC109	0·12
BC113	0·15
BC117	0·21
BC143	0·30
BC147	0·10
BC148	0·08
BC169C	0·15
BC182	0·12
BC182L	0·12
BC184L	0·13
BC338	0·15
BCY32	0·85
BCY33	0·38
BCY34	0·45
BCY70	0·18
BCY71	0·22
BCY72	0·15
BCZ11	0·65
BD121	1·00
BD124	0·65

BD131	0·42
BD132	0·50
BF115	0·20
BF167	0·25
BF173	0·28
BF179	0·33
BF180	0·36
BF181	0·35
BF194	0·10
BF195	0·12
BF197	0·15
BF200	0·32
BF861	0·25
BF898	0·25
BFW10	0·61
BFX29	0·28
BFX88	0·24
BFY50	0·20
BFY51	0·20
BFY52	0·20
BR100	0·40
BY100	0·27
BY126	0·14
BY127	0·12
BZX61 series	0·20
BZY88 series	0·10
CR81-05	0·45
CR81-40	0·65
CR83-05	0·40
CR83-40	0·65
MJE340	0·47
MJE370	0·68
MJE520	0·65
MJE2955	1·27
MJE3055	0·75
MPF102	0·40
MPF103	0·36
MPF104	0·35
MPF105	0·36
NKT404	1·00
OA5	0·72
OA10	0·40
OA79	0·10
OA81	0·18
OA91	0·07

OA200	0·08
OA202	0·06
OC16	1·00
OC20	2·00
OC23	1·25
OC25	0·40
OC28	1·00
OC35	0·75
OC36	0·60
OC42	0·40
OC44	0·20
OC45	0·20
OC71	0·25
OC72	0·28
OC76	0·30
OC77	0·55
OC81	0·29
OC81D	0·28
OC81Z	0·45
OC83	0·60
OC140	1·14
OC170	0·30
OC171	0·30
OC200	1·00
OC201	1·50
OC202	1·50
OC203	1·25
OCP71	1·20
ORP12	0·60
ORP60	0·55
TIC44	0·29
TIC226D	1·50
TIL209	0·20
TIP42A	80p
ZTX107	0·12
ZTX108	0·10
ZTX300	0·13
ZTX301	0·14
ZTX302	0·18
ZTX304	0·24

ZTX500	0·13
ZTX501	0·15
ZTX503	0·16
ZTX531	0·25
ZTX550	0·18
1N914	0·06
IN4001	0·06
IN4002	0·07
IN4003	0·08
IN4004	0·08
IN4005	0·10
IN4006	0·12
IN4007	0·12
IN4009	0·06
IN4148	0·06
1S921	0·07
1S2033	0·20
1S2051A	0·20
1S2100A	0·20
1S3010	0·25
2N696	0·15
2N697	0·16
2N706	0·10
2N706A	0·12
2N1131	0·25
2N1132	0·24
2N1302	0·18
2N1303	0·18
2N1304	0·22
2N1305	0·22
2N1306	0·28
2N1307	0·28
2N1308	0·32
2N1309	0·30
2N1613	0·21
2N1614	0·45
2N2147	0·78
2N2160	0·78
2N2369A	0·16
2N2646	0·50

2N2904	0·20
2N2904A	0·25
2N2905	0·32
2N2905A	0·25
2N2906	0·20
2N2926	0·12
2N3053	0·18
2N3055	0·45
2N3525	0·91
2N3614	0·65
2N3615	0·65
2N3702	0·11
2N3703	0·12
2N3704	0·14
2N3705	0·15
2N3706	0·11
2N3707	0·15
2N3708	0·07
2N3709	0·10
2N3710	0·11
2N3711	0·11
2N3819	0·33
2N3820	0·50
2N3823	0·50
2N3903	0·15
2N3904	0·20
2N3905	0·25
2N3906	0·25
2N4058	0·15
2N4059	0·10
2N4060	0·12
2N4061	0·18
2N4062	0·14
2N4289	0·30
3N125	1·75
3N141	0·81
40360	0·40
40361	0·45
40362	0·40
40430	0·85

SN7400	0·16
SN7401	0·16
SN7402	0·16
SN7403	0·16
SN7404	0·26
SN7405	0·22
SN7406	0·42
SN7407	0·42
SN7408	0·28
SN7409	0·28
SN7410	0·16
SN7411	0·25
SN7412	0·30
SN7413	0·36
SN7416	0·36
SN7417	0·36
SN7420	0·16
SN7422	0·25
SN7423	0·37

SN7428	0·40
SN7430	0·18
SN7433	0·37
SN7437	0·37
SN7438	0·37
SN7440	0·22
SN7441AN	0·92
SN7442	0·79
SN7450	0·16
SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·36
SN7473	0·41
SN7474	0·42
SN7480	0·60
SN7483	1·10

SN7486	0·47
SN7490	0·55
SN7491AN	1·00
SN7492	0·70
SN7493	0·70
SN7494	0·80
SN7495	0·80
SN7496	0·95
SN7497	3·87
SN74100	1·89
SN74107	0·45
SN74110	0·58
SN74118	0·90
SN74119	1·68
SN74121	0·50
SN74122	0·70
SN74123	1·00
SN74141	0·90

SN74145	1·26
SN74150	1·75
SN74151	1·00
SN74154	2·00
SN74155	1·00
SN74156	1·00
SN74157	0·95
SN74170	2·52
SN74174	1·57
SN74175	1·10
SN74176	1·26
SN74190	2·00
SN74191	2·00

SN74192	2·00
SN74193	2·00
SN74194	1·30
SN74195	1·10
SN74196	1·20
SN74197	1·20
SN74198	2·77
SN74199	2·52

DIL SOCKETS 14 pin 15p, 16 pin 17p

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To be added to all orders
VALVES & TRANSISTORS $12\frac{1}{2}\%$
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- OSCILLOSCOPE TUBES
  Types CV 1526, DG 7-5, VCR 139A
  All at **£8·00** each, + p & p 25p.
  Add 8% VAT

SPECIAL OFFER

TERMS OF BUSINESS: C.W.O. A/c's available to approved companies on application. Telephone and telex orders accepted. Export and trade enquiries welcomed. Open daily to callers 9 a.m.–5 p.m. Mon.–Sat. Closed Sat. 1–3 p.m. Prices correct when going to press. Prices on application for any types not listed. Obsolete valves a speciality.

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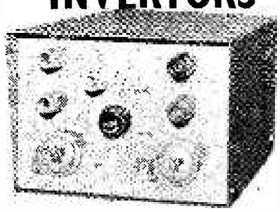
INVERTORS



240v-50Hz from your 12v car battery

25 watt–£4·75	300 watt (12v)–£33·08
40 watt–£8·27	400 watt (24v)–£39·05
75 watt–£12·03	500 watt (24v)–£48·18
150 watt–£21·27	1 Kw (50v)–£127·00
300 watt (24v)–£26·45	1·5 Kw (110v)–£140·80

All above Invertors are in kit form but may be purchased built up in metal case and ready for use. Price list sent on receipt of s.a.e. Prices include p. and p.

P.W. AUTOMATIC EMERGENCY SUPPLY

240v-50Hz-150 watt Inverter with built in battery charger. In event of power failure switches over automatically from battery charging to inverter operation. Cct. as appeared in Dec. 72 P.W. Complete kit of parts (excluding meter) £24·50 plus £1·70p.p.

FLUORESCENT LIGHT INVERTER KIT

8 watt-12v-Fluorescent light, suitable for tents, caravans, houses, boats and secondary lighting for factories, hotels, &c.

12"–8 watt £3·90 + 35p p. & p. Built up £4·90 + 35p p. & p.

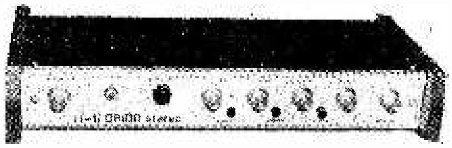
21"–13 watt £4·20 + 52p p. & p. Built up £5·80 + 52p p. & p.

TRANSFORMERS AND COILS

Both high volume and small order capacity available.

Special offer. Miniature mains transformer 12-0-12v-6v. A. 85p + 10p p. & p.

ORION STEREO AMPLIFIER



20 + 20 Watts r.m.s. into 8 ohm load. Distortion less than 0·01% 100Hz–10kHz. Frequency response ± 1dB 20 Hz to 20kHz. Hum level virtually nil with volume full on.

This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc, tape, tuner, etc.

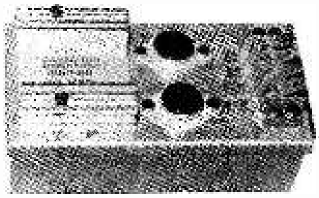
Complete kit of parts including slim line bookend case, silk screened front panel and knobs **£47·30 inc. VAT and p. & p.**

The bookend case, I.C's and semiconductors, P.C. board, Transformer, etc. may be purchased separately if desired. Send S.A.E. for further information.

INSTRUMENT CASES

Bookend Amplifier and attractive styled Instrument Cases available. Send S. and A. envelope for Price List.

ASTRO IGNITION



ASTRO IGNITION SYSTEM

Complete kit of parts for this proven and tested system **£10·45 inc. VAT** Ready built with only two connections to alter **£13·75 inc. VAT.** Thousands have used this system both home and abroad. Consider these advantages—more power, faster acceleration, fuel economy, excellent cold starting, smoother running, no contact breaker burning. Also because of the high energy spark the fuel mixture can be made weaker giving further economy and fewer plug problems. Fitting time when built 5 minutes approx. Please state whether positive or negative earth.

TRADE and EXPORT ENQUIRIES WELCOMED ON ALL PRODUCTS

ASTRO ELECTRONICS
Springbank Road, West Park
CHESTERFIELD. 31475

MAINS TRANSFORMERS

PRI. 240v sec. 27/0/27v at 800 m/a, £2·35. P.P. 50p.
PRI. 110/240v sec. 50v at 10 amps, £10·00. P.P. £1·50.
PRI. 110/240v sec. 20/21/22v at 8 amp, £6·00. P.P. £1·50.
PRI. 110/240v sec. 23/24/25v at 10 amp, £7·00. P.P. £1·50.
PRI. 110/240v sec. 24/40v at 1½ amp, £1·90. P.P. 60p.
PRI. 240v sec. 20/40/60v at 2 amp, £3·00. P.P. 70p.
PRI. 240v sec. 20v at 2½ amp, £2·00. P.P. 65p.
PRI. 240v sec. 18v at 1·5 amp and 12v at 1 amp, £2·25. P.P. 50p.
PRI. 240v sec. 18v at 1 amp, £1·10. P.P. 35p.

12 volt MINI UNISELECTOR

11 way. 4 bank. (3 non-bridging 1 homing) £2·50. P.P. 35p.

24 volt MINI UNISELECTOR

11 way, 6 bank (5 non-bridging, 1 bridging) £2·00. P.P. 35p.

SIEMENS MINIATURE RELAYS

6v 4c/o with base, 65p ea.
24v 2c/o with base, 50p ea.

MAINS RELAY 240v

3 c/o 10 amp contacts, £1 with base.

MINIATURE RELAYS

(1¾ x 1½ x ½) 24 v. 4 c/o 40p

GARRARD PLINTH & COVER

For Zero-100, etc. Finished in brushed aluminium and black, with hinged smoke grey perspex lid, £11·00.

SCR 1 amp 400 P.I.V. 35p.
5 amp 400 P.I.V. 40p.

EDGE CONNECTOR

54 way ·1 vero size etc.
Can easily be cut to any length 55p. P.P.10p.

CIRCUIT BOARD

P.C.B. 1/16 1 oz. COPPER

FORMICA

Dim. 8·4 x 7·7 in 3 pcs., 80p.
Dim. 9·4 x 8·1 in 3 pcs., 90p.
Dim. 10·1 x 7·9 in 3 pcs., £1·00.
Dim. 13·1 x 9·4 in 3 pcs., £1·20.
Dim. 17·0 x 9·0 in 2 pcs., £1·20.
} P.P. 35p

BARGAIN PACK

10 pcs. 10·1 x 7·9 in. Plus free ½lb etching Xtals, £3·10. P.P. 45p.

FIBRE GLASS P.C.B.

Dim. 6 x 6, in 50p each.
Dim. 12 x 6 in, 75p. each.
Dim. 12 x 12 in, £1·30 each.
} P.P. 15p
Equals less than 1p sq.in.

RESIST COATED P.C.B. FIBRE GLASS

6 x 6 in, 65p ea.
12 x 6 in, £1·20 ea.
12 x 12 in, £2·00 ea.
Post & Packing 15p per sheet.

FERRIC CHLORIDE ETCHING XTALS

1 lb makes 1 litre pack, 70p. P.P. 35p.
5 lb makes 5 litre pack, £2·65. P.P. 65p.

PRINTED CIRCUIT KIT

The no frills all value kit. Containing 4 pcs 8 x 7 Formica laminate. 1 pce 6 x 6 Fibre glass laminate, 1 lb Etching Crystals, 50 c.c. Resist Ink, with instructions. £2·40. P.P. 65p.

BLUE P.C.B. INK

Etch resist use with any pen. Much cheaper than ready loaded pens.
50 c.c. 55p. P.P. 10p.

S-DECS AND T-DECS

S-DEC £1·90. T-DEC £3·60.
U-DEC A £4·20. U-DEC B £6·90.
} P.P. 25p.

FIBRE GLASS BARGAIN PACK

200 sq. in. single & double sided pieces, £1·25. P.P 25p.

OVERLOAD CUT-OUTS

Panel mounting 800 M/A. 1.8 amp. 10 amp. 55p ea.

HIGH CAPACITY ELECTROLYTICS

250mfd/63 volt, 20p. P.P. 8p.
1000mfd/100 volt, 70p. P.P. 25p.
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NEWS... NEWS... NEWS...

SUBSCRIPTIONS – PRACTICAL WIRELESS AND TELEVISION MAGAZINES

WE are still receiving numerous letters requesting subscriptions to *Practical Wireless* and *Television* magazines. For those readers who are not aware, we regret that our magazines can no longer be supplied on direct subscription by IPC Limited due to escalating costs.

This action is very much regretted, but it should not mean that any reader is deprived of his/her regular copies of *Practical Wireless* or *Television*. Readers should order direct from their local newsagents. Any readers outside the UK who have difficulty in locating a supplier should write to the Editor and he will advise them of their local agent.

Soldering Catalogue

A NEW catalogue covering a wide range of soldering instruments and accessories is now available from Adcola Products Ltd. The contents include the well-established range of Invader lightweight soldering instruments for operation from either mains or low voltage supply, the medium 'A' series range and the heavy duty 'R' series of tools. Safety stands and stations, desoldering instruments including the Remov-Ic for DIP extraction and desolder braid are also featured together with solder pots, and wire cutting tools. Details of Superspeed cored solder are also featured.

Despatched with the catalogue is a separate four page technical specification covering the Unit 222 electronically switched variable temperature, thermostatically controlled soldering instrument, and a four-page price list. Details of the Bahco range of pliers for electronics use are also included in the form of a separate leaflet.

Copies of the catalogue and supplementary specifications are available free on request from *Adcola Products Ltd., Adcola House, Gauden Road, London SW4 6LH (01-622 0291).*

Foundations

WELL-KNOWN author M. G. Scroggie whose work Foundations of Wireless and Electronics has just reached its 250,000 sale, is shown here being presented with a specially bound copy of his book.

The publishers, Newnes Butterworth also announced the new 9th Edition of Mr. Scroggie's book.

M. G. Scroggie, B.Sc., C.Eng. FIEE was the second radio Amateur, under the callsign 5XJ, to make two-way radio contact across the Atlantic.

Mr. Scroggie, centre, shows his specially-bound book to Fred Judd, G2BCX (right) while a Newnes-Butterworth employee looks on.

Tyneside Amateur Radio Society

THE Borough of North Tyneside is holding a Festival of Sport and Recreation during July and the Society which operates within the Borough has agreed to take part by establishing an amateur radio station. Members of the public will be invited to see the station in operation and persons interested in the hobby will be assisted wherever possible.

It is intended to go on the air from approximately 10.00 hours on Saturday, 10th July to 18.00 hours on Sunday, 11th July. They hope to be operating on all bands from Top Band to 10 metres and also on 2 metres.

Special QSL cards are now being printed using the Club callsign G3ZQN. All contacts will be sent a card and Special Certificates to be signed by the Mayor of the Borough will be sent to the furthest contact on each band. The venue of the Festival Station is the Pavilion at the Churchill Playing Fields, Monkseaton, Whitley Bay. The venue for normal Society meetings is the *Wallsend Community Centre, Vine Street, Wallsend* every Monday evening at 20.00 hours. New members will be welcome.

RADIO SHOW

SOUND and Vision 76, National Exhibition Centre, Birmingham, 28/31 May, 1976

BBC Stereo Radio from Tacolneston, Norfolk

THE BBC announced that the Radio 2 and Radio 3 VHF transmitters at Tacolneston, Norfolk broadcast in stereo from Friday, 19 March. The start of a full stereophonic service on all three VHF channels is dependent upon the completion of a new pulse code modulation (pcm) link to the station at Tacolneston. It is hoped that this will be possible within the next two years, but to provide stereo in the meantime, a rebroadcast link has been installed, and this will make it possible to provide Radio 2 and Radio 3 in stereo to about 1,100,000 people in Norfolk, Suffolk and the eastern part of Cambridgeshire. Radio 4 stereo programmes will be added to the service when the permanent pcm link has been completed.

With the present extension, BBC stereo radio will be available to approximately 88 per cent of the United Kingdom population. The start of stereo transmissions does not affect listeners using ordinary monophonic receivers, and to take advantage of the stereophonic information, a receiver having a stereo decoder is required. Advice about reception of the BBC's stereophonic service may be obtained from the *BBC's Engineering Information Department, Broadcasting House, London W1A 1AA.*

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

Eagle 1976 catalogue

TO mark their 25th year in electronics Eagle International have created a comletely different format for the new 1976 catalogue. A comprehensive range of over 500 models including some 45 new products are featured in this absorbing 64 page full-colour publication.

For easy reference the catalogue is divided into nine broad product categories — each page carrying a colour code indicating a particular section. It contains more factual information, comprehensive specifications, frequency response graphs and many additional detail photographs. The sections cover hi-fi, tape, headphones, audio, microphones, public address equipment, intercoms, test equipment and ancillary products, plus a comprehensive index with recommended retail prices.

The section on intercoms includes a useful selection guide and the clamp meter and multimeter guides in the test equipment section are of particular interest. A welcome addition is the connecting lead guide which shows the correct hook-up for a complete hi-fi system. As always every Eagle product line carries a two-year guarantee plus a reputable after-sales service, even after the warranty period.

The new Eagle catalogue for 1976 is available on request from *Eagle International, Precision Centre, Heather Park Drive, Wembley, HA0 1SU.*

The Budget and prices in P.W.

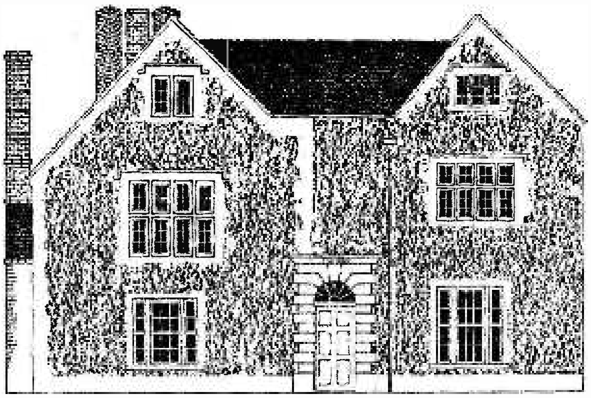
IN the April 6th Budget, VAT at the 25% rate was cut to $12\frac{1}{2}$%. At the time of our going to press we were unable to make alterations to all of our advertisements but we would advise readers that some of the prices quoted on our pages will be different and if ordering goods, it might help to check with the advertisers concerned before purchasing.

Mullard Data Book 1976

THE 1976 edition of the Mullard Data Book is now available. It contains abridged data on the company's range of components for use in consumer applications, including valves, integrated circuits, semiconductor devices, TV picture tubes, capacitors and resistors. Equivalents and comparables are also listed.

Designed for the radio and TV dealer and his service engineers, the pocket-size book runs to 176 pages and, for easy reference, different coloured papers are used for each of the main sections: blue for semiconductors, yellow for picture tubes and receiving valves and green for capacitors and resistors.

The Mullard Data Book is obtainable for 50p direct from *Technical Press Ltd., Freeland, Oxford OX7 2AP.*



The 15th century building, part of which has been offered free of charge for anyone in the Wallingford (Oxon) area wanting to join a Radio/Electronics club.

The Eagle strikes

A NEW symbol has been perfected for Eagle International, which will be systematically applied to all Eagle audio and electronic products, packaging, advertising and promotional material in the coming months.

Marketing Director David Harris says, "The symbol will project an agressive identity for Eagle and will provide an internationally recognisable image for overseas markets". The design adopted is a totemic device depicting a stylised eagle head which expresses the power and majesty of the keen sighted king of the sky.

Free offers galore!

ORCHARD Electronics Director Mr. D. M. Trueman recently sent us this picture of the firm's premises at Wallingford, Oxon. He's offering, completely free, one floor of the building to anyone interested in joining/forming an amateur radio and electronics club in the area. If any readers would like to help form something along these lines, Orchard Electronics would be pleased to hear from them.

Another offer from the firm comes in the form of a free transistor (CIL 108) it's the equivalent of the BC108 and the first 3000 readers who send a stamped, addressed envelope for the Orchard list of components will get one.

If you want a free transistor and components list or are interested in joining up with other enthusiasts to form a club, write to *Mr. D. M. Trueman, Orchard Electronics, Flint House, High Street, Wallingford, Oxon, OX10 0DE. (Telephone: Wallingford (0491) 35529 or 36588).*

RHYTHM GENERATOR

PART 2 A.S.WEBB B.Sc

Power supply

The power supply circuit shown in Fig. 8 is of conventional design providing the three regulated voltages required by the rhythm generator. The regulation is necessary to reduce false triggering of the twin-T oscillators which are very sensitive to supply fluctuations and to ensure that the voltage delivered to the M252 chip across pins 9 and 10 remains at 17V ± 1V. The total current consumption of the complete generator is very low, about 30mA when the LED is off rising to 44mA when on.

Construction

The construction of the rhythm generator is simplified by the use of three printed circuit boards, one for the snare drum, long cymbals, short cymbals, maracas, M252 chip, clock generator and down-beat indicator; the second for the bass drum, high bongos, low bongos, claves, conga drum and pre-amplifier and the third for the power supply unit. No detailed procedure for the mounting of the components is given as this is fairly straight forward although careful soldering is required.

There is, however, one point over which **extreme care** should be taken. The M252 chip and the 4011A NAND gate ICs are manufactured using MOS technology and although various input protection components are built in they are vulnerable to high voltage static electricity. They are normally supplied packed in conductive foam or surrounded in metal foil and should not be removed until ready to be inserted into their respective sockets.

A static charge can build up on anything that is insulated from earth. Friction with modern plastics such as nylon or PVC quickly cause static to accumulate e.g. by combing one's hair or wearing synthetic fibre clothes. A plastic laminate surface on a table with rubber feet could become highly charged after polishing. The basic rule when handling these devices is that the pins should not be allowed to come into contact with anything that is not an earthed conductor. The author uses a pair of metal tweezers connected to earth which automatically earths the body thus making handling completely safe. If the ICs have to be removed from their sockets they should be placed in conductive

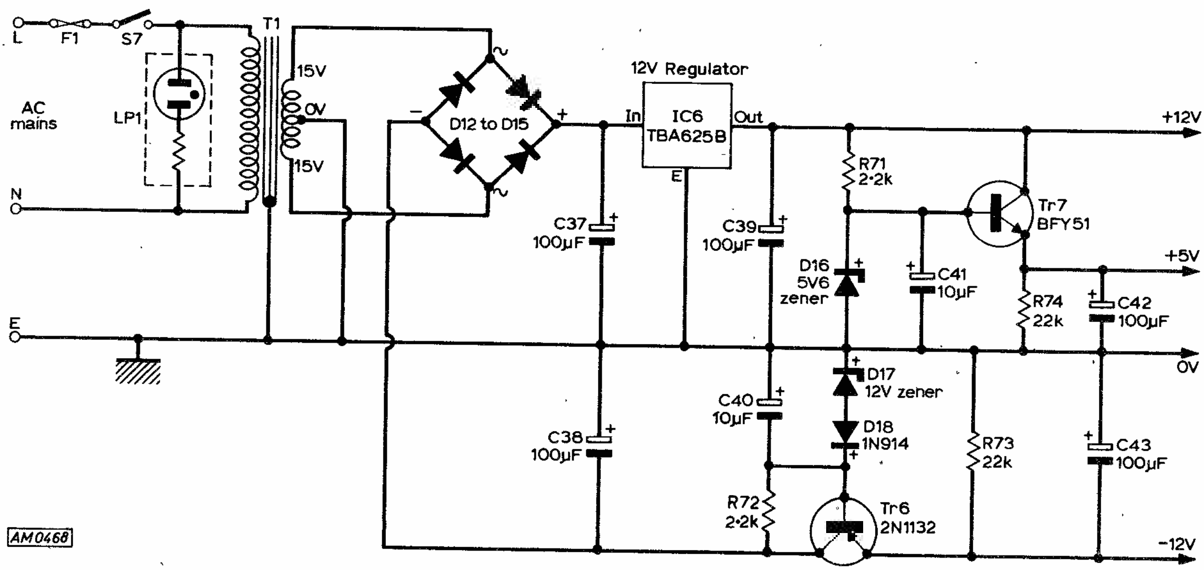


Fig. 8: Circuit diagram of power supply giving −12V and +5V for IC1, +12V and −12V for IC5, and +5V/+12V and 0V for the remaining IC's and transistors.

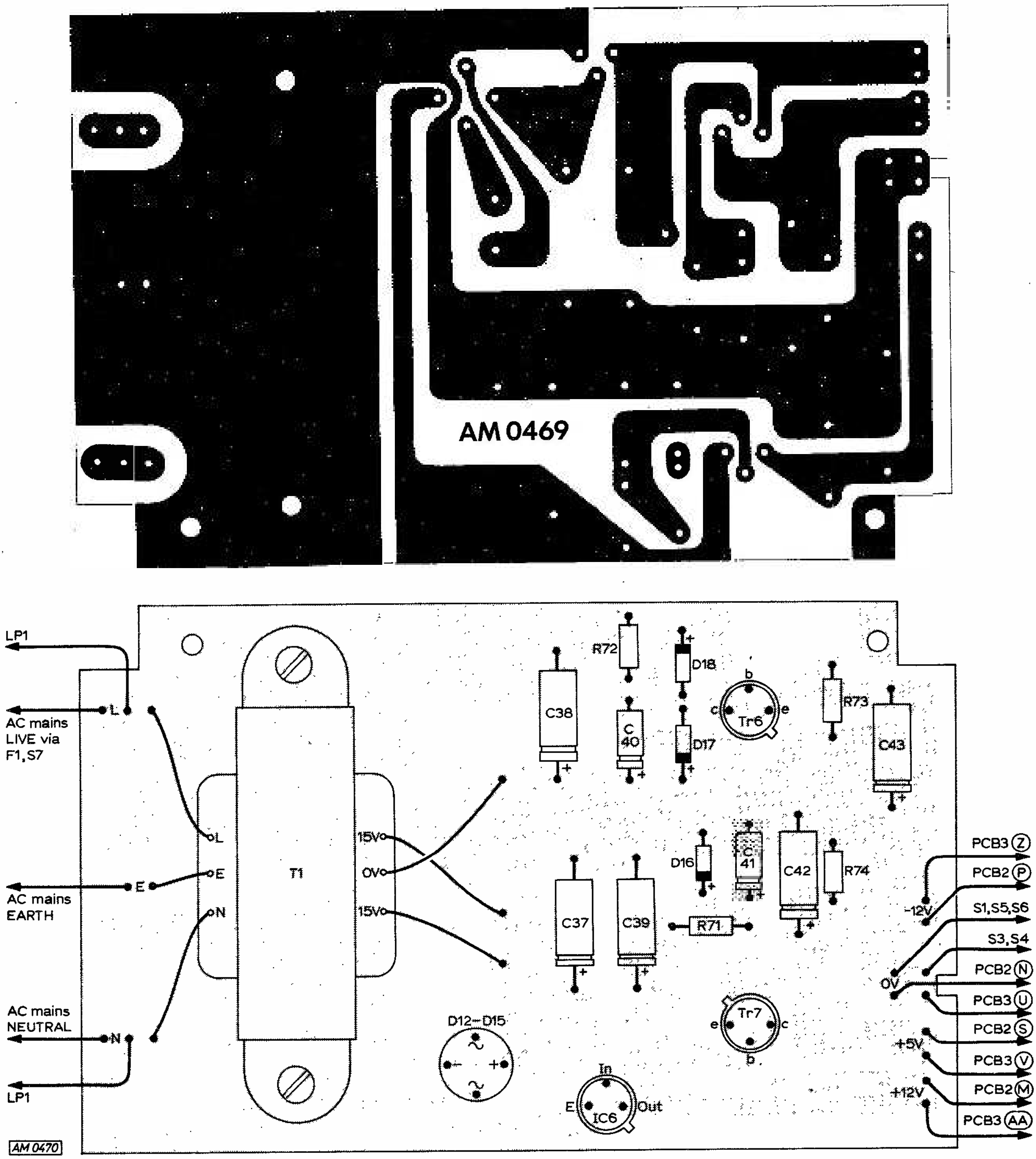
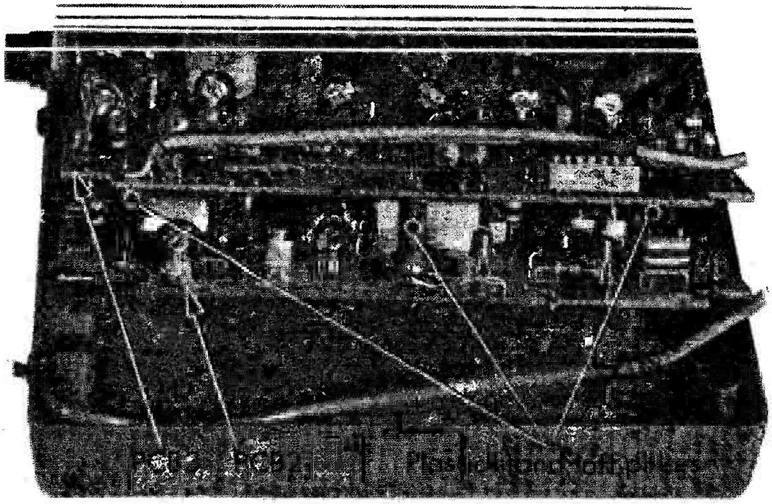


Fig. 9: Full size drawings of the power supply board showing foil side above, and component overlay below.

foam or on an earthed metal plate. **No alterations should be made to the circuit with these devices in position and they should not be inserted with the power switched on.** No apologies are made for stressing these points as a replacement for the M252 chip will cost over £9!

