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JAN 1979

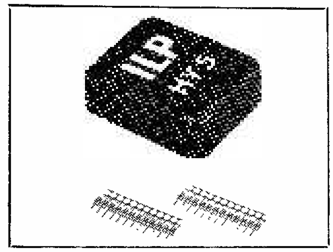
Special feature on~ Metal Detection plus~

the PW Sandbanks METAL DETECTOR

plus~EXPERIMENTAL ACOUSTIC DELAY LINE

15—240 Watts!

HY5
Preamplifier



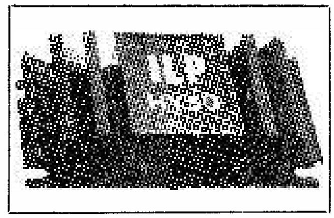
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £6·27 + 78p VAT P&P free.

HY30
15 Watts into 8Ω



The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board. 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω; DISTORTION 0·1% at 1 5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £6·27 + 78p VAT P&P free.

HY50
25 Watts into 8Ω

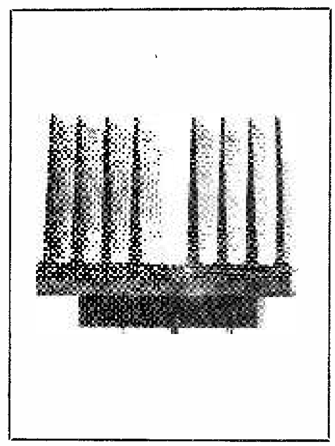
The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £8·18 + £1·02 VAT P&P free

HY120
60 Watts into 8Ω



The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz–3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm
Price £19·01 + £1·52 VAT P&P free.

HY200
120 Watts into 8Ω

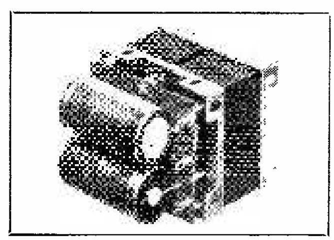
The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz–3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £27·99 + £2·24 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz–3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm
Price £38·61 + £3·09 VAT P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's **£6·44** plus **81p** VAT. P/P free.
PSU50 suitable for two HY50's **£8·18** plus **£1·02** VAT. P/P free.
PSU70 suitable for two HY120's **£14·58** plus **£1·17** VAT. P/P free.
PSU90 suitable for one HY200 **£15·19** plus **£1·21** VAT. P/P free.
PSU180 **£25 42** + **£2·03** VAT.
B1 **£0·48** + **£0·06** VAT.

TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

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practical WIRELESS

JANUARY 1979
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Published by IPC Magazines Ltd., Westover House, West Quay Rd., POOLE, Dorset BH15 1JG

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NEWS & VIEWS

FOR OUR CONSTRUCTORS

GENERAL INTEREST

SPECIAL FEATURE

SPECIAL OFFER

Our February issue will be published on 5th January 1979
(for details see page 59)

FABULOUS PROFESSIONAL DISCO SYSTEM

F.A.L. De Luxe PROFESSIONAL CONSOLE (Powered) **Carr. etc. £15**

Slide Fade Controls. Autofade with Music Overide on both mic. and jingle inputs. Headphone pre-fade monitor with 5 Push-button selector. Illuminated V.U. meters. Illuminated rocker switches. LED cue indicators. Tape or Jingle inputs, unity gain. Mic. channel with Bass & Treble. Slave outlet.

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Bass Control (Music Channel)	Microphone Input.
Bass Control (Mic. Channel)	Tape/Jingle. I/P

£399

SAVE £100

DEPOSIT £29.12 and 38 weekly payments of £9.74 (Total £399)

TURNTABLES: Garrard 125SB Belt-drive with Low-Mass 'S' arm and Magnetic Cartridge.
POWER: 120 watts continuous RMS into 4 ohms
DECK LIGHTS: Fully adjustable flexi-beams over each turntable with independent switching.
CABINET: Solidly made to withstand the rigours of transporting. Covered in heavy duty leather cloth type material in attractive colour combinations Corner cap protectors Recessed carrying handles.

INTEREST FREE CREDIT on this system only

List £320.76

ALL THREE UNITS PRODUCED BY BRITAINS LARGEST MAKERS OF DISCO EQUIPMENT

PAIR MATCHING FULL RANGE De Luxe 80w LOUDSPEAKERS

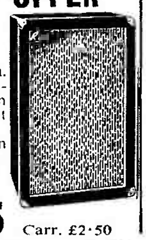
Each inc. Pair of Powerful 12" Bass units (with aluminium centre domes), and High Frequency Horn unit to extend frequency range to above 17 kHz. Normally £89·95 ea.

FANTASTIC SPEAKER OFFER

TWIN 12" SPEAKER CABINET PLUS PAIR 12" SPEAKERS

of Robust vibration-proof construction. Fitted protective corner pieces, Removable Vynair covered front with silver effect trim. Sunken jack socket with escutcheon at the rear.
Pair 12" 20w speakers for wiring in series and front mounting in above supplied to complete a 40 watt unit for lead guitar or P.A.

While stocks last Three items



£19·95 Carr. £2·50

Make your own Console with these DISCO MODULES

CONTROL UNIT (mains powered)
Vol. (Left) Vol. (Right) Tape input and volume control. Bass, Treble, ON/OFF switch for each Table. **£25·00** Carr. £1

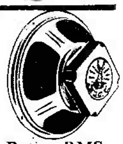
MONITOR UNIT With H/Phone Socket and Vol. Control Carr Free **£7·95**

FADER UNIT Carr Free **£7·95**

100w OUTPUT UNIT Mains powered Carr. £1·50 **£29·95**

TITAN GROUP/DISCO SPKRS

	Value	RSC Price
T12/45R 12" 45w	£15·00	£11·95
T12/60R 12" 60w	£22·50	£13·95
T12/100 12" 100w	£36·00	£25·95
T15/60 15" 60w	£26·00	£17·95
T15/70 15" 70w	£28·00	£19·95
T15/100 15" 100w	£41·00	£29·95
T18/100 18" 100w	£51·00	£38·95



Rating RMS Imp 8-15 ohms

Carr. £1·20, under £18, over this add 6p per £1.

CABINETS FOR ABOVE Heavy duty, finished in black Vynide with Vynair fronts, protective corner pieces, various sizes cut-outs. TE1 1 × 12" **£11·95**. TE2 2 × 12" £16·95. Deposit Terms orders over £20.

RSC 100 WATT DISCO SYSTEM

AT A FANTASTIC LOW PRICE

Consisting of (1) TWIN T/TABLE CONSOLE with PRE-AMP, and POWER OUTPUT STAGES (2) & (3) PAIR 50 WATT LOUDSPEAKERS including 12" UNITS

£169·95 Carr. £4·75

- ★ DISCOMAJOR POWER DISCO CONSOLE with integral Power Amplifier.
- ★ TWIN FULL SIZE BSR turntables with cueing device.
- ★ CARTRIDGES with Diamond Styli.
- ★ 3 SEPARATE VOLUME CONTROLS for each turntable and Mic.

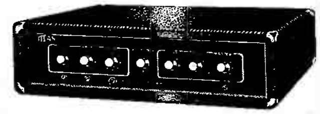
CONSOLE COMPLETE WITH LID. FULL HEADPHONE MONITORING FACILITIES

Terms: Deposit £30·00 and 18 fortnightly pymts. £9·80 (Total £206·40). Carr. £4·00.
Also available 200 WATT SYSTEM **£199·95**

ALL RSC PRICES INCLUDE VAT

50 WATT AMPLIFIER SACRIFICE

Limited stocks of **TITAN TA/50A** to be cleared to make way for a re-styled model.



Solid state, 3 sep. controlled inputs plus Master control. Bass, Treble & Presence Controls. Vynide covered cab. with corner protectives. Value £60. Terms: Dep. £7·95 & 8 monthly payments £4·72 (Total £45·71). Matching Cabinets 1 × 12" £29·95, 2 × 12" £49·95 Carr. £1 **£39·95**

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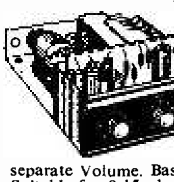
SUPERSOUND 13 HI-FI MONO AMPLIFIER



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 £15·00. P. & P. £1·20.

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mv into 47k. Input 2, 15mv into 47k. (suitable for use with mic. or guitar etc.). Input 3 200mv into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12¼" w.×5" h.×7¼" d. Special introductory Price £28·00+£2·50 carr. & pkg.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14$\frac{11}{16}$" × 1$\frac{1}{16}$" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £8·40 each + p. & p. (one 90p, two £1·10). Now available in either 8" round version or 4½" × 8½" rectangular. 10 watts RMS 60Hz-20KHZ £5·25 + P. & P. (one 65p, two 75p).

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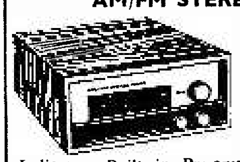
2" PLASTIC CONE HF TWEETER 4 ohm, £3·50 per matched pair + 50p P. & P.

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State FM AM Stereo Tuner. Covering M.W. A.M. 540-1605 KHz VHF/FM 88-108 MHz. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600m/v RMS into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8¼"w × 4"h × 9¼"d approx.
LIMITED NUMBER ONLY at £28·00 + £1·50 P. & P.

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 £14·50 P. & P. £1·40. Also available ready built and tested £19·00 P. & P. £1·40.

STEREO DECODER
SIZE 2" × 3" × ½" ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6·00 plus 20p. P. & P. Stereo beacon light if required 40p extra.

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Slightly shop soiled radios by well-known manufacturer for AC Mains or battery use. MW and FM bands. Dynamic M/coil speakers, telescopic aerial and internal ferrite aerial. Earpiece socket for personal listening. Finished in attractive simulated leatherette. Size 7" H × 9½" W × 4" D approx. Fully guaranteed. Bargain price of only £10·00 + £1·30 p. & p.

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Few only similar to above, but battery operation only and fitted with twin speakers. Four wave bands. MW, FM and two VHF bands for reception of aircraft and some public services. ONLY £9·50 + £1·30 p. & p.

MODEL MULTI 5
Specification as Model FL4 but with additional SW band. Fitted wih twin speakers. ONLY £11·00 + £1·30 p. & p.

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. Integral 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 1M Ω: 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. 80p
(Magnetic input components 33p extra)
POWER PACK KIT .. £5·50 P. & P. 95p
CABINET .. .. .. £5·50 P. & P. 95p

SPECIAL OFFER—only £23·75 if all 3 items ordered at one time plus £1·25 p. & p.
Full after sales service
Also avail. ready built and tested £31·25, P. & P. £1·50.

HARVERSONIC STEREO 44
A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets & 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2½" × 1" max. depth. Supplied brand new & tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only £9·00 plus 50p P. & P. Mains transformer with an output of 17v a/c at 500m/a can be supplied at £1·50 + 40p P & P if required. Full connection details supplied.

All prices and specifications correct at time of press and subject to alteration without notice.

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. SEND SAE WITH ALL ENQUIRIES.

HARVERSON SURPLUS CO. LTD. (Dept. P.W.) 170 MERTON HIGH ST., LONDON, S.W.19. Tel.: 01-540 3985
A few minutes from South Wimbledon Tube Station. Open 9.30–5.30 Mon. to Fri. 9.30–5 Sat. Closed Wed.

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Large speaker cabinets slightly damaged daks 8" × 5" elliptical speaker valve £1·50.
Shure N75/6 stereo dynatic stylus £4·60.
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Loudspeaker columns Type A. 6'6" Tall with cut-outs for 8" × 5" Speakers and Motorola tweeters. **Only £16·50 each.** Ideal for P.A. work for discos.
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200uf at 500vdc **each £1·60**
400uf at 500vdc **each £2·00**
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IMCO AC working cap 16uf ± 5% at 500v **only £3·00 each**
Felsic Computer grade caps for your power amp 3900uf at 100v **each £2·20**
Caps by G.E. 1400uf at 200vdc. Screw terminals **each £1·85**
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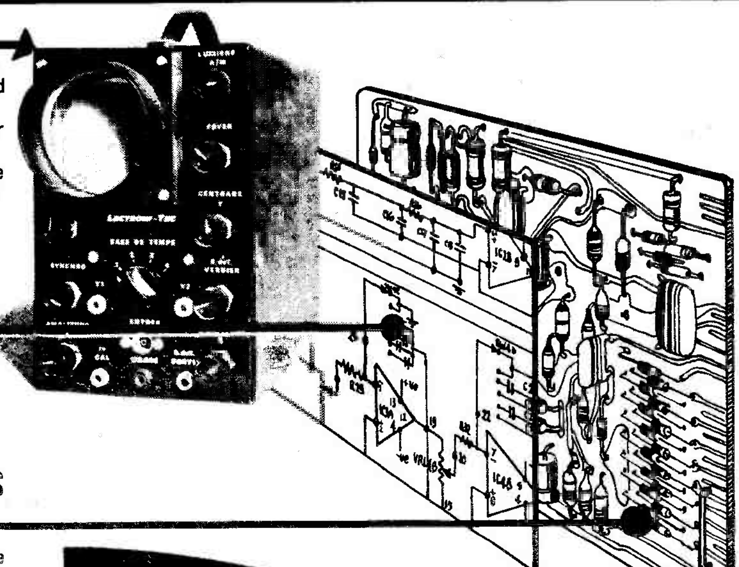

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P & P. Orders up to £5, add 30p. Orders £5–£10, add 50p. All orders over £10 post free! Please add V.A.T. as shown. S.A.E. with all enquiries please.

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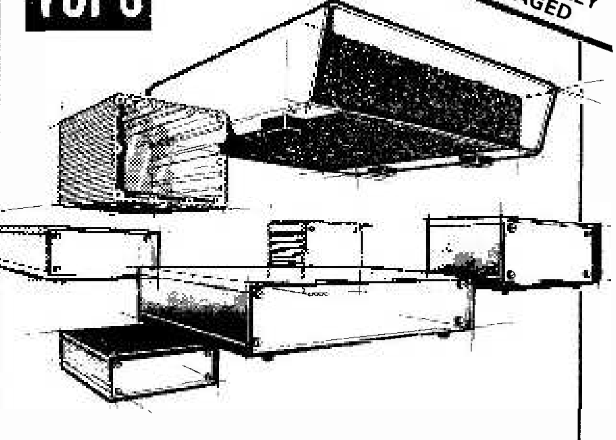

Our new 1978 catalogue lists a whole range of metal cases to house all your projects. And we've got circuit boards, accessories, module systems, and plastic boxes — everything you need to give your equipment the quality you demand. Send 25p to cover post and packing, and the catalogue's yours.

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EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p.

★ As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions. Size approx 20" x 11" x 9½" **£28.00** Per stereo pair + £5.00 p&p.

EASY BUILD RECORD PLAYER KIT

for the D-I-Y man who requires a stereo unit at a budget price, comprising ready assembled stereo amp. module. Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phones socket and record/replay socket including 2 SPHERICAL HIFI speakers **£19.95** p&p £4.05

BARGAINS FOR PERSONAL SHOPPERS

PORTABLE STEREO RADIO CASSETTE RECORDER UNREPEATABLE MW, LW, SW and Stereo VHF. 6 watts output Battery/Mains operation. **£69.95**

16v 16 VOLT MAINS TRANSFORMER, 2½ amp. **£2.50**

BSR Record auto deck on plinth with stereo cartridge ready wired. **£11.95**

LED 5 function men's digital watch stainless steel finish **£5.95**

LCD 5 function men's digital watch stainless steel finish **£6.95**

LCD 8 Function CHRONOGRAPH men's digital watch, stainless steel finish **£13.95**

POCKET CALCULATOR. With LED display, memory and percentage key. **£2.95**

AM/FM DIGITAL CLOCK RADIO Accurate 4 Digit Electronic Clock with ½" LED display. Buzzer and snooze timer. **£11.95**

125 Watt Power Amp Module **£13.95**

Mains power supply for above unit. **£3.50**

MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers, size 30¼" x 14½" x 7¼" approx **£5.95**

MULLARD Built power supply **£1.50**

DECCA DC 1000 Stereo Cassette P.C.B. complete with switch oscillator coils and tape-heads **£2.95**

DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3½" approx. tweeter inc. crossovers **£20.00**

'VIDEOMASTER' Super Score TV Game with pistol mains operation **£14.95**

PORTABLE RADIO/CASSETTE RECORDER, AM/FM with clock. LW, MW, SW, VHF mains/battery operation. **£41.95**

7" TAPE TRANSPORT Mechanism—a selection of models from **£8.95**

SANYO Nic/cad. battery, with mains charger equivalent in size and replaces 4 SP11 type batts. Size 3¾" x 1¼" x 2" approx. **£7.50** p+p £1.50p

AM/FM STEREO TUNER AMPLIFIER CHASSIS *COMPLETE*

Ready built. Designed in a slim form for compact, modern installation.
Rotary Controls Vol On/Off, Bass, Treble, Balance.
Push Buttons for Gram, Tape, VHF, MW, LW and 5 button rotary selection switch.
Power Output 5 watts per channel Sine at 2% THD into 15 Ohm 7 watts speech and music.
Tape Sensitivity Playback 400mV/30K OHM for max output Record 200mV/50K output available from 25KHz. (150mV/100K) deviation FM signal **Frequency Range (Audio)** 50Hz to 17KHz within ± 1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV AM sensitivity for 20dB S/N MW 350 uV/Metre LW 1mV/Metre
Size approx length 16" x height 2¾" x depth 4¼"
240 Volts AC Complete with Circuit diagram. **£19.95** p&p £2.25

Mullard

AUDIO MODULES IN BARGAIN PACKS

CURRENT CATALOGUE PRICE £ AT OVER 25 PER PACK

SEE OUR PRICES

1 PACK 1. 2 x LP1173 10w. RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input. OUR PRICE p+p £1.00 **£4.95**

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ACCESSORIES Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors £1.00 p+p **£1.95**

Recommended set of rotary stereo controls comprising BASS, TREBLE, VOLUME and BALANCE. p+p 50p **95p**

THIS MONTHS OFFER added to our bargain packs When you buy Pack 3 at £9.95, together with a mains transformer at £1.95 and a set of controls for 95p you receive FREE a Mullard LP1400 Decoder to match Listed at £11.90 p & p £2.50 **£12.85**

20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak finished cabinet. Silver fascia with aluminium rotary controls/pushbuttons, red mains indicator and stereo jack socket. Functions switch for mic. magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers. **£29.90** + £2.50 p&p

SPECIAL OFFER **FOR PERSONAL SHOPPERS ONLY**

FREE 4 dimensional stereo sound adaptor, when purchasing the 20x20 Viscount amplifier.

30x30 WATT AMPLIFIER IN KIT FORM

For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output. 60x60 watts peak. For use with 4-15 ohms speakers. £23.00 without cabinet. £29.00 complete with cabinet. p&p £2.50 in each case.

£23.00 + £2.50 p&p without cabinet (NOTE Cabinet not available separately.) **£29.00** + p&p £2.50 complete with cabinet

SPECIAL OFFER Complete with case **30x30 WATT AMPLIFIER IN KIT WITH SPEAKERS**

2 Goodman compact 12" bass woofers with cropped size 14,000 Gauss magnet. 30 watt RMS handling + 3¼" approx. tweeters and crossovers. **£49.00** + p&p £4.00

BUILT AND READY TO PLAY 39.00

30x30 Viscount. Available fully built and tested. + p&p £2.50

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323 EDGWARE ROAD, LONDON W2
21B HIGH STREET, ACTON W3 6NG
ALL PRICES INCLUDE VAT AT 12½%
All items subject to availability. Price correct at 1.12.78 and subject to change without notice.

50 WATT MONO DISCO AMP **£29.95** P&P £2.50 Size approx. 13¾" x 5¼" x 6¾"

50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.
SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P 8" speakers. Package price £45.00 + £4.00 P&P.

70 & 100 WATT MONO DISCO AMP Size approx 14" x 4" x 10½"

Brushed aluminium fascia and rotary controls. Five vertical slide controls master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

70 watt **£57** 140 watt peak p & p £4.00 100 watt **£65**

STEREO CASSETTE TAPE DECK ASSEMBLY

Consisting of ready built tape transport system/mechanism, mated to the electronics. Unit is ready built for installing into cabinet of own choice. Features include pause control, solenoid assisted auto-stop, 3 digit tape counter, belt driven balanced fly wheel by DC motor with electronic speed control, twin VU meters. Specification Power Output, more than 0.5v, mic. -65dB 10KΩ, DIN -47dB 100KΩ, Track-2 channel stereo record play-back. Tape speed 4.8cm/sec Freq. response 50-12,000 Hz signal to noise ratio 42dB Recording system AC bias Erasing system AC erase Bias freq. 57KHz. Compatible for both normal and chrome dioxide tapes. Size of mechanism only 4½" x 6¼" x 11¼" approx. included a moulded top-plate as illustrated 13¾" x 9¼" approx with circuit diagram. **£25.00** P&P £2.50
Opt. extras: Mains transformer to suite **£2.50** + £1 p & p.

Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-5.30pm. Half day Thursday. ACTON: Mail Order only. No callers GOODS NOT DESPATCHED OUTSIDE UK

ARMY TX/RX 128B. Battery operated unit reqs 135v HT & 1·5v DC. two part unit overhaul size 10 × 8 × 5" Rx section covers 2 to 8Mc/s in 2 bands 5 valve superhet circ with BFO & O/P for HR phones. Tx section 2 to 8Mc/s crystal controlled C.W. only o/p approx 1 watt with tune up meter, supplied with battery container & crystals for testing. Price **£18.**

SPEAKER UNIT P.A. type by Tannoy 15 ohm nom 15 watts weatherproof size 10" dia 5" deep with mounting brk, new unused, finished in black **£10·50.**

COAX CABLE type UR43 50 ohm 5 mm OSD solid centre good RF cable new 15 mts for **£2** or 30 mts **£3·50.**

AUTO TRANS C core type nom 200/250 to 110/120 at 2Kva new unused **£22.**

AUDIO WARNING DEVICE small transistor unit 1$\frac{1}{4}$" dia × $\frac{1}{2}$" nom 12v DC will work down to 6v give loud tone at 800c/s, takes 100 Ma at 12v new unused **£1** ea or 2 for **£1·70.**

GENERATOR UNIT portable unit made for Army, o/p 110v nom at 40 watts AC fitted o/p Ind, these are supplied with set of accs to adapt to either foot or hand operation, break down into 6 items to fit into transit container or carrying haversack new unused **£32·40.**

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METER UNIT special purpose with 3" dia 5-0-5 Ua meter with linear scale 5-0-5 fitted in neat carrying case size 10" × 8" × 6$\frac{1}{2}$" with terminals, swt etc & circ very well made unit **£8·50.**

DIODES stud mt type 100 PIV at 10 amps new Westinghouse 4 for **£1·60.**

ROTARY SWTS large inst type 2p 23 way & 8p 12 way both new **£1·60** ea.

CRYSTAL UNIT dual 100Kc & 1 Mc/s in 10X case with circ **£2·80.**

POWER UNIT general purpose bench P.U. O/P var 0 to 350/500v at 100 Ma DC & 6·3v ct both o/ps floating, fitted meter to lead volts or Ma, standard 200/250v I/P by Solartron tested **£15.**

TEST SET RTTY. Distortion & Margin T.S. mains operated unit used for testing 7B series Teleprinters & variants also provision for testing drive magnets & polar relays, supplies test signal with int centre reading meter complete in case size 12 × 10 × 13 with circ, will not supply motor power. **£10·80.**

TAPE RECORDERS made for use in language lab equipment, standard 240v I/P uses BSR TD.10 3 speed deck 5" spools, two channel transistor amps with separate O/Ps can be used for stereo, provision for Record & Playback. P.U. & Circuit boards are mounted below tape deck approx overhaul size 12" × 11" × 7" supplied in clean condition may be less knobs & indicator lamps, some circ details supplied, these provide o/p for low res phones, no ext case. **£13.** Also similar to above, valve unit 6 valves plus rect uses TD.2 single speed deck int mains P.U. mounted on wood plinth size 17" × 13" this is a dual chan unit but with single O/P (has dual pre amps) provision for Record & Playback, some circ details supplied **£8·50.**

RECTIFIER UNIT general purpose ex Army 200/250v I/P gives dual O/Ps of 12v DC at 3 amps ea i.e. 12v 6 amp or 24v 3amp will do 4 amps without trouble in steel case size 19" × 8" × 7" with circ & front cover, okay for battery charger **£10·50** in new cond or **£8·50** used.

C.C.T.V. SYSTEMS we have a few Marconi Industrial T.V. systems valve type in servicable condition, consists of Camera with Vidicon, Cam C.U. 14" Monitor, Cam Cable, 405/625 lines, these are complete except for Camera Lense & power cables with circs, secondhand condition **£108** or **£95** for callers.

Above Prices include post & V.A.T. goods ex equipment unless stated new, S.A.E. for List 20 or enquiry. Shop open Tues. to Sat.

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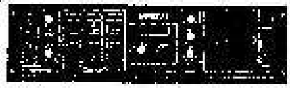
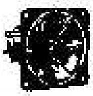
NO DISCO SYSTEM IS COMPLETE WITHOUT...



CITRONIC MM 313 MIXER

Ideal for the DIY enthusiast building up a complete disco system. 4/6 ch. mono, inc. LED indicators, connections via phono sockets at rear Bargain price including PSU **£80.46** inc. VAT (P.P. £1.50)

PIEZO HORNS



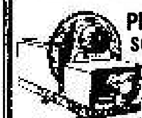
FANTASTIC SPECIAL OFFER TO READERS OF PRACTICAL WIRELESS

Tweeters for your disco, PA system or Hi-Fi, Frequency range 5K-20K No X over required They can be used in any PA system up to 100W. Why pay more? OUR PRICE ONLY **£4.99** each (P&P 35p each)

BULGIN OCTAL PLUGS AND SOCKETS

There's always hundreds of Bulgin Octal multiway plugs and sockets in stock at Roger Squire's. Each pin rated 6A Perfect for your Sound to Light System P552 SOCKET **£0.65** (P&P 35p) P551 PLUG **£1.84** (P&P 35p) Carriage on 10 or more nominal £1.00 Also available 6-way multicore cable (6 Amps per core) ex stock £0.65 per metre. Please phone for carriage quote.

PROJECTORS



SQUIRE MULTIFECT 150

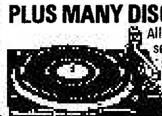
— including rotator and effects wheel. A truly versatile projector which uses a powerful 150W Tungsten bulb, all effects attachments simply slot in ready for use.

A BARGAIN AT £40.50 (P&P £1.00)

STARLITE 250

An exclusive new line to Roger Squire's Disco Centres. Superb high powered 250 W quartz halogen bulb, fan cooled, accepts wide range of multifect attachments. Unique connection slot for orbit prism revolvers. Only **£65.00** + VAT attachments extra

PLUS MANY DISCO ACCESSORIES



All Roger Squire's shops have a service department which carries large stocks of DISCO SPARES & ACCESSORIES For example: Fane and H/H Disco Speakers 12" and 15" BSR and Garrard decks at discount prices

Plus sockets, Fuses, Plugs, etc etc

Roger Squire's DISCO GEAR

Send Mail Orders to: Roger Squire's Mail Orders, Barnet Trading Estate, Park Road, Barnet, Herts. EN5 5SA 01-441 3527 (Hotline) 01-441 1919 (Switchboard) Open. Mon-Fri, 9-5.30

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PRACTICAL WIRELESS T.V. SOUND TUNER

(Nov. 75 article by A. C. Ainslie) ***Copy of original article supplied on request***

IF Sub-Assembly (G8) **£6·80.** P & P 75p.

Mullard ELC1043 V'cap UHF Tuner **£5·50.** P & P 35p.

3-way Station Control Unit **£1·20.** P & P 25p.