Having obtained all the necessary components the enthusiastic constructor often finds it difficult to resist the urge to put everything together as quickly as possible. Although a lot of the complexity of the circuitry has been taken out of the hands of the constructor and built into the printed circuit boards there is nevertheless a certain amount of interwiring involved. This means that if the generator is not functioning correctly when it has been completed it may be difficult to locate and rectify any fault.

For this reason it is highly recommended that all the components **with the exception of the integrated**



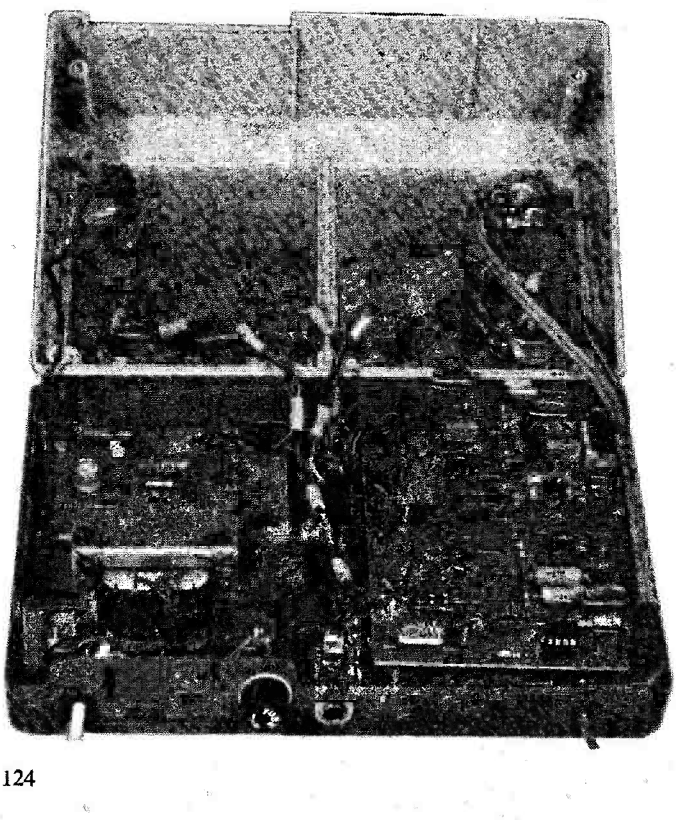
The two pcb's containing the rhythm generating sections are mounted one above the other by means of three plastic stand-off pillars.

circuits are individually checked before assembly. With an ordinary multimeter set to measure resistance, check the values of the resistors against their colour codes, check for leakage of the capacitors, the forward drop and reverse leakage of the diodes and transistors (these may be considered as two diodes connected back to back) and the continuity of the transformer windings, chokes and switches. Also carefully examine the copper track on the printed circuit boards for any hair-line cracks or for bridging caused by roller tinning smear or under-etching.

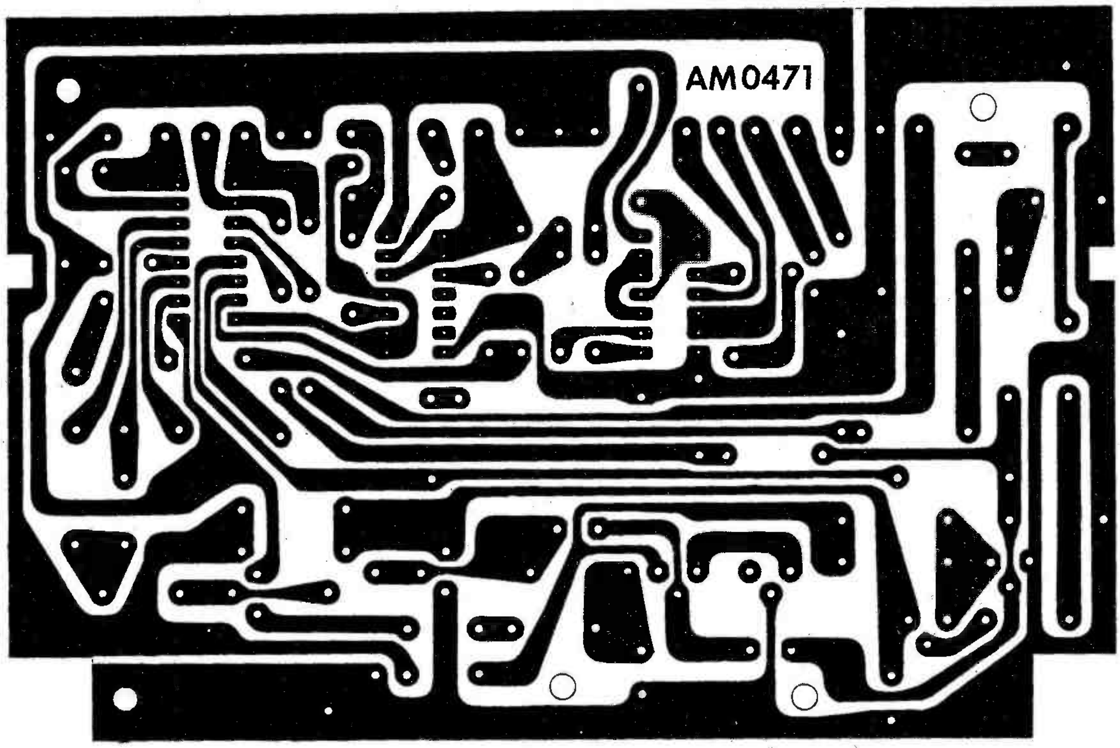
The first step is to assemble the power supply unit on PCB1 referring to the component layout given in Fig 9. Begin by inserting the Vero pins at the appropriate points, followed by the resistors, capacitors, semiconductors and finally the transformer. Having completed the board, check that the capacitors and diodes have been soldered in the right way round. Temporarily connect the mains to the transformer and ensure that the power supply unit is functioning correctly by measuring the three voltage outputs.

If all is well, proceed to assemble the components in the same order as indicated above on PCB2 and PCB3 according to the layouts in Fig. 10 and Fig. 11. When completed check the circuit boards over for mistakes and for any solder bridging the copper tracks. It is well worth taking some time over this as mistakes are easily made and careful checking now may eliminate time-consuming and possibly expensive trouble-shooting later. Don't forget the links!

The interwiring leads are then soldered to the pins on PCB2 in accordance with Fig. 10 allowing sufficient length of wire. The three stand-offs are next inserted and PCB3 pressed home on top. The wiring to this board may now be completed routing all the



Overall photograph of the complete unit, showing details of the PCB layout and positioning of the various switches.



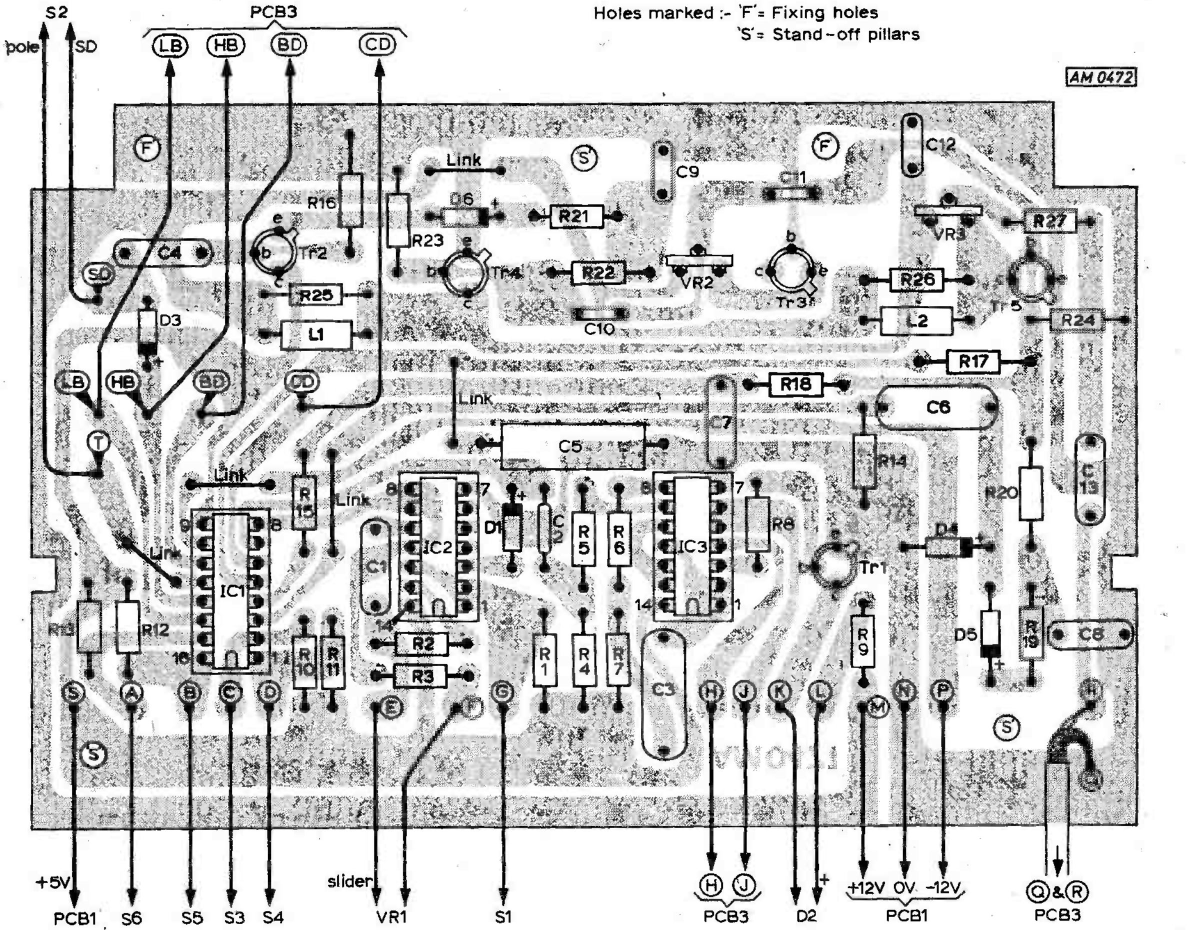


Fig. 10: PCB2 containing the master chip IC1, together with the individual circuits for clock generator, down-beat indicator, snare drum, long and short cymbals, and maracas. Board is shown full size.

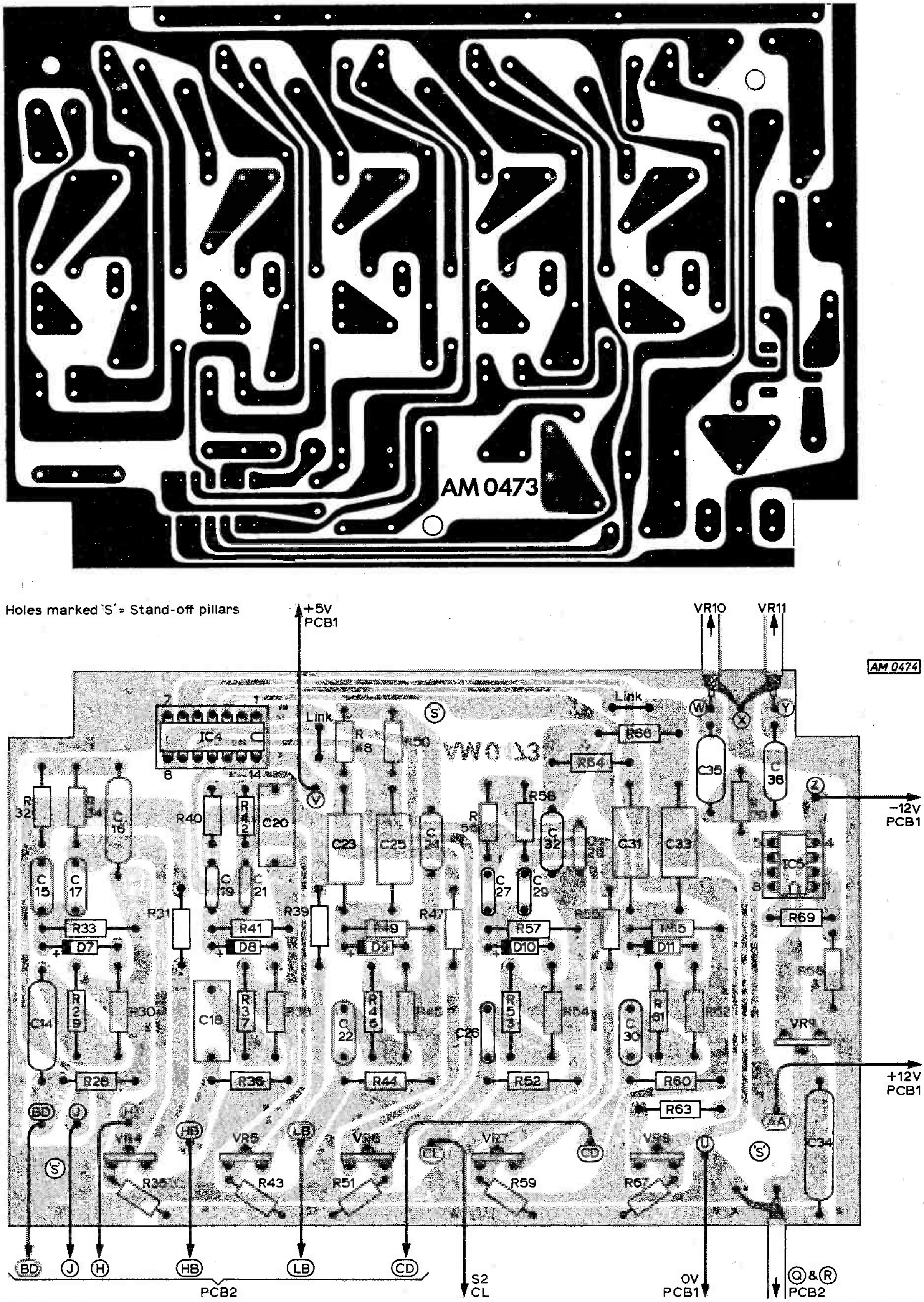


Fig. 11: PCB3, which again is shown full size and contains components for the bass and conga drum, high and low bongos, claves and the pre-amplifier. The NAND gate used for the bass drum is 'borrowed' from IC3 which is situated on PCB2.

wires from the board below on the right hand side. This allows the top board to be "hinged" from the lower one when fitting and making adjustments. Note that the bass drum oscillator utilises a spare NAND gate in IC3 on the lower board.

Case assembly

The Vero plastic box type 65-2523E used in the prototype makes a small and very attractive housing. The light grey moulding is removable allowing easy access to the base. Before mounting the boards inside the case four holes must be

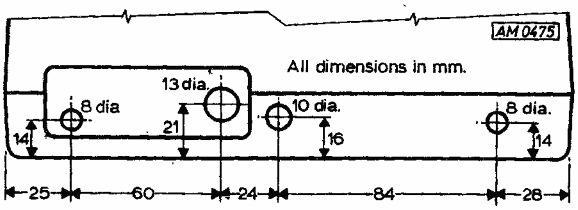


Fig. 12: Rear view of the Vero plastic box base, giving details of the drilling dimensions.

drilled in the back of the base as shown in Fig. 12 to accommodate the fuse-holder, foot switch socket, mains input and signal output leads.

The drilling layout for the front panel is shown in Fig. 13. A really professional finish may be achieved by using Letraset for the legend on the panel as in the photograph. The code table (Fig. 2) should be cut out or copied and stuck in the position indicated for easy reference. The panel will then require protection from abrasion and may be sprayed with a protective lacquer such as Letracote Gloss or alternatively covered in a sticky-backed clear film similar to "Libraseal". Both these items are obtainable from most stationers or artists supplies shops. If the film is used it will be necessary to trim it close to the sides of the panel and in the holes with a razor blade to prevent it peeling off.

The boards may now be fitted in the base with power supply unit on the right and the double board assembly alongside on the left. The base incorporates brass inserts for this purpose. These require 3mm metric screws although at a pinch 6BA could be used if the metric size proves difficult to obtain. The +12V, −12V, +5V and 0V supply lines are now connected up from the power supply to the instrument boards and the mains input lead wired in.

The controls are then assembled on the front panel, see Fig. 14. To preserve the neat appearance of the panel the locating lugs on the potentiometers should be filed off and any locating washers supplied with the miniature switches discarded. To prevent rotation in the absence of these, crinkle washers are fitted between the components, and the back of the panel and the nuts screwed up tightly. Note the tag under the stop switch, S1, to allow earthing of the panel.

The light grey case moulding is placed on the base and the panel controls wired in. There is a supporting strut running vertically across the opening ot the box and the wiring must be routed so that wires are not trapped between this and the panel. For this reason there are two earth wires running from the code switches, one on either side.

The switches S3 and S4 are fairly close to PCB3 when the panel is screwed in position so the link wire between them should be insulated and pressed flat on the panel to prevent it touching VR4.

Final adjustments

For making the final adjustments the output of the generator is connected via a screened lead to an external amplifier and loudspeaker. The three 4011A and the 741 ICs may now be inserted. The insertion of an IC into a socket can be a bit of a problem the more so when the IC has to be handled with caution. New sockets are often very tight and a useful tip is to 'ease' the socket by repeatedly inserting and removing an old IC of the same outline until it is free. With VR9 set midway and with the volume of the amplifier at a fairly low level the preset potentiometers VR4 to VR8, should be adjusted in turn until oscillation occurs and then backed off until it just disappears. In some instances it may not be possible to achieve continuous oscillation of the bass drum circuit but this does not matter. The bass drum may be made to sound momentarily by connecting its input, i.e. the non-earthy side of R28, to the +5V supply. The potentiometer VR4 is then further adjusted to achieve the best sound. The procedure is repeated for the remaining four instruments on PCB3.

The adjustment of the instruments on PCB2 is made by varying VR2 which controls the filtered white noise level in conjunction with VR3 which balances the output from the snare drum with the rest of the instruments on this board. The instruments may again be made to sound by connecting

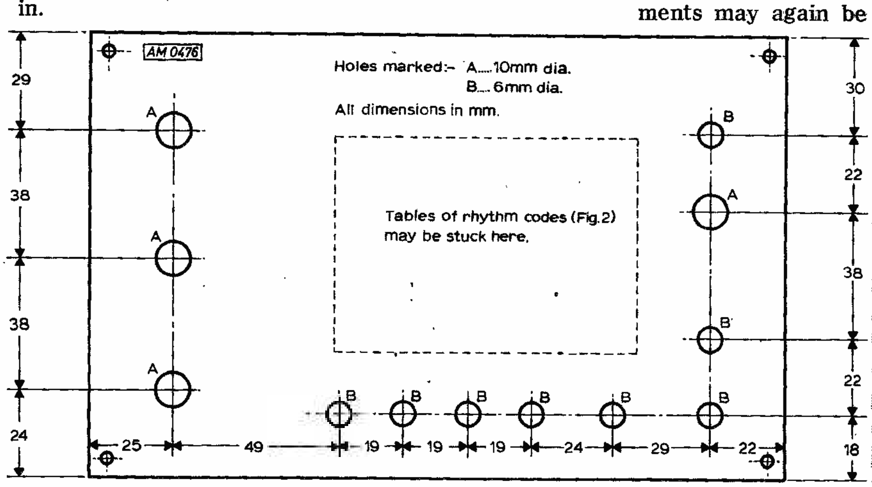
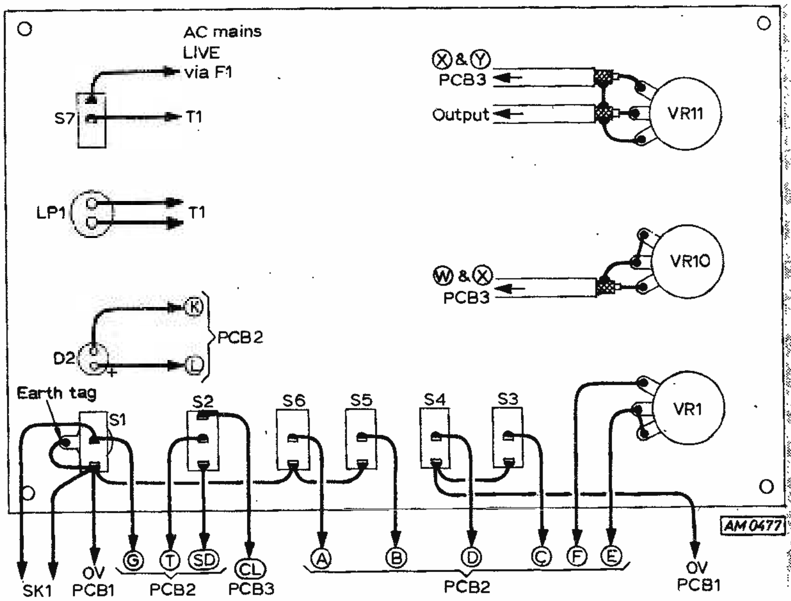


Fig. 13: The front panel is part of the Vero box and should be drilled to these dimensions. After drilling and lettering, the complete panel should be protected with a clear lacquer.



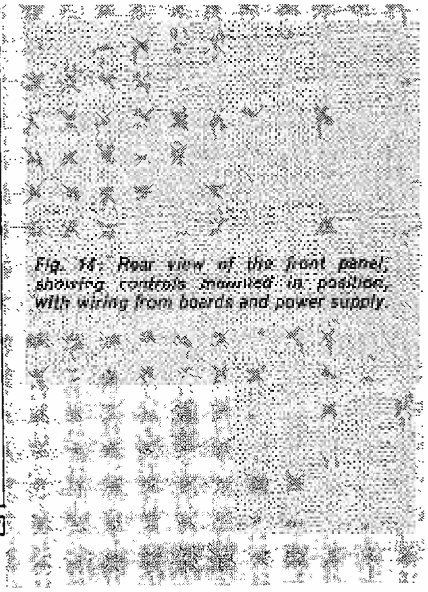


Fig. 14: Rear view of the front panel, showing controls mounted in position, with wiring from boards and power supply.

their respective inputs momentarily to +5V. The preset potentiometer VR9 controls the maximum voltage output from the Rhythm Generator and should be adjusted to suit the sensitivity of the external amplifier.

Having completed the preceding adjustments it is worthwhile checking that the voltage between pins 9 and 10 on the M252 socket is 17V±1V with pin 9 positive. **Switch off the power** and carefully insert the M252 chip in its socket, **the correct way round!** bearing in mind the handling procedure outlined previously. Check through the fifteen rhythms (with S1 open) by entering the various codes given in Fig. 2 on switches S3 to S6. It is important that the tempo is adjusted so that the particular rhythm sounds right and that the snare drum or claves is correctly selected. Final adjustment to the instruments should be made while the generator is running to correct any excessive "ringing", and to achieve the best overall balance of sound. If a foot operated switch is added it should be of the "press to break" type in order to inhibit the generator in its "off" position.

Finally, a word about loudspeakers. The Rhythm Generator by its very nature produces large transient signals especially from the bass drum circuit where, because of its low frequency, large excursions of the loudspeaker cone are required. It is therefore essential that a speaker of adequate power rating is used to avoid permanent damage.

Acknowledgements are due to SGS-ATES for some circuit details. PW

Note. R4 in the components list, Part 1, was incorrect, and should have read 220kΩ and not 22kΩ.

KINDLY NOTE!

STEREO DISCO SYSTEM

Dec 75-Jan/Feb 76

Some readers report encountering earthing problems with the stereo unit. To obviate the risk of earth loops the following earthing table should be followed. The terminal block, Fig. 14 page 849, negative side of the bridge rectifier, will be referred to as the "common earth".

Pin 23 RH amplifier	to Common earth
Pin 23 LH amplifier	to Pin 23 RH amplifier
Pin 2 LH amplifier	to Pin 2 RH amplifier
Pin 2 LH amplifier	to E tagstrip B Fig. 11
Pin 2 RH amplifier	to E tagstrip B Fig. 11
Pin 23 RH amplifier	to Neg. RH speaker socket
Pin 23 LH amplifier	to Neg. LH speaker socket
Mains earth in	to Copper plane, mains panel
Copper plane, mains panel	to Common earth
Transformer metalwork	to E on mains input socket
Pin 32 Light Modulator	to E on mains input socket
Turntable metalwork	to Common earth

All connecting leads to the speaker output sockets should be routed well clear of pre-amplifier and mixer panel. Good quality screened lead must be used for the turntable and mixer connections and the screens of these connected as shown in Fig. 11. It will be noted that all these connections are made to the mixer ONLY.

A transformer of low flux leakage must be used if hum is to be eliminated. The hum level of the prototype at maximum gain setting was virtually nil on both channels.

It is an advantage to exchange capacitors C3 and C5 i.e. C3 to be 100μF and C5 25μF. Resistor R19 should be changed to 390Ω. On mono versions of the Disco omit the balance control and make VR9 10kΩlog.

The polarity of C6 in Fig. 6 and on the PCB supplied by the Readers PCB Service is reversed to what it should be. Reverse the capacitor if already fitted.

Before initial switch-on ensure that VR52 is set fully clockwise.

talking TRANSISTORS

P. MATTHEWS

BEFORE the design formulae of transistors are derived, it is necessary to examine how a transistor is capable of amplification. Conduction is simply the movement of electrons in a general direction within a substance. A substance which allows electrons to flow freely through it is called a "conductor", one which does not is called a "non-conductor" or "insulator". The electrons responsible for conduction are those most loosely held by the nuclei of the atoms of the substance and lie in the outer parts of the atoms. These electrons are known as the "bonding" or "valence" electrons and there are usually two or three of these for each atom. Note that the definition of conduction does not imply that the electrons which start from one end of a conductor need be those which reach the other end, although this is usually the case with good conductors. It could happen that after an electron had been removed from an atom A, leaving a "hole" in A, it could fill up a previously existing hole in an atom B, leaving the electron from atom B to continue. This process is shown in Fig. 1. Note that this is a purely diagrammatical representation of conduction in general, and that in a good conductor all the bonding electrons are quite free from the rest of their atoms.

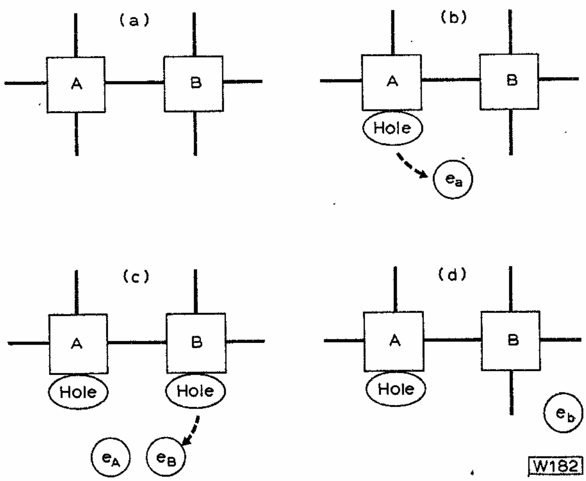


Fig. 1: Diagram to illustrate the idea of movement of electrons in a conductor.

A point worth mentioning is that electrons are considered to have unit negative charge, which is 1 electron-volt (ev) in value, and that a flow of negative electrons in one direction is denoted by a flow of positive current in the other direction. This fact is brought out in Fig. 2, which depicts a simple battery and resistance circuit. At the negative battery terminal there is available a supply of electrons which flow through the resistor to the positive terminal where there is a shortage of electrons. In fact, the battery serves just to pump electrons from its positive to its negative terminal, through the internal circuit of the battery. An electric current flows from the positive, through R, to the negative terminal.

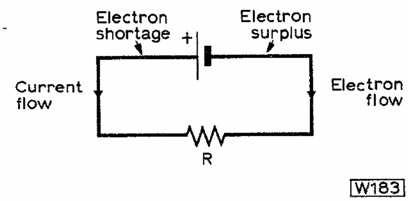


Fig. 2: The electron state in the simplest of circuits.

In summing up, it should be remembered that in conductors, including "resistances", the bonding electrons are effectively separate from the rest of the atoms, whereas they are tightly held in insulators. As a matter of interest, this can be illustrated by observing the effect of heat on conduction, through the two classes of materials. An increase in the temperature of a conductor causes a drop in conductance (and increase in resistance) because the increasing vibration of the "stationary" ions impedes the otherwise almost free flow of electrons. When an insulator is heated it remains as such until a certain high temperature when the insulator "breaks down" into a conductor because the electrons part from the atoms.

SEMICONDUCTORS

A semiconductor is a substance which falls between the general categories of conductors and non-conductors. In other words, it is a very high resistance conductor at room temperature. As an example, the resistivity of silver, a conductor, is about $10^{-6}\Omega/cm^3$, that of pure germanium, a semiconductor, about 60, and glass, an insulator, 10^{10}.

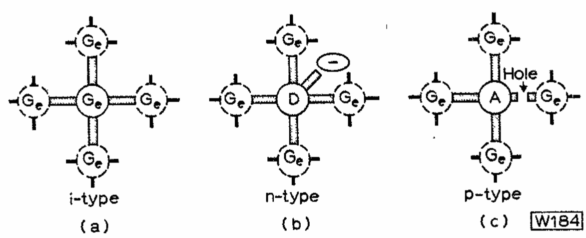


Fig. 3: Three types of germanium, the n and p types being the result of added impurities.

Semiconductors are really insulators which have a low "breakdown" temperature and they behave as insulators when cooled appreciably. Between somewhat below room temperature and about 75°C in the case of germanium (approx. 150°C for silicon) the resistivity falls very sharply until it is so low that the material acts as a conductor.

It happens that the introduction of traces of impurities into the semiconductor over this temperature range has unusual effects on the resistivity and to see why this occurs it is necessary to take a closer look at the structure of semiconductors. Germanium, an elemental semiconductor, has four bonding electrons, and forms a crystalline type of structure, with each electron teaming up with one other electron from and adjacent germanium atom. Although the bonding pairs of electrons are symmetrically arranged in three dimensions, Fig. 3 has been drawn in two dimensions for simplicity.