6-way Station Control Unit (Special Offer) **£1·00.**

Power Supply Prtd Circuit Board **£1·00.** P & P 30p.

Res, Caps, Semiconds, etc. for above **£5·80.**

Mains Transformer for above **£2·50.** P & P 30p.

Add 12$\frac{1}{2}$% VAT to price of goods. **P & P all items 85p.**

Callers welcome at shop premises.

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NOBLE ELECTRONICS (P.W.)
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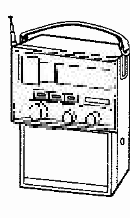
MAINS/BATTERY RADIO



Super sensitive mains/battery 3 band radio receiver covering MW,VHF (88-108 MH3), AIR-PSB (108-174 MH3), complete with earpiece, shoulder strap and telescopic aerial. Size approx 25×18×10 cm.

DISCOUNT PRICE £13.95

ALSO NOW AVAILABLE POCKET SETS BATTERY ONLY

MW/VHF-AIR (88-135 MH3) ———— £9.95
Extra sensitive de-luxe version ———— £11.45
MW/VHF (88-108 MH3) AIR-PSB (108-174 MH3) ———— £13.95

CASSETTE TAPE RECORDER

Mains/Battery quality cassette recorder with built-in condenser microphone, piano key controls, earphone, clip-on carry strap, detachable plug-in mains lead, autostop, DIN socket for record and play back via radio or stereo unit, C60 cassette and microphone with on/off remote switch (motor control).

DISCOUNT PRICE £19.95

All prices include p & p, VAT, Batteries, Guarantee & accessories. Full refund if not completely satisfied. Fast repair service free under guarantee.

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A Case for Change

IT is more than seven years since an article describing the construction of a metal detector first appeared in *Practical Wireless.* Since then, as technology has progressed, new types of detector have been developed and appeared on the market, and several more designs have been published in our pages. This month, we present a Pulse Induction detector, the PW "Sandbanks", plus a feature on metal detectors and their use.

It can be argued that metal detecting is not a subject appropriate to *PW*, though it has an affinity to radio or more closely to radiolocation, in that a field is radiated, and the effect of an object within that field is monitored by some sort of receiving system. One thing which cannot be disputed is the amazing rise in popularity of this hobby of searching for buried objects. During 1977, the Home Office issued some 24,000 "Pipe Finder" licences. In 1978, the figure had reached 30,000 by September, and during October licence applications were flooding in at a rate twice that of the 1977 average. This resulted in the accumulation of a back log of several thousand applications, and a wait of some weeks before licences were despatched.

The suggestion has been put forward that metal detector users could be granted "blanket" licences, authorising them to use any machine which has received Home Office approval. At present, anyone buying or building a new detector has to obtain a new licence, and this must obviously increase the number of applications being dealt with, perhaps unnecessarily. After all, the current system of issuing a licence only for a named brand does no more to prevent the unscrupulous from using a detector which has not been approved.

* * *

I wonder how many readers have noticed that *Practical Wireless* issues are numbered in annual volumes which run from May to April? Or at least they did; commencing with this issue, they change to January to December. The previous rather odd arrangement came about when the magazine changed from its original weekly format to monthly in the 1940s. Volume 54 therefore comprises eight issues from May to December 1978, and Volume 55 begins this month. I hope this change will have removed a source of occasional confusion.

* * *

May I take this opportunity to wish all our readers a very happy Christmas and a healthy and prosperous 1979, on behalf of all the staff on *PW.*

PW PERSONALITY

Dick Ganderton—Assistant Editor

Dick joined *PW* a year ago after six years as Features Editor of *Electronics Weekly*. His entire working life has been spent in professional electronics including ten years in the guided weapons business. He turned to technical journalism, still in electronics, some twelve years ago.

Much of his spare time is devoted to model engineering and serious railway modelling to P4 and Scale Seven standards. As an active member of the EM Gauge Society he edits their journal. Other interests are radio control, dinghy sailing, and a Honda 400/4.

Married for fifteen years to a wife who mostly tolerates his long hours in 'the shed', he has a daughter and two sons. Dick now lives in Verwood, enjoying the peaceful life after the hectic existence of working in London, and missing the privilege of helping to keep British Rail insolvent.

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

'Sounds Vintage'

Readers who are interested in early electronic equipment will be pleased to know a magazine is to be launched exclusively for the vintage enthusiast.

'Sounds Vintage' will be published bi-monthly, catering for those interested in vintage wireless, gramophones and cylinder machines, vintage amplifiers, pre-war literature, practical hints on the care, maintenance and restoration of vintage equipment, news from the major auction rooms, readers' letters and wants, and—in fact—anything which will be of interest to the collector.

Starting off as a 32-page A4 presentation, 'Sounds Vintage' will be available on subscription only. Issue No. 1 is scheduled for publication in mid-January 1979. The annual subscription will be £5·80 inland, £6·80 overseas, postage paid. A special offer is being made for issue No. 1 only—a sample single copy at 65p post-paid from: *'Sounds Vintage', 28 Chestwood Close, Billericay, Essex.*

Technical Literature

General Instrument Microelectronics have issued a new product guide describing the company's complete range of MOS-LSI microcircuit products.

The 24-page guide lists product types, functions, brief parameters and special features in many different application areas, including microprocessors, t.v. games, domestic appliances, industrial, radio & t.v., telecommunications, etc. It also includes details of GIM's MOSFET range.

Copies may be obtained free of charge from *G.I.M. Ltd., Regency House, 1-4 Warwick Street, London W1R 5WB. Tel: 01-439 1891.*

The new guide to Mullard 'preferred' power transistors is now available. Categories included are complementary power transistors, complementary Darlingtons, *npn* high-voltage transistors, *npn* switching power transistors and transistors for switched-mode power supplies. Also included in the guide are recommended power transistor line-ups and an equivalents list.

Requests for copies should be addressed to *Central Enquiry Handling Unit, Mullard Ltd., New Road, Mitcham, Surrey.*

CRT investment

Mullard Ltd. have announced details of a £24m investment programme to further improve manufacturing facilities at the company's colour t.v. tube assembly plant at Durham and to establish a 20inch 90° tube production line at their Simonstone plant, to be known as Project Vanguard.

Backed by a £4·5m grant under the Government's industry support scheme, the programme covers a three-year period. Investment at Simonstone will total £13·1m and at Durham £7·8m.

Further investments of £2·4m will be made at Washington, which produces the neck components for the tube, and £0·9m at Crossens where the related magnetic components are manufactured. Together, these plants employ some 4000 people engaged directly or indirectly in t.v. tube production.

Mullard is now the UK's only manufacturer of picture tubes, following the closure of the Thorn plant in 1977.

New catalogues

Carel Components latest Product Guide and Price List is now ready for distribution.

The catalogue, which covers Carel Components' comprehensive product range of 'Sure Connections and Practical Devices' is obtainable free upon request from: *Carel Components, 40-44 The Broadway, Wimbledon SW19 1SQ. Tel: 01-540 7186.*

Home Radios' latest catalogue is now available. A number of items for which the company experienced little demand have been dropped, resulting in the catalogue being a little slimmer. However, the company hope to compensate for this by expanding the 'Bargain List' over the next few months.

The price is £1·00 plus 25p P&P from: *Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey CR4 3HD. Tel: 01-648 8422.*

Ace Mailtronix Ltd. mail order catalogue issue 2, covers components kits, modules, tools, test equipment and audio accessories. The catalogue costs 30p, which is refundable with an order of £5·00 or over.

Following the policy change by Doram, not to supply R.S. Components products (see News column — November 1978), Ace Mailtronix Ltd. have undertaken to obtain any current R.S. item subject to a minimum order of £2·00.

For details of prices of R.S. items and applications for the catalogue, please contact: *Ace Mailtronix Ltd., Tootal Street, Wakefield, West Yorkshire WF1 5JR. Tel: (0924) 250375.*

Verospeed the fast-turnround component suppliers, inform us that their latest catalogue is now available. To obtain this free, expanded catalogue, apply to: *Verospeed, Barton Park Industrial Estate, Eastleigh, Hants. Tel: (0703) 618525.*

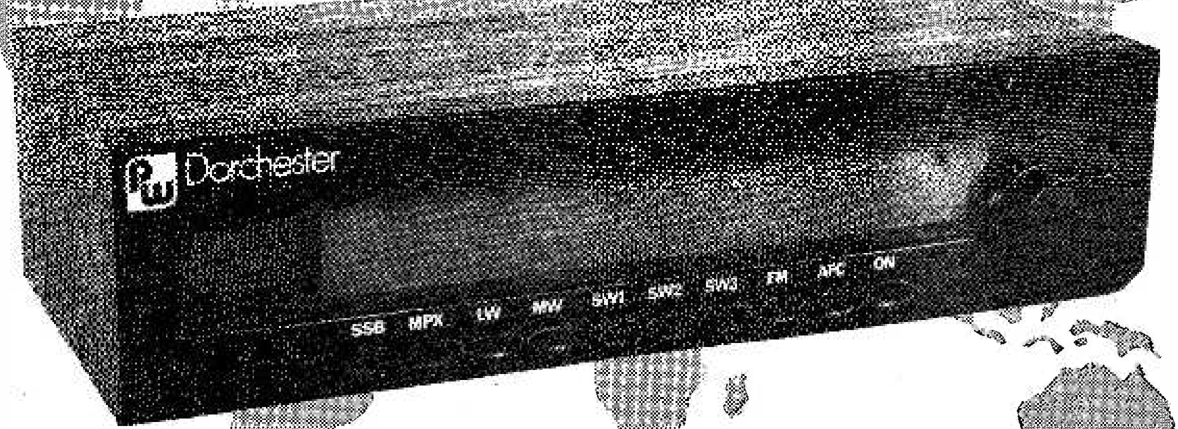
The latest Radio and Electronics Books catalogue is now available from Bernard Babani (publishing) Ltd., if you apply enclosing a stamped addressed envelope. *Bernard Babani (Publishing) Ltd., The Grampians, Shepherds Bush Road, London W6 7NF. Tel: 01-603 2581.*

Vero push retail side

A new, bright packaging style has been adopted by Vero Electronics to protect and promote the range of their products offered to the home constructor. The larger boxes will be individually packed in cartons, while smaller items will be bubble packed. The extra costs of bubble packing will be offset by reduced handling costs during manufacture, so that the end price to the constructor will not alter.

A catalogue of Vero Products for the Home Constructor is available, price 10p, from Vero stockists or direct from: *The Retail Dept., Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Hants SO5 3ZR.*

PW Dorchester PART 2



ALL-BAND TUNER

W. S. POEL

This part of the Dorchester project deals with the construction and the complete circuit is shown in Fig. 7. To those of you weaned on valves—and even transistors—the TDA1090 should be something of a revelation in terms of parts-count shrinkage. In keeping with the policy of designing a readily repeatable unit, all switching is performed with devices which fit directly on to the p.c.b., thus greatly reducing the chance of mis-wiring such a complex arrangement.

The fact that the TDA1090 requires only single coupling to the oscillator coil is a significant factor in making this design possible. As it is, some under-board link wiring is essential if some very necessary earth plane areas are not to be chopped and become parasitic v.h.f. tuned 'lines'.

The coils are selected from the recently expanded range of Toko short-wave devices and fit between the switch modules. Their impedances are generally somewhat higher than those usually associated with bipolar circuitry, since the input resistance of the a.m. mixer stage is relatively high at 5kΩ.

Each coil is provided with a trimmer, with the exception of the l.w. coil on the rod antenna. A ferrite rod is used for the usual m.w./l.w. as it offers better immunity to the electrostatic interference associated with wire antennas at these frequencies. A coupling coil may nevertheless be provided if required, but a separate antenna to that used for short waves is advised.

The i.f. filtering for the a.m. system employs a Toko MFH series mechanical unit. These are available in many bandwidths and the board is adaptable to the CFU and CFM 2 ceramic and mechanical series. In this project, a 4 or 5kHz bandwidth is used. Whilst this may seem low for the usual m.w. and l.w. channel spacings, it is quite necessary for s.w. reception, where all the channels are far closer and likely to cause mutual interference.

The only additional points of note with regard to f.m. are the quadrature feed choke and low pass (birdie) filter. The quadrature choke is a tuneable screened type L132, as opposed to the more usual fixed variety. It performs a dual function—primarily screening the radiation of 10·7MHz squarewaves from the rest of the circuit, but also providing a means of adjustment to the detector injection level on f.m., thus achieving optimum muting operation.

The birdie filter used is of LC construction. Too many modern designs overlook the basic benefits of the LC filter in this position, favouring instead more complex (and often more ineffective) active arrangements. The pi-LC filter provides a virtually flat response from d.c. to 55kHz and, most important, it effectively decouples all the remaining i.f. and i.f. harmonics from the audio which is fed to the decoder stage. A pre-decoder pre-amplifier drives the 1310 circuit with a reasonably high level of composite signal to ensure a good signal-to-noise ratio. Output terminations along one edge provide the majority of connection points.

Construction

The component layout (Fig. 8b) describes the location of all parts used in the tuner. A printed circuit of the given design is virtually essential if repeatable performance is to be achieved, the layout of r.f. stages being particularly critical.

Fig. 7: (right) The complete circuit diagram ▶

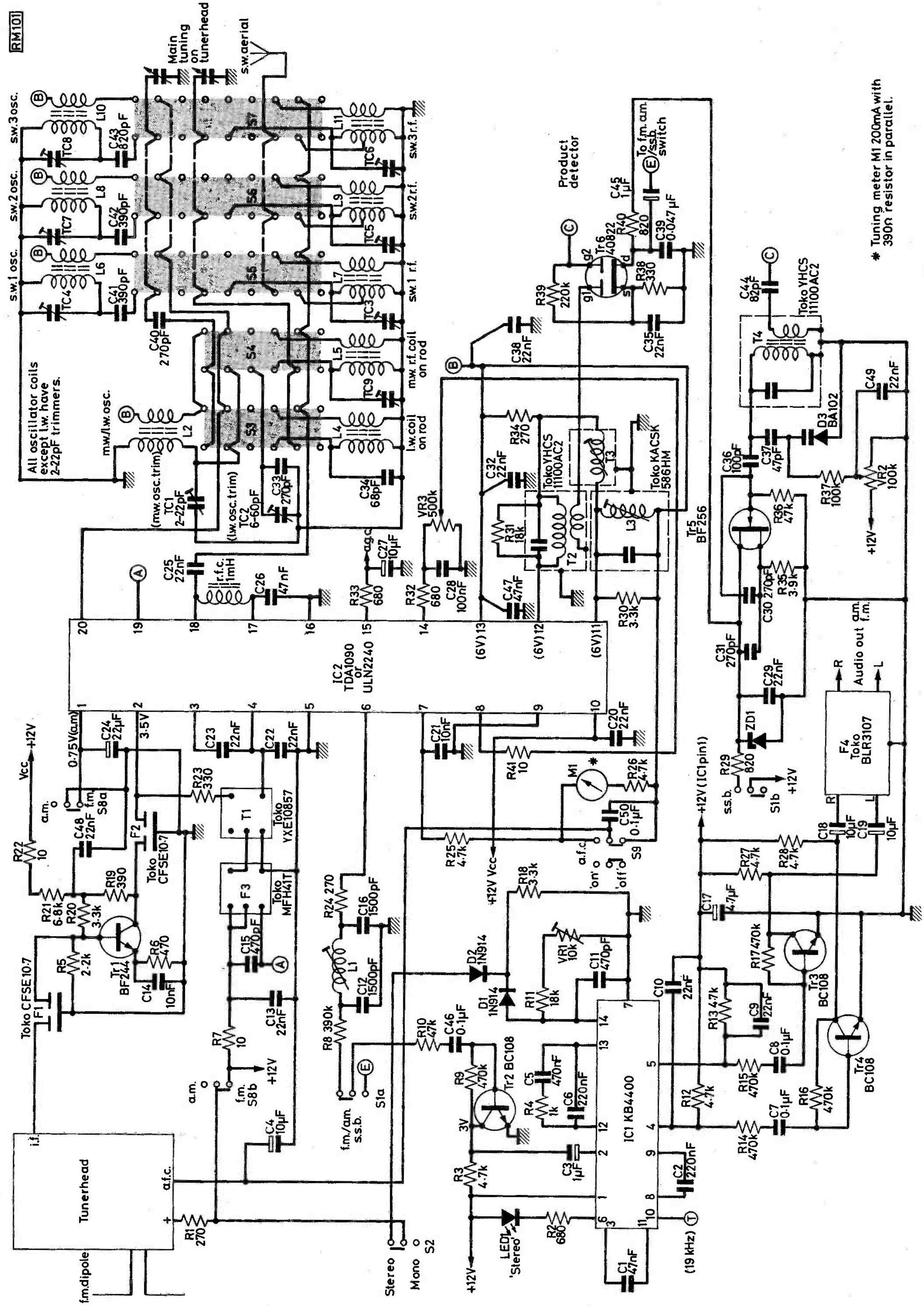
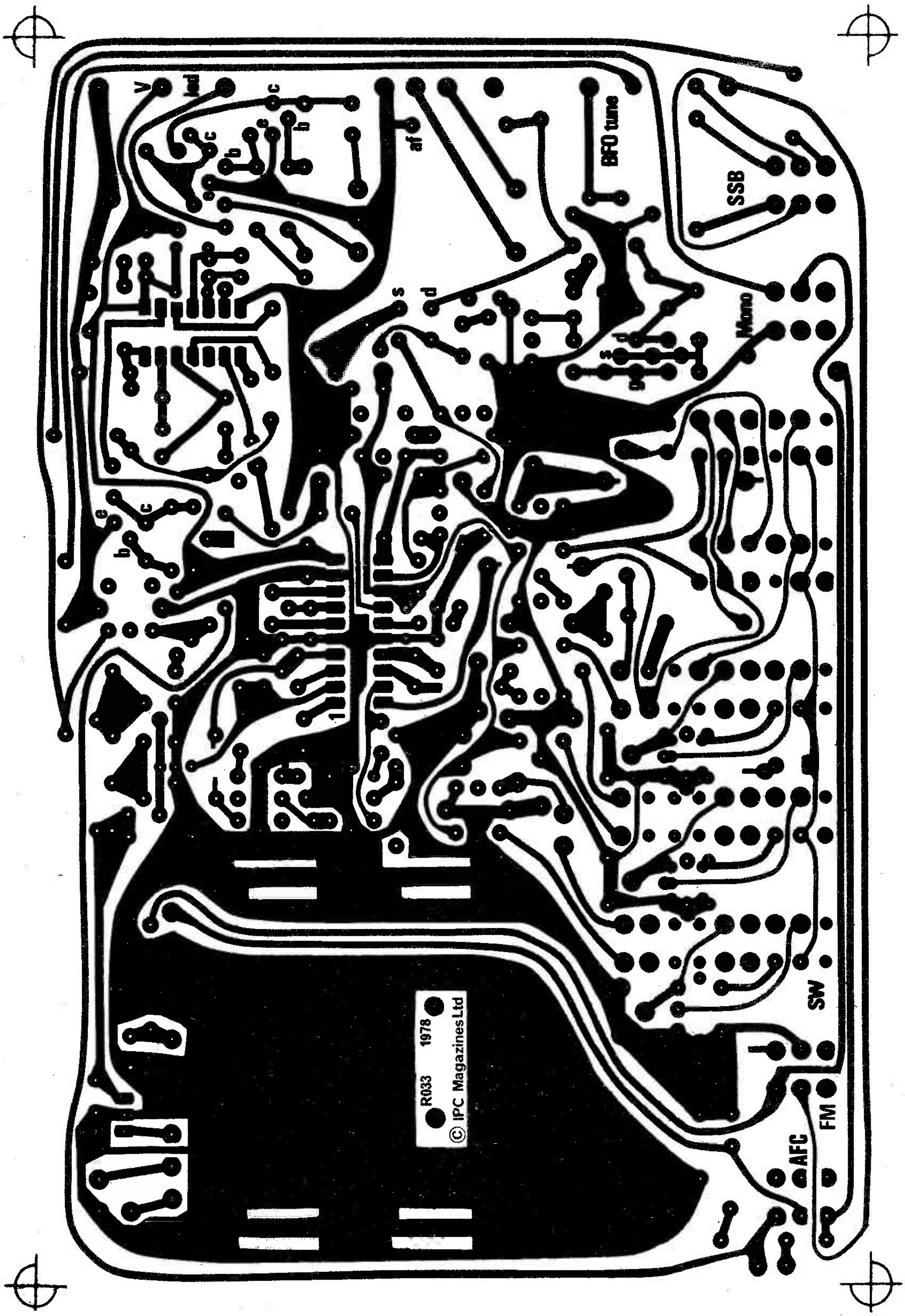

RM101
Main tuning on tunerhead
s.w. aerial
s.w.1 osc.
s.w.2 osc.
s.w.3 osc.
s.w.1 r.f.
s.w.2 r.f.
s.w.3 r.f.
mw/l.w. osc.
m.w. r.f. coil on rod
l.w. coil on rod
All oscillator coils except l.w. have 2-22pF trimmers.
Product detector
To f.m. a.m. /s.s.b. switch
Tuning meter M1 200mA with 390Ω resistor in parallel.
IC2 TDA1090 or ULN2240
IC1 KB4400
Tunerhead
f.m. dipole
Toko CFSE10.7
Toko YXE10857
Toko MFH41T
Toko YHCS 11100AC2
Toko KACSK 586HM
F4 Toko BLR3107
Audio out a.m. f.m.
LED1 'Stereo'
Stereo
Mono
(19 kHz)

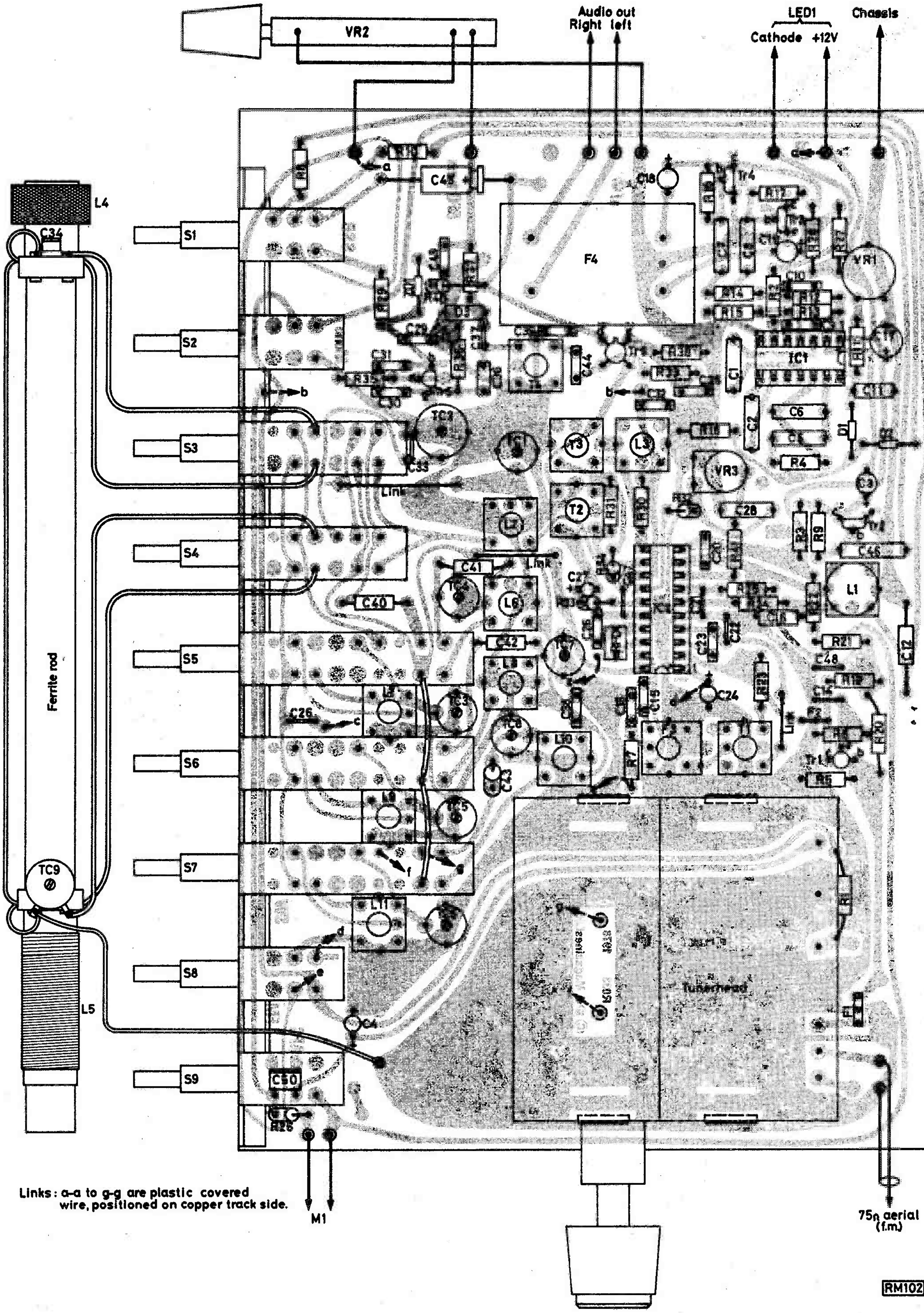
Fig. 8a: (below) The copper side layout of the p.c.b. (shown full size)

Fig. 8b: (right) The p.c.b. component placement layout



As ever, the prime 'caveat' for the constructor is to ensure good soldering. This may sound repetitive to those of you who have heard it all before, but soldering is the first and last word in any electronics project. Far too many theoreticians in electronics are truly hopeless when it comes to wielding a soldering iron.

Always use an iron that is hot enough. Broadly, this means one which doesn't leave great blobs of flux at the joints, since this should evaporate in the



VR2
Audio out
Right left
LED1
Cathode +12V
Chassis
L4
C34
S1
S2
S3
S4
S5
S6
S7
S8
S9
Ferrite rod
TC9
L5
F4
IC1
VR1
VR3
T3
L3
T2
L1
C41
C40
C42
C26
C33
C50
C4
L11
Link
Tunerhead
M1
75Ω aerial (f.m.)
Links: a-a to g-g are plastic covered wire, positioned on copper track side.
RM102

Resistors

¼ W 10% metal oxide		
10Ω	3	R7, 22, 41
270Ω	3	R1, 24, 34
330Ω	2	R23, 38
390Ω	1	R19
470Ω	1	R6
680Ω	3	R2, 32, 33
820Ω	2	R40, 29
1kΩ	1	R4
2·2kΩ	1	R5
3·3kΩ	3	R18, 20, 30
3·9kΩ	1	R35
4·7kΩ	7	R3, 12, 13, 25, 26, 27, 28
6·8kΩ	1	R21
18kΩ	2	R11, 31
47kΩ	2	R10, 36
100kΩ	1	R37
220kΩ	1	R39
390kΩ	1	R8
470kΩ	5	R9, 14, 15, 16, 17
Pre-set variable, horizontal mtg. 10mm "Piher" type		
10kΩ	1	VR1
500kΩ	1	VR3

Potentiometer

100kΩ	1	VR2 (Multi-turn)

Capacitors

Polystyrene or low-K Ceramic. Minimum 30V wkg.		
47pF	1	C37
68pF	1	C34
270pF	4	C30, 31, 33, 40
390pF	2	C41, 42
470pF	2	C11, 15
820pF	1	C43
1500pF	2	C12, 16
47nF	1	C47
220nF	2	C2, 6
470nF	1	C5
0·1μF	4	C7, 8, 46, 50
Sub-miniature ceramic min. 30V wkg.		
82pF	2	C43, 44
100pF	1	C36
10nF	2	C14, 21
22nF	13	C9, 10, 13, 20, 22, 23, 25, 29, 32, 35, 38, 48, 49
47nF	2	C1, 26
100nF	1	C28
0·047μF	1	C39
Solid Tantalum, 16V		
10μF	4	C4, 18, 19, 27
22μF	1	C24
Electrolytic, min. 16V, axial leads		
1μF	2	C3, 45
4·7μF	1	C17
10μF	3	4, 18, 19
Trimmers, miniature, polypropylene dielectric		
2-22pF	6	TC1, 3, 4, 5, 6, 7
5-60pF	2	TC2, 9

Semiconductors

Transistors		
BC108	3	Tr2, 3, 4
BF224	1	Tr1
BF256	1	Tr5
40822	1	Tr6
Integrated circuits		
KB4400	1	IC1
TDA1090 (or ULN2240)	1	IC2
Diodes		
1N914	2	D1, 2
BA102 (or BB105)	1	D3
TIL209	1	LED1
Zener Diodes		
7V5 (BZY88-series)	1	ZD1

Inductors

Chokes	
RFC	1mH Toko 7BA102J (Ambit)
Transformers	
T1	Toko YXE 10857 (Ambit)
T2, 4	Toko YHCS 11100AC2 (Ambit) (2 off)
T3	Toko KACSK 586HM (Ambit)
Coils	
L1	Toko CAN 1980 (Ambit)
L2	Toko YMRS 80046N (Ambit)
L3	Ambit L132
L4	Ambit LWC (l.w. antenna coil)
L5	Ambit MWC2 (m.w. antenna coil)
L6	Ambit SWO1
L7	Ambit SWR1
L8	Ambit SWO2
L9	Ambit SWR2
L10	Ambit SWO3
L11	Ambit SWR3
Filters	
F1	Toko CFSE 10.7
F2	Toko CFSE 10.7
F3	Toko MFH41T
F4	Toko BLR 3107 Multiplex filter

Miscellaneous

Tunerhead Ambit AT3302 UG or NT3302 UG Switch assembly, 10-way Ambit AMT10 Meter, 200μA 750Ω internal resistance (with 390Ω in parallel) Case (see text) process, leaving only a small residue. The hotter the iron, the quicker the joint will be made—and the brighter and better your work will become. The temperature should be such that the instrument will just scorch a piece of wood without charring it rapidly.