Suppose an impurity is introduced into the structure. In diagram Fig. 3(b) so-called "donor" impurities, such as arsenic or phosphorus, which have five bonding electrons, are fitted into the structure. It can be seen that one electron is left over because only four are required for bonding, hence the name "donor". The space electron is weakly held by the donor nucleus. Germanium modified in this way is known as n-type germanium alloy and contains large numbers of virtually free electrons.

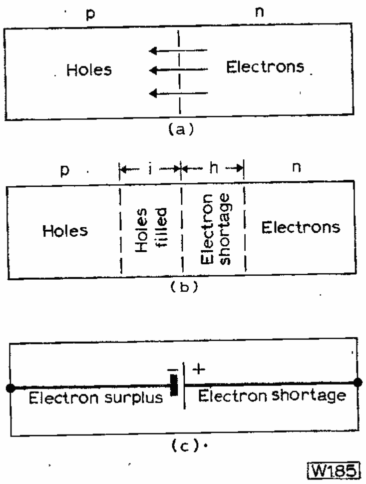


Fig. 4: Illustration of electron flow in a p-n junction.

An opposite effect occurs when "acceptor" impurities, such as aluminium, boron or indium, with three bonding electrons, are added to form p-type germanium, Fig. 3(c). One electron is needed to complete the structure so that there is a positive hole. It can be seen that this p-type germanium is conductive since electrons can be attracted away from nearby atoms to fill the hole. In this way, the passage of a negative electron from A to B corresponds to that of a positive hole from B to A.

There are, therefore, two important types of impure germanium, the n-type which has been treated with a trace of a **donor** impurity, and the p-type with an **acceptor** impurity. Electrons can move freely through both p and n alloys so they can be classed as conductors. This is contrasted with pure or "intrinsic" i-type germanium, in which there is only limited intrinsic conduction at a given energy level.

THE P-N JUNCTION

When a strip of pure germanium is treated so that one half is of p-type and the other of n-type germanium, there is said to be a "p-n junction" in the middle. Almost as soon as the junction is formed, some loose electrons break away from the n-layer and a few of these diffuse into the p-layer to fill in the holes nearest the junction. This means that there is a

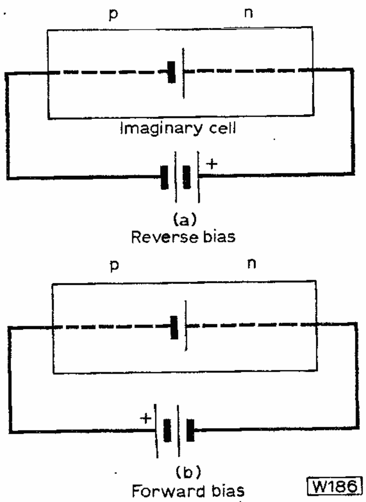


Fig. 5: The two forms of biasing applicable to a junction.

layer of intrinsic germanium on the p-side of the junction. However, i-type germanium constitutes a comparatively very high resistance and so the electron flow from n to p ceases almost immediately, an equilibrium being set up at a given temperature. This is illustrated in Fig. 4 (a) and (b). Since electrons have moved from the n layer to the p layer, there is a shortage of electrons in the n-region and a surplus in the p-region. Another way of saying this is that the n-half of the p-n junction has obtained a positive charge with respect to the p-half. This is represented diagrammatically by means of a cell in Fig. 4(c). The value of this "contact potential" is about half a volt, and it is important to remember this.

Consider what happens when an external source of EMF is applied across the junction terminals, and its polarity opposes that of the imaginary cell, as in Fig. 5(a). This is known as biasing in the reverse direction. Only a small current flows as the insulation or "depletion" region of germanium atoms in the junction is "reinforced" or widened. When the external battery is connected the other way, as in (b), the depletion region is broken down and electrons flow freely from the n-region to the p-region. This is known as biasing in the forward direction. In other words, the p-n junction acts as a rectifier provided that the applied voltage is greater than its contact potential. This simple p-n junction rectifier has found a large number of applications in industry and is currently available in a wide variety of types ranging from modern versions of the "cat's whisker"

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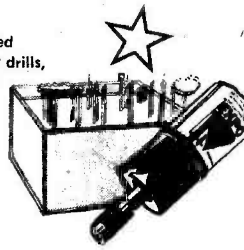

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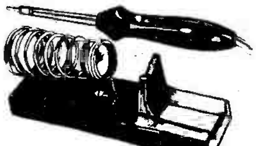

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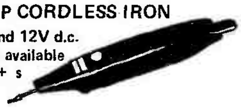

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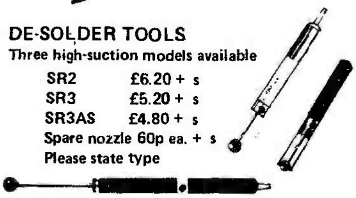

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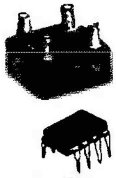

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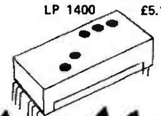

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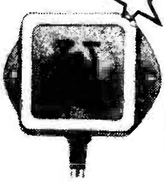

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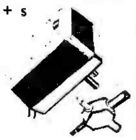

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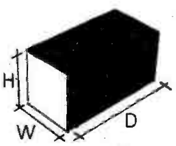

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detector to power units capable of handling hundreds of ampères.

It should be mentioned that germanium is not the only semiconductor, there being many covalently bonded crystalline compounds and a few elements which exhibit this effect. Silicon is commonly used today and, in all that has been written so far, "silicon" can be substituted for "germanium" as both elements have four bonding electrons and function in the same way.

THE JUNCTION TRANSISTOR

An ordinary junction transistor is basically a strip of semiconductor material, such as germanium or silicon, which has been processed so that it is either all n-type except for a narrow p-region in the middle (n-p-n transistor) or p-type except for a narrow n-region (p-n-p transistor). These connections are made to the strip, one to each end (emitter, collector) and one to the centre region (base). The p-n-p transistor has been very popular in Britain for many years, but n-p-n transistors are now becoming more common. The following discussion will be confined to the n-p-n transistor, although what is stated applies also to the p-n-p transistor, but with voltages reversed and "holes" in place of "electrons".

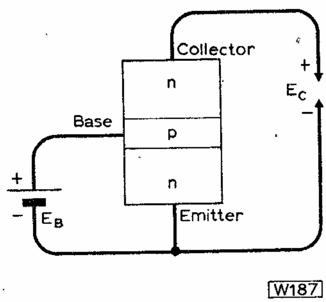

Fig. 6: Polarities of voltages applied to a junction transistor, in this case an n-p-n type.

Transistors are normally biased by two external voltage sources, as shown in Fig. 6. When the base lead is disconnected, only a small leakage current flows through the transistor. If the base is given a small positive bias E_B, the emitter-base pn junction is biased in the forward direction and electrons are emitted from the emitter towards the base. Now the base region is very thin, so that a large fraction of the electrons travel on into the collector region where they are attracted by the electron shortage caused by the collector-emitter battery, E_C. This fraction, which is obviously less than unity, is given the symbol "α" and with most transistors has a value of about 0·98. The remainder of the electrons flow out through the base connection.

It has therefore been shown that a small current, Ib, flowing into the base causes a much larger current, Ic, to flow into the collector, and this is what is meant by "current amplification". The ratio, small change in Ic/corresponding change in Ib, is known as the "current gain" of the transistor of a particular working point, and it is denoted by the symbol "β". Many transistors have a β of about 50. It will be shown later that $\beta = \alpha/1-\alpha$.

AMPLIFICATION

The emitter of a transistor corresponds to the cathode of a triode valve, the base to the grid and the collector to the anode. The polarities of the bias voltages for an n-p-n transistor are similar to those of a triode, but those for a p-n-p type are different. It is convenient at this point to note two important differences between valve and transistor characteristics.

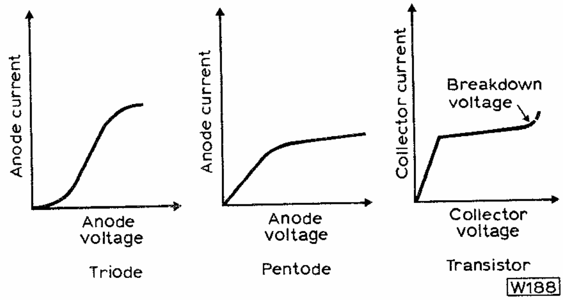

Fig. 7: Characteristics of a transistor compared to two types of thermionic valve.

(i) Transistors have a finite base current flow and consequently a low input impedance. Valves do not.

(ii) The collector voltage/current graph of a transistor can be divided into two sections characterised by a low collector (output) impedance at low voltages, and a linear high impedance region of higher voltages. Valves show somewhat different characteristics as illustrated in Fig. 7.

Transistors can be operated in the three modes, common base, common emitter and common collector, similar to their valve counterparts, and these circuits will now be considered in greater detail.

COMMON BASE

The common base or "collector follower" amplifier circuit is used, like the common grid circuit, for VHF and UHF amplification, as well as to match low impedance to high impedance. Its theoretical and representative practical circuits are shown in Fig. 8.

The current amplification, A_I, is defined as small change in ic/corresponding change in ib which is equal to α. Voltage amplification A_v, is given by small change in output voltage/corresponding change in input voltage, and since, from Ohm's Law, $V = I \times R$, this can be written as $\frac{ic}{ie} \times \frac{R_L}{r_{IN}}$, which is the same as $\alpha \frac{R_L}{r_{IN}}$.

The power gain, A_p, is the product of voltage and current gain which is $\alpha^2 \frac{R_L}{r_{IN}}$ or just $\alpha \cdot A_V$.

The input impedance is defined as r_{IN} = small change in ebe/corresponding change in i_e. However, from Ohm's Law, $V = I \times R$, so that

$$e_{be} = i_e (r_{IN} + R_S) = i_e \cdot r_{IN} + i_e R_S.$$

$$\therefore i_e r_{in} = e_{be} - i_e R_S$$

$$\therefore r_{IN} = \frac{e_{be}}{i_e} - R_S$$

It is thus shown that the total effective Rin is the sum of the transistor input impedance and the source impedance, Rs, of the input. The transistor input impedance is found to vary greatly with R_L.

The output impedance, r_{out}, is small change in e_{cb}/ corresponding change in i_c.

This quantity tends to increase as the source impedance, Rs, increases.

Examples

Fig. 9 depicts an impedance converter for matching a 200Ω (low impedance) moving coil microphone to a 24V transistorised amplifier with a 10kΩ input impedance. A low-noise n-p-n medium power transistor with an α of 0·990 is used. Find, approximately, (a) current (b) voltage (c) power gains of the circuit, assuming $r_{IN}=200\Omega$.

(a) Current gain $= \alpha = 0{\cdot}99$

(b) Voltage gain =

$$\alpha \frac{R_L}{r_{IN}} = \left(0{\cdot}99 \times \frac{10{,}000}{200}\right) = 50 \text{ approx}$$

(c) Power gain $= A_I A_V = 50$ approx

Note that R_L has been made as small as possible to ensure low input impedance and that a resistor R1 has been included in series with the input to increase the transistor output impedance, typically,

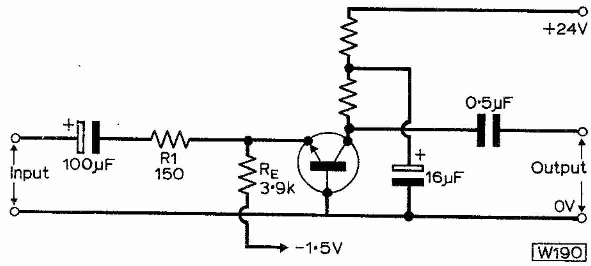

Fig. 9: Circuit using a collector-follower as an impedance matching device, the characteristics of which are discussed in the text.

to over 100kΩ. This is, of course, shunted by R_L, so that the overall output impedance is nearly 10kΩ, as required.

COMMON EMITTER

The theoretical and practical representative circuits of common emitter amplifiers are shown in Fig. 10. The common emitter circuit is widely used for AF and many lower frequency RF applications where a

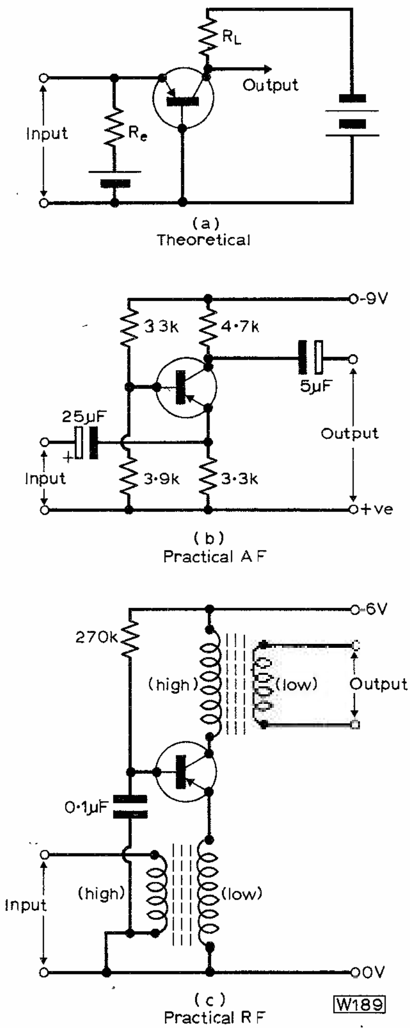

Fig. 8: Transistor in a collector-follower configuration (a) with a practical circuit for audio applications (b) and high-frequency use (c).

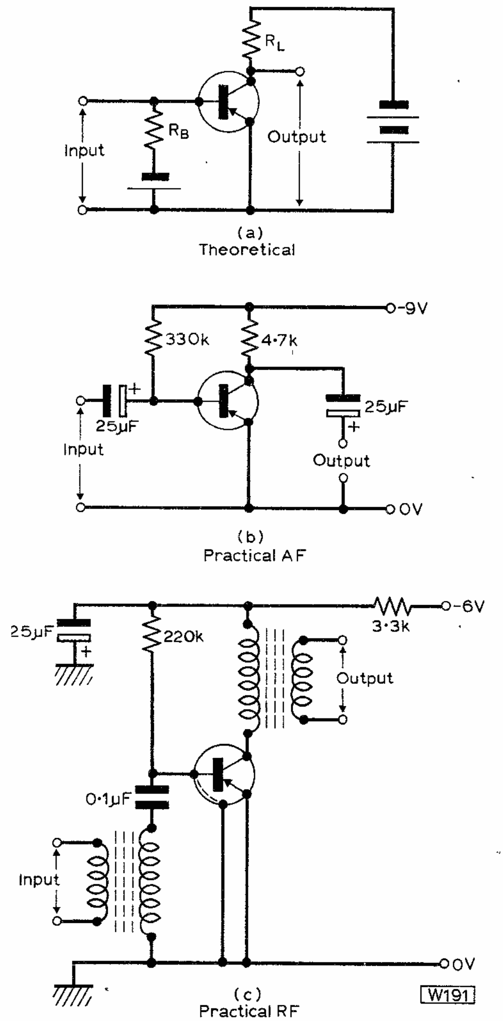

Fig. 10: Theoretical circuit (a) and two practical circuits (b) and (c) for a common-emitter high gain application.

high gain is necessary. It is seldom found in VHF applications because common base circuits are more stable and give greater gain.

The common emitter current gain, often denoted by β, is given by $\beta = \frac{\alpha}{1-\alpha}$, which is derived as follows:—$\alpha = i_c/i_e$ But $i_e = i_c + i_b$ (Using Kirchoff's 1st Law) (as)

$$\therefore \alpha = \frac{i_c}{i_c + i_b} \therefore \alpha\,(i_c + i_b) = i_c \text{ and eventually}$$

$$\frac{i_c}{i_b} = \frac{\alpha}{1-\alpha} = \beta$$

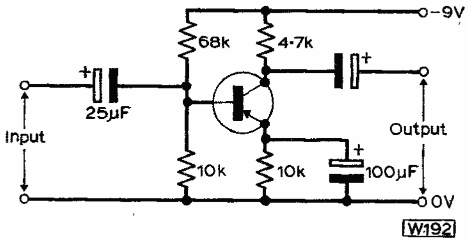

Fig. 11: Typical audio stage using the common-emitter circuit.

Thus, if for a given transistor $\alpha = 0{\cdot}98$, then

$$\beta = \frac{0{\cdot}98}{1 - 0{\cdot}98} = 49.$$

As for common base operation, the voltage gain is calculated from Ohm's Law:—

$$A_v = \frac{\text{small change in } e_c}{\text{corresp. change in } e_{eb}} = \frac{i_c \times R_L}{i_b \times r_{IN}} = \beta\left(\frac{R_L}{r_{IN}}\right)$$

The power amplification, being the product of voltage and current amplifications, is given by

$$\beta^2\left(\frac{R_L}{r_{IN}}\right) \text{ or } \beta(A_v).$$

As with valves in the common cathode (normal)

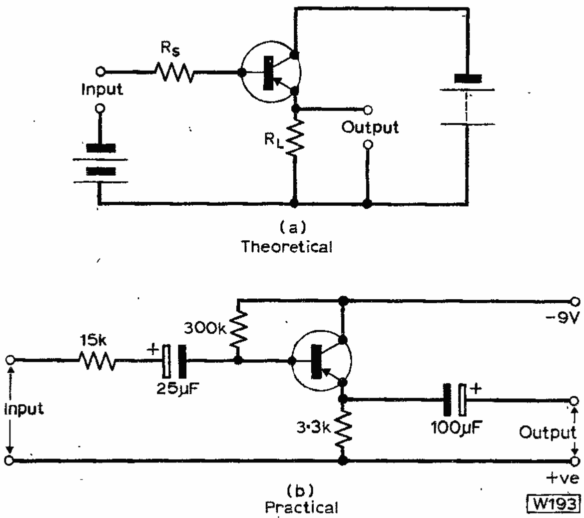

Fig. 12: Theoretical and practical circuit for the emitter-follower which can be used to convert a high impedance circuit to a low one.

configuration there is a phase change of approximately 180° between output and input.

Similarly the input impedance $r_{IN} = \left(\frac{e_{be}}{i_b} - R_s\right)$.

This quantity is greater (about 1kΩ for a small AF transistor) than in the common base mode, and decreases slightly with increasing R_L. The output impedance r_{out} is considerably lower than in the common base mode, and decreases somewhat with increasing R_S.

Fig. 11 depicts the first AF stage in a transistor radio set. Find (a) the current gain (b) the voltage gain (c) the power gain, if the transistor has an α of 0·983 and the input impedance is 1kΩ. Neglect the loading of the following stage.

(a) $\alpha = 0{\cdot}983 \therefore \beta = \frac{\alpha}{1-\alpha} = \frac{0{\cdot}983}{0{\cdot}017} = 58$ approx

(b) Voltage gain $= \beta \times \frac{R_L}{r_{IN}} = \frac{58 \times 4{\cdot}7 \times 10^3}{1 \times 10^3}$
$= 273$ approx

(c) Power gain $= \beta \times A_V = 58 \times 273 = 15834$

COMMON COLLECTOR

This third configuration, sometimes known as the "emitter follower", is used only for matching a high impedance to a low impedance. It is not commonly found elsewhere because little power gain is possible, the voltage gain being less than unity. The current gain is about the same as for common emitter operation. Input impedance is found approximately from $\frac{\beta}{R_L}$, output impedance from $\frac{R_S}{\beta}$. Although these are only approximate it is found that accurate values are seldom needed. Fig. 12 shows theoretical and practical common collector circuits.

PW TECHNICROSS PUZZLE

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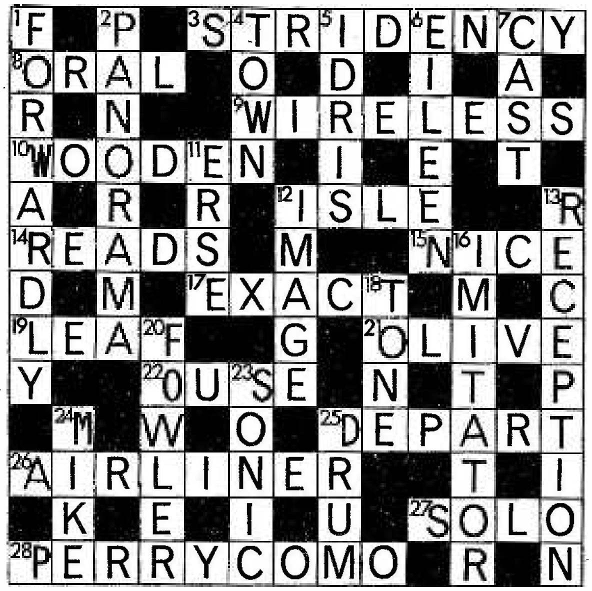


receiver calibration AID

F.G.RAYER

IF a home-built receiver or a signal generator is to be calibrated, or a receiver with errors in calibration is to be adjusted, some accurate means of obtaining frequencies for this purpose is required. Assuming that an accurately calibrated signal generator is not available, one method is to employ a harmonic marker giving a range of known frequencies. Such a marker is generally crystal controlled and thus relatively expensive. However, it is possible to dispense with crystals and still obtain a degree of accuracy which is greater than that with which the usual tuning scale can be read visually and which is thus high enough for most purposes.

The unit described here is not crystal controlled, but provides frequencies of 100kHz, 1MHz and 5MHz, and their harmonics, and can be of enormous aid in calibrating the tuning scales of receivers covering frequencies to 30MHz or higher.

HARMONIC CALIBRATION

Fig. 1 shows some of the calibration signals obtained from the unit, and which might be marked on a receiver tuning scale. These will explain how the calibrator aid is used. One fundamental frequency provided is 100kHz, and its harmonics are multiples such as 200kHz, 300kHz, 400kHz, and so on. Scale "A" is a typical medium wave range for a receiver and the 100kHz harmonics furnish calibration points from 600kHz to 1500kHz (or 1·5MHz). If necessary, the 1000kHz mark is at once identified by the 1MHz fundamental frequency provided by the unit.

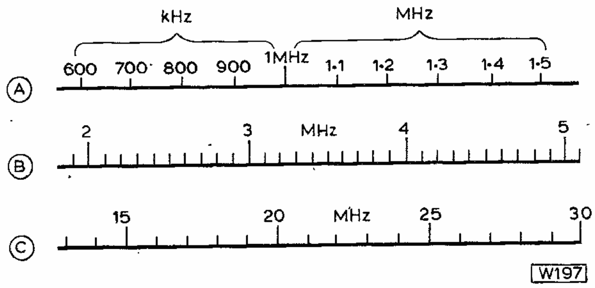
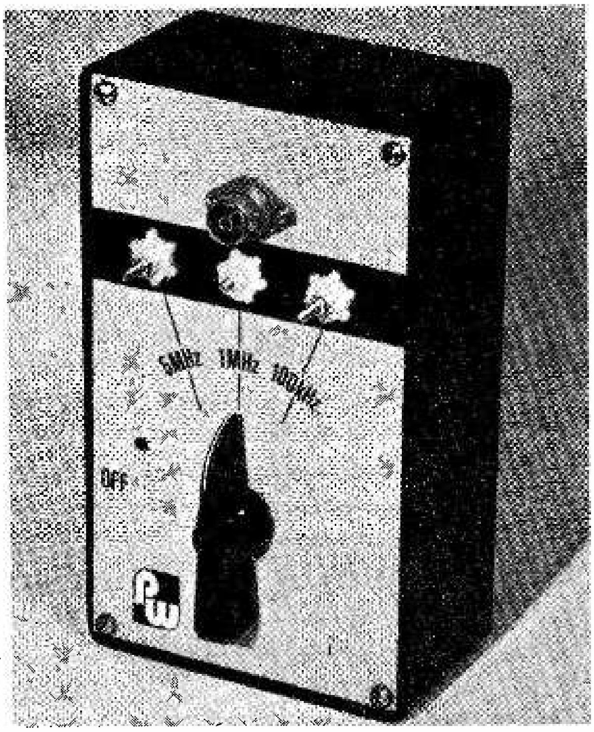


Fig. 1: Typical dial calibrations on a receiver, all of which can be checked with the calibrator.

Scale "B" is a short wave band, in this instance covering from 1·8MHz to 5·1MHz. The 2, 3, 4 and 5MHz tuning points are given by harmonics of the 1MHz frequency and the 100kHz (or 0·1MHz) harmonics fill in between these. This permits calibration for an Amateur band such as 1·8-2·0MHz or 3·5-3·8MHz to be made easily.

Scale "C" is that of a higher frequency range with 5MHz points from 15MHz to 30MHz given by harmonics of the 5MHz frequency, and 1MHz intervals completed by the 1MHz signal harmonics. There is of course no need to provide only those calibration marks shown in Fig. 1. The 100kHz signal and its harmonics, the 1MHz signal and its harmonics, and the 5MHz signal and its harmonics may be used without breaks over the whole frequency range, up to the frequency limit at which they can no longer be detected.



The author's prototype built on a metal panel and fitted in a plastic box. General radiation may provide sufficient signal for most purposes but for maximum output the signal can be taken from the coaxial socket.

Each range of harmonics is obtained without any indication of the order of multiplication. For example, if a MW band is dealt with (such as "A") marker signals will be heard at 100kHz intervals. To number these, it is necessary to discover what the frequency of one such mark is. Here, the 1MHz signal does this, and the scale can be counted off and numbered up and down from this point.

With a range similar to that at "B" 5MHz could be identified from the calibrator and 1MHz harmonics counted off from this. With range "C" it would be necessary to identify readings to one 5MHz point, either by reference to the expected tuning coverage of the receiver, or by finding a known band, such as the 14MHz or 21MHz Amateur band, by listening. Once any single frequency is identified, calibration points can be counted from it, and numbered.

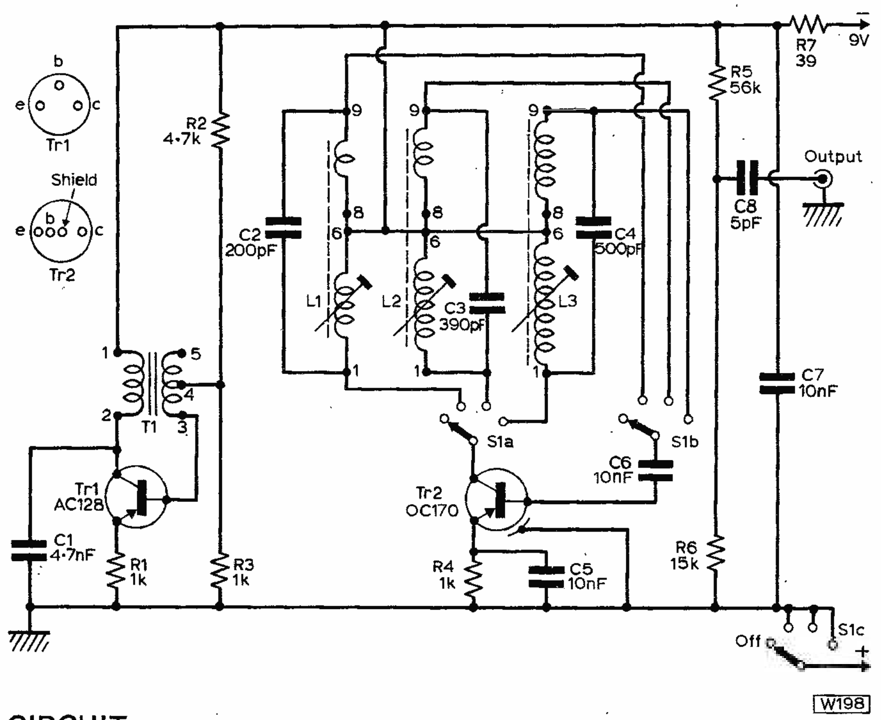


Fig. 2: Circuit of the calibration aid and transistor leadout diagrams. Modulation is obtained by means of the common load resistor R7. If the audio modulation is absent reverse ONE winding only of transformer T1.

CIRCUIT

In Fig. 2, Tr1 is an audio oscillator and modulates the RF oscillator because of the common resistance R7, to allow easy identification of the marker signals. Should T1 be other than listed, it may be necessary to reverse connections to one winding to obtain oscillation, or to change C1 or R1 to secure a suitable tone.

Transistor Tr2 is the RF oscillator and the 4-way switch S1 transfers collector and base circuits to L1, L2 or L3. These inductors are tuned by capacitors C2, C3 and C4 and are set to 5MHz for L1, 1MHz for L2, and 100kHz for L3, by adjustment of the cores. Signal output is taken from the capacitor C8, but in many cases no electrical connection to the output socket is necessary. One pole of the switch breaks the battery circuit.

CONSTRUCTION

Most of the components are assembled on plain perforated Veroboard 95 x 41mm ($3\frac{3}{4}$in x $1\frac{5}{8}$in) as in Fig. 3. A bracket cut from scrap metal is bolted to the board which allows the switch to be used to mount the board on the panel. The collector lead of Tr2 and C6 are connected directly to tags S1a and S1b of the switch. S1c has a flexible connection with a positive clip while the battery negative runs from R7. Put sleeving on all leads where necessary.

The case used has a panel 152 x 90mm (6 x $3\frac{1}{2}$in) but any box of somewhat similar size would be satisfactory. The switch and assembled circuit board fit as in Fig. 4. Holes are also drilled for the three coils and for the output socket. The latter holds a bracket, fitted to retain the battery at the end of the case.

For easy soldering, the coil pins should be scraped first and lengthy heating must be avoided here or the pins may become loose in the formers. Wiring can be finished off from Fig. 4 and a check made that all is in order.

COIL ADJUSTMENT

The capacitor values are chosen so that adjustment of a coil core allows a fairly small band of frequencies around that wanted to be tuned. Before the unit can be used the cores have to be set with the aid of a radio receiver. To set L3 to 100kHz tune the receiver to the long wave programme of BBC on 200kHz. Switch the calibrator to 100kHz and turn the core of L3 until a whistle is heard on the programme. This is the second harmonic of 100kHz. A zero beat or central position will be found, which is

★ components list

Resistors

R1 1kΩ	R5 56kΩ
R2 4·7kΩ	R6 15kΩ
R3 1kΩ	R7 39Ω
R4 1kΩ	

All $\frac{1}{4}$ or $\frac{1}{2}$ watt 10%

Capacitors

C1 4·7nF	C5 10nF
C2 200pF SM	C6 10nF
C3 390pF SM	C7 10nF
C4 500pF SM	C8 5pF

Semiconductors

Tr1 AC128	Tr2 OC170

Miscellaneous

T1, AF driver transformer (Doram 217-668 or Home Radio TR63. L1, 'yellow' range 4, L2, 'yellow' range 3, L3, 'yellow' range 1 (Denco, valve type). S1, 3-pole 4-way wafer switch. Knob. Output socket. Case approx 152 x 90 x 50mm deep with metal panel. Plain veroboard 95 x 41mm approx. Battery and clips.