Before fitting the tunerhead, remember to attach a couple of wires to the connection of the a.m. gang (Fig. 9) to feed through the underside of the board. Connection may be made to the top of the tuning gang, but the additional lengths of wire used in the process will be an unnecessary source of stray capacity and unwanted pickup.

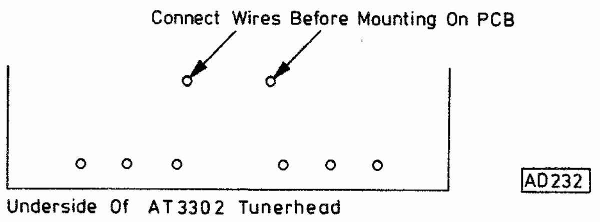


Fig. 9: A.M. tuning gang sections

The a.m. trimmers should be removed from the gang, by unscrewing the points shown in Fig. 10: they are provided for each individual range. The necessary underboard linking, is given in Fig. 8b (don't forget the links on the top of the switch, also shown in the basic layout plan. As a general guide, always fit components with the most leads first, thus narrowing down the numbers of holes for incorrect insertions.

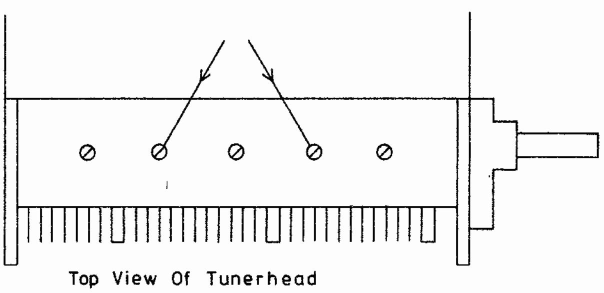


Fig. 10: A.M. trimmers to be removed

Testing and alignment procedures

The frequency ranges for the appropriate bands are listed in Table 1, part 1. The f.m. tuner is fully pre-aligned, and only the i.f. output coil of the tunerhead is likely to require adjustment. The f.m. detector stage may be readily aligned in conjunction with the built-in tuning meter, using the i.f. white noise to centre the detector stage on the centre-zero tuning meter.

The mute pre-set must be fully anti-clockwise during this process, and the core of L132 about 1 to 2 turns below the top of the assembly.

With the f.m. i.f. detector aligned, and using white noise, turn the mute control to its threshold—i.e. until the tuner just mutes. If proper muting cannot be achieved, then a capacitor of between 220 and 330pF should be placed across the output side of the first f.m. ceramic i.f. filter to reduce the i.f. gain. This does not adversely affect the f.m. sensitivity.

Alternatively, L132 could be trimmed, but please note that this approach will require re-tuning of the detector stage quadrature coil after each adjustment. A meter to monitor the control voltage at pin 14 will indicate the status of this part of the circuit, and mute will occur when the voltage at pin 14 is in the region of 1·5 to 4·5 volts.

Since the f.m. tuning meter is centre zero, note also that another amplitude-related function takes place at the a.g.c. terminal, pin 15. However, a.g.c. onset does not occur until a fairly sizeable level of signal is present (100μV or so), and so this is not as effective a feature as on the CA3089E.

With a.m., the first points to align are the i.f. stages. The use of a ceramic or mechanical filter arrangement will simplify this process quite considerably since a wide-band signal injector may be used, simply adjusting the a.m. detector coil for maximum noise. If this is not available a finger placed on the input to the a.m. mixer stage will be found more than adequate in all but the most remote of areas.

The mechanical i.f. filter will also need peaking to match the circuit—but not more than a couple of turns. With the a.m. i.f. functional, select the m.w. pushbutton, and tune around. The m.w. antenna coil should be about 3-5mm over the end of the rod, with the trimmer capacitor across this coil about 20% meshed. The oscillator trimmers for all a.m. stages should be initially set to minimum capacitance.

It should not be too difficult to find out the a.m. frequencies of local stations so, with the tuning capacitor out of mesh, turn the core of the m.w. oscillator coil until it is lined up on a known station at the top end of the band. Mesh the trimmer approximately 30%, and re-adjust the core to recover the original station. Turn now to the l.f. end of the m.w. and find a station. This time peak the signal by adjusting the position of the coil on the ferrite rod. Return to the h.f. end, and trim the antenna trimmer. Repeat the process until no further improvement can be obtained.

Next month concludes this article with mechanical details and some useful thought on extending the functions of the receiver.

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article

Rising solar cells

Japan is often called the Land of the Rising Sun and its current interest in solar cell technology supports this. Among the many newer developments reported is a process for fabricating solar cells but using a low temperature technique which could lead to low cost cells. Instead of the more usual 1,000 C diffusion temperatures commonly required for the conventional diffusion process when making silicon pn cells, the new method needs temperatures of only 300-350 C. A film of tin dioxide, less than 100 Angstroms thick, is deposited by evaporation at 300 C to form a hetrojunction with the n-type silicon. A further deposition at 350 C of a conductive film (about 1,000 Angstroms of it) completes the process. The conversion efficiencies are said to be easily comparable to those of the more conventionally produced silicon cells. With a polycrystalline substrate this is around $8\frac{1}{2}$%, while single crystal substrates allow this figure to rise to 12%.

Wire edged terrier

If you're ever in the countryside, and you get this strange feeling that you're being "watched", it could be the fence! This latest attempt at a barbed wire eyeball is the product of a British company. Its barbed wire fence is different to others in that it has an optical fibre in each wire. If the wire is broken, the system will not only warn of this but can also give the location of the break. A permanent "all quiet on the Western Front" code is transmitted along the fibre, and any interference with our skinny optical friend anywhere along its length (like trying to bridge it) will disturb the code and sound an alarm.

Little repeater stations are located at strategic intervals and these are optically coupled to the fibre. The system puts a special coded signal along the wire; transmitted at one end, received at the other. When a break in the wire occurs, the next little repeater along the line doesn't receive the signal. To register its disappointment it puts out a warning signal of its own, thus locating the break. Because of the complexity of the coded signal, some 8,000 sections of fencing can be guarded by a single installation. A system to keep an eye on a small garden might cost near to £1,000. Personally, I prefer a Doberman with a grudge and a nervous disposition.

Silly Saph

Diamonds may be a girls best friend, but to computer manufacturers it could be sapphire. Silicon-on-Sapphire (or s.o.s.) is fast gaining recognition and application as the latest central processing unit (c.p.u.) indicates. Previously, the c.p.u. took nine boards and occupied some 700 square inches. The new s.o.s. c.p.u. takes less than one square inch! Small is not only beautiful, it's fantastic.

Grooveless

How many grooves has a gramophone record—just one, it's a single spiral. This old joke will soon be out of date for all time if the Victor Company of Japan has its way. This organisation is working on a grooveless record suitable for playing both video and digital audio. The pick-up is capacitive by means of a tiny conducting strip on the trailing edge of the stylus and the surface of the disc. Special narrow tracks give a servo signal and this is used to keep the stylus in proper tracking. The discs themselves use a conductive plastic and this, of course, can be simply "pressed" in manufacture. The disc then does not need any extra plating, etc. Looks like there's hope yet for audio enthusiasts who think they're in a rut.

And it's not only at JVC where all the action is. There's similar work going on in Poland where spies nform that at least one company out there is working on a capacative video disc player. The 32cm disc gives about 30 minutes of colour TV per side. It is interesting that recording techniques of this type are dividing. JVC, a company in Poland, and the mighty RCA are all working on similar systems, while another method using optical pick-up techniques is favoured by such people as Philips and French giant Thomson-CSF.

Wait for it

A new chip for hi-fi buffs will make constructors lives a little easier. Instead of all those expensive and bulky potentiometers (usually ganged, too) this chip will offer elegant and very compact control of base, treble, balance and volume. Direct-current control signal is the secret and can be effected by means of varying a voltage in the range 0 to 6V. The total gain variation is said to be of the order of −72dB to +12dB on both base and treble. It is hoped that the new chips will sell for £1-£2 although these are not as yet available. Until they do arrive, readers will just have to control themselves!

Hot Plasma

If you're the proud owner of a microwave oven you are not the only one putting those magic waves to good use. A short while back, an American University managed to heat some plasma to a mere 60,000,000 C. The interest in such fantastic temperatures is a thing called sustained nuclear fusion which is going to give us all a source of power when there's no oil or other fossil fuels. Snag is, that for sustained nuclear fusion you need things just a might hotter; like 100,000,000 C!

Enter another University complete with a "toroidally-shaped Tokamak chamber" (in Barnsley, they speak of nothing else). Into this luckless toroid, it is intended to beam microwave energy. Technical buffs hovering around the project are muttering something about needing to supply 4,000,000 Watts of power at 4GHz. One of the goals in nuclear fusion is to contain the plasma for a whole second at 100,000,000 C. Apparently this makes hydrogen atoms change, by fusion, into more complex atoms and release energy. Definitely not in the shops—yet.

Ginsberg

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AL2	4"	× 3"	× 1½"	70p
AL3	4"	× 3"	× 2"	80p
AL4	6"	× 4"	× 2"	90p
AL5	6"	× 4"	× 3"	£1·25
AL6	8"	× 6"	× 2"	£1·50
AL7	8"	× 6"	× 3"	£1·75

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BC1	6"	× 4½"	× 2"	£2·00
BC2	6"	× 4"	× 3½"	£2·25
BC3	8"	× 5½"	× 2⅛"	£2·50
BC4	10"	× 6½"	× 3"	£3·00
BC7	12"	× 6½"	× 3"	£3·25

MAINS TRANSFORMERS. Type 15/300 240V Input. 15V at 300mA output. **£1·50** each.

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BCY72 Transistors. 4 for **50p.**
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BF152 (UHF amp/mixer). 3 for **50p.**
2N3819 Fet., 3 for **60p.**
BC148 NPN SILICON, 4 for **50p.**
BC158 PNP SILICON, 4 for **50p.**
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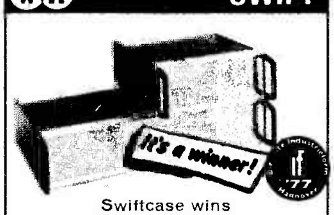

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7448	50p
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74125	35p
74126	35p
74128	60p
74130	120p
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74162	55p
74163	55p
74164	60p
74165	60p
74166	75p
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4030	30p
4032	80p
4033	100p
4040	60p
4043	60p
4046	90p
4047	80p
4048	50p
4049	25p
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22/50	8p
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33/16	8p
33/25	8p
33/40	8p
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47/10	8p
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BC119	25p
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BC138	30p
BC140	30p
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BC142	30p
BC143	30p
BC147	10p
BC148	10p
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BC149	10p
BC153	16p
BC154	18p
BC157	10p
BC158	10p
BC159	10p
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BC183L	12p
BC184	10p
BC184L	12p
BC186	20p
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BC212L	12p
BC213	12p
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BC214	15p
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BC303	30p
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BD222	65p
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BD252	50p
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BD609	80p
BD610	80p
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BF121	45p
BF123	45p
BF125	45p
BF127	50p
BF137	35p
BF154	18p
BF160	18p
BF161	18p
BF173	20p
BF178	25p
BF179	25p
BF180	30p
BF181	30p
BF182	30p
BF183	25p
BF184	20p
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BF199	25p
BF200	30p
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BF258	25p
BF259	25p
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BF274	30p
BF324	30p
BF336	35p
BF337	35p
BF451	25p
BF367	20p
BF394	35p
BF458	50p
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BFX81	100p
BFX85	30p
BFX87	25p
BFX88	25p
BFY10	30p
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TIP30B	40p
TIP30C	45p
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TIP31A	45p
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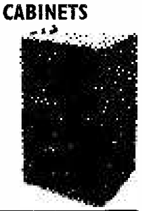

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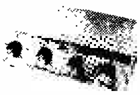

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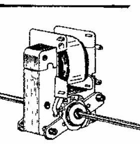

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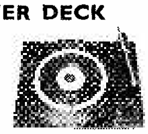

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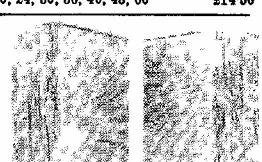

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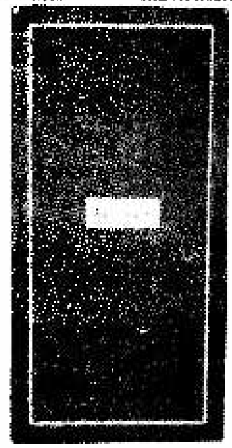

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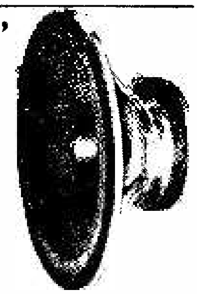

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Flux Density	16,500 gauss
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8 or 16 ohms models.

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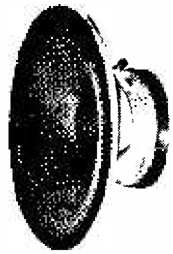

A full range reproducer for high power. Ideal for Hi-Fi and Discotheques. Electric Guitars public address, multi-speaker systems, electric organs.

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Flux Density	15,000 gauss
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OPTICAL FIBRE TELECOMMUNICATIONS

The conventional telephone system is essentially electrical in nature. The audio voice signal is converted into audio frequency electrical signals by means of a microphone before it passes to the local exchange; although the form of the signals may be changed in some way (for example, into a pulse code modulation signal or into a microwave beam for carrying the signal to a satellite and hence to another continent), in conventional systems the signal always travels by electrical signals or radio waves.

The installation of an experimental fibre glass link into the UK telephone network last year was therefore something of a revolution in telephone techniques. In essence, the telephone signal is used to modulate the infra-red radiation emitted by a gallium arsenide laser diode. This radiation is coupled into a length of glass fibre no thicker than a human hair, the fibre being constructed so that virtually all the radiation is reflected from the sides of the fibre along its length.

The length of such fibres may be of the order of 1km, but a few such fibres may be connected end-to-end so that a single fibre-optic link may carry a signal a distance of the order of 10km. At the receiving end the infra-red radiation is fed to the junction of a sensitive infra-red detecting diode which converts the signal back into an electrical voltage or current. After amplification this signal can be fed through the telephone network to any destination.

Fibre Production

It is essential that optical fibres for telecommunications applications should be produced in long lengths. Although lengths of fibre can be joined, there are inevitably losses at each junction. Such losses can amount to as much as 1 to 2dB per junction, but the use of very refined jointing techniques can reduce the losses somewhat. Nevertheless, it is essential to keep the number of junctions to a minimum in order to obtain efficient communication.

In practice it has been found possible to manufacture glass fibres in 1km lengths for telecommunications work. It is essential to employ ultra-pure chemicals to manufacture the glass, since impurities can act as light scattering centres which introduce losses into the fibre. The losses in a typical fibre are of the order of 5dB per km at present, but fibres with considerably lower losses have been produced in the laboratory.

The structure of an optical fibre cable is shown in Fig. 1. Two steel wires are embedded in flattened polythene strip to provide the required strength. The very small diameter optical fibre cables are placed in cavities in the polythene material. Graded optical fibres have been used in the Post Office experimental link; that is, the refractive index of the fibre decreases gradually with increasing radial distance from the centre of the fibre. This type of graded fibre results in the radiation being returned to the centre of the fibre not by total internal reflection from a sharply defined interface, but by a more gradual refraction in the outer layers of the glass fibre.

The use of such graded fibres reduces the spread in time which various rays take to pass through the fibre and enables a better performance to be obtained with a wide bandwidth. Fibres of graded refractive index can be made in long lengths by drawing glass simultaneously from two crucibles, the inner crucible containing the core glass and the outer crucible the cladding glass. The boundary diffuses as the glasses flow out of the crucible, thallium being employed as the diffusing ion.

The PO trial

The Post Office experimental trial of optical fibre communications has been used to link the PO Research Centre at Martlesham Heath with the main Ipswich telephone exchange, a distance of some 12km. Only one repeater was used, this being in the Kesgrave telephone exchange which is situated

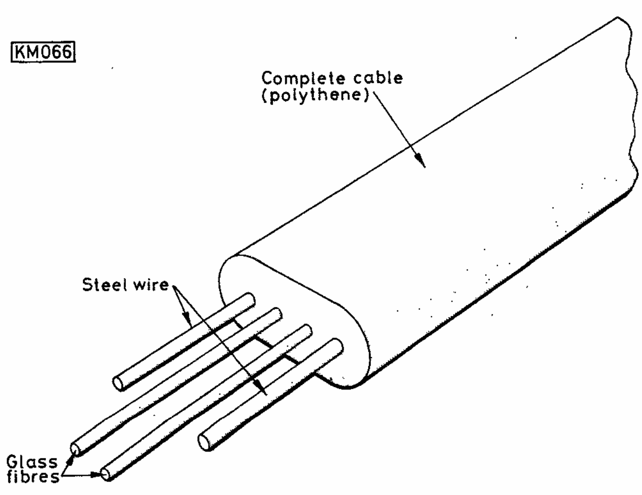


Fig. 1. The structure of the optical fibre cable used in the Post Office trials in East Anglia.

approximately half way between Martlesham Heath and Ipswich. Cable of the type shown in Fig. 1 has been employed, each glass fibre having a diameter of 62·5μm (0·0625mm). Two different types of cable have been tried, one type having a bandwidth of about 200MHz.km and the other a greater bandwidth of about 400MHz.km. In both types of cable the losses are some 4·5dB per km, whilst the weight of a 1km drum of the cable is some 50kg.

A total of about 14km of the lower bandwidth cable has been employed to link Martlesham with Kesgrave and Kesgrave with Ipswich. The work with this cable involved a 8·448Mb/s data rate feasibility study.

The 6km length of the higher bandwidth cable was used to link Martlesham with the Kesgrave exchange at data rates of up to 140Mb/s. An additional length of 1km of this cable was used for experimental work whilst wound on a drum.

The cables were installed in existing underground telephone ducts, but great care had to be taken to prevent breakages of the glass fibre, since no spare lengths of cable were available. A dummy cable of similar structure was therefore placed in the ducts initially and was used to draw the valuable optical fibre cable into the ducts. Each 1km length of the cable was installed by placing the 1km drum near the centre of the section and drawing the cable first in one direction and then in the other so that the maximum length of each section to be inserted into the ducting did not exceed 500m.

Special tools were designed to enable low-loss joints to be made between successive sections of the cable. A tool with a tungsten carbide blade was used to "glue" the two ends together, the fixing of the ends The ends of the two cables to be joined must be very accurately aligned, since an alignment error can result in considerably greater signal losses.

The Post Office engineers employed a jointing machine to align the two ends of the cable. An epoxy adhesive of suitable refractive index was then used to "glue" the two ends together, the fixing of the ends being accomplished in a few minutes by raising the temperature of the epoxy adhesive.

Performance

The optical fibre experimental link connects four telephones at the Martlesham Research Centre to the Ipswich telephone exchange. Telephone calls can be directly dialled from any of these four telephones to most of the 22 million telephones in the British Isles. However, the optical fibre links used are capable of carrying up to 120 telephone calls simultaneously. The separate fibres each carry signals in one direction only.

An important feature of the system is that only one intermediate repeater (or signal amplifier station) is required, this being at Kesgrave. If the signals were sent for the same distance along conventional telephone lines, the signal would have to be boosted at six different points. The small diameter of the optical fibres will enable large numbers of them to be grouped together and installed in small diameter ducting so that many telephone calls can be carried simultaneously.

In the Post Office experimental link, data and clock inputs at 139·264Mb/s are taken to an encoder and the signal is processed so as to convert it into a form suitable for the current drive of a laser diode. There is a coupling loss between the diode emitter and the cable of some 0·5dB, this leaving a maximum power of some 850μW to enter the fibre. The wavelength of 840nm is in the near infra-red region.

A digital "1" signal level corresponds to the 850μW level approximately. Owing to laser threshold delays, the digital "0" signal is not made the level at which no radiation is emitted from the laser diode, but rather a level of about 70μW so as to keep the diode in its lasing state at all times. The mean input power is thus some 460μW, but the signal emerging at the far end of the line has a power level of only about 1·4μW. This output signal is coupled into an extremely sensitive avalanche photodiode which provides an input to an amplifier using a gallium arsenide MOSFET.

The maximum distance between repeater stations in the present system is some 9km at infra-red input power levels of 1mW. Calculations indicate that optical fibre systems can be designed which have a cost of only two thirds of that of conventional cable connections. It may well be that optical fibres will not be used to convey signals to individual houses and other premises, but rather to convey large numbers of multiplexed signals between telephone exchanges.

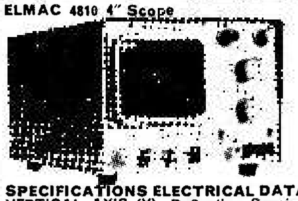
The length of optical fibre between Martlesham and Kesgrave, a distance of nearly 6km, shows a loss of some 25dB overall with a bandwidth of about 160MHz. Transmission of data is thus possible at rates of up to at least 300Mb/s.

Conclusion

The Post Office field trials and other experimental links using glass fibres (such as the Standard Telephones and Cables link between Hitchin and Stevenage laid in Post Office telephone ducting) have shown that this form of communication is readily compatible with the existing telephone networks and it seems that it is likely to be very cost effective.

Although it is impossible to forecast future developments, one can imagine that optical fibres may be extremely attractive when one wishes to convey wide bandwidth signals rather than a narrow bandwidth telephone conversation.

Optical fibre communications could even make it an economic possibility to introduce the "videophone"—seeing by 'phone as well as speaking!



SPECIAL FEATURE

METAL DETECTION

New metal detector designs with weird and wonderful names like VLF Phase Angle or Induction Balance TR, keep popping up and manufacturers are keeping their techniques very much under wraps. This article tries to describe how various machines work and what sort of performance can be expected from them. In some cases the sensitivity quoted may be exceeded by a highly developed machine.

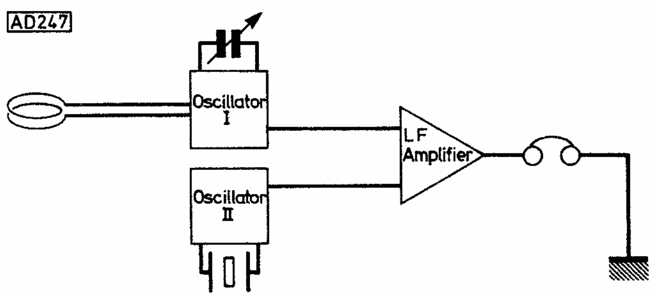
Beat Frequency Oscillator (BFO)

The BFO is the simplest type of metal detector and hence it is the least sensitive and the most difficult to use. The essence of the design is having two oscillators tuned to frequencies very close to each other. One oscillator is the reference and the other is tuned by the inductance of the search coil, which will alter as metal is brought near it. Either oscillator can be tuned by the operator, depending only upon the manufacturer's choice. When the two oscillators are at nearly the same frequency, mixing their outputs together produces a beat note which is equal to the difference between the two frequencies. This note is arranged to be in the audio spectrum, and thus it can be amplified and fed to the headset.

The output from the headset is thus a tone which increases or decreases in frequency when the coil is brought near to metal. If the metal is ferrous then the inductance of the coil will increase and the frequency of the oscillator will fall. This gives a falling note in the headset. The opposite applies to non-ferrous metals which gives a rising note in the headset. Needless to say, this can be reversed by tuning to the other side of the reference oscillator. Extra sensitivity can be obtained by tuning the reference oscillator to a frequency which is a multiple of the coil oscillator and using a phase-locked loop to control the system as in the *PW* "Ferret".

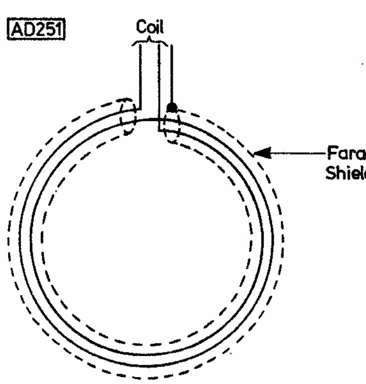
One disadvantage of these machines is that two oscillators are used. Each can drift causing constant retuning to be necessary, although some manufacturers have used a crystal-controlled reference leaving only one oscillator with a drift problem. These machines are also affected by ground capacitance causing the coil oscillator to vary in frequency, though this can be partially avoided by using a Faraday shield round part of the coil. The BFO machine cannot tune out silver paper, coke, ring pulls from beer cans etc. and will be affected by salt water, wet grass and terrain changes. Its typical sensitivity is 100 to 120mm on a 2p coin.

AD247



Block diagram of a BFO detector

AD251



Adding a Faraday shield. Note that this does not form a complete ring

Induction Balance (IB) and Transmit/Receive (TR)

A great deal of confusion has arisen from these two names, one manufacturer calling his IB a TR and vice-versa and other manufacturers calling them IB/TR machines. They both work on the same principle of Induction Balance though even this is somewhat of a misnomer. The true IB machine has three coils, while the TR has two coils. The effect used for detection is the change in coupling which occurs as the coils are brought near to metal. Both machines use only one oscillator.