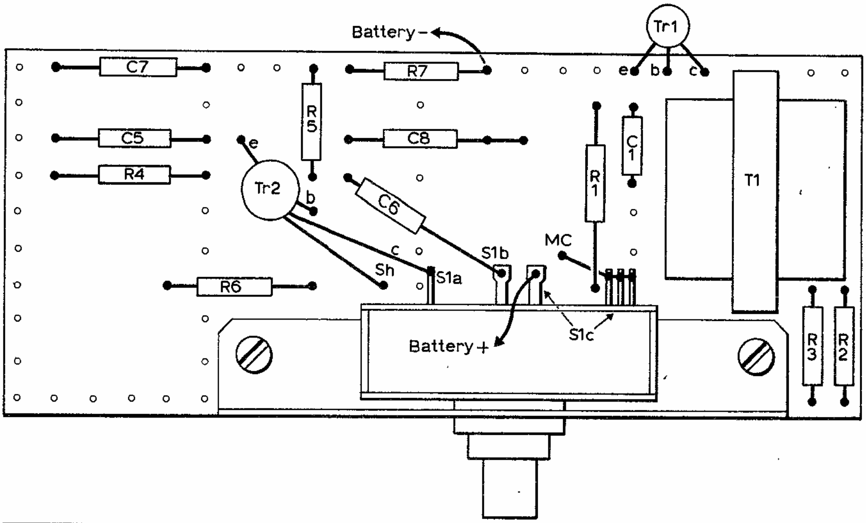
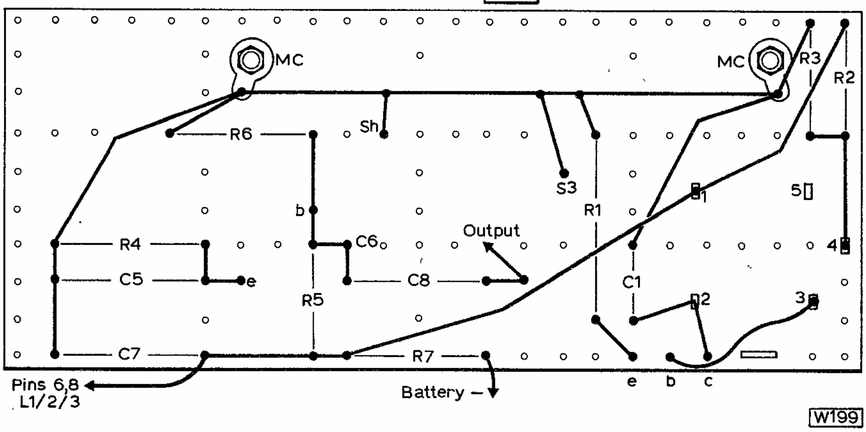
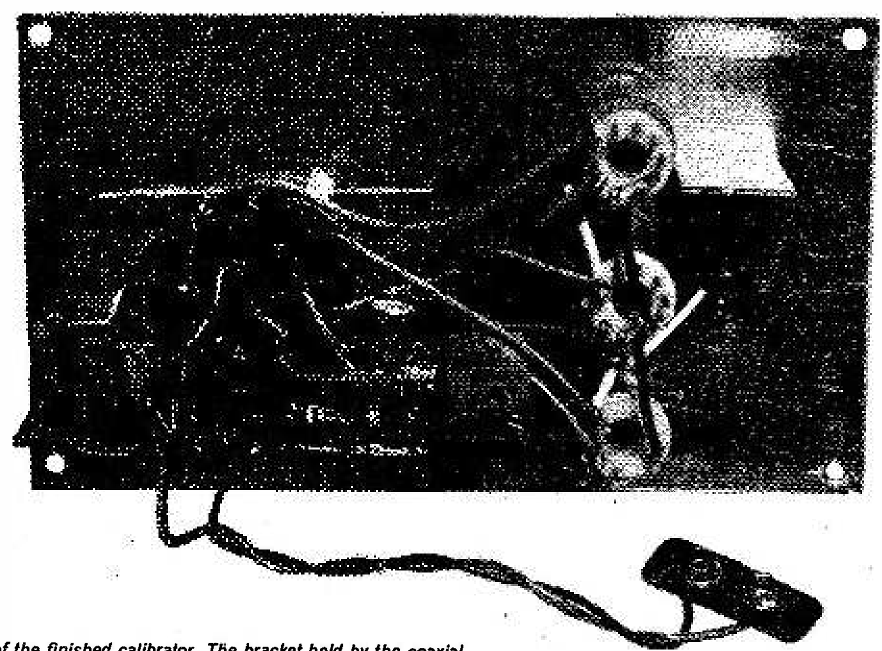


Fig. 3: Top view of the veroboard on which the calibrator is constructed. A metal bracket carries the wafer switch, the lock nuts on the switch spindle being used to secure the unit to the panel.



The wiring under the board. In most cases the component leadout wires can be used instead of cutting them short. Terminal pins can be fitted to the board as required and used for anchoring points.



Photograph of the finished calibrator. The bracket held by the coaxial socket locates the PP9 battery when the calibrator is placed in its case.

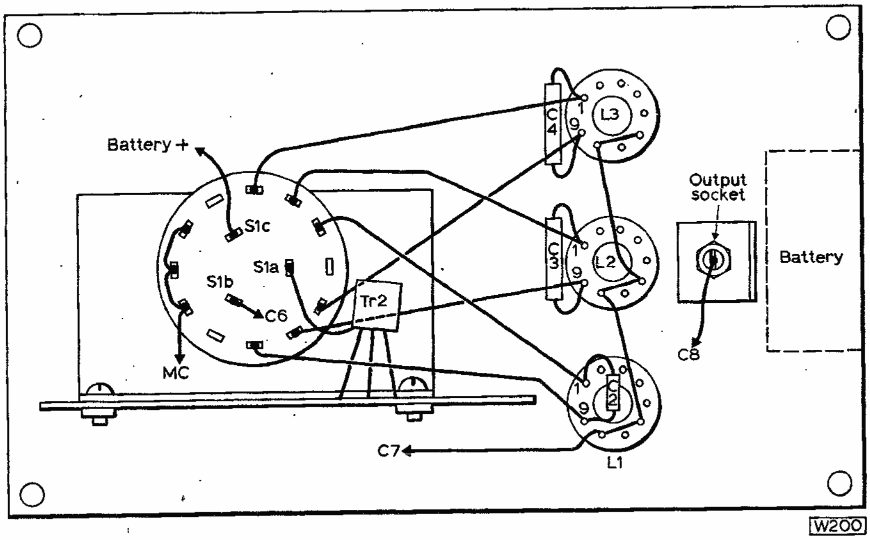
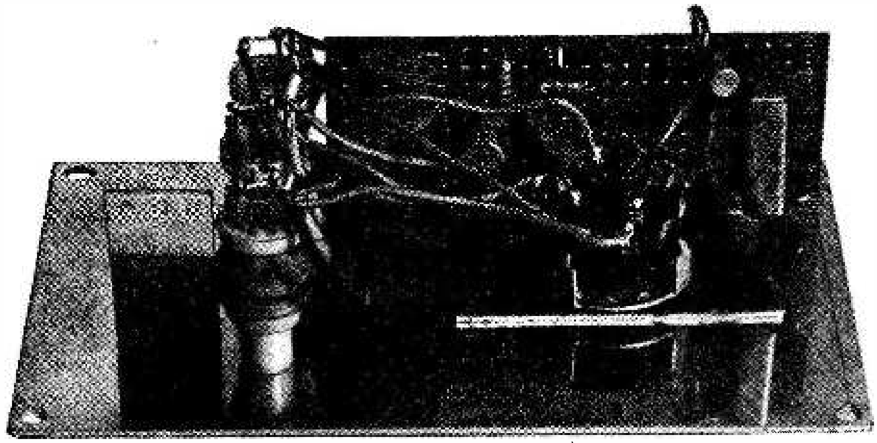


Fig. 4: Details of the wiring between the coils and the selector switch. If it is not possible to obtain the correct zero beat with a particular coil the parallel capacitor can be altered in value. Ensure the slug in the coil is moved through its entire range before changing any of these capacitors.

The photograph below is another shot of the finished calibrator.



the correct position. Turning the core either way from this will result in a whistle which rises in pitch.

The core of L2 is most easily set to 1MHz by using a short wave receiver to tune in a standard frequency transmission on 5MHz and adjusting L2 for zero beat. Check that this is correct by noting that the signal comes up at 1MHz or 1000kHz on the MW band of the receiver. L1 can also be adjusted to 5MHz by this means.

One range may help provide tuning points for another. For example, when the 100kHz frequency is set using the BBC's long wave transmitter, 1000kHz can be identified on the receiver MW band and L2 can be tuned to this. Harmonics of 1MHz will then allow a fairly accurate location of 5MHz on the receiver, to find the standard frequency signal, so that L2 can be correctly set, and also L1.

Once the cores are correctly positioned, they will need only a small re-adjustment occasionally, and this can be done in a few moments with the aid of the 200kHz and 5MHz signals mentioned. The long term stability is of course not that of a crystal controlled oscillator, but if the calibration is checked before using the calibration aid, accuracy easily equals the ability to read an ordinary tuning scale.

For long and medium waves, it may be sufficient to place the unit near the receiver, especially if the latter has a ferrite rod aerial for these bands. For higher frequencies, and higher orders of harmonics, more coupling is required. A lead from the output socket can then be placed near the receiver aerial socket or can be directly connected, as necessary. With the usual communications type receiver or reasonably efficient short wave receiver, the 1MHz and 5MHz harmonics can be heard up to 30MHz. The upper limit at which the 100kHz harmonics can be heard depends on the receiver, and these become rather difficult to detect above about 5MHz, but can be heard well beyond this with a sensitive receiver.

When preparing the scales for an actual receiver, note that the high-frequency end of a band is generally to the left, and that marking become progressively closer together. Despite this, they will have a regular appearance when counted off systematically.

To calibrate or check the calibration of a signal generator tune a receiver to various harmonics of the calibration aid and then tune the generator to zero beat and mark its scale. Where the receiver does not cover the generator frequencies completely, a harmonic of the generator signal may be used. For example, 900kHz on the receiver can be used for 450kHz on the generator, or second harmonic.

As the unit is not crystal controlled, remember to check the frequency when it is used to calibrate other equipment. The cores may be locked with 6BA nuts.

EDITORIAL ANNOUNCEMENT

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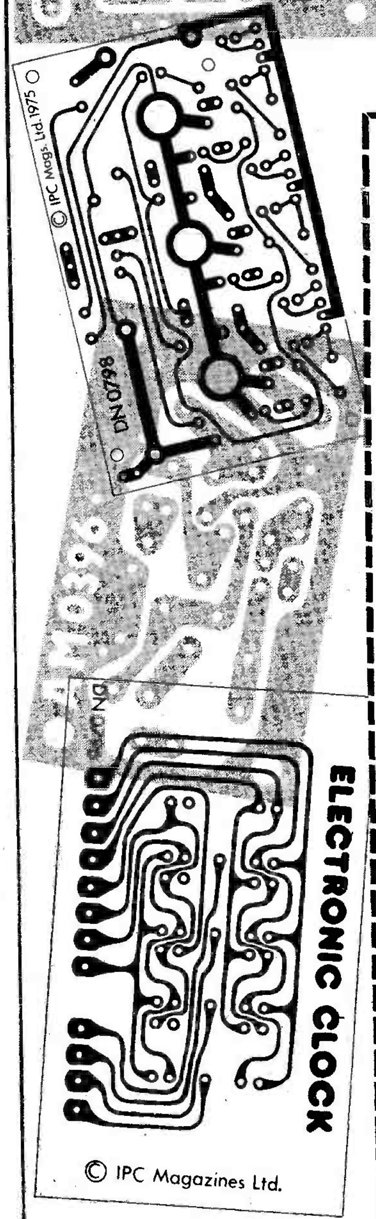

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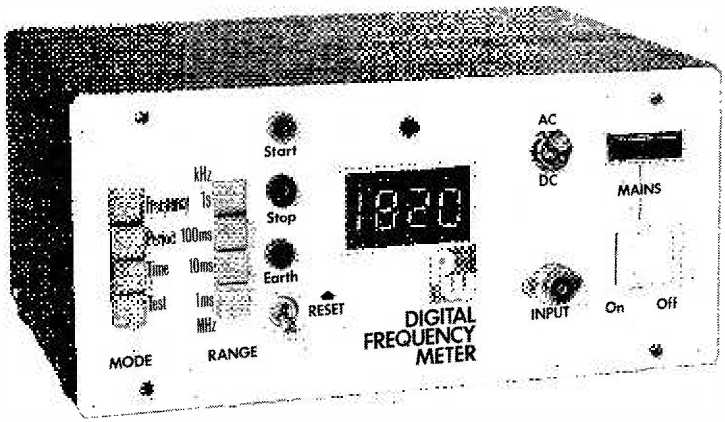

DIGITA FREQUI METER

T. J. JOHNSON

Specification

Frequency range	0-15MHz
Input voltage	60mV to 10V
Input impedance	1kΩ to 10kΩ
Period	1ms to 9999s (2¾ hours)
Time interval	1ms to 9999s
Gate times	100μs to 1s
Accuracy	1 part in 10^5 ±1 count
Stability	Dependent on crystal—typically 1 in 10^5 @ 20°C
Input waveform	Immaterial
Display	4 digits, 7-segment filament type

WHEN first designing the counter, cost was the first consideration, since it needed to be a versatile instrument, and within the pocket of the home constructor. At the same time it needed to compete favourably with commercial designs, and for this reason the counter design has been kept as simple as possible.

One of the major considerations was in deciding the type of display to be used. Having surveyed the various types available, it was decided to use Doram filament types, as they come complete with ready made PCB's. Alternatively, LED's may be used.

CIRCUIT DESCRIPTION

The input stage centres around IC1 which has 3 functions; (a) To amplify the incoming signal (or attenuate as appropriate) suitable for operating the counter. (b) To shape the signal into a waveform for operating the counter, and (c) To provide a suitable impedance so as not to unduly load the circuit under test.

The crystal clock, provided by Tr1 and 2 operates at 100kHz, to provide a square wave to operate the counter. IC3-7 divide the clock down to the required times. The display consists of a four stage counter, IC11-IC14. Four BCD stores, IC15-IC18, and the decoder/driver, IC19-IC22, driving the display. The control logic of the counter is centred on the pulse generator, IC9 and IC10. When in the frequency mode, the signal, having been "cleaned up" is passed into the counter IC14, via the switching system and the gate of IC10, the state of which is determined by the flip flops (FF1 and 2) in IC9.

In operation a clock pulse will change the state of the second flip flop, which in turn will open the gate in IC10 and allow the signal to pass. When the clock pulse ends, the state of the flip flop is reversed, thus ending the count. At the same time a condition is passed to the pulse generator causing it to operate. This has three functions; (1) To enable the stores, thus registering the count in the displays, (2) To reset the counters to zero, (3) To set the first flip flop in IC9, thus enabling the second flip flop to operate on the next clock pulse.

In the **period** mode, the clock pulse is continually passed to the counter, and the incoming signal now operates the flip flop in IC9. In the **time** mode the same happens, except that the control signal to IC9 comes from the monostable IC2. This provides a short pulse when triggered by a logic "0" at either SK1 or SK2. In the **test** position the switching system selects a clock time of one second and a frequency of 1kHz, the counter thus has a display of 1000.

OPERATING PRINCIPLES

Referring to Fig 1, the input signal is applied to the input of a counting stage with its associated display, via a switch. Assume for the moment that the signal is a square wave of 1000Hz, and the switch is closed for exactly 1 second. In that time therefore 1000 cycles will have passed through to the counter. If the counter has 4 decades driving 4 separate dis-

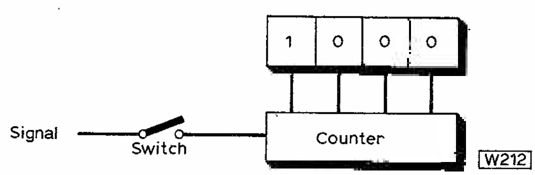

Fig. 1: Block diagram showing the path of a signal applied to the counting stage.

plays, then the number displayed will be 1000. It follows then, that the maximum frequency of the counter will be 9999Hz, ie, a maximum of 4 digits in the display.

To increase the maximum frequency of the counter, all we need to do is to shorten the time the switch is closed. Take for example a signal of

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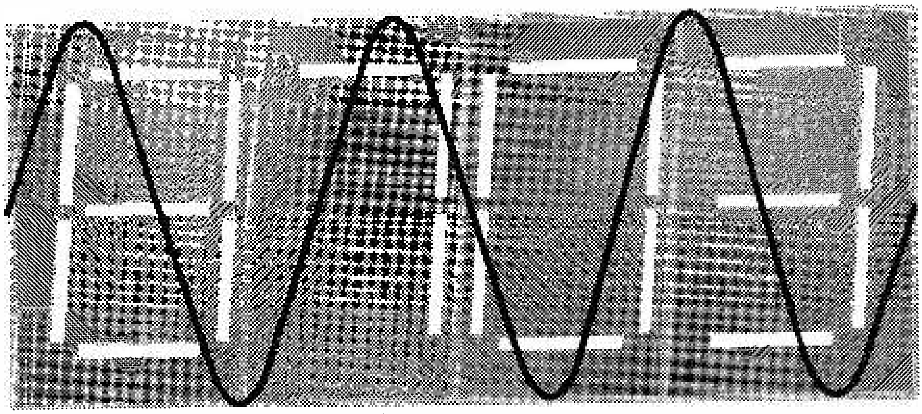


PART 1

1MHz. If we close the switch for 1/1000 of the time, then the display will again show 1000 but this time it will represent kHz. In a practical counter the switch is replaced by an electronic **gate,** and the time the switch is closed, is referred to as the **gate time.** The accuracy is therefore dependent on the accuracy of the gate time, and in the present design this is accomplished by using a highly stable crystal oscillator.

MODES OF OPERATION

In this design, 3 basic modes of operation have been provided for, these are detailed as follows;

Frequency

With reference to Fig. 2, the signal whose frequency is to be measured is applied to the input stage. The function of which, is to either amplify or attenuate the signal and to convert it into a square wave. The gate time is selected by S4 and applies it to the control logic, assuming the counter has

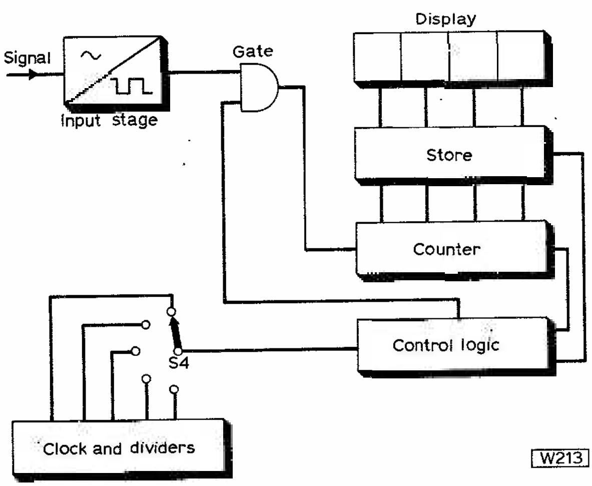


Fig. 2: The incoming signal is converted into a square wave, amplified or attenuated, and applied for one clock pulse.

been reset to zero, the operation is as follows; The gate is enabled for one period of the gate time (clock-period) which allows the square wave to pass through to the counter. At the end of this period, the control logic inhibits the gate, and provides two pulses. One for enabling the store thus registering the count, and the second to reset the counter. At the same time it enables the gate to open on the

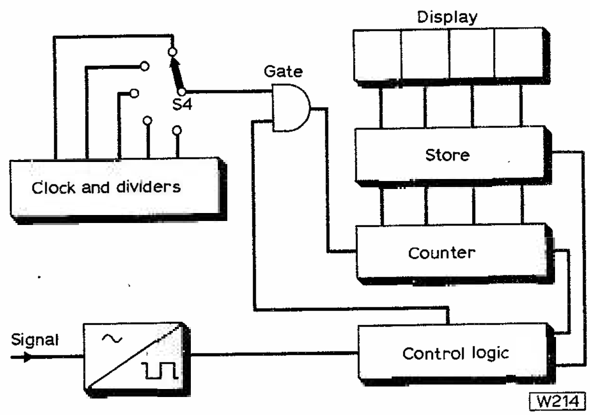


Fig. 3: In order to measure low frequencies, the roles of the clock generator and input stage are reversed.

next clock pulse, the result of which causes the display to update alternate clock pulses.

Period

The main difference between period and frequency measurement is that the roles of clock generator and input stage are reversed, as shown in Fig. 3. Instead of counting the number of input cycles during one clock period, the number of clock pulses

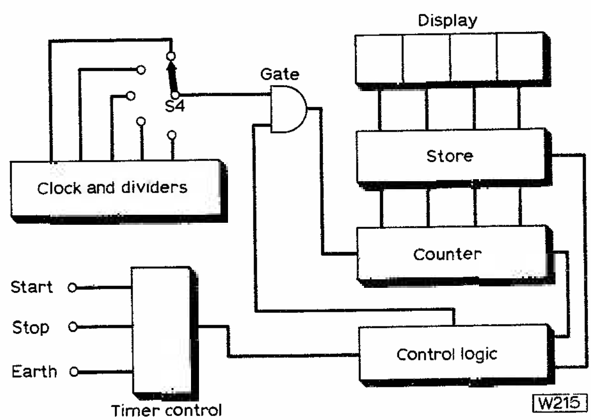
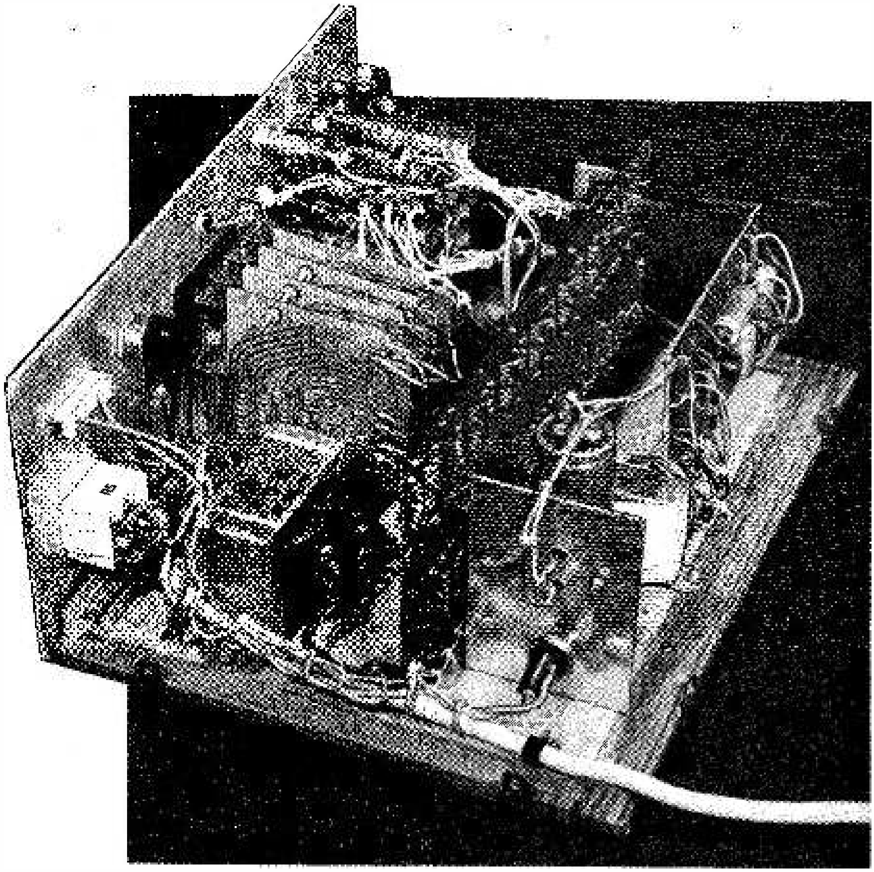


Fig. 4: Block diagram showing the method used for **time** *measurement. In this mode, maximum time indicated is 9999s.*



General interior photograph of the unit, showing layout of displays and their associated PCB's, function switches and main board containing all logic and transistor components.

during one input cycle is counted. The selected clock period is applied to the counter via the gate. The input waveform, after being cleaned up, is applied to the control logic. The store and reset pulses are generated in the same way but this time using the input waveform as the initiating signal. The period measurement is useful for low frequencies, such as those below 10Hz. At the same time it is more accurate.

Time

Referring to Fig. 4 it may be seen that time measurement closely resembles that of period. The major difference is that the control signal to the control logic comes from the timer control.

In operation, the time interval selected again passes to the counter and the timer control is connected to the control logic. When the **start** terminal is connected to 0V, the timer control produces a short pulse which operates the control circuitry to open the gate. The counter will now count in units as selected. For example, if a time interval of 10m is selected, the counter will count in units of 10ms, the display therefore will be in units of 10. A display of 875 therefore represents 8750ms or 8·75 seconds.

When it is desired to end the count the **stop** terminal is connected to 0V, which again produces a short pulse to close the gate and initiate the store and reset sequence. The display will now hold that count until the counter is reset.

STAGES

A block diagram of the frequency counter is shown in Fig. 5. All of the above modes have been catered for, plus an extra position for testing.

PSU: This section provides the following voltages for the various sections, +5V for the main circuit board, +5V for the display, +12V and −6V for the input stage.

Input stage. This section converts the incoming waveform to operate the TTL circuits correctly.

Timer control. This stage produces a short pulse to operate the control logic when used in the **TIME** mode.

Crystal clock. This stage operates at 100kHz and provides a square wave to operate the dividers.

Dividers. Five stages divide the standard frequency down to the times shown.

Control logic. This performs the following functions; (1) To reset the counter to zero, (2) To store the count reached, (3) To open the gate for the time selected.

Counter/store/decoder/display. These units together perform as a 4 stage counter, to count and display the frequency being measured.

Switching network. The switches incorporated in this section perform the three modes of operation as detailed above.

Referring to the power supply circuit diagram, Fig. 6. T1 provides two windings of 6·3V at 1·8A. The first winding being half wave rectified with C1

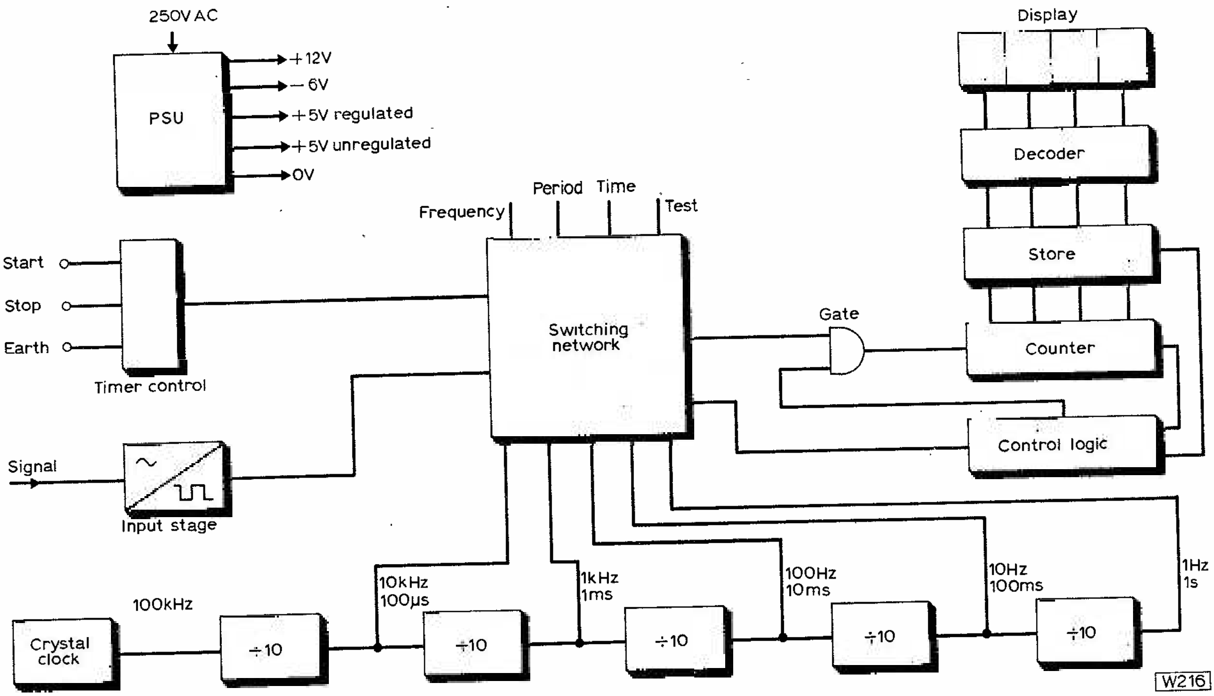


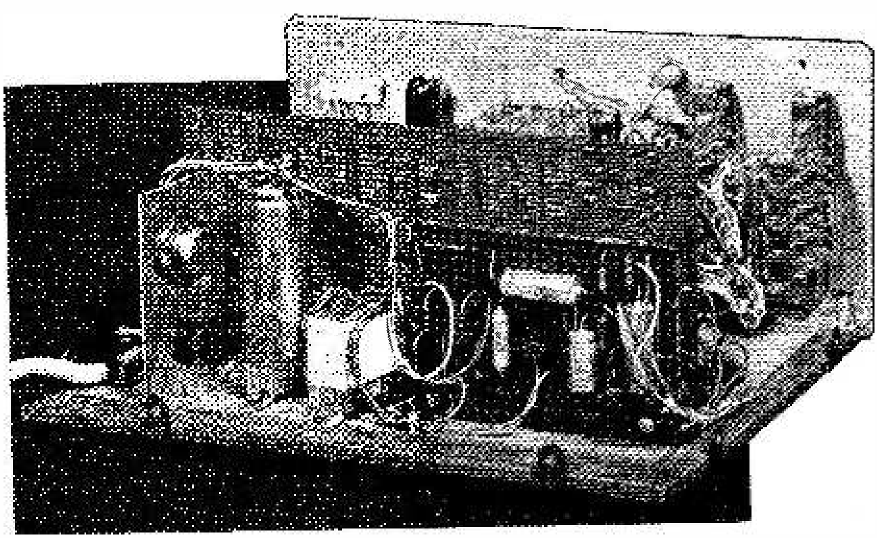
Fig. 5: Diagram showing the complete unit in block form. The crystal clock has a frequency of 100kHz, which is subdivided down to 1Hz by means of five 7490 IC's.

providing a small amount of smoothing. This is then used to power the displays. The second winding is bridge rectified by D2-D5, and smoothed by C2. A 5V regulator is used to provide the required voltage for the remaining circuit. A small amount of smoothing is provided by C3, and RF noise being decoupled by C4. The second transformer T2, supplies 18V to the bridge rectifier Br1, while the two zener diodes provide +12V and −6V for the input stage.