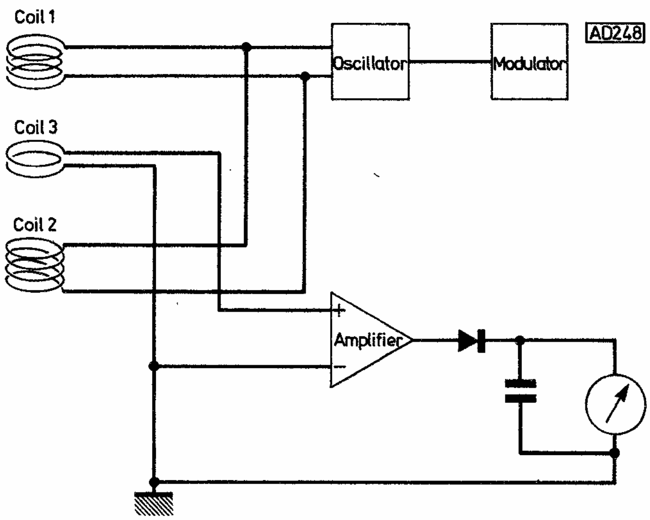
In the IB machine the oscillator is fed to two coils. The three coils are arranged on top of each other, very slightly displaced from centre, and the top and bottom coils are connected to the oscillator. The bottom coil is wound in the reverse direction to the top one, and thus the two coils generate antiphase fields. The third coil is placed between the other two where the fields balance and thus, at its terminals, has no signal. When metal is brought near to the coils an imbalance occurs and the centre coil then picks up a signal as the amplitudes of the other signals change unequally. The output from this coil can then be amplified and rectified to drive a meter, and the oscillator is usually amplitude modulated to produce an audio tone for the headset.

The TR machine has only one coil connected to the oscillator. The other is connected to the non-inverting input of an amplifier. The inverting input is connected via the control potentiometer to the oscillator and thus the amplifier can be set to give no output when the coil is not near metal. As the coil approaches metal a transformer effect occurs, coupling more signal into the receiving coil. The imbalance is amplified as before for the headset and meter.

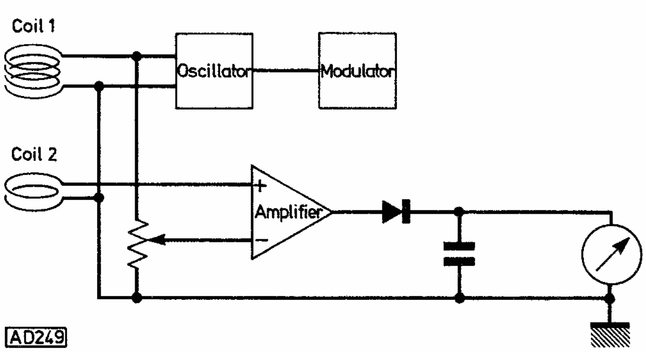
In both machines the coupling increases for ferrous metals and decreases for non-ferrous, so by mixing the output from the amplifier with the signal from the oscillator the resulting signal will increase for ferrous metals and decrease for non-ferrous metals.

It has also been found that small ferrous objects and aluminium objects, silver paper or bottle tops exhibit a skin effect where the coupling causes phase changes, and thus these items can be discriminated against. The final result is a comprehensive metal locator with lots of control knobs. This makes it look very impressive but unfortunately also makes it very difficult to set up perfectly. Generally, if the discriminating mode is used, the sensitivity of the machine is reduced.

The problem with both these types of machine is the ground effect, which causes changes in the coupling of the two coils and thus causes false readings if the coil is not held at a constant height above the ground. Salt water, wet grass and terrain changes can also upset the machine, although manufacturers are introducing Ground Exclusion Balance (GEB) machines which can eliminate any effect caused by the ground. GEB machines are expensive at around £250 and are complex to set up. A good IB/TR machine will detect a 2p coin at over 200mm.



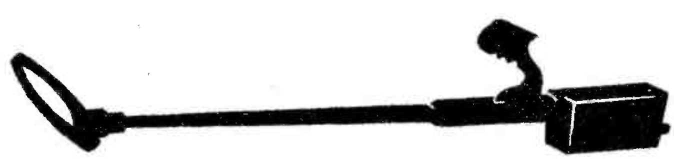
Block diagram of an IB detector. Coil 2 is wound in the reverse direction to Coil 1



Block diagram of a TR detector. The balancing signal is adjusted by means of the potentiometer

Pulse Induction (PI)

The PI machine is described elsewhere in this issue, so it is unnecessary to spend too much time explaining how it works. The stability of the Pulse machine is vastly superior to any other and it does not suffer from ground effect. It cannot differentiate ferrous and non-ferrous materials and has a relatively high power consumption. The other important factor is that the PI machine is an absolute metal detector, whereas the other machines are relative metal detectors. This means that on a relative metal detector it is possible to put metal near the coil and then tune it out without losing sensitivity. On the PI machine this is not possible, and sensitivity will be reduced if any metal is near the coil when the machine is set up. The net result of this is that PI machines cannot have metal shafts etc, but other machines can.

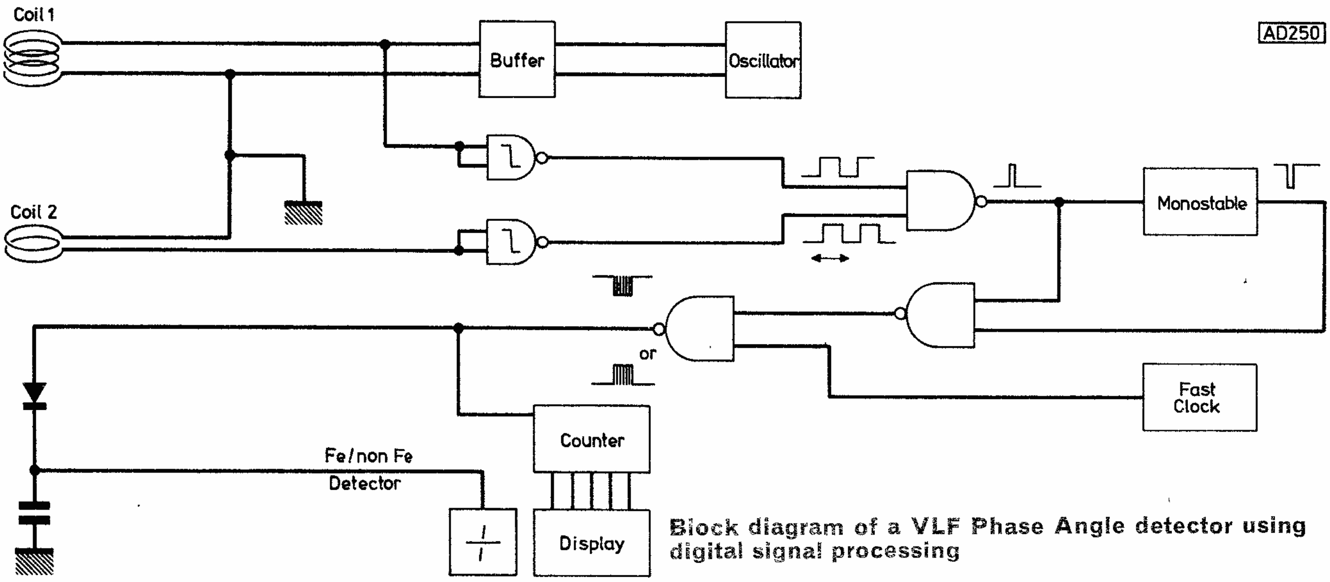


VLF Phase Angle

The VLF stands for Very Low Frequency and refers to the frequency of the oscillator used to drive the coil. The advantage of using low frequencies is to reduce the effect that the ground capacitance has upon the circuits, and thus the coils tend not to be affected by terrain changes. VLF is also used in IB machines which have the GEB suffix and it is this factor which contributes so much to their expense. When low frequencies are used the changes produced in the coils are much less than for high frequencies, no matter which technique is being used for the detector, and thus much greater signal processing and hence stability is necessary to produce a machine with the same capabilities.

The phase-angle method of metal location is the latest development in this field, and as yet is very underdeveloped by commercial manufacturers. It offers the greatest scope in location techniques as it can easily be made with digital electronics. and thus a great deal of digital signal processing can be carried out at relatively low cost. The phase-angle machine has two coils, one of which is connected to an oscillator via a buffer stage. This ensures that the coil cannot alter the frequency of the oscillator. The second coil is connected to an amplifier which produces a square wave at the same frequency as the oscillator. The oscillator is also fed into an amplifier to produce another square wave. When the coil is brought near to metal, the phase difference between the two square waves alters, increasing for ferrous and decreasing for non-ferrous. The implications of this phenomenon should now be obvious. The simplest form the circuitry could take would be to invert one signal and add the results to produce a spike. Feed this into a smoothing circuit and there you have a voltage to drive a meter. To improve the gain, a monostable could be used to generate an inverted spike of the same period to cancel out the first spike. Followed again by a smoothing circuit and now a d.c. amplifier and the gain is vastly improved.

To continue in the digital sphere, a fast clock could be gated by the spike to produce a count for a digital readout which could read + for non-ferrous and − for ferrous, with the magnitude of the number indicating the depth and size of the find. Sensitivity on these machines can easily be 250-300mm on a 2p piece with full discrimination.



Block diagram of a VLF Phase Angle detector using digital signal processing

Licensing Requirements

Having, hopefully, provided food for thought on designing and building your own metal locator, or even for the wealthy, going out and buying one, there are other matters to be considered. The first point is that to use one of these machines a licence is required. It is referred to as a Pipe Finders Licence and costs £1·40 for 5 years, application forms are available from the Home Office, Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London SE1 8UA. A licence covers only one type of detector, and if you buy another design you need a new licence.

The Home Office also has regulations concerning the signal in the coil and if you are designing your own equipment you should stay within their specifications which state:

1. Air-cored or ferrite-cored coils may be used but the energisation shall not exceed 0·1 amperes r.m.s. per turn.
2. Modulation, either a.m. or f.m. may be used if required.
3. The depth of a.m. shall not exceed 100% so do not use square waves.
4. The authorised bands for use are 0-16kHz and 16-150kHz.

In a nutshell, they say do not use a 2N3055 to switch the coil across a car battery at 1MHz!

General hints on designing your own metal detector are: try to keep the operating frequency as low as possible. This reduces the effects of ground and water. Frequencies below 25kHz should produce few false readings from the terrain.

An audio output gives far more dynamic range to the man-machine interface than a meter, and the changing pitch of a voltage-controlled oscillator (v.c.o.) is far better than a rising volume output. Do not worry about driving a loudspeaker, a headset is

SPECIAL FEATURE

far easier to use and makes it easier to detect minute changes in the signal in high ambient noise levels. When developing your circuit, pay attention to supply decoupling as large currents in coils or headphones can cause most weird effects on the sensitivity of your circuit. The size of the coil is important both for inductance and sensitivity. The larger the coil the more sensitive the machine, but the more difficult it becomes to find the centre of any metallic object discovered.

Using your Detector

Building or buying a metal detector is one thing but using it is something else. Unless you are on your own land you need permission to use one, and in many parts of the country the use of metal detectors on public land (parks, footpaths etc.) is forbidden by a bye-law, so check first.

The other main rule is that which concerns any finds that you may make. Gold and silver are classed as Treasure Trove and are the property of the Crown, and must therefore be handed in to a Coroner, who will hold an Inquest to decide true ownership rights. Items of historical value usually end up in a museum and in order to promote handing in of Treasure Trove, the finder is generally given a reward to the value of the items. Further information on Treasure Trove may be obtained from the Director, British Museum, London WC1. Any other items found become the property of the owner of the land, not the finder, so it is best to come to an agreement with the landowner before you start searching. Archaeologists do not like metal detectors or people who use them so do not go on known historical sites with yours. You could be prosecuted!

After you have dug up everything in sight and found very little, you may care to do a little research at your local library. Establishing the likely positions of ancient Roman camp sites may not be easy, but professional metal detector users, and there are many, spend nine months researching and three months out in the field with their machines. One tip is to ask your local museum curator where not to dig, and if he gets his atlas out then try another museum. Curators will generally be found to be very helpful about known sites which are taboo and possible sites which are likely.

Waving your machine at the cows

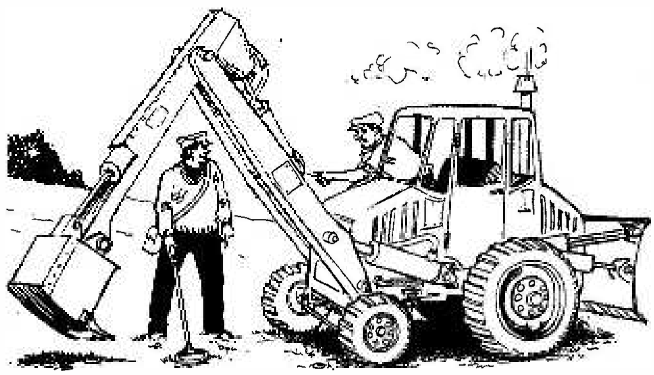
METAL DETECTION

Having built or bought your machine, and researched your possible site, and got permission from the owners of the land, how do you find large hoards of gold? If I knew I would not be writing this article. It is no use walking aimlessly around waving your machine at the cows to frighten them away, and to expect to trip over a large treasure chest. Take some pegs and some string with you and mark out a square about 3m side. This is the first area to search and it must be searched fully.

If you have a BFO or IB/TR machine without GEB, you will find that the height of the coil above the ground is critical. If you set up your machine with the coil resting on the ground then as you raise the coil to start searching it will give a reading. If the machine is set up in the air, then when it is placed near the ground it will become less sensitive. The correct way to set them up is by adjusting the controls with the machine on the ground and then backing off the sensitivity just a fraction so that when searching the tone is just audible. As you move around, signals will be heard as the coil moves up and down, and only practice will allow you to know which is a find and which is not. When you sweep, the action must be slow and smooth and that comment applies to PI and Phase Angle machines as well. Integrators take time to work.

Having searched the area in your 3m square completely, lift two pegs and move them to form another square adjacent to the first. In this way it is possible to be sure that the whole of the suspect area has been searched. Remember that every centimetre the coil is above the ground is a centimetre it cannot detect below ground, so keep the coil low down. When the machine has detected something, concentrate on finding exactly where the object is. Sweep the coil NS and EW to find the exact centre, raising the coil head and retuning if necessary to reduce the sensitivity of the machine. Dig your find up carefully, using a small trowel, not a JCB! Remove a triangle of turf and then the minimum of earth, checking frequently to see whether you have dug it up or if it is still there. Do not throw scrap metal finds away; you may find them three or four times again if you just chuck them about, take them with you. Replace the earth that you have removed and stamp the turf down evenly so that it is impossible to see where you dug. Do not leave a trail of potholes and divots behind you. Good hunting!