It will be noticed that when all the segments of the displays are on, slight dimming occurs. This is due to the rather simple nature of the supply, although in practice this is quite acceptable, since when operating with their correct voltage, the displays can be quite dazzling.

INPUT STAGE

IC1 Fig. 7 together with its associate components form the input stage of the circuit. The 710 is a comparator and has two inputs, inverting and non-inverting, pins 4 and 3 respectively. In use if the non-inverting input goes more than 5mV positive than the inverting input, the output goes high. Conversely, if the inverting input goes more positive than the non-inverting input, then the output goes low. R5, 6 and 7 provide positive feedback to the non-inverting input, which causes the device to



Rear view photograph giving details of the power supply board, regulator and fuse bracket, and smoothing capacitor C2.

★ components list

Resistors

R1	180Ω	R11	2·2kΩ
R2	120Ω	R12	1kΩ
R3	1kΩ	R13	10kΩ
R4	10kΩ	R14	1kΩ
R5	10kΩ	R15	10kΩ
R6	1kΩ	R16	1kΩ
R7	10Ω	R17	10kΩ
R8	1·8kΩ	R18	1kΩ
R9	220kΩ	R19	10kΩ
R10	5·6kΩ	R20	1kΩ
		R21	120Ω

All resistors ¼W, 10% except R1 which is 1W

Capacitors

C1	100μF 10V	C11	1nF silver mica
C2	2000μF 10V	C12	10nF polyester
C3	100μF 10V	C13	200pF silver mica
C4	10nF polyester	C14	2nF polyester
C5	100μF 10V	C15	10nF polyester
C6	100μF 10V	C16	22pF silver mica
C7	10nF 250V DC	C17	22pF silver mica
C8	10nF polyester	C18	22pF silver mica
C9	10nF polyester	C19	22pF silver mica
C10	4μF 6·3V		

Semiconductors

Tr1	2N3704	IC18	7475
Tr2	2N3704	IC19	7447
Tr3	BSX20	IC20	7447
Tr4	BSX20	IC21	7447
Tr5	BSX20	IC22	7447
Tr6	BSX20	D1	1N4001
IC1	710	D2-D5	1N4001
IC2	74121	D6	BZY88 12V/ 400mA zener
IC3	7490	D7	BZY88 6V/ 400mA zener
IC4	7490	D8	1N914
IC5	7490	D9	1N914
IC6	7490	D10	1N914
IC7	7490	MVR1	5V 1·2A voltage regulator Doram type 305-614
IC8	7474	Br1	Mains rectifier, encapsulated type, 1A rating.
IC9	7473		
IC10	7400		
IC11	7490		
IC12	7490		
IC13	7490		
IC14	7490		
IC15	7475		
IC16	7475		
IC17	7475		

Miscellaneous

T1, 0-6·3V, 0-6·3V 1·8A mains transformer (196-189). T2, 0-12V, 0-12V miniature mains transformer (196-303). S1, DPST rocker switch. S2, SPST rocker switch. S3 and S4, four-pole change-over switches, push type in banks of four (338-635). S5, DPDT rocker switch. Eight square opaque buttons for push switches (338-456). Two, 4 switch mounting frames with latching bar for push switches (338-254). SK1, surface mounted coax socket. SK2/3/4, 4mm chassis sockets, black, red, and green. Four, 7-segment filament type tubes (591-852). Four, PCB's for filament tubes (433-905). X1, 100kHz crystal. Socket for crystal. Piece of Veroboard 95 x 210mm, 0·1in matrix. Piece of Veroboard for power supply 0·1in matrix, 100 x 88mm. N1, mains neon. Aluminium front panel 205 x 116mm. Aluminium regulator/fuse bracket 55 x 90mm. Wood for case, screws, fablon, rubber feet, coloured wire. Fuse holder. (Numbers in brackets indicate Doram type numbers).

operate as a schmitt trigger, and is used to shape the signal into a square wave. Input protection to the device is provided by the two diodes D8/D9, which conduct at about 0·7V thus limiting voltage excursions to the IC.

The maximum voltage which may be applied to the instrument, is mainly dependent on the dissipation of R3. In the present design this works out to approximately 14V. If the power rating of the resistor is increased, to say, 2W then the input voltage may then

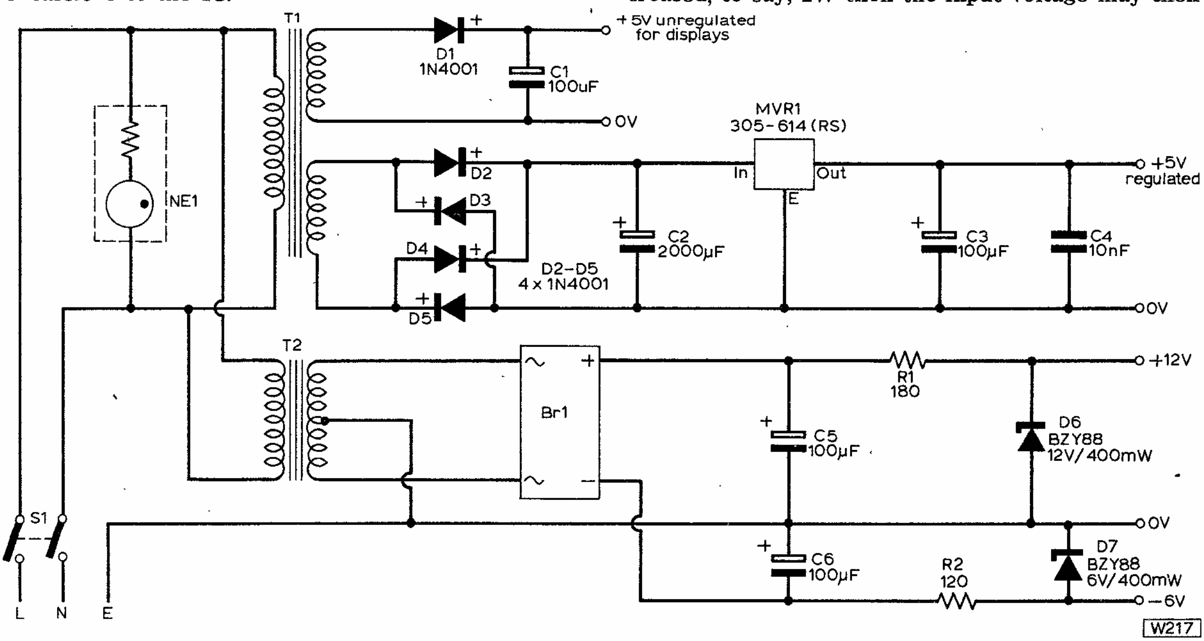


Fig. 6: Although the above power supply is of a simple form, it has to supply four separate voltages. These are +5V regulated, +5V unregulated +12V and −6V.

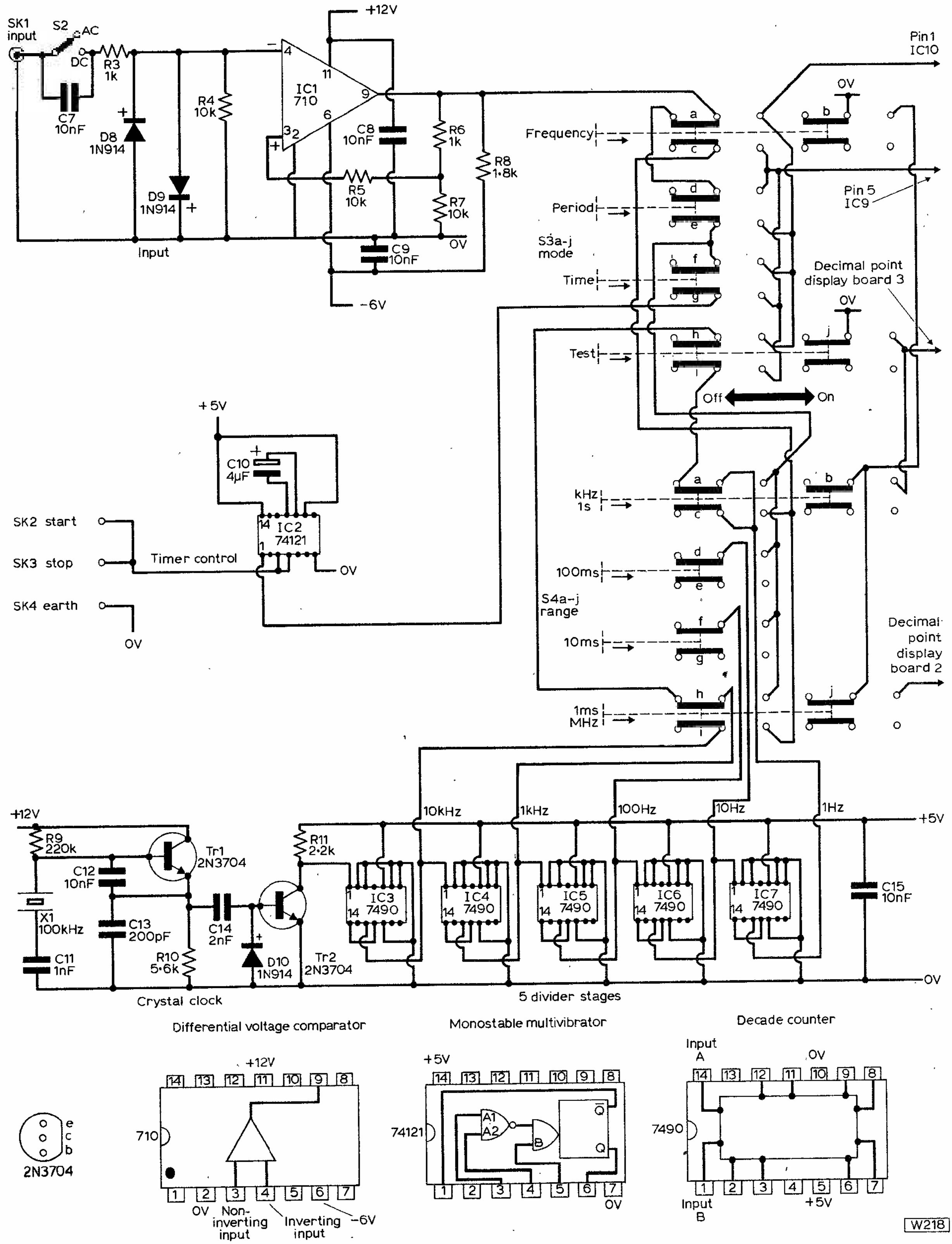


Fig. 7: Part of the complete circuit diagram showing details of the following stages:—Input stage, timer control, crystal clock, divider stages and switching network. *continued on page 156*

SOUND DESIGN

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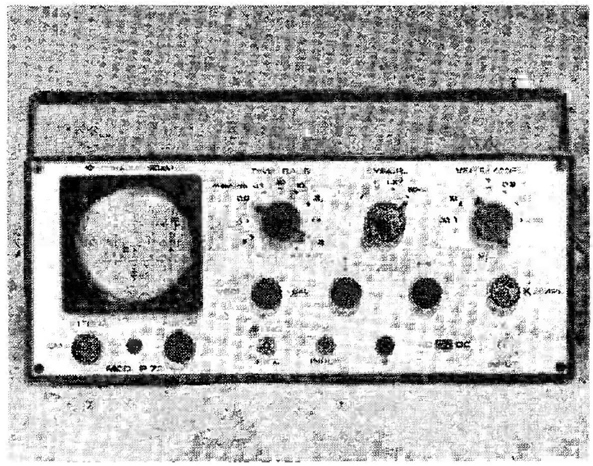
PRACTICAL WIRELESS
FAULT-FINDING GUIDE
continued from April 1976

In the first part of this Guide Les Lawry-Johns concentrated on test equipment and methods of checking transistors and components. This concluding article deals with the technique of logical fault-finding in a typical piece of equipment, a Music Centre, and on getting the maximum amount of information from observed fault symptoms.



The Chinaglia Belluno P73 single trace oscilloscope has an input impedance of 1MΩ and the input capacity is 45pF. The Y amplifier response is 3dB down at 8MHz.

IN the first part we looked at the bare essentials as far as tools and service aids were concerned. We also looked at the basic methods of testing diodes and transistors and briefly touched upon RF and IF alignment, testing capacitors and resistors with a multimeter etc. Once it becomes known that you are a servicing man you will be expected to become a convenience for all and sundry, to perform miracles at the drop of a hat, repairing everything from hair dryers to colour TV's. Practically all these jobs will be a labour of love and you will gain little, except an ever-growing circle of "friends" that you could well do without!

You will have to develop a defence mechanism which will enable you to escape without giving offence. To be able to give an apologetic smile and say "I'd love to do it, old chap, but it's not my line. You should see old so-and-so, he's an absolute wizard with these things! I wish I was half as clever as he is but I'd probably make a mess of it. Sorry". If this is not the right line, try, "Oh yes, it's well worth spending a fiver on it, provided I can get the spares from the maker but they are very pricey you know". At the mention of a fair amount of money, the golden object becomes as tinkling brass and is not worth the trouble.

In fact this is not an excuse as spares are very expensive. Recently a plastic spool carrier for a well known tape recorder was ordered thinking it would be no more than a £1 or so. When it arrived it was £6·25 including postage and COD. We paid but we doubt if the customer is going to be pleased! In any case you will have to make up your mind just what you are going to tackle and what you are not. Make these dividing lines and stick to them.

What's all this got to do with fault finding? Precious little but there are other matters to consider and it is as well to ponder on these as it is very difficult to earn a living at servicing alone. The one that can make a fortune at it will have to be a hard man indeed, and I don't know of him!

General servicing, such as we have in mind, will mainly concern radios and TV receivers, but the latter are adequately covered by our sister magazine *Television* and so we must concern ourselves here with the radio side, with reference to tape recorders, amplifiers and the like. Recent issues of PW have given a general idea of the methods employed in servicing car radios, unit audios and valved equipment etc. So here we are concerned with fault tracing, diagnosis and handling.

DISMANTLING

Whilst one glance is all that is required in some cases, to see how a particular set is to be dismantled, in others no amount of inspection seems to reveal how the thing comes apart. If the maker's service information is to hand this may explain all, or it may not. The best thing to do in such cases is to remove what can be removed and hope that this leads on to the next step. For example, if it is a battery operated transistor radio, the cover of the battery compartment, as well as concealing the battery, will often conceal the main fixing screw, the remaining fixings being tongue-and-groove pressings. Others may require the dial glass to be removed before the main frame screws are revealed. Quite a few require the carrying strap to be removed by a

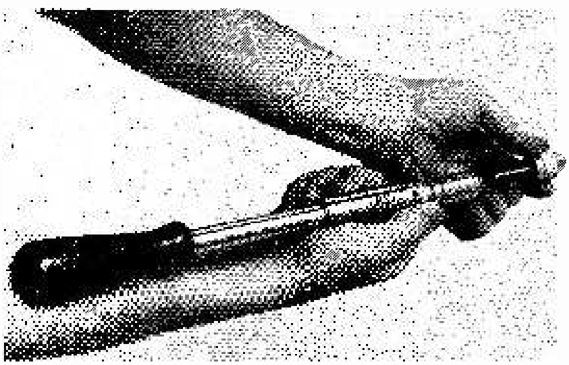
FAULT~FINDING GUIDE

downward pressure against a spring which then reveals the side fixing screws.

Having overcome this first hazard it is often necessary to remove the panel from the main frame. Care is required here as some of the screws may be employed in securing the dial drive to the panel and these **must not** be loosened. Reassembling a dial drive can be one of the most frustrating and time-wasting exercises it is possible to imagine so it is well worthwhile assessing the exact purpose of each visible screw. In many cases the relevant screws are marked with a spot of coloured paint to identify them and these are the ones which should be removed first.

FAULT TRACING

Having gained access one can then get down to the main object of the exercise which is to find out what is wrong and ascertain what is likely to be needed to put it right. We say likely because it is often well-nigh impossible to do this without actually doing the job. This is why it is not feasible to supply an accurate estimate of cost and why, if one is pushed to supply one, the job should be turned down as gracefully as possible. What is more reasonable is a rough estimate combined with a goodly amount of mutual goodwill and trust.



The Paramo loose drill chuck can be quickly fitted to almost any ratchet screwdriver and will take drills up to 6mm for smaller ratchets and 8mm for larger ratchets.

A fair amount of battery operated equipment fails to function purely as a result of poor contact in the battery compartment. This is often the result of batteries being left in too long, the resultant weeping of electrolyte corroding any metal which may be in the vicinity. If the battery box is a separate item, it is best to replace it, clear up any spillage from the receiver, with bicarbonate of soda, fit new cells or batteries and make sure the thing works. If there is no battery box, only a compartment, the job may be more complicated even after the spillage has been neutralised and cleaned up. Some improvisation may be necessary to replace corroded springs and this is why an old torch is never thrown away without removing the springs. Even the springs from ball-point pens have their uses when the pen is finished.

Even though there is no sign of trouble, it pays to check that all is well in the battery compartment before moving on. We have bitter memories of a Philips receiver which used two 9V batteries. One battery read 8V and the other nothing. There was a good reason for this, since there was a dead short across it! Tracing the leads back, we found they went to the on-off switch and were shorted by the switch. It took a little time to realise that this was quite correct and that the black leads were on the wrong batteries. They had been originally taped to prevent this confusion but the tape had been removed at some time and the owner had finally made the fatal wrong connection and concluded that the set was at fault. The possibility of this happening should have been anticipated by the designer and the batteries should not have been side by side, but there it is, the set was quite old and had functioned for years before this happened.

If a short or partial short is found across the batteries the normal cause is defective output transistors or a shorted electrolytic capacitor. A fair indication can be obtained by switching the meter to the 100mA range, lifting off one of the battery connections and connecting this to one meter lead, and the other to the battery. The actual connection of course depends upon which lead is lifted. If negative, the positive probe of the meter goes to the lead, the negative to the battery. With the volume control turned down a reading of not more than 20mA can be regarded as reasonable, depending upon the receiver, the average being quite a bit less than 20mA but usually over 10mA. If the meter reads over this either the sound will be deafening where the volume was left turned up or there is indeed a short of some kind.

THE 'SHORT' !

Now let's pause here and consider the term "short". It implies that the circuit is of much lower resistance than intended and that it cannot operate correctly. This is the opposite to "open" circuit, which is the other basic fault usually of extremely high resistance. Putting it in the simplest possible terms we can say that there are only two basic faults which can happen to an electrical circuit, either an "open" circuit where nothing happens or a "short" where too much happens! The complication arises due to the degree of the condition i.e. a partial short which is a leak, or a partial open circuit which is a higher resistance than intended. Most appliances consist of not just one circuit but of a great many, so "circuitry" is the better term. The art is to locate the faulty circuit in the shortest time, recognising the nature of the fault and knowing what is needed to put it right.

The first step is to find out what does work as opposed to what doesn't. Let us consider the case of a mains operated Music Centre, consisting of a cassette recorder-player, a record player with auto changer and radio facilities with stereo VHF plus long and medium wave AM. We will assume this has been received for servicing, without loudspeakers, and with the minimum of information regarding the nature of the fault(s). Probably just a label marked, unhelpfully, "does not work"! This shouldn't be allowed to happen in the first place and more information should have been supplied, but this is an exercise, not an actual case.

A preliminary check shows that the appliance is marked at the rear with the mains input, if you are lucky, complete with lead and not just an awkward input socket with no lead! The loudspeaker terminals or sockets will be marked

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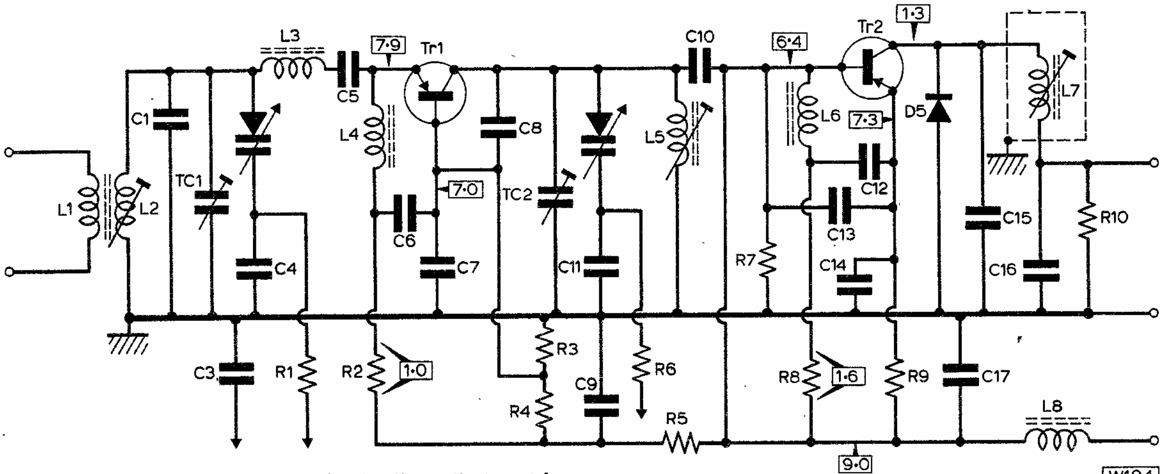
C	1 TC1 4 5 6 7 8 TC2 11 10 13 12 15 16 3 9 14 17
R	1 2 3 6 7 9 10 4 5 8
L	1 2 3 4 5 6 7 8



A small part of a typical service sheet showing the method used for rapidly locating a component on the circuit diagram.

with the matching impedance, probably 8Ω. Possibly 4Ω but use 8Ω if in doubt: better to underrun than risk losing the output transistors. Connect suitable speakers and if the mains input lead has a fused plug, check on this first before taking any other action. Remove the fuse and check its rating and whether it is intact. It will probably be intact but it could be too high a rating. Reduce to 3A or less. If, in fact, it has blown, check the receiver end and if there is a filter capacitor across the on-off switch suspect this and use a suitable replacement rated at least 240V AC or 1kV DC.

The method of gaining access will depend upon the unit and it must be admitted that there are a few which appear to have been designed with absolutely no regard for service at all! If there is a dust cover, carefully stow this in a safe place, ensure the record deck is locked in the transit position and the PU arm clipped. Turn the unit up on one end and make sure it cannot topple over. If there is a bottom cover, note how many screws secure it. If there are a large number in various places it probably holds some of the units and is probably not meant to be removed for normal service. If it is of light construction and is only secured around the edges it can probably be removed for inspection. If the bottom cover is not meant to be removed, it will probably have either a couple of holes to provide access to the retaining clips of the auto-changer or some screws which reach through and secure the top cover. If in doubt, the maker's service information should be consulted.

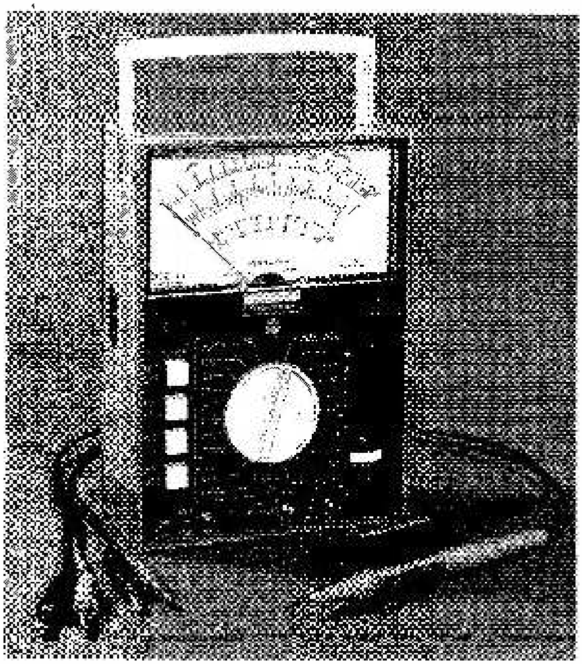
Having ensured that the speakers are connected and the mains input is intact, plug in and switch on. The mains indicator light may come on but if it does not, switch on the auto-changer to see if the turntable rotates. If nothing happens it can be assumed the set fuse in the mains supply, somewhere around the mains transformer, has failed. The rating of this will be around 300mA surge limiting, the ones with a little spring inside. There are times when these can fail simply because they are fed up with life and a replacement will restore normal operation but a little caution is required here. First look at the fuse to see how it has failed. If it has shattered or is blackened there is no point in putting another one in, and on no account put a fuse in which has a much higher rating. The cause must be traced and rectified.

FUSES

We all get caught out with fuses sooner or later as it is difficult to carry all ratings and types at all times. A little common sense can be used however and if the original rating was say 315mA fit one of between 250mA and 500mA without too much fuss, but these limits should not be exceeded. If the blown fuse is blackened, there is probably a direct short across the supply or there is a short across the secondary of the transformer, most likely a defective bridge rectifier. The former should direct attention to any mains filter capacitor included after the fuse, rather than across the on/off switch and also to the gram motor, the winding of which may appear blackened. Not very often but it does happen. The latter fault, a bridge rectifier breakdown is quite common. The bridge may be formed by four separate diodes or one block with four lead outs. If it is (they are) defective there is usually some visual sign, a block may be bulged or individual diodes blackened. If the fault is further in, the supply fuse would not normally be the one to fail as there is a fuse included in the lower voltage supply line to the amplifiers and the cassette player etc. This fuse will usually be rated at some 2A and will fail when a short or other overload occurs in the associated circuitry. There is little doubt which fuse is which as they are marked on the panel or at least on the fuse and their situations leave little doubt, the smaller mains fuse being near the mains transformer or on/off switch, the larger rating fuse being on or near the rectifier or main electrolytic smoothing capacitor.

Now there is always the possibility that some bright spark has been there before you and has fitted a heavy fuse in the low voltage (LV) side, say 5A, and that the mains fuse has failed because of this and that the fault will, after all, be found on the amplifier panel. If this is indeed what has happened, leave out both fuses and check, both visually and with a meter, to see if the fault can be spotted or isolated. We say spotted as it is quite common to see some evidence of overheating usually in the small resistors associated with the output transistors, which immediately calls attention to the transistors, or slight discolouration around the audio chips if ICs are used. Also bear in mind the fact that dial lamps are often fed from the LV line or from the transformer secondary and that the lamps themselves can short or the holders into which they are fitted can be defective. If in doubt disconnect the supply lead(s) and check each separately. If no shorts are found, fit the correct fuses and switch on. It is possible that both fuses will hold and the set will operate for some time, say on radio. If this is so, switch over to the cassette player and see what happens. It is possible, again, that the LV fuse will now fail. If it does you then know where the enemy is hiding!

If the fuses hold, it means a long soak test and possibly a request to inspect the loudspeakers, one of which may have defective wiring. This latter check is not likely to be fruitful as a shorted speaker outlet would normally cause damage to the output transistors or chip and recovery is most unlikely, but it can happen. If the LV fuse blows on switch-on, you probably haven't conducted your investigation in the true traditions of the service so start again, isolating and testing each take off point, possibly cutting through a track or two to isolate a particular line, joining up with a lead soldered across the gap, not, repeat not, just a blob of solder which may hold for a moment and then crack. When faulty section has been located you may well kick yourself because the visible evidence was there all the time and missed it. If this is not so you can congratulate yourself for tracing it logically, even if it was only a whisker of wire across two tracks at some hidden point.



The Heathkit Type 670 in-circuit tester is capable of measuring the current in a conductor on a PCB while the circuit is in operation.

Now it is quite likely that the fuses may hold but some overheating may be taking place and a resistor or perhaps a heat sink may feel quite hot to touch. Whilst this may be due to a faulty transistor or a leaky capacitor, it is possibly due to a preset control being maladjusted, causing the output circuit to draw too much current. If the circuit is available the voltages can be checked to see if they conform or can be made to conform, otherwise the voltages on the normally working channel can be compared with the defective channel and the right conclusions drawn

OUTPUT TRANSISTORS

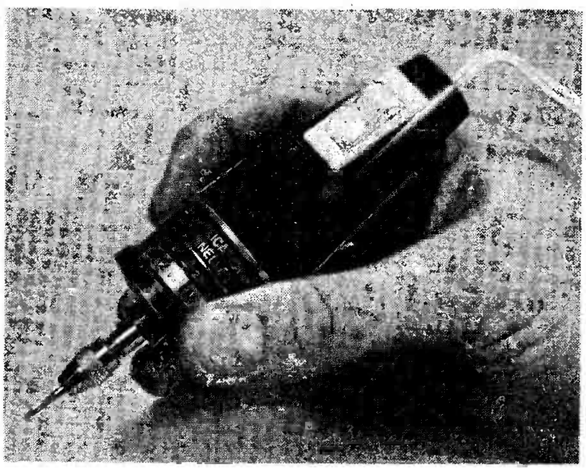
Output transistors often have a smaller transistor wired across their bases with a preset control provided from collector to base, to set the conduction of this smaller transistor. The more it conducts the closer are the potentials of the bases of the output transistors and the less they conduct, and vice versa, with increased conduction producing more heat. If this causes some head shaking in some quarters because it seems hideously wrong we would point out that the reader should do his own homework, we are only concerned here with the practical results not the theory! We could say that if the small transistor were replaced by a simple resistor, the value of which determine the conduction of the output pair, the lower the resistance the less current is drawn, but such a device allows no compensation such as is provided by a transistor, properly set up.

In stubborn cases, the freezer solution aerosol and the hair dryer mentioned in the first part of this saga can be brought to bear and the results obtained by these assessed, to pin-point a certain component or small area which enables one to draw a conclusion, hopefully the right one, and the correct replacements made.

HUM

One of the most common complaints is not that the equipment does not work at all but that "it hums". The first question must be, assuming this is a stereo outfit, "which side hums, or is it both channels"? If both, the problem is a little easier and is likely to be due to a defective rectifier, probably of the bridge type, which is leaking but not enough to blow a fuse, or a faulty electrolytic capacitor where one of the end contacts is not properly made to the lead-out tab. The electrolytic could be dried up and this is what we would have gone for, once upon a time. Times change though and so do the habits of certain components. If the rectifier is not running warm and the electrolytic is not at fault it is likely that it was not the right assessment in the first place and that one channel is in fact inoperative, drawing too much current and thus impairing the smoothing. If this is so there is probably output trouble, so back to the previous paragraph!

However, hum is not all in the power supply and output transistors overheating. It can be due to poor earthing, dry joints, defective controls but less often to resistors which have gone "high". Once more, ask the questions. Is it one side only or both, does it occur on radio or gram or both, what effect does the volume control have? When those questions are answered leap into action and head straight to the source of the trouble!



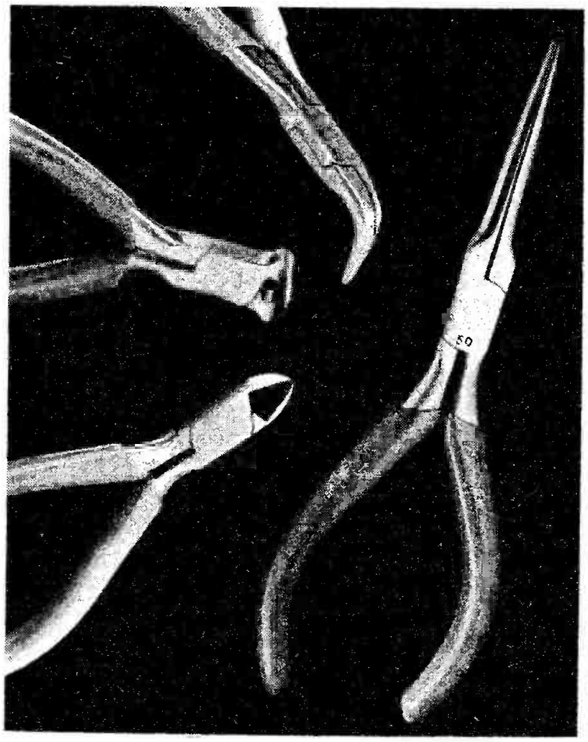
Precision Petite Ltd. produce this very useful 12V DC electric drill. A stand is also available and a kit of tools.

The radio doesn't hum but the gram does, the volume control reducing the hum. Start from the pick-up head, checking the tags first and the way the wires are secured in the tags. Often they are not soldered, merely pressed with the tag making better contact with the plastic insulation than with the actual wire. Correct this and follow through to the underside of the deck where a similar system may be employed, checking the lead-outs and terminals (or phono plugs if used) and the earthing of inner tags or outer screening, as appropriate. Follow on to the input to the amplifier and note that many units use a preamplifier stage for gram input which is not used on radio. The hum could well be occurring in such a preamplifier stage especially if this is a separate unit raised from the main board. These are the simple but essential lines one follows to locate hum, there is nothing complicated about it but some patience is often necessary in order to pin it down.

DISTORTION

We have mentioned this problem in several articles and do not wish to go on unnecessarily. There are all types of distortion and one's ears become trained to detect the differences between a low supply voltage (the battery's flat!), cross-over distortion where the output stage is not being allowed to work properly, unbalance where one transistor is working and the other cannot or will not, loudspeaker rubbing where the speech coil is fouling the magnet, the strangled sound of an output valve running into grid current or the clipped noise of a high value resistor stressing the sibilants.

Sounds are very difficult to describe in words and if the ear is not educated enough to enable a short cut to be made, routine tests will have to be made, starting from the supply and working through, checking voltages and, if necessary, the current drawn, plus cold resistance tests etc. to ascertain where the readings depart from those expected. If it takes a long time, don't worry, you'll recognise that sound again and it won't take nearly so long next time.



West Hyde now offer a new range of quality tools including these long-nosed pliers, curved needle-nosed pliers, side and face cutters. The long-nosed pliers have an internal spring to bias them in a normally-open position.

TAKING VOLTAGE READINGS

It is one thing to take a number of readings, it is another to review them in order to reach the right conclusion. In order to do this one needs to know, within limits, what to expect before any readings are taken. This can be gathered from service information or from previous knowledge of this or a similar circuit. As far as individual stages are concerned, divorced from the preceding and succeeding stages by capacitors or transformers, one or two readings immediately establish the conditions and enable a diagnosis to be made. For example, if a transistor is inoperative, with no emitter reading, although the base and collector

FAULT-FINDING GUIDE

voltages are about right, it does not require much thought to reach the conclusion that the transistor is likely to have an open-circuit base-emitter junction. Note that we said "likely". Now, should the reading show the emitter with a higher voltage than the base, still assuming a straightforward amplifier layout where the collector is relatively high, the emitter and base low, with the base sufficiently above the emitter to allow it to conduct, one can conclude that the transistor cannot operate and one has to find where the emitter voltage is coming from. If there is only a straightforward resistor from emitter to supply or return, it can be concluded that there is a collector to emitter leak in the transistor, which will normally show up on an ohms test.

For example, if the emitter resistor is say 470Ω, this is the minimum reading to be expected and, if there is doubt, the resistor can be lifted from the circuit at one end to ascertain the exact reading, which should be high, except in the case of one or two specialist types. Where transistors are DC coupled, as in most audio designs, voltage readings must be looked upon as a very rough guide and not as an instant fault locator. The same can be said for AGC systems where the controlled stages are dependent upon a controlling voltage derived from a source which is itself controlled. If that sounds decidedly awkward, it is.

The audio stages are less awkward since the majority of troubles are usually in the output stage and can be identified by disconnecting the suspect transistor and cold testing it (or them) and associated resistors and then working back from this point.

GENERAL

These are the general lines to follow. Note what is working and what isn't, disconnect what can be disconnected in order to narrow the field. Accept the fact that you are going to be misled by "red herrings" and write this down to experience. The man that hasn't made a mistake hasn't made anything but you don't have to make the same mistake twice. If a thing looks horribly complicated this is because one is not used to looking at it, but divided into sections there is little to fear although it is still necessary to understand the basic operating principles.

Once the fault has been localised, the rest can be ignored. Concentrate on that section, understand what it is supposed to do before trying to put it right. Get it working properly and then connect up the rest ensuring that this doesn't upset the operation. Start from the supply, get that right or see that it is right, check the output stage as this is where most of the trouble abides and then isolate sections to see which parts are functioning and which are not.

Use the tools you have to the best advantage, including the ears, eyes, nose and sense of touch. Your multi-meter, signal injector, coolants and "heatants", this unlikely last term to include your soldering iron and the hair dryer we spoke of earlier, and above all your ability to think electrically. This is half the job. PW

Photographs were kindly supplied by the following companies to whom all queries on the instruments illustrated should be addressed.
Heath (Gloucester) Ltd., Gloucester GL2 6EE.
Precision Petite Ltd., 119A High Street, Teddington, TW11 8HG
Chinaglia Ltd., 19 Mulberry Walk, London SW3 6DZ
Parramore Ltd., Caledonian Works, Chapeltown, Sheffield S30 4WZ
West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, Middx HA6 1NN.

DIGITAL FREQUENCY METER—*continued from page 149*

be increased to 28V. However this was not thought too important, since we are generally concerned with low level signals. R8 is added to increase IC1's output current sinking ability. The supply lines are decoupled at RF by the two capacitors C8 and C9.

The input is applied to a standard coaxial socket SK1 by screened lead, and then passes to S2. The purpose of which is to short out the capacitor to allow either AC or DC signals to be measured. It is also used in the DC position when measuring low frequencies, such as those below 25Hz, and also when in the **Period** mode.

TIMER, CRYSTAL, CLOCK AND DIVIDERS

The monostable IC2 uses the external capacitor C10 to achieve a pulse length of about 10ms to clock FF2 of IC9. The monostable produces this pulse when pins 3 and 4 are connected temportary to 0V. In the prototype, two sockets are used together with an earth socket to achieve this. In fact only one socket is needed, although two make the connection of external control easier.

Tr1 is connected as a Colpitts oscillator, Fig. 7 in the emitter follower mode while the crystal X1 works in the parallel mode of resonance. C11 provides series blocking, and R9 base bias. Positive feedback is achieved across the potential divider C12 and C13, the centre point being taken to the emitter. Output is developed across R10, and is then fed to the squaring amplifier Tr2, via C14. Diode D10, together with Tr2 provides symmetrical clipping of the signal, the output being developed across R11, and finally coupled to the divider stages.

IC3 to IC7 make up the divider stages and are connected in the square wave output mode. They divide the 100kHz of the oscillator down to the following gate times; 1Hz—1 second; 10Hz—100ms; 100Hz—10ms; 1kHz—1ms; 10kHz—100μs.

These outputs are then selected by S4 and passed to S3 where they are passed to either the counter or FF2 as appropriate.

SWITCHING NETWORK

This hardly needs explanation, since the various paths for the signals etc, may easily be followed in Fig. 7. However, a few points to notice are as follows;

Referring to the **range** switch S4a-j. When the **test** position is selected by S3 (**mode**) the 1kHz and 1Hz times are connected through sections h and a, it is therefore important that no **range** switches are depressed when in this mode. When masuring frequency, only two gate times may be selected, these are 1s (S4c) and 100μs (S4i), therefore pressing any other times will not operate the counter.

Referring to both switches, sections b and j. These position the decimal point in the display, eg. when in the **TEST** and **FREQUENCY** mode the decimal point will be positioned between the fourth and third digit on the left, thus indicating 1·000kHz.

Part 2 continues in the July issue, and will be covering details of the circuit, Veroboard layout, and case construction.

SPECIAL PRODUCT REPORT

sinclair

'BLACK WATCH' KIT

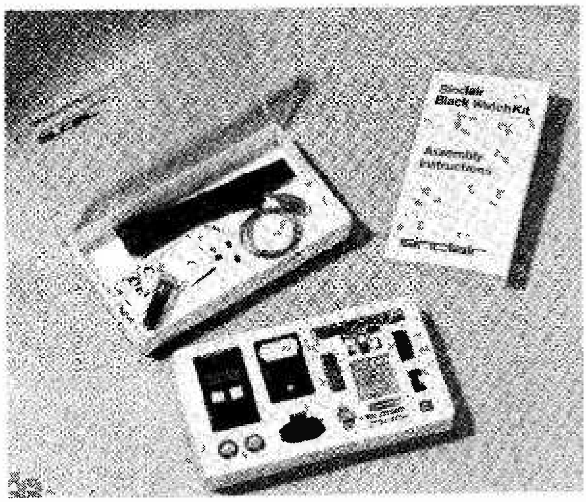
THE Sinclair "Black Watch" is a digital wrist watch of unconventional appearance, as may be seen from the illustration. The watch is available ready-built, or in kit-form, the latter version being priced at under £15, including VAT.

The components supplied include a double-sided glass fibre printed circuit board, a flexible self-adhesive printed circuit, an LED digital display, an 18-pin IC, a quartz crystal, a trimmer, all parts for the case, two cells, a flexible insulated copper screen, a plastic strap, varnish, grease and solder. Assembly and operating instructions are also provided.

The case of the watch is moulded in black plastic material, the back fitting on the front section by "click" retaining lugs. A transparent purple window is fixed in an aperture in the front of the case so that the LED display is visible. Three flexible diaphragms are moulded into the case, two in the front and one in the back. The diaphragms have small pieces of metal foil attached and, when the watch is in use, pressure on the diaphragms causes the foil to short together pairs of contacts. The rear diaphragm is used when setting the watch to the correct time and pressure on the two front diaphragms causes the display to work.

HOW DOES IT WORK ?

The heart of the watch is a quartz crystal which oscillates at 32,768kHz divided by the IC to obtain one pulse per second, the pulses being counted into minutes and hours by circuitry in the same IC. A 4-digit LED display is connected to the IC and brought into action by shorting two pairs of contacts, as mentioned earlier. One pair is used to obtain a display of the hours and minutes held by the watch and the other displays the minutes and seconds. Thus, for a time of 12 06 42, the two displays are 12 06 and 06 42. If the contacts are shorted together briefly, the display is illuminated for about half a second, or continuously by keeping the contacts closed.



A further pair of contacts is used when setting the watch to the correct time. The hours can be made to advance at one per second until the correct hour is reached and the minutes can also be advanced similarly, while the seconds are held at "00". The only discrete components in the watch are the quartz crystal, a trimmer to allow a small variation in the frequency of the oscillator and a tantalum bead capacitor, though this is omitted from later kits. The battery consumption is only a few microamps when the display is not in use, but rises considerably when the display is operating. This is the reason why the display cannot be illuminated continuously; battery life would then be very short indeed.

ASSEMBLY

Assembly of the watch is carried out in a number of stages: preparation and assembly of the PCB; fitting of the flexible PCB; fitting of the insulated copper screen; testing and adjustment; final assembly into case.

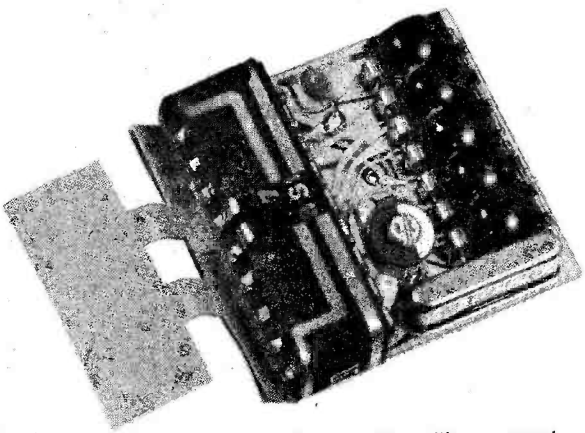
The first step is to varnish most of the component side of the glass fibre PCB. The varnish is left to dry, about two to four hours. The ceramic trimmer is then soldered into position on the PCB. The tantalum capacitor is next, followed by the quartz crystal, the display and the IC. This stage is completed by fitting the flexible printed circuit, wrapped round the IC. The flap of the flexible printed circuit carries the two battery contacts.

The watch assembly then looks like the illustration. The total time spent so far will probably be about an hour, excluding the drying time of the varnish. The next step is to fit the insulated flexible copper screen, which is wrapped round the assembly and soldered to one pin of the IC.

TESTING AND ADJUSTMENT

Testing of the watch is carried out by setting the trimmer capacitor to mid-range and connecting the batteries by a temporary arrangement. If the two pairs of contacts on top of the IC are shorted together, the display should function. Using a radio time-signal, or the telephone clock, the display time is noted at the same time on consecutive days, to determine if the watch is gaining or losing and appropriate adjustment made to the trimmer.

Sinclair say that the watch is ultimately capable of an accuracy of about one second per week. When the accuracy is satisfactory, the watch is fitted into the case, the strap is attached, and the watch is ready to wear.



First stage of construction with components mounted on PCB and the flexible printed circuit in position round the IC at left.

For the temporary connection of batteries, Sinclair advise the use of a "Bulldog" clip, but it was very easy to short the batteries accidentally and almost impossible to hold two batteries, a flexible printed circuit and a Bulldog clip in the correct positions, all at the same time! This difficulty was aggravated by a tendency for one digit of the display to light up as soon as the batteries made contact. The instructions said that this might happen and that the remedy was to interrupt the battery supply. Then, of course, the clip, the batteries and the flexible printed circuit tended to part company once more! The problem of accidental short circuits was cured by using insulating tape on one jaw of the clip, but the operation remained very difficult to carry out.

The idea of using two wooden clothes pegs (of the spring type), two drawing pins and a piece of insulated wire solved the problem. This enabled the batteries to be fitted one at a time and made the procedure comparatively easy. The adjustment of the watch took some four days to accomplish, but was not difficult, rather a little tedious through having to wait four days before being able to complete the watch.

FITTING INTO CASE

Trying to fit the watch into the case was where the problems really started. The PCB assembly was too thick for the space available and there were two reasons for this. The impression was that the flexible copper screen had not been part of the original design; the instructions for the fitting of this screen were separate from the main assembly instructions. The two thicknesses of screen obviously reduced the front-to-back clearance between PCB assembly and case. However, the main reason for the difficulty was that the soldered joints were protruding too far from the PCB. The importance of making very small solder joints had not been emphasised sufficiently in the instructions, which merely called for the use of a fine-tipped soldering iron, and "small wire cutters capable of cropping within ½mm of the PCB".

Sinclair have since stated that an improved IC is now being supplied which is free from any effects due to external static. The insulated copper screen is no longer necessary.

Sinclair Radionics Ltd., St. Ives, Huntingdon, Cambs. PE17 4BR.

PRODUCTION LINES

colin riches

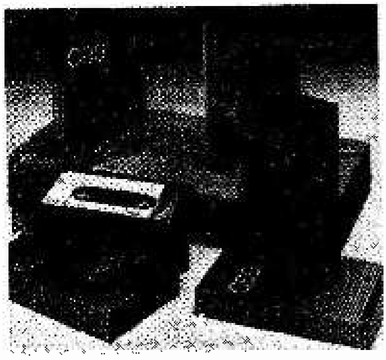
GOLDRING G.900

In the item on the G.900 Cartridge in the April issue the total mass should have read 5gm and the moving mass 0·32gm. We thank Mr. Sharp of Goldring Limited for bringing these points to our notice.

JONELLE CASSETTES

Stores in the John Lewis partnership have introduced their own brand—Jonelle—blank cassette tapes. They come supplied in the usual snap-pack cases, complete with an index card.

The cassettes are made in England using tape supplied by "a large West German manufacturer". The Jonelle C60 (30 minutes per side) costs 39p and the C90 (45 minutes per side) costs 49p. *The John Lewis Partnership (Dept. P.W.) Merchandise Information, Oxford Street, London W1A 1EX. (Telephone 01-637-3434).*



AIWA BREAK ALL THE RULES

If you ask an expert in the HiFi field, what he thinks of music centres i.e. a complete system, less speakers, housed in a single cabinet, he would probably quickly eject you from his presence and swear never to speak to you again. His loathing for this particular form of 'HiFi' was, in the past, justifiable, and could be backed up with test data from both manufacturer and independent reviewer. The fact that true HiFi could not be obtained at a reasonable cost from a system housed in a single cabinet has always been a stumbling block, but Aiwa, have shattered this long-held belief.

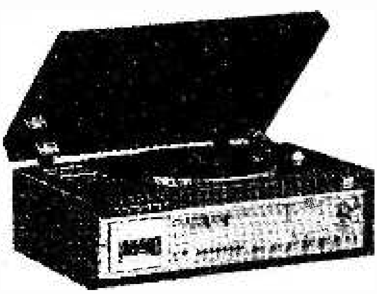
With their model, the AF-5080, they have brought together in a single cabinet an AM/FM stereo tuner, a Dolby cassette recorder, a 24W per channel amplifier and record turntable. The tuner section covers LW, MW and SW on the AM band, while on the FM band, coverage is from 87·5MHz to 108MHz. Sensitivity ranges from 550μV/m (LW), through to 2·5μV/m on the FM band. The amplifier section has a rated output of 24W RMS per channel, with a THD factor at 1kHz of 0·08%. Power bandwidth is from 20Hz to 20kHz.

To satisfy the ever increasing demand for cassette recorders, Aiwa have had the good sense to incorporate a Dolby recorder into the system, which boasts a frequency response of 30Hz to 17000Hz (fe-Cr). The cassettes are front loaded, with all controls oil damped, to give precise and noiseless operation.

Moving on to the record playing section, the aluminium turntable is belt driven from a synchronous motor, giving W & F and S/N figures of 0·1% and 45dB's respectively. The lightweight tubular S-shaped arm, is fitted with an anti-skate device and magnetic cartridge, Recommended tracking force is 2gms.

Obviously there are many more parameters available than the ones discussed here, but taking into account the stylish cabinet, facilities available and price, a potential buyer would be hard pressed to better this combination, either in music centre form or as separates.

Price of the AF-5080 is £288·63 inc. VAT, and it is distributed by *Johnsons of Hendon, (Dept. P.W.) 14 Priestly Way, Eldonwall Trading Estate, London NW2 7TN.*

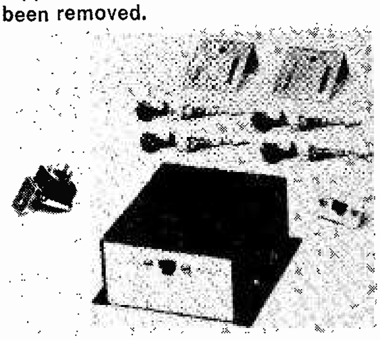


Aiwa's AF-5080 Music Centre

CAR INTRUSION ALARM KIT

The new Heathkit GD-1157 not only protects your vehicle from tampering and theft, but it protects your entire car—engine, boot and passenger compartment—from would-be thieves by sounding your car's horn.

The alarm unit itself can be mounted almost anywhere and is connected to pushbutton switches on the doors, bonnet and boot. The entire system can be armed or disabled by a convenient underdash switch. Two controls in the alarm unit set entry and exit delay times so you can enter or leave the car without accidentally triggering the alarm. However, with the system armed the alarm sounds instantly whenever the doors, bonnet or boot are opened. The alarm sounds for approximately two minutes, then resets and repeats the two-minute alarm cycle until the reset switch on the GD-1157 is flipped or the cause of the alarm has been removed.

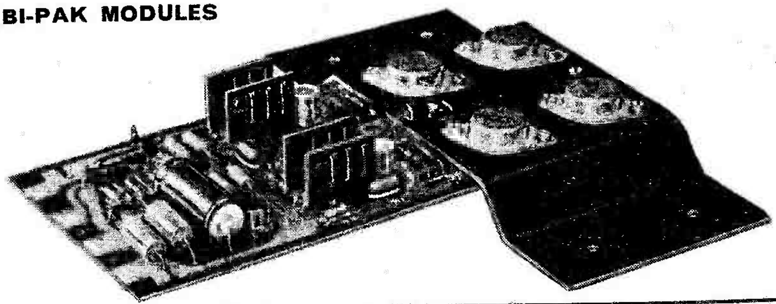


Once the alarm sounds, the underdash arm/disable switch no longer functions and the only way to disable the system is to flip the set/reset switch on the concealed alarm unit.

There is just one simple printed circuit board to wire and the manual gives complete installation instructions. The kit includes 4 pushbutton switches, mounting hardware and cables. And, to simplify installation, your car's existing courtesy light switches can double as switches for the alarm.

Prices: Kit GD-1157 £18·80 (including 8% VAT and delivery within the UK). Full details available upon request from: *Heath (Gloucester) Ltd., (Dept. P.W.) Bristol Road, Gloucester GL2 6EE or The London Heathkit Centre, 233 Tottenham Court Road, London W1P 9AE.*

BI-PAK MODULES



A major addition to their range of Audio Modules is announced by *Bi-Pak Semiconductors, (Dept P.W.) 63 High Street, Ware, Herts.*

The unit, designated AL250, is a power amplifier providing an output of up to 125W RMS into a 4Ω load.

The module has a sensitivity of 450mV and a frequency response extending from 25Hz to 20kHz whilst distortion levels are typically below 0·1%. The use of 4, 115W transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.

The unit is intended for use in many applications such as disco units, sound re-inforcement systems, background music players etc.

Priced at only £15·95 plus V.A.T., the module is supplied with complete instructions and is fully guarenteed.

BARRIE ELECTRONICS

Barrie Electronics inform us that they market the Bi-Kit range of kits with BSR decks in addition to stocking a very large range of components, especially resistors. The firm also supplies Avo meters.

Where possible, Barrie pride themselves on their 'same day dispatch' service and say that they will be pleased to supply readers with their price lists upon receipt of a stamped, addressed envelope. *Barrie Electronics (Dept. P.W.) Ltd., 3 The Minories, London EC3N 1BS.*

DRILL CHUCK

Paramo Tools have introduced a loose drill chuck, mounted on a spiral ratchet bit. This slides into any spiral ratchet screwdriver, either Paramo or their competitors, to replace the standard screwdriver bit.

Quickly fitted, the chuck will take twist bits up to 6mm for the smaller two sizes of spiral ratchet, and up to 8mm for the 131AH. The speed of replacement of the drill chuck enables drilling and screwing operations to be speedily carried out. The high speed attainable with the spiral ratchet action, of course, makes drilling thin materials easy.

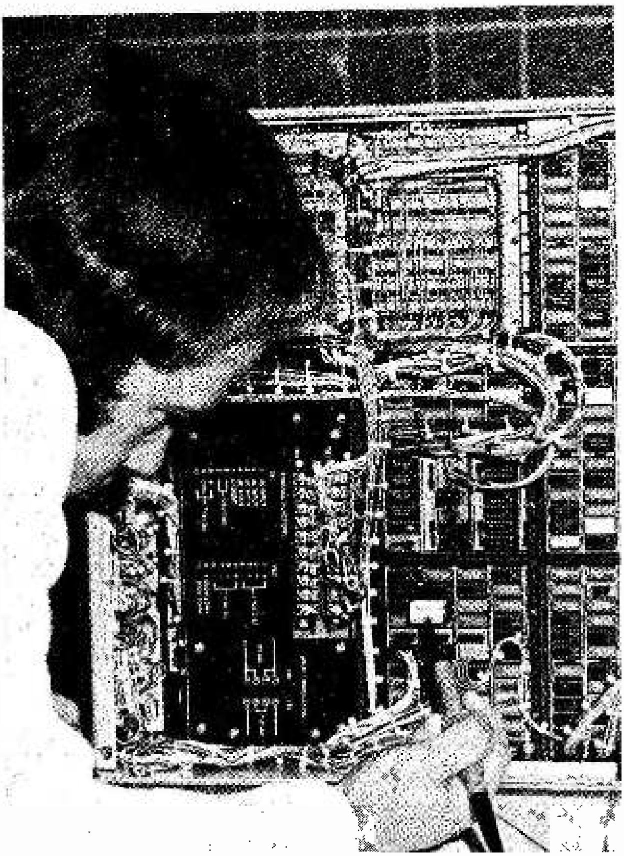
The drill chucks are priced at £3·15 plus V.A.T. for all sizes, and are available from your usual Paramo Tool stockist. *F. Parramore & Sons (Dept. P.W.) Ltd., Caledonian Works, Chapeltown, Sheffield S30 4WZ.*

LUX PD-131

Howland-West have pleasure in announcing the Lux PD-131 turntable. It comes without arm, but is fitted with bayonet type mount to take the SME arm. Features include: brushless DC servo-controlled motor (ensures excellent stability of rotational speed and offers high torque): Turntable platter—so designed as to give not only necessary inertia but possible heaviest weight in consideration of motor bearing and resonance/tension of each part of the turntable: Chassis, wooden frame and panel — aluminium die-cast chassis with sufficient strength and weight, 3mm-thick anodised aluminium panel are firmly assembled together with rubber and the wooden frame has a bumper effect which keeps this turntable immune from vibration: Acrylite case—4mm-thick (0·16in) dust cover: Insulator Compliance and control required for prevention of vibration is obtained by combination of spring, rubber and silicon grease: Unique mirror system stroboscope which permits visual identification of AC line frequency by colour in addition to indication of rotation speed by number of pulses blinking black light.

The price of the turntable, without arm, is £195·00, plus VAT, and it will be available through Lux appointed dealers only. *Howland West Ltd. (Dept. P.W.), 3-5 Eden Grove, London N7 8EQ.*

Two amplifier kits and BSR deck supplied by Barrie Ltd.



This hobby brings big rewards.

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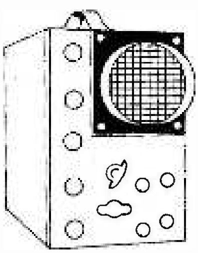

1

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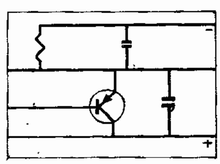

Read, draw and understand circuit diagrams.

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

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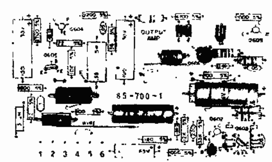

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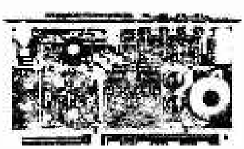

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HOTLINES ON RECENT DEVELOPMENTS

IT FOOLS 'EM!

If you are one of those people who enjoys dropping the odd mouthful of technical novelty—try monolythic gyrator. Ageing engineers have known about them for years but the gyrators were costly to fabricate and so did not appear on the market in any great numbers.

A Dutch company has now manufactured what many believe to be the very first monolythic gyrator. So what are they? Well, they are very small, and when you terminate them with a capacitor, they pretend to be an inductance—but without bulky coils. At present, one adds a single capacitor plus two resistors to form a frequency conscious circuit which can be extremely compact. Another rather startling fact about these gyrators is the size of coil they can fool other electronic circuits into thinking they are. For example a 1,000,000H (one million Henries) coil can be simulated—and to within 0·2% too. Just imagine a 1,000,000H coil—and the gyrator chip measures only 3·4mm x 3·4mm. Used in resonant circuit applications, a Q of between 500 and 5,000 is achievable.

A CALCULATING MOVE MATE!

The second idea (I predict) will take off very fast indeed once it becomes available. It's a pocket sized calculator in appearance—but it isn't, if you follow me. Closer examination reveals a miniature chess board engraved or screened on the face together with the necessary buttons to enter moves. The hand held unit employs a microprocessor and the unit was on show at a recent International toy fair. Not available yet but the price looks very reasonable. Just the thing you've always wanted; chess without getting board!

ELECTRONIC NOSH

With Easter now firmly behind us for another year, it allows a full twelve months to prepare ourselves to receive an electronically cooked hot cross bun. Not really so far-fetched and will be in our homes by next Easter. Gone are the old switches and timers. In their place has come a cooker with digital readout, electronic cooking keyboard and a store of some 120 cooking programs in its own memory banks.

The housewife of the future needs only to mix ingredients as per the cooking book (supplied with the cooker) and then punch in the relevant code for perfect cooking. The grilling and baking programs can be used with hundreds of different recipes and dishes. The cooker uses two Read-Only Memories (ROMs) and a Central Processing Unit (CPU).

Fancy that; if you want to dial-a-doughnut then there's just one place to press!

CREDITABLE

It is a peculiarity of the hologram that if one tiny part of its area is examined, the whole complete holographic image can be seen. To check authenticity of any one of these cards, it is only necessary to examine a tiny part of the card and the holographic image at that point will show the whole card—as it was originally. This image, together with a direct image of the card being viewed are shown side by side in a special viewer. Any alteration can thus be immediately detected. Clearly a method that will not forge ahead!

1k CQ's

Good news for Hams and anyone else interested in producing a number of different frequencies with crystal controlled accuracy. A CMOS LSI digital chip is now on the market which will provide 1,021 output frequencies from one crystal—a truly digital v.f.o. It will operate from a 5V line and will accept input frequencies of up to 5MHz. Another bonus too, it isn't greedy on power; dissipation is only 5mW. I note that in the United States, a sample by post costs $19 76c. It seems doubtful if the company would send one over to the UK against a remittance but the number to watch for when they become available here is HCTRO320. Lids on the Amateur bands should note that this is not a heaven-sent device for calling CQ on 1,021 frequencies at the same time!

Bad news for the forgery profession. Alteration of credit cards and the like will soon be quite impossible if a German company gets its system accepted. The original card is photographed using a laser to form a holographic image which is then bound with the original card and sealed in.

SKINNY C's

How thin is thin? It really depends upon what one is talking about. I was impressed by the thinness of a series of capacitors called Thintrim. These are variable types with an adjustable range from 7 to 45pF. They measure 0·2 x 0·2 x 0·05in. The manufacturers inform that they make another type with a 25pF maximum value—but of course, that's much smaller! Wonder how many puffs to the pound?

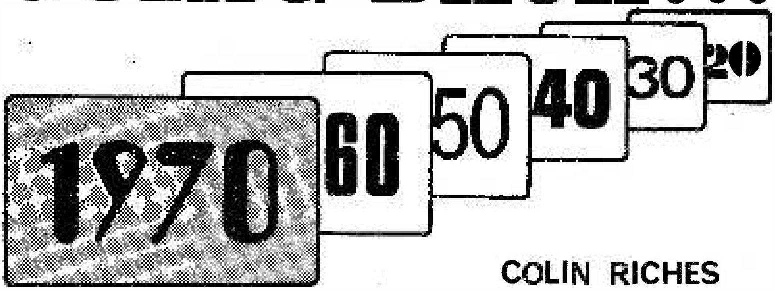
READ-OUT

Playing games with electronic calculators has been in vogue for some time. The idea is that by turning the unit upside down, it is possible to "read" a message formed by the number displayed. It seems that certain companies are taking the whole thing a few steps further—and it isn't necessary to turn the calculator upside down.

One idea shortly to be introduced allows a calculator to be used as an active terminal for a computer. In this application, it forms a substitute for a teletype terminal. With this unit, it will be possible to talk to the computer and to receive information which will then be displayed on the calculator's readout.

Ginsberg

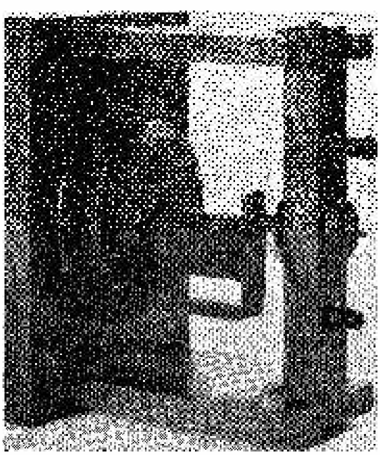
GOING BACK...



COLIN RICHES

ALEXANDER Graham Bell was born in Edinburgh on 3 March, 1847. His father and grandfather were teachers of elocution and he used a new system of phonetic symbols, invented by his father, to teach the deaf to speak. In 1870 the family emigrated to Canada and Bell established himself in Boston as a teacher of the deaf.

Bell's telephone arose from a chance observation made in 1875 when he was working on his "harmonic telegraph". This was an instrument designed to carry several telegraph messages over a single circuit by using currents of a different frequency for each message, and detecting each signal by a tuned reed and an electromagnet. With two such instruments connected together he noticed that when one reed was twanged the corresponding reed on the other instrument vibrated in sympathy. Bell had assumed that the current generated by a vibrating reed would be too feeble to be of use. The discovery that it could set another reed in motion established a train of thought that led to his "gallows frame" telephone (see picture). A pair of these, used as transmitter and receiver, produced sounds that were unmistakably vocal, though not intelligible.



Bell's "gallows" telephone. Science Museum picture.

On 7 March, 1876 Bell was granted a patent that covered the harmonic telegraph, telephones acting on the principle of the gallows-frame instrument, and also the production of a signal by varying a resistance and thereby controlling the current from a battery. He returned to his telephone experiments, now using a crude variable-resistance transmitter. On 10 March, 1876 his assistant heard the first intelligible sentence conveyed by a telephone, **"Mr. Watson—Come here—I want to see you"**. Since then most telephones have used the variable-resistance principle in their transmitters, though Bell returned to the electromagnetic transmitter and used it to establish the telephone commercially in North America. In August 1877 he came back to Britain to promote the telephone. In January 1878 he demonstrated it to Queen Victoria and in June established The Telephone Company Limited.

Meanwhile Thomas Edison had produced a practical variable-resistance transmitter employing compressed lamp-black , which gave a much greater output than Bell's electromagnetic instrument. Edison could not use Bell's receiver because of the patent, so had to invent his own. This was an electrochemical device, the "motograph", which gave loud but poor-quality reproduction and required the user to turn a handle continuously. However, it served its purpose of strengthening Edison's commercial position, and he founded a British company in August 1879 which merged with Bell's in 1880 to form The United Telephone Company Limited.

By 1880 commercial rivalry was less important to the telephone than its legal status. For ten years public telegraphy in Britain had been a state monopoly run by the GPO. So long as Bell confined the telephone to private wires, relations with the GPO were reasonably cordial. But from the outset he realised that the future of the telephone lay in the operation of *exchanges*, enabling any subscriber to be connected with any other, and in 1879 both the Bell and Edison Companies opened exchanges in London. The GPO realised that this new development could undermine the revenue of the telegraph service, though it was not sufficiently convinced of the

Alexander Graham Bell (1847–1922).

telephone's usefulness to wish to be committed to exploiting it. It was nonetheless able to control the development of the telephone system after obtaining a High Court judgment that the telephone was a telegraph and a telephone message was a telegram within the meaning of the Telegraph Acts. Commercial companies were licensed and though there were numerous companies in operation during the 1880's, the three largest merged in 1889 to form The National Telephone Company, which thereafter held a dominant position until its licence expired on 31 December, 1911; the GPO then took over full responsibility for the nation's telephone service.

We thank the Science Museum for information used in this article.

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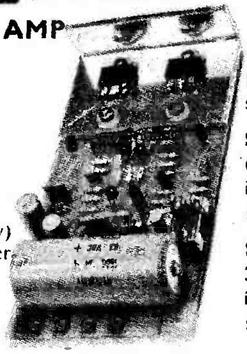

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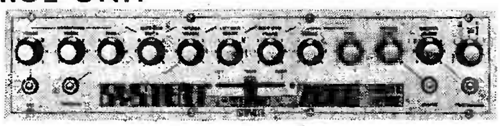

- Controls—L. to R.: Mic, Vol/Treble/Bass, Autofade depth, L/Deck Vol, R/Deck Volume, Tape Volume, Treble, Bass, Master, Monitor Volume, Monitor Selector-On-Off

MONO **£34·50** STEREO **£49·50**

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Printed circuit sub-assembly version of disco control unit: All electronics included. Only plugs, socket and one switch required.

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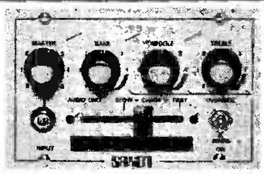

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INPUT Mono £8·50, Stereo £12·00

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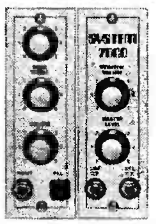

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ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

THE author of a feature such as this is usually left with mixed feelings after completing his stint for the month. Letters from newcomers to the amateur and broadcast bands or those seeking information on our hobby raise the spirits no end, while established correspondents who write in happily to tell me that they've just passed the Radio Amateurs Examination bring despair, as I realise I've lost a reader but elation to know that a new callsign has come into being.

I believe it is important to find out just how the newcomer has got around to the SW bands. Often it is the result of casually tuning over the SW bands on a domestic receiver and wanting to do it better on a decent receiver. Sometimes it's an offshoot of listening to aircraft, police and other Public Services on the VHF bands, something to be strongly deprecated. There is much more fun on the SW broadcast and amateur bands especially when it leads to getting one's own transmitting licence and talking back to other amateurs.

At one time, when amateur band telephony was strictly double sideband and unsuppressed carrier stuff, it could be picked up and resolved on almost any domestic receiver, even if it did not cover the amateur bands! Enquiries locally usually revealed the amateur concerned but the complainant often became interested to the extent of taking up the hobby himself! Or herself, since there were ladies enjoying the hobby from the early days. However with the development and use of single sideband telephony by amateurs this method of "contact" has virtually disappeared since SSB on a domestic set is just a horrible noise. Come to think of it, it's often a horrible noise on the bands themselves! The QRM remains but the source is harder to locate, often requiring the services of the Post Office, and sometimes leading to unpleasantness all round. I often think that the coming of SSB has led to the amateur becoming more isolated from the general public.

Excellent news of **Tim Charles** A8927 of Colchester who has passed his RAE and is taking his code exam in a couple of weeks. He was one of the few readers of this column who bothered to send in logs of stations heard on CW. Let's hope the experience will pay off first time for Tim. With a bit of luck we may get his new callsign before we go to press. So another reader bites the dust! Inevitable, I suppose! The last bit of news from Tim concerned the positive reception of JA3ONB on 160m! he was 449 on 1908kHz so Tim can go out in a blaze of glory!

Ray Woodward in Colne now has an RQ80 ATU in front of his CR70A which, with 132ft of wire, albeit at only 10ft up, has greatly improved reception. He's getting some gear together for the 2m band and hopes to do well on the VHF's as he is some 700ft above sea level up there in Lancashire. **Paul Barker** BRS34898 in Sunderland had a bad month what with the flu and bands in a poor state. SSTV on 20m brought only G4BFB and I8JTU while on SSB CT4AJ proved to be a non-event being just another CT1 in reality!

Steve Cottis of Harrogate worked his way through all the bands from 80 to 10m. His best on 80 was JD1AKE while KC6AQ relieved the monotony on 20m. **Dennis Anderson** writes from Brookwood in Surrey to say that he is now BRS36591 and has joined the Farnborough and District Radio Club and "they are very helpful" which is nice to know. **Paul Flatman** (Ipswich) could only get on for a few days last month but when he did he found 20m pretty active but next to nothing on 15m. A nice one on 80m reported by Paul was K3HVG/P/HR6 on Swan Island. Paul is about to replace his old faithful HRO receiver but I hope he gets something that turns out to be at least as good. With a few mods the HRO can be turned into a pretty good receiver which will out-perform a lot of the modern sets especially in the areas of cross-modulation and inherent noise.

Stephen Budd A8713 in Worthing found 80m "unbelievably fantastic" in the early mornings but was not enthusiastic about the rest of the HF bands. He has shelved plans for a 6-element beam and rotator for 2m after seeing the "ridiculous prices". Especially, as he says, it would only be for one band. **Paul Flatman,** Ipswich, is pretty busy with other commitments, his only free time coinciding with the gap between 20m going dead and 80m coming alive!

Paul Cowburn writes from Leyland, Lancs for the first time and is full of praise for the help he is getting from local G3RFN on the many problems that beset a newcomer to the SW bands. Certainly everyone new to our hobby ought to try and contact his local amateur or radio society rather than try to steer a lonely path, often in the wrong direction. Paul has a Marconi CR300/2 but finds that its performance tends to drop off at the higher frequencies. When this happens it is not a bad idea to build a crystal controlled converter for say 20, 15 and 10m and use the main receiver as a tuneable IF around 3 to 4MHz.

ON THE AIR

Log extracts

T. Charles:- 160m JA3ONB 40m FM7AV H13HOT **20m VP2MJ ZP5AO 2m DM2BEN/P SM7CHX SP1II UR2RDR** (auroral opening) via Oscar 7 VE3SAT **W2BLV W9OII** W0EAZ **70cm** PA0GDM PA0MHK

R. Woodward:- 80m CO2JA HK4DF YV4ATI 8P6FV **20m** DU9FB HK6CMA VP2MEV 6W8NW

P. Barker:- 20m CT2BB VQ9R VU2HI **SSTV** G4BFB I8JTU

S. Cottis:- 80m JA6BSM VP9G OE6DK/YK ZL1BJ **40m** ZL4ND 6W8DX **20m** DU1DBT KC6AQ VP2KJ 5V7WT 9M2FR **15m** CT2BB EL2T FM7AQ TU2DF 5N2ESH **10m** 9J2WR

P. Flatman:- 80m K3HVG/P/HR6 KG4FU **20m** DU9FB HR3JJR VK9XI VP8HZ 6W8MW 8P6FU

All SSB except those in bold which are CW.

S. Budd:— 80m A4XFX EP2SN FP8DX HR2FP KG4GG KZ5JM PJ0USA VP1DW VP2ABC VP2DM VP2KJ YN7R 5T5ZR 8P6GN **40m** VK7GK ZL2AQ **20m** A6XP C5AF KG6JBX TA1MB 5N2ESH 9X5SP **15m** ZD7FT **2m via Oscor 7** DC2ST F6APU PA0JHM

P. Cowburn:— 80m CO2JA JA6BSM ZB2DK **40m** VK2AVA VK5PB VK7DK YA2WJ YV6CD AD3EST (Washington, special event station, 200 years American Independence).

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Derek Bell

MANY a time and oft the controversy has been bandied about as to the stability of various SW sets. Those who run what are known as communications receivers maintain that their type of set is far and away the best and indeed the only type of set to use for DX. This point is made, often with some force and the right hand firmly round the opponents throat, in order to ensure that he sees the error of his ways! **R. Burgess** has it seems the best of both worlds in that he has recently purchased a Grundig Satellit 2000 and, though very very expensive, this set has a fair degree of portability and is fine for putting in the car. From his Haywards Heath QTH R.B. has, with the internal aerial pulled in the following:

Radio Aparecida on 9635 at 0000
Radio Nacional Colombia on 4955 at 2300
Radio Abidjan on 11920 at 1940
FEBA Seychelles on 11715 at 1700
Radio Togo on 5047 at 2300
Radio Grenada on 15105 at 2030

This set seems to have the advantage of pulling in the Latin Americans an hour earlier than they are heard with a cheaper set, and as R.B. says "L.A.'s are at their best in the wee small hours". The latter item on the log, Radio Grenada, was however heard in Huntingdon, Cambs. by **Richard King** on a Russian Vega Selena, logged at 2000 and who rates the signal at nothing less than fours on the SINPO scale. Alongside this item Richard passes on the info that HCJB Quito is to build a 500kW transmitter in Indiana USA and quite pricey it sounds. One of the valves for example will cost 17000 dollars!

Another item of station news is that Indonesia is to phase out its short wave broadcasts by 1979. At present these can be heard on a wide range of freqs. from 2300 up to 17792. The transmitters are all of modest power since they are intended to serve only the home listeners but then so are the Latin Americans and these are heard here in the UK every night. I presume that the Indonesian Radio Jakarta with its overseas service will still be active and this can be heard in English on 11790 and 6045 at 2300, 0900 and 1100 with an introduction played on a Hammond organ.

To continue the theme of cheap transistor sets versus the more expensive rig, **John Baker** of Birkenhead joins in to ask this question and then on his Philips 90L goes on to log:

Radio Nacional de Brasilia on 11780 at 2100
Radio Australia on 9570 at 0817
RSA on 5980 at 2133

"Do the more expensive communications sets offer better value for money than the portables?" asks John, well let's explore this question a little more. To do so we must call in our overseas reader this month **Martin Kennedy** from Christchurch, New Zealand. Martin runs a Codar CR70A hanging on the end of a 100ft long-wire. Pride of the log is the AFN "National Public Radio" from Greenville USA, this signal arrives either over the Pacific or across the pole according to which way Greenville's aerials are switched. Also featured is Radio Free China from Taiwan on 11825 at 0210, so it would seem that communications sets earn their keep wherever they are.

"What", you say "about the home built sets then" **David Wyatt** of Oswestry has built one, a seven transistor superhet with a 20ft wire. David logs on it

Radio Pakistan on 17910 at 1100
Voice of Turkey on 11808 at 0017

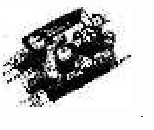
David gives the address of Voice of Turkey for QSL fans as TRT Voice of Turkey, Ankara, Turkey. He requests the address of Radio Canada, which I can supply, and that is P.O. Box 6000, Montreal, Canada, H3C 3A8.

So, what have we learned up to now?, well that both types of set fill a need but that need must depend not only on the pocket but the situation of the user.

Recently an enquiry was featured in this column for information on a certain type of Royal Navy set. An ex-member of the "Andrew" **E. J. Scudder** adds more to the gen already received. This gentleman had the job of maintaining these sets during the war and informs us that they were made by Eddystone. The main problem was the coil pins it seems as operators would pull the coils forward instead of up thus bending the pins and eventually breaking them off, causing much grief and no small amount

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.



Model 1153 500mW power output £1·10 + 40p post & VAT. Model 1172 1W. power output £1·35 + 45p post & VAT. Model EP9000 4 watt power output £2·40 + 50p post & VAT. EP 9001 twin channel or stereo pre amp. £2·50 + 50p post & VAT.

TINY RADIO CASES

Intended to be spares for the microsonic key chain radio, size approx. 2¾ x 2½ x 1½, back removable also metal flap for battery compartment, should be about right for building your own miniature radio, transmitter or bugging device. Price 40p + 10p each.

MICRO RADIO CONSTRUCTOR'S PARCEL

Not complete kit but consisting of eight matching components as follows:—(1) Wound ferrite aerial. (2) oscillator. (3) 4 IF's (4) Twin gang tuning condenser (5) volume control. These last two items being fitted with control knobs. Price 80p + 20p. Post 20p + 5p.

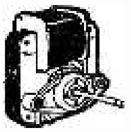
MAINS TRANSISTOR PACK

Designed to operate transistor sets and ampliers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: main transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only £1·50 VAT & Postage 50p.

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450w). Unit in Box all ready to work. £7·95 plus 95p VAT and postage.

MAINS MOTOR



Precision made—as used in record decks and tape recorders—ideal also for extractor fans, blower, heaters, etc. New and perfect. Snip at 95p + VAT & Postage 35p. 1" stackmotor £1·50 + VAT & postage 35p. 1½" stackmotor £2 + VAT & Postage 40p.

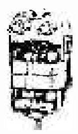
6 DIGIT COUNTER

Made by famous American Company, operated by 24V D.C. or mains through resistor, 1⅛" x 1" x 2¼" deep. 80p Post & VAT 20p each.

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 30p + 15p post & VAT each.

MULTI-SPEED MOTOR



Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. x 5 in. long. Price £1·40 + 45p post & VAT.

MERCURY BATTERIES

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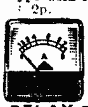
Extremely well made, intended for upright mounting and impregnated for quiet operation. Price £1·75 + 2p. Ditto but drop through chassis type with top cover. Price £2. + 16p. Post 15p + 2p.



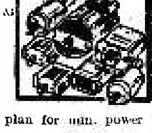
AMMETERS

Ideal for chargers etc. 2" sq. full vision 0·8 amp 95p. 1½" round 0·2 amp 55p, 0·3 amp 65p, 0·4 amp 75p. Post & VAT 25p each.

RELAY BARGAIN

Type 600 relay, 2 changeover one open and one closed contact. Twin 500 ohm coils make this suitable or closing off DC 6v, DC 12v, DC 24v or AC mains using resistor and rectifier. 40p each. Resistor or rectifier 20p extra. Post & VAT 20p.

ONLY £1·50 FOR SEVEN ELECTRIC MOTORS



7 powerful batt. motors as used in racing cars & power models. Output & types vary for use in hundreds of different projects — Tools, toys, models, etc. All brand new reversible & for 1½-12v. batts. Wiring diagram. inc. VAT & Post 40p. FREE plan for min. power station.

TWIN OUTPUT POWER PACKS

These have two separately R.C. smooth outputs so can operate two battery radios on a stereo amp without cross modulation (they will of course operate one radio-tape-cassette-calculator in fact any battery appliance and will save their cost in a few months). Specs.: Full wave rectification, double insulated mains transformer—total enclosed in hard P.V.C. case—three core mains lead—terminal output. When ordering please state output voltage 4½v, 6v, 7½v, 9v, 12v or 24v. Price £3·95, post and VAT included.

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A mains operated travelling light array. 24ft. long, it uses 130 miniature bulbs which flash in sequences to make bands of light move along the tube—The tube can be draped around a particular item or set and cannot fail to attract attention—complete kit consists of—24ft. of translucent tubing—140 miniature lamps 8 yards mulitcore cable—motorised switch, taps for quick connections and full wiring instruction special introductory offer £10 for the complete kit post and V.A.T. paid.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·75, VAT & postage 65p.

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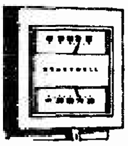
Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2·95, VAT & Postage 60p, or with glass front, chrome bezel, £1·50 extra.

THIS MONTH'S SNIP

D.I.Y. BURGLAR ALARM KIT No. I

This is simple enough for the average householder to install and maintain. It will give protection against intruders coming in through any of four windows and or two doors. Intended to frighten intruders away it will start loud ringing bell which will not stop until reset by owner. Kit consists of 6 large trigger mats, 1 loud bell, 1 relay for latching, 1 secret switch, diagram and notes. Price £14 + £1·50p. Post £1·00 + 25p.

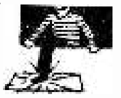


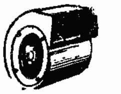
THERMOSTAT WITH THERMOMETER

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. Elegantly styled and encased in an ivory plastic case with clear plastic windows, thermometer above and switch setting scale below—size approx. 3·8" x 3·2" x 1·4" deep—can be mounted on conduit box or directly on wall. Price £2·25 plus 50p Post & VAT.

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in x 18in £1·99. Post & VAT 60p. 13in x 10in £1·50. Post & VAT 50p.





CENTRIFUGAL FAN

Mains operated, turbo blower type. Pressed steel housing contains motor and impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½" x 4½" £9·50 plus Post & VAT.

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Size	*Amps*	*Type*	*Price 100 metres*	*Carriage n/o 200 miles*
1·5mm	16A	Single c.c.	£2·50 + 20p	80p + 6p
1·5mm	16A	Single double insulated	£3·50 + 28p	90p + 7p
1·5mm	15A	Flat twin	£5·50 + 44p	£1·25 + 10p
1·5mm	15A	Flat twin & E.	£6·50 + 52p	£1·50 + 12p
1·5mm	13A	Flat 3 core	£8·50 + 56p	£1·75 + 14p
1·5mm	13A	Flat 3 core & E.	£9·50 + 60p	£2·00 + 16p
4mm	30A	Single c.c.	£7·50 + 60p	£2·00 + 16p
4mm	30A	Single double ins.	£7·95 + 64p	£2·00 + 16p
4mm	27A	Flat twin	£12·00 + 96p	£2·00 + 16p
4mm	24A	Flat three core	£14·50 + £1·16	£2·50 + 20p
4mm	24A	Flat three core & E.	£18·50 + £1·48	£2·50 + 20p
6mm	38A	Single c.c.	£9·50 + 76p	£2·00 + 16p
6mm	38A	Flat three core	£23·00 + £1·84	£3·00 + 24p
6mm	38A	Twin & E.	£22·50 + £1·80	£3·00 + 24p
10mm	48A	Twin & E.	£35·00 + £2·80	£4·00 + 32p
16mm	64A	Twin & E	£55·00 + £4·40	£5·00 + 40p

TERMS: Where order is under £5 please add 30p surcharge to offset packing expenses.

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ITS FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and its free—just send S.A.E. Below are a few of the Bargains still available from previous lists:

Spit motor with Carter gear box. Probably one of the best spit motors made. Originally intended to be used in very high priced cookers: however, this can be put to plenty of other uses, for instance your garden barbecue or to drive a colour disc for a dance or display or to drive a tumbler for stone polishing; in fact, there is no end to its uses. Normal mains operation. Special price during May and June £2·50 + 20p, post 30p + 2p.

Pulse transformer with circuit for sound to light unit. It is a very simple circuit and all parts are readily obtainable from us or you may already have them in your junk box. Price of the transformer with circuit 75p, post and VAT paid.

ORP 12 light cell. This device has been going for some years now but it has not been bettered and new applications keep being found for it. We have good stocks, price 65p + 5p.

Throat mikes. These are an ex WD item as used by air crew on their intercom, but being electro-magnetic they also serve as pick-ups on musical instruments, talking to passengers on motor bike and no doubt many other use. Price 60p a pair + 15p.

12½ watt speaker bargain, 8" round mid-range, made for high price hi-fi outfit, a really super speaker, £3 + 37p, post 60p + 15p.

O.C.P. photo transistor by Mullard, very popular for circuits such as infra-red burglar alarms, smoke detectors, etc. A big buy enables us to offer at the very favourable price of 25p each — 2p, or 5 for £1 + 8p.

Component boards, mainly ex computer, these contain many useful parts and represent fantastic value at 5 for £1 + 8p. We guarantee the 5 would be different. You would receive ICs etc., variable controls with long leads and so are easy to remove and re-use. Post 50p – 4p.

Microswitch bargain, made by Pye, Honeywell, Burgess and similar first class makers originally for the Post Office, in fact they have been fitted to Post Office Equipment which was never put into use. They are a changeover microswitch with 10 amp contacts offered at the very low price of 20 for £1 + 8p. Post 40p + 3p.

Ferrite pot core (Vinkor) made by Mullard, maker's ref. No. LA 14107402K, circular, size approx. 1⅞" x ⅞", a size which is the same as the one specified for the Scorpio car ignition system. Price only 50p + 4p per pair. Post 15p + 1p.

12v DC motor made by Smiths, powerful, ideal for car blower; motor size 4" long x 3" diameter, ¼" spindle, 1½" long. £2. + 16p. Post 40p + 3p.

Thermostat with capilliary with sensor joined by approx. 1 metre of capilliary covering the temperature range 0-170°C capable of switching 16 amps at 250v. Made by the famous Ranco Company with screwed thread and spindle rather like a volume control—has dozens of applications. Offered at only 75p + 6p. Post 12p + 1p.

Aerials. For medium and long wave, wound and fitted on ferrite rod, 6" long by ⅜" diameter. Price 60p + 15p Post 10p + 5p.

Dial thermometer by Rotetherm. Indicates from 50F to 250F, dial size 3½", chrome and glass front. 75p + 6p. Post 10p + 1p.

Instrument Mains Transformer, 6·3v at ¼ amp and 115v at 100mA. This is an upright mounting open construction, small size (2¼ x 2¼" x 2¼"). Price £1·40 + postage and VAT 60p. DITTO. 6·3v at 1 amp and 150v at 200mA. This is a fully shrouded upright mounting transformer, size approx. 2¼" x 3" x 3". Price £1·95 + post and VAT 88p.

Instrument power supply mounted on a chassis size 9½ x 2¼" x 4¼". This is suitable for instruments which use valves and hs AC output of 6·3v at 1 amp and a fully smoothed DC outputs of 150v and 200v. Price £2·50 + post and VAT 74p.

FM Band amplifier. This is a 4 valve amplifier tunable to cover FM and nearby frequencies. Tuning is by lecherlines in fully screened compartments and the whole is mounted on a heavy metal chassis size 9" x 2" x 2¼" x 5". This requires a separate power supply of 150v DC at 100 mA and 6·3V at 1 amp. Price £3·75 + post and VAT £1·58.

Instrument case, grey steel finish size 9½" x 3¾" x 2½". These cases are not secondhand but come from partly assembled equipment, so the front panel has a few holes already punched through. However, these are very suitable for toggle switches, etc. There are no really big holes, 50p each + post and VAT 36p.

6 switch disco lamp controller. This is a mains motor driving a rotating drum made up of discs with cut-outs. As the cut-outs engage on the switch levers, contact is made via 10 amp switches. A large variety of lighting effects can be obtained. A real bargain at £2·75 + post & V.A.T. 65p.

Clock switch for Tricity cooker, made by Smiths and probably a replacement in many other cookers. This has clock in the centre and the two controls switches on the right-hand side. The top control switch sets the on-off times and is infinitely adjustable over the 12 hours; the lower switch selects manual or automatic. No glass front, but you could take this off your existing clock. Price £1·75 each + post & V.A.T. 35p.

ON THE AIR

of Navy language to Mr. Scudder. Thus it seems the more complicated the set, the more it will cost to repair. This repair could result in having to send overseas for spares, increasing the cost and time spent without the use of the set. On the other hand cheap sets are often improved by the addition of aerial tuners and pre-selectors. **John Higginbotham** of Holyhead has written to say that the Radio Nederland ATU specification sheet is once more being sent out. Readers will remember that news reached this column recently of RNI being lax in their reply to an enquiry for the plans for this handy bolt-on extra. John viewed in amazement his postbag from stations which totalled five cards and 17 calendars after the Christmas rush was over. I have recently had a card from Radio Sofia wishing me a happy Spring!

The main conclusion is that the cheap transistor radio is fine for a second or bedside set and for the person of limited budget, and that means most of us these days. While the communications set is for those who have the money to spare and the space to fit the set into. The AR88, for instance, needs a stout table just to take the weight! It is of course pointless to expect the cheaper transistor set to pull in the signals that the Grundig Satellit will or some of the American products, or even the Codar, but the use of a cheaper set may fire you to go on to bigger and better things and even aspire to the RAE.

So until next month I will simply say 73s to you and yours.

MEDIUM WAVE DX

by CHARLES MOLLOY

READER "Steve" who lives in Truro, Cornwall reports hearing CFGO in Ottawa on about 1440kHz at 0305GMT after Radio Luxemburg had closed down for the night. CFGO does operate on 1440kHz and is heard quite often in the UK. Steve uses a Philips IC326 receiver coupled to the co-ax downlead of his VHF TV aerial. The receiver is placed on top of the co-ax, the screen of which is earthed and this gives a very good boost to reception. Steve mentions hearing Radio Sweden on approx. 1151kHz as well as on 1178kHz which is the listed frequency. This effect is almost certainly due to a spurious signal generated within the receiver as a result of overloading by the pick-up from the co-ax downlead aerial. Portable receivers are normally designed to work with the comparatively low signal input from a ferrite rod aerial. Care should be taken when an external aerial is used that the coupling is not too close otherwise the increased signal strength obtained will be accompanied by whistles and spurious signals.

Quite often the medium wave tuning scale on a receiver is not accurate enough to show the frequency to the nearest 5kHz or so. The DXer is then uncertain which one of two or even three channels he is listening to and problems with station identification can arise. A logging scale, if the receiver has one, can be used to improve matters. This scale is marked from 0 to 100 or perhaps, 0 to 1000 and is used with a sheet of graph paper to plot a curve that will enable logging scale divisions to be converted to frequency. Known local broadcasting stations can be used to mark a number of points on the graph, these points being joined with a continuous line to form a curve which is used to convert frequency to logging scale reading and vice versa.

An alternative is to use a crystal calibrator. The writer's has switched outputs of 10kHz, 50kHz and 100kHz which are found to be adequate for MW DXing. The calibrator is connected to the receiver in parallel with the aerial and it acts as a miniature transmitter to give marker points at intervals across the band. The method used by the writer is to draw up a table giving a logging scale reading for each 10kHz point on the medium waves which is very useful when DXing North Americans where the stations are on channels which are multiples of 10kHz. A more usual method is to switch-in the calibrator in place of the aerial and use the 100kHz markers to identify sections of the band and the 10kHz markers to tune to an exact channel. "Odd" frequencies between the 10kHz points can be estimated. Domestic type receivers in the UK are usually marked in metres on the tuning scale. To convert, divide 300,000 by the wavelength in metres, to get the frequency in kHz.

Roy Patrick reports from Mackworth, Derby with news of his recent broadcasts from Radio Derby on "Late Night Derby". He has been telling listeners about DXing and says it was nice to be on the other end for a change. Roy's medium wave catches made on a Trio 9R59D receiver include CJCH in Halifax, Nova Scotia on 920kHz; CJON St. John's on 930kHz; WINS in New York City on 1010kHz; WHN also in NYC on 1050kHz; CBA Moncton, New Brunswick on 1070kHz and Urumchi in China on 1525kHz at 2300GMT with a programme in Russian. Good luck with your broadcasting Roy!

When two adjacent broadcasting stations are identified by wavelength rather than by frequency it will be difficult to decide from this information whether they will interfere with each other. Only the frequency separation in kHz is of value since the bandwidth of a receiver and hence its selectivity, the ability to separate adjacent signals, is measured in kHz. On the medium and long waves in Europe the majority of channels have a separation of 9kHz. At the HF end of the MWs, channel 107 (1484kHz) corresponds to 202·2 metres while channel 106 (1475kHz) corresponds to 203·4m, the difference in wavelength being 1·2m. At the LF end of the band channel 5 (566kHz) is 530, while channel 4 (557kHz) is 539m the difference in this case being 9m. On the long waves 209kHz corresponds to 1435m and 200kHz to 1500m the difference being 65m. From an interference point of view the "distance" between the two stations in each case is the same, namely 9kHz but the wavelength separation varies between 1·2m and 35m.

ON THE AIR

The advantages of using kHz instead of metres are so obvious that the practice is now in use by DXers and broadcasting authorities in most parts of the world. In the UK, FM stations on VHF are quoted by their frequency in megahertz though the use of metres on the medium and long waves lingers on. In North America, where the separation is 10kHz the medium waves, or "Broadcast Band" extends from 540kHz to 1600kHz. Receiver manufacturers often drop the last zero, and mark the scales 54 to 160, a practice that can be seen on many imported domestic receivers on sale in the UK.

An interesting letter from **Ian Rennison** in Horsham, Sussex tells of a holiday spent in Richmond, Virginia, USA where he heard US radio first hand. He mentions picking-up WKBW Buffalo NY on 1520kHz on a car radio and commenting that he had clearer reception of the same station back home! WKBW is often a strong signal here in the UK just before sunrise at this time of year. Ian has been trying to pick up WRVA Richmond on 1140kHz and asks if it has been logged in this country. WRVA has been heard but not often because of the directional aerial system in use at the transmitter. WRVA and CBI in Nova Scotia both transmit on 1140kHz and to reduce mutual interference each station has a directional aerial which has a null towards the other. The null from WRVA is towards the North East which is also the bearing of the DXer in the UK and as a result, CBI comes in well in the UK while WRVA is something of a rarity. Ian's excellent log of DX heard at Horsham on a Trio 9R59D receiver, medium wave loop and PW differential loop amplifier includes 19 Canadians (CKVO is the unidentified one on 710kHz); 20 from the US the more outstanding being WSB Atlanta, Georgia on 750kHz; WHO Des Moines on 1040kHz and KMOX St. Louis on 1120kHz, along with a number from the Caribbean area such as CMKV Radio Rebelde in Cuba on 600kHz, Radio Demerara, Guyana on 760kHz and Radio Belize on 834kHz.

BROADCAST BANDS
Short Wave reports by the 15th of the month to Derek Bell c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.
Medium Wave Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

AMATEUR BANDS
Logs covering any Amateur band/s in band/alphabetical order by the 25th of the month to Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.

NEW BOOKS

THE ELECTRONIC MUSICAL INSTRUMENT MANUAL
By Alan Douglas
Published by Pitman Publishing Ltd.,
39 Parker Street, London WC2B 5PB.
205 pages 25·5cms × 19·0cms
Price £7·50

IN this entirely revised sixth edition, the author sets out to start the reader right at the fundamentals of sound and to progressively work up to examples of current organs. He has not, however, forgotten the owners of valve organs.

Basically this book is a comprehensive guide to the theory and design of musical instruments, with particular reference to the organ. It covers the entire field of sound theory and the function of physical sound sources and their electronic counterparts.

The author, Alan Douglas, is a well-respected expert on the design of electronic musical equipment. He is a senior member of the IEEE and an Associate of the Incorporated Society of Organ Builders. Other books from his stable include "Frequency Divider Organs for the Constructor", "Electronic Music Production" and (with Sid Astley) "Transistor Electronic Organs for the Amateur".

ELECTRONIC DIAGRAMS (A Newnes Constructors Guide).
by M. A. Colwell
Published by Butterworth & Co. (Publishers) Ltd.,
88 Kingsway, London WC2B 6AB
104 pages 21·5cms × 13·5cms
Price £1·80

THE reader is led through a course of learning how to understand graphical symbols of circuits. In compiling this book—with the evident aid of the British Standards Institution—the author has assumed that the reader is familiar with electrical terminology, particularly regarding components, but not a thorough knowledge of all types of circuit theory. It is suggested that this book will be an aid to studies and practical work for newcomers and a reference for those more experienced in the planning and preparation of circuit diagrams.

WORLD RADIO TV HANDBOOK 1976
Edited by J. M. Frost
Published by Billboard Publications,
7 Carnaby Street, London W1V 1PG.
500 pages 23cms × 14·5cms
Price £4·50

THIS 30th Anniversary Edition of the W.R.TV Handbook is, as usual, an authoritative source of information about radio and TV stations all over the world. It is really a 'must' for anyone who even thinks he/she may take up short wave listening and a veritable 'bible' for the ardent listener or TV DX enthusiast. This edition includes excellent articles on the technical planning of a short wave service, 20 best short wave receivers on the world market, tips on tapes, new aerial developments, 'pirate' stations etc. etc. in a special supplement bound in at the back of the book and entitled, "Listen to the World".

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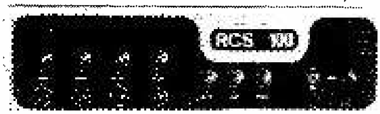

Four inputs. Four way mixing, master volume, treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required. 5 speaker outputs. A/C mains operated. Slave output. Produced by demand for a quality valve amplifier.
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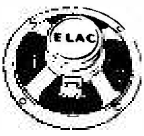

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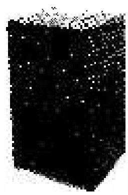

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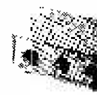

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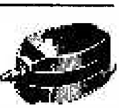

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All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 2-way mixing. Output 8/15 ohm A.C. mains. Separate treble and bass controls. Guaranteed. Details S.A.E. **£49** Carr. £1·00
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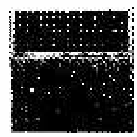

Teak veneered ¾in thick wood cabinet. Size 18¾in × 18½in × 8½in. Weight 23lb. This cabinet features a wide mesh Silver Grill covering a separate compartment for mounting Tweeters or Mid-Range Horn. The fully sealed bass compartment is cut out for 6½in Woofer. £7·50. Carr. 85p. Rosewood Version £8·50. Carr. 85p. Baffle could be cut for larger speaker.

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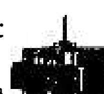

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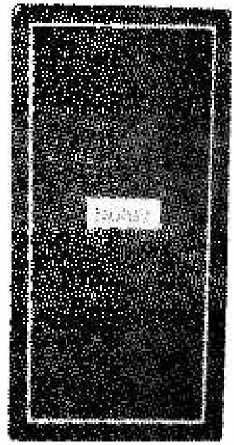

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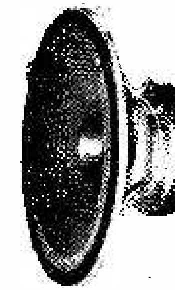

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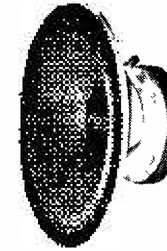

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EBF80	0·40
EBF83	0·45
EBF89	0·40
EC52	0·40
ECC81	0·45
ECC82	0·35
ECC83	0·35
ECC84	0·35
ECC85	0·45
ECC86	1·25
ECC88	0·55
ECC189	0·80
ECF80	0·45
ECF82	0·45
ECF801	0·75
ECF804	2·50
ECH42	0·85
ECH81	0·40
ECH84	0·60
ECL80	0·60
ECL82	0·40
ECL83	0·75
ECL86	0·60
EF36	0·65
EF37A	1·10
EF40	0·70
EF41	0·75
EF80	0·35
EF83	1·25
EF85	0·40
EF86	0·40
EF89	0·35
EF91	0·60
EF92	0·50
EF95	0·45
EF183	0·40
EF184	0·40
EFL200	0·75
EL34	0·70
EL35	0·70
EL37	2·20
EL41	0·80
EL81	0·60
EL84	0·35
EL85	0·60
EL86	0·50
EL90	0·50
EL91	1·00
EL95	0·70
EL504	0·80
EL821	1·80
EM31	0·70
EM80	0·55
EM84	0·40
EM87	1·00
EY51	0·45
EY81	0·45
EY86/87	0·45
EY88	0·50
EZ40	0·70
EZ41	0·75
EZ80	0·30
EZ81	0·35
GT1C	5·00
GY501	0·80
GZ32	0·65
GZ34	0·80
GZ37	1·00
KT66	2·90
KT88	3·85
MH4	1·00
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OA2	0·45
OB2	0·45
PABC80	0·40
PC86	0·65
PC88	0·65
PC97	0·55
PC900	0·55
PCC84	0·45
PCC89	0·60
PCC189	0·65
PCF80	0·40
PCF82	0·40
PCF84	0·65
PCF86	0·65
PCF200	0·90
PCF201	0·90
PCF801	0·55
PCF802	0·55
PCF805	1·10
PCH200	0·80
PCL81	0·60
PCL82	0·40
PCL83	0·70
PCL84	0·50
PCL86	0·60
PCL805/B5	0·60
PFL200	0·70
PL36	0·60
PL81	0·55
PL82	0·50
PL83	0·50
PL84	0·50
PL504	0·85
PL508	0·95
PL509	1·35
PL802	1·85
PY33	0·60
PY80	0·60
PY/81/800	0·50
PY82	0·45
PY83	0·50
PY88	0·50
PY500	1·10
PY801	0·55
QQV03-10	1·50
QQV06-40A	8·00
QV03-12	1·60
SC1/400	3·60
SC1/600	5·50
SP61	0·80
IT21	6·00
U25	1·00
U26	0·80
U27	1·00
U191	0·75
U801	0·80
UABC80	0·45
UAF42	0·70
UBC41	0·60
UBF80	0·50
UBF89	0·50
UBL1	1·00
UBL21	0·75
UCC85	0·50
UCF80	0·80
UCH42	0·80
UCH81	0·50
UCL82	0·45
UCL83	0·70
UF41	0·70
UF80	0·40
UF85	0·50
UF89	0·50
UL41	0·70
UL84	0·50
UY41	0·50
UY85	0·50
VR105/30	0·45
VR150/30	0·45
X61M	1·50
X66	0·75
Z800U	3·00
Z801U	3·00
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1A3	0·55
IL4	0·30
IR5	0·50
IS4	0·35
IS5	0·35
IT4	0·35
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5B/254M	5·00
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5R4GY	1·00
5U4G	0·55
5V4G	0·65
5Y3GT	0·60
5Z3	1·20
5Z4G	0·60
5Z4GT	0·65
6AB7	0·60
6AC7	0·60
6AH6	0·70
6AK5	0·45
6AK8	0·40
6AL5	0·30
6AL5W	0·60
6AM5	1·00
6AM6	0·60
6AN8	0·70
6AQ5	0·55
6AQ5W	0·70
6AS6	0·80
6AS7G	1·00
6AT6	0·60
6AU6	0·40
6AV6	0·50
6AX4GT	0·75
6AX5GT	1·00
6B7	0·70
6BA6	0·40
6BE6	0·40
6BG6G	1·00
6BJ6	0·75
6BQ7A	0·60
6BR7	1·30
6BW6	1·10
6BW7	1·00
6C4	0·40
6C6	0·50
6C6B	0·50
6CH6	1·60
6CL6	0·75
6D6	0·45
6EA8	0·75
6F7	1·10
6F8G	0·75
6F12	0·60
6F17	1·00
6F33	3·50
6H6	0·45
6J4WA	1·25
6J5	0·65
6J5GT	0·55
6J6	0·35
6J7	0·65
6J7G	0·40
6K6GT	0·80
6K7	0·55
6K7G	0·35
6K8GT	0·55
6L6M	1·90
6L7G	0·40
6SA7	0·55
6SC7	0·75
6SG7	0·55
6SJ7	0·60
6SJ7GT	0·35
6SK7	0·60
6SL7GT	0·55
6SN7GT	0·55
6SQ7	0·60
6V6GT	0·60
6X4	0·45
6X5G	0·40
6X5GT	0·55
6Y6G	0·95
6Z4	0·65
6-30L2	0·90
7B7	0·80
7Y4	0·80
9D2	0·60
9D6	0·50
11E2	6·00
12A6	0·60
12AT6	0·45
12AT7	0·45
12AU7	0·35
12AX7	0·35
12BA6	0·50
12BE6	0·55
12BH7	0·55
12C8	0·60
12E1	3·75
12K5	1·50
12K7GT	0·55
12K8GT	0·75
12Q7GT	0·50
12SA7GT	0·80
12SG7	0·55
12SJ7	0·55
12Y4	0·40
14S7	1·00
19AQ5	0·70
19G3	8·00
19G6	6·50
19H5	15·00
20P3	0·60
20P4	1·10
25L6GT	0·70
30C15	1·00
30C17	1·10
30F5	1·00
30FL1	1·10
30FL12	1·10
30L15	1·00
30L17	1·00
30P12	1·00
30P19	1·00
30PL13	1·10
30PL14	1·10
35L6GT	0·80
35W4	0·55
35Z4GT	0·70
50C5	0·65
50CD6G	1·20
75	1·00
75C1	0·75
76	0·75
78	0·70
80	0·75
85A2	0·75
803	6·00
805	18·00
807	0·75
813	6·50
866A	1·60
931A	6·00
954	0·50
955	0·50
956	0·50
957	0·50
1629	0·70
2051	1·00
5933	3·00
6057	0·80
6060	0·70
6064	0·60
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	AF124	BC172A	CRS25/025	OC35	ZR11	2N4061
AC113	AF125	BC212A	GET115	OC36	ZR21	2N4172
AC126	AF126	BCY31	GET116	OC42	ZR22	2N5295
AC127	AF127	BCY33	GEX66	OC44	2N456A	3N126
AC128	AF139	BCY72	NKT222	OC45	2N525	3N128
AC176	AF178	BF115	NKT304	OC70	2N696	3N154
ACY17	AF186	BF167	NKT404	OC73	2N708	3N159
ACY18	AF239	BF173	OA5	OC75	2N918	SX754
ACY19	AFZ12	BF185	OA47	OC78	2N1305	2S303
ACY20	ASY26	BFY51	OA70	OC78D	2N1307	T12082
ACY39	ASY27	BFY52	OA71	OC81	2N1309	40235
ACY40	ASY28	BSY27	OA73	OC82	2N2062	40250
AD149	BC107	BSY38	OA79	OC82DM	2N2411	40251
AD161	BC108	BSY95A	OA91	OC83	2N2989	IN23A
AD162	BC109	BY100	OA200	OC83B	2N3053	IN25
ADZ11	BC113	BYZ16	OA202	OC139	2N3054	IN38A
ADZ12	BC116	CRS1/20	OAZ200	OC140	2N3055	IN43
AF114	BC118	CRS1/30	OC22	OC170	2N3391	IN70
AF115	BC136	CRS3/10	OC25	OC172	2N3730	IN677
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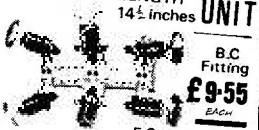

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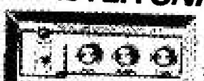

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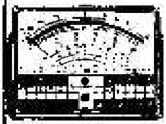

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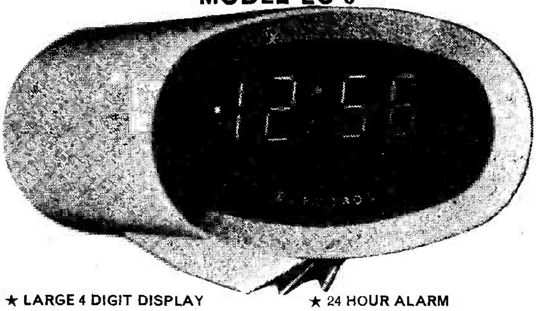

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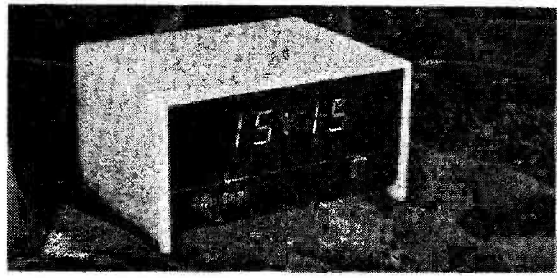

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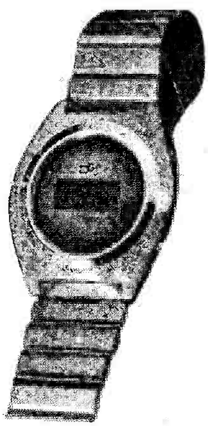

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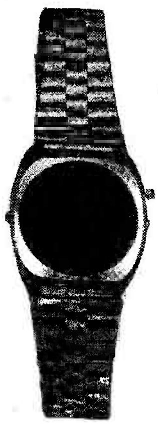

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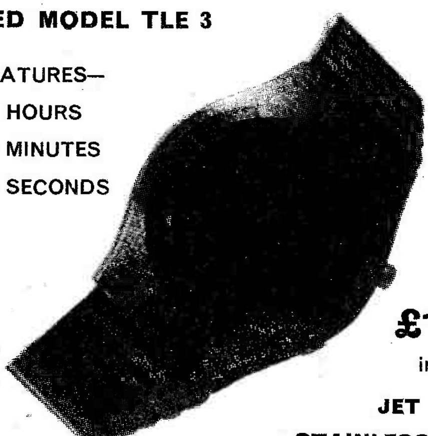

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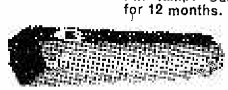

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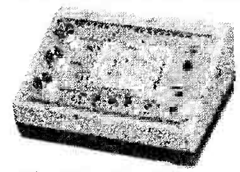

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AF121*	33	BC213	11	BFX85*	25	TIP30A	54	2N1132	18	2N3820	40
AF124*	30	BC213L	13	BFX86*	24	TIP30B	64	2N1301*	20	2N3823	50
AF125*	30	BC214	14	BFX88*	22	TIP30C	76	2N1302*	17	2N3824	89
AF126*	30	BC214L	16	BFY50*	15	TIP31*	54	2N1303*	20	2N3866*	69
AF127*	30	BC441*	30	BFY51*	15	TIP31A*	58	2N1304*	24	2N3903	15
AF139*	33	BC461*	30	BFY52*	15	TIP31B*	70	2N1305*	28	2N3904	15
AF178	49	BC462*	30	BSX20*	20	TIP31C*	84	2N1306*	28	2N3905	17
AF179	59	BCY42	28	BSY95A	14	TIP32*	64	2N1307*	28	2N3906	17
AF180	55	BCY43	28	MJ491	160	TIP32A*	68	2N1308*	35	2N4037	34
AF181*	48	BCY58	18	MJE370*	68	TIP32B*	80	2N1893*	30	2N4058	15
AF185	60	BCY59	18	MJE371*	80	TIP32C*	99	2N1990*	48	2N4061	13
AF186	48	BCY70*	18	MJE520	65	TIP33*	95	2N2160*	55	2N4062	14
AF239*	34	BCY71*	18	MJE2955*	95	TIP33B*	112	2N2217*	23	2N4871	34
ASY26	31	BCY72*	18	MJE3055*	65	TIP33C*	130	2N2218A	20	2N4922	52
ASY29	40	BD115*	52	MPF102	30	TIP34*	110	2N2219A*	22	2N5457	30
ASY50	17	BD121*	115	MPF103	30	TIP34A*	115	2N2220A*	18	2N5458	30
BC107*	9	BD123*	95	MPF104	30	TIP34B*	167	2N2221A*	21	2N5459	30
BC108*	9	BD124*	75	MPF105	30	TIP35*	259	2N2222*	20	2N6027*	45
BC108B*	12	BD131*	40	MPSA06	30	TIP36A*	370	2N2303*	30	3N140*	95
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CMOS*

4000AE	16p	4028AE	74p
4001AE	16p	4029AE	94p
4002AE	16p	4030AE	45p
4006AE	77p	4033AE	111p
4007AE	16p	4034AE	134p
4009AE	65p	4040AE	88p
4010AE	44p	4042AE	67p
4011AE	16p	4043AE	81p
4012AE	16p	4044AE	75p
4013AE	44p	4045AE	111p
4015AE	81p	4046AE	109p
4016AE	44p	4047AE	74p
4017AE	71p	4049AE	44p
4018AE	71p	4050AE	44p
4019AE	44p	4055AE	106p
4020AE	90p	4056AE	106p
4021AE	81p	4069AE	16p
4022AE	78p	4070AE	16p
4023AE	16p	4510AE	124p
4024AE	64p	4511AE	191p
4025AE	17p	4518AE	100p
4026AE	138p	4520AE	99p

LINEAR IC'S

709C 14 pin	29p	LM300H	170p	SN72702	80p
710	43p	LM301AM	38p	SN76033	150p
741C	20p	LM380	90p	SN76115	200p
747C	70p	LM381	160p	TAA550B	36p
748C	28p	LM3900	65p	TAA621A	203p
AY-1-0212	550p	MC1303L	148p	TAA661A	180p
AY-1-5051	120p	MC1304P	360p	TAD100	130p
AY-5-1224*	349p	MC1310P	180p	TBA540Q	265p
AY-1-67216	175p	MC1312PQ	150p	TBA641B	225p
AY-5-3500*	610p	MC1458P	70p	TBA800	80p
CA3011	82p	MC1710CG	55p	TBA810S	95p
CA3018	72p	MFC4000B	48p	TBA920Q	350p
CA3020	145p	MFC6040*	86p	TDA2020	300p
CA3028	90p	MK50253*	550p	TCA270SQ	399p
CA3046	59p	NE555*	45p	ZN414	99p
CA3048	210p	NE556DB*	99p		
CA3075	150p	NE561*	325p		
CA3081	150p	NE562B*	270p		
CA3089E	150p	NE565A*	200p		
CA3090AQ	250p	NE566*	150p		
CA3123E	140p	NE567V*	200p		
ICL8038CC*	270p	SL403D	176p		
		SL414A	176p		

REGULATORS*
723C DIL/TO5 **45p**
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12V 1A(TO3) **140p**
18V 1A(TO3) **185p**
MVR5(TO3) **160p**
MVR12(TO3) **158p**
TBA625B **95p**

TTL 74* Less 5% for 15 + mxd
Less 10% for 25 + mxd
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7401	13p	7474	32p	74150	143p
7402	14p	7475	32p	74151	69p
7403	15p	7476	32p	74153	70p
7404	18p	7480	44p	74154	150p
7405	18p	7481	99p	74155	70p
7406	38p	7482	75p	74156	70p
7407	38p	7483	83p	74157	80p
7408	15p	7484	90p	74159	196p
7409	15p	7485	125p	74160	101p
7410	13p	7486	35p	74161	101p
7412	20p	7489	275p	74162	101p
7413	35p	7490	40p	74163	101p
7414	60p	7491	80p	74164	132p
7416	35p	7492	48p	74165	132p
7417	35p	7493	39p	74166	140p
7420	15p	7494	80p	74167	315p
7422	27p	7495	63p	74170	215p
7423	22p	7496	72p	74172	540p
7425	27p	74100	135p	74173	153p
7426	27p	74104	40p	74174	118p
7427	27p	74105	40p	74175	92p
7428	38p	74107	33p	74176	103p
7430	15p	74109	54p	74177	101p
7432	25p	74110	43p	74178	142p
7433	36p	74111	63p	74179	142p
7437	27p	74116	170p	74180	106p
7438	27p	74118	100p	74181	301p
7440	15p	74119	160p	74182	83p
7441	65p	74120	93p	74184	160p
7442	65p	74121	30p	74185	169p
7443	120p	74122	45p	74186	950p
7444	105p	74123	63p	74188	494p
7445	88p	74125	54p	74190	160p
7446	105p	74126	54p	74191	160p
7447	80p	74128	70p	74192	125p
7448	70p	74132	70p	74193	125p
7450	15p	74141	63p	74194	125p
7451	15p	74142	266p	74195	79p
7453	15p	74143	274p	74196	103p
7454	15p	74144	274p	74197	103p
7460	15p	74145	88p	74198	210p
7470	30p	74147	233p	74199	210p
7472	26p				

DIODES

AEY11	70p
BA100	10p
BY126	12p
BY127	12p
OA5	39p
OA9	9p
OA10	40p
OA47	8p
OA70	8p
OA79	10p
OA81	8p
OA85	10p
OA90	6p
OA91	6p
OA95	8p
OA200	9p
OA202	6p
PL4001	6p
PL4004	8p
PL4006	12p
IN914	4p
IN4001/2	5p
IN4003	6p
IN4004/5	6p
IN4006/7	7p
IN4148	5p
IN5401	13p
IN5406	19p
IN5408	25p

BRIDGE RECTIFIERS (plastic case)

1A50V	20p
1A100V	24p
1A200V	26p
1A400V	27p
1A600V	29p
2A50V	30p
2A100V	38p
2A200V	44p
2A400V	48p
2A600V	54p
4A100V	53p
4A400V	60p
4A800V	90p
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6A400V*	80p
BY122	54p
BY164	54p

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1A100V	42p
1A200V	47p
1A400V	52p
1A600V	70p
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3A100V	43p
3A200V	55p
3A400V	74p
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7A400V	125p
C106D	50p
MCR101	29p
TIC44	29p
2N4444	191p

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3A400V	100p
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DL728 ·5" Red **180p**
DL747 ·63" Red Cmn Anod. **150p**
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XAN652 ·6" Grn Cmn Anod **170p**
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MAN 3640 **170p**
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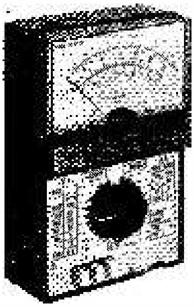

AC/DC MULTIMETER TYPE U4324

33 ranges covering D.C. current 60μA to 3A; AC current 300μA—3A; DC voltage: 0·6—1200V AC voltage: 3—900V Resistance: 500Ω—500kΩ Level: —10 to +12db Sensitivity: 20,000 o.p.v. DC. 4,000 o.p.v. A.C.

Instrument is powered by re-chargeable nickel cadmium batteries.

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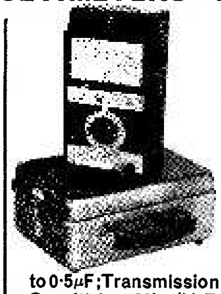

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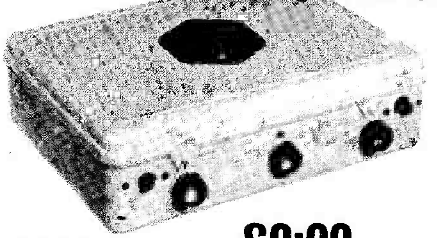

Completely Solderless Electronic Construction Kit. Build these projects without soldering iron or solder

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★ 4 Transistor Push Pull Amplifier
★ 5 Transistor Push Pull Amplifier
★ 7 Transistor Loudspeaker Radio MW/LW
★ 5 Transistor Short Wave Radio
★ Electronic Metronome
★ Electronic Noise Generator
★ Batteryless Crystal Radio
★ One Transistor Radio
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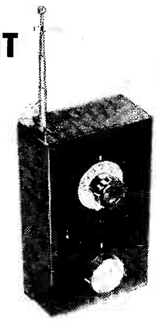

Build this Converter Kit and receive the Aircraft Band by placing it by the side of a radio tuned to Medium Wave or the Long Wave Band and operating as shown in the instructions supplied free with all parts. Uses a retractable chrome plated telescopic aerial, Gain Control, V.H.F. Tuning Capacitor, Transistor, etc.
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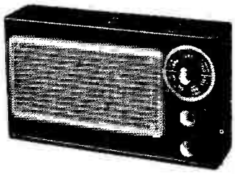

Build this exciting new series of designs.

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E.V. 6. Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output.
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E.V. 7. Case and looks as above, 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker.
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WITH VHF INCLUDING AIRCRAFT

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POCKET FIVE

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Complete kit of parts including construction plans
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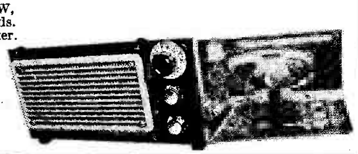

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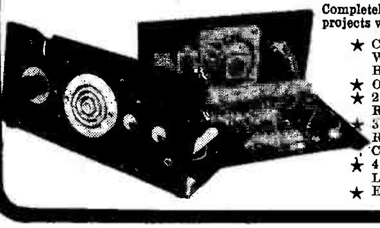

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