Trip over a large treasure chest



Use a small trowel, not a JCB!

Introduction to LOGIC ~ 6

S.A.MONEY

A cursory glance through any catalogue of digital integrated circuits will show that there are some hundreds of different logic devices available. Many of these devices will simply be various arrangements of the basic gate or flip-flop elements, and there may be one to four of these logic elements within a single circuit package. Typically there might be some twenty to fifty transistors etched and diffused into a single silicon chip to form such a device. Such simple logic elements are usually referred to as Small Scale Integrated or SSI circuits and they will generally be packaged into a 14- or 16-pin DIL assembly. The 7400 and 4011 gates and 7474 or 4013 flip-flops are in this logic category.

As techniques for fabricating integrated circuits improved it became possible to build more complex circuits, having perhaps a few hundred transistors, on to a single silicon chip. These more complex logic devices are called Medium Scale Integrated, or MSI, circuits and most of the newer devices in the TTL and CMOS ranges tend to be of this type. Now it becomes possible to have the four flip-flops and the associated gates for a complete decade of a BCD counter as a single logic unit. Examples of this are the 74160 and 74190 in TTL or the 4518 in CMOS. In fact the latter unit contains two complete decades of a BCD counter. Similarly complex gate arrays such as those for decoding BCD inputs to produce ten-line or seven-line outputs for driving a display can be manufactured on a single chip.

What are the advantages of MSI circuits in comparison with the more basic SSI elements? First the number of integrated circuits needed for a given logic system will be reduced, since some five or six SSI devices are replaced by each MSI circuit that is used. As a result both the size and complexity of the circuit board can be reduced and a more compact logic system can be produced.

When an integrated circuit is manufactured the testing and packaging of the device form a significant part of the total manufacturing cost whether it be an SSI or MSI device. As a result of this the MSI circuit will often cost less than the equivalent set of SSI devices. Another advantage is that there will be less connections to be made. For the amateur this means a saving in time and less chance that an error in wiring will be made. Reliability tends to improve since there are fewer soldered joints in the system. In the device itself the interconnections are produced by plating and etching which are inherently more reliable than solder for making connections.

Although MSI has its advantages it does not completely eliminate the need for the simpler SSI devices. In general MSI circuits are used for the more common logic sub-systems, such as counters, registers and complex gate arrays, but SSI devices are still required for the interconnecting logic and for any special logic functions that may be required.

Logic Families

Apart from the TTL and CMOS type logic elements that we have been discussing in this series there are a number of other families of logic elements which may be encountered. Although they follow the same basic rules of logic, an AND gate still has the same logical action, the signal levels and the input/output characteristics will vary from one logic family to another. It may be interesting to look at the characteristics of some of these other logic types and see how they compare with TTL and CMOS.

One of the earliest types of logic device to be made in integrated circuits used Resistor Transistor Logic (RTL) where the gate elements consisted entirely of resistors and transistors. Typically a 2-input NOR gate would have the arrangement shown in Fig. 68. If either input is driven to the *1* level, its associated transistor will turn on and pull the output line down to the *0* level. RTL devices were generally run from a supply line of about +3 to +3·5 volts and tended to be relatively slow in operation. This type of logic has now virtually disappeared from the scene.

Prior to the arrival of TTL one fairly popular type of logic was Diode Transistor Logic (DTL) which is still available today although it is steadily being replaced by CMOS devices. Here the gates are basically diode gates as described in the early part of this series and these are followed by transistor buffer stages to provide the output drive capability. A typical DTL NAND gate would have the circuit shown in Fig. 69. There were several variations of DTL made by different manufacturers but the most common were the 900 series devices. Typical of these was the 930 which contained two 4-input NAND gates. Logic signal levels and supply voltage are basically the same as for TTL but the switching speed is about three times slower than TTL. In fact DTL and TTL devices can be used together, although a DTL gate can only drive about one TTL input.

Low Power Logic

A number of variations of the 7400 series TTL devices have appeared over the years since TTL was first introduced. One of the earliest of these was Low Power Transistor Transistor Logic (LPTTL) in which the internal resistors of the logic element are increased to reduce the supply current. These low power versions of TTL also used 7400 series type numbers but an L was included to denote a low power

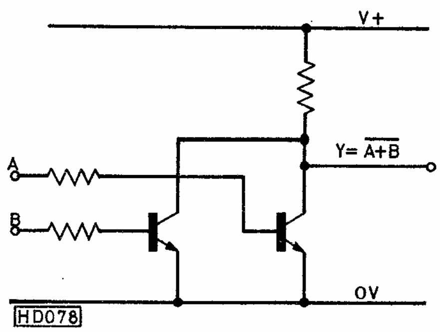


Fig. 68: Typical RTL NOR gate

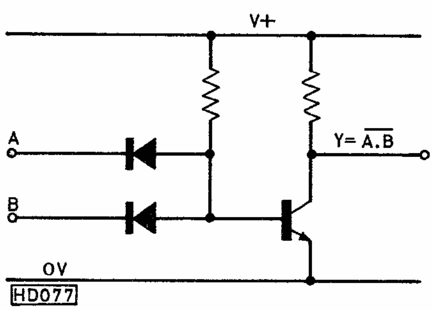


Fig. 69: A DTL NAND gate

type. Thus the 7400 becomes a 74L00 in its low power version but otherwise the function and pin layout are the same. It should be noted that one or two 74L devices do not have the same pin layout as their 74 series equivalents so it is as well to check this before using a 74L to replace a 74 device.

Typically a 74L series device will consume a quarter of the current that a normal 74 device does but this has to be paid for by switching speed reduction to about a third that of a 74 series device. Normally an LPTTL circuit will be capable of driving some two standard TTL loads. This type of logic is useful for battery-operated systems, although it is now tending to be replaced by CMOS which is less critical on supply voltages.

One interesting variation with 74 series numbers is the 74C00 type which is not TTL at all but uses CMOS logic. In fact these are CMOS devices designed to have the same pin layout and function as equivalent numbered 7400 series logic.

High Speed Logic

Normal TTL devices are limited in speed to about 30MHz because the transistors in the gate or flip-flop are run into saturation when they switch. Excessive base drive will build up a charge on the base which has to be removed before the transistor can switch off and this causes the slower switching action. One form of TTL element which overcomes this problem is Schottky TTL whose devices have 74S series numbers. In a Schottky TTL circuit a Schottky diode is connected between the base and collector of all switching transistor stages as shown in Fig. 70. This type of diode has a low forward voltage drop, which allows excess current in the base circuit to flow directly to the collector via the diode thus preventing the transistor from going fully into saturation. Now there is little charge to be removed from the base and the stage switches off more rapidly.

A typical Schottky TTL device will be about three times as fast as its normal 74 series counterpart but it will require a little more supply power. With Schottky TTL more care is needed with decoupling and circuit layout if reliable operation is to be achieved.

For even higher switching speeds, up to perhaps 600MHz, Emitter Coupled Logic (ECL) devices are used. In this type of logic the transistors do not saturate at all thus giving a high switching speed. Standard ECL devices such as the Motorola 10000 series are used in computers but are not normally available to the amateur user. Some special ECL devices such as divide-by-ten counters which operate at u.h.f. (made by Fairchild and Plessey) can be obtained however, and may be useful for v.h.f. frequency counters or synthesisers. These devices generally run from a −5V supply and are not directly compatible with TTL circuits.

There is also a low power version of Schottky TTL which has type numbers starting with 74LS. These devices have about the same switching speed as standard 7400 TTL but draw about one fifth the amount of power. Output drive capability is about the same as for 74L devices.

Logic System Design

We have seen how the various logic elements work and how they can be used but one question remains to be answered. How is a logic system designed? The first step in the design process is to decide exactly what the logic system will be required to do. This may seem obvious and yet it is quite surprising how many engineers try to design logic systems without first getting absolutely clear in their minds what the logic has to do. This basic rule applies not only to the design of new systems from scratch but also to modification of existing logic systems to make them do something different. In the latter case it is, of course, helpful if the action of the existing system is clearly understood before any attempt is made to alter it.

For any logic system there will be a set of input signals and some output signals and these will be related in some way to one another. Also there may

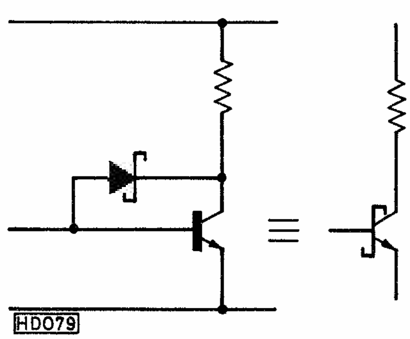


Fig. 70: A Schottky transistor as used in 74S-series logic

be a sequence of actions that the logic must carry out or events to which it must respond. In a simple system, once these things have been defined, the actual logic arrangement can often be worked out by simple commonsense reasoning.

As an example, let us suppose that we have to design a warning system that will alert a car driver to the fact that his car lights are still turned on after he has turned off the ignition. Here we have two input signals, one from the ignition switch (I) and the other from the light switch (L). The output of the logic, which we shall call A, is used to operate an alarm buzzer when I=*0* (ignition off) AND L=*1* (lights on). We can write this down as;

$$A=\bar{I}.L$$

Now this looks as if it could be met by using an AND gate. However to get the proper action we shall need to invert the I input signals so that both inputs of the AND gate go to *1* when the alarm condition exists at the input. The alarm must not operate if I=*1* or L=*0*. The circuit shown in Fig. 71 will perform the required function.

There are various other gate arrangements which will also meet the requirements of this alarm system. How about using a NOR gate instead of the AND arrangement? Think of what you must do to the inputs to make such a scheme work.

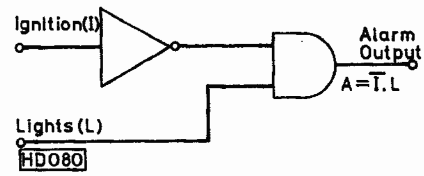


Fig. 71: Logic scheme for a car lights warning system

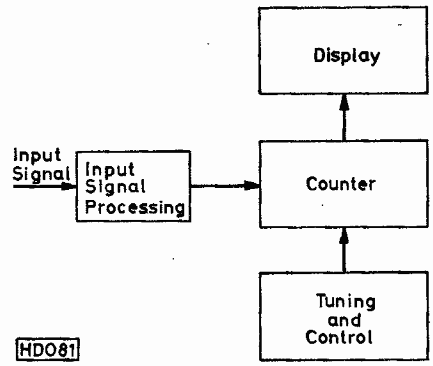


Fig. 72: Basic block diagram of a Digital Frequency Meter

Digital Frequency Meter

When more complex systems are designed, it is usual to try to break them down into a series of sub-systems each of which can be dealt with separately. In a very complex arrangement even the sub-systems may be broken down further into smaller sections of logic. Having decided what the main system must do the action of each of the sub-systems can be defined and they can be designed as independent systems. At all times however the interaction between the sub-system must be borne in mind since if the action of one sub-system is altered it may affect the design of some of the others.

As an example of a more complex logic system let us consider the design of a digital frequency meter. How can we measure frequency digitally? In the old days, before the term hertz crept into our language, frequency was measured in cycles per second, or maybe kc/s or Mc/s for the higher frequencies. Suppose we count up the number of cycles of the input signal that occur in a period of exactly one second. The resultant total will be the frequency in cycles/second or in our modern terminology it will give the frequency in hertz.

At the heart of our frequency meter therefore we shall have a counter to total up the number of cycles of the input signal. Having obtained this total we shall need some kind of display system to provide a numerical readout of the frequency we have just measured. Next we need an accurate clock to determine the one-second period over which input cycles will be counted, and some control logic to regulate the sequence of events involved in making each measurement of frequency. Here the counter must first of all be reset to zero, then it must count input cycles for some fixed time period and finally the result must be presented on the display.

The input signal itself may need a certain amount of processing to make it compatible with the logic system. Usually this simply consists of amplification and perhaps shaping of the waveform to give square-edged logic signals. So we end up with a basic system diagram which is roughly as shown in Fig. 72. The counter, display, timing and input sub-systems can now be dealt with separately to arrive at the detailed logic design, and we can look at the options available in the design of these sub-systems.

The Main Counter

Starting at the heart of the unit, let us consider the counter which will total up the number of cycles of input signal. The simplest form of counter would be a pure binary type. For convenience in use the display will need to be in decimal form and this is not normally compatible with a pure binary counter output. The obvious choice here is to use a BCD counter chain to total up the cycles of input signal. Matching the BCD outputs to a decimal display system then becomes quite straightforward.

How many decades of counter de we need? The answer to this question will depend upon the range of frequency to be covered and the precision to which frequency is measured. If we want to cover the range 0 to 30MHz in 1kHz steps then a counter reading from 0 to 30,000 is needed so there will have to be five decades in all.

What kind of logic is needed? In order to achieve a counting rate of 30MHz either TTL or Schottky TTL might be used. Even at 15V supply, CMOS devices would not be capable of this speed. However, CMOS could be used if we build some form of prescaler counter into the input signal processing circuits. Suppose we divided the input frequency by ten before making our measurement. Now the counter would have to work at only 3MHz and CMOS could cope with this easily. In order to get the correct answers, however, we would need to increase the time period over

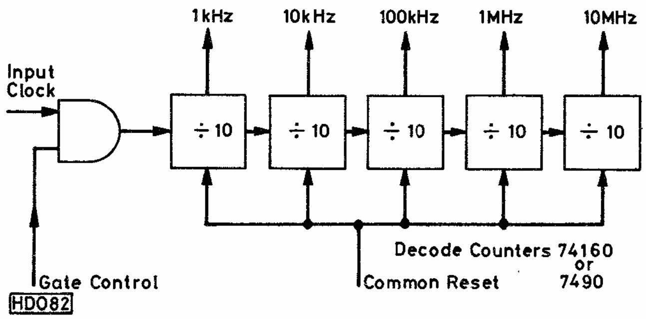


Fig. 73: A typical scheme for the main counter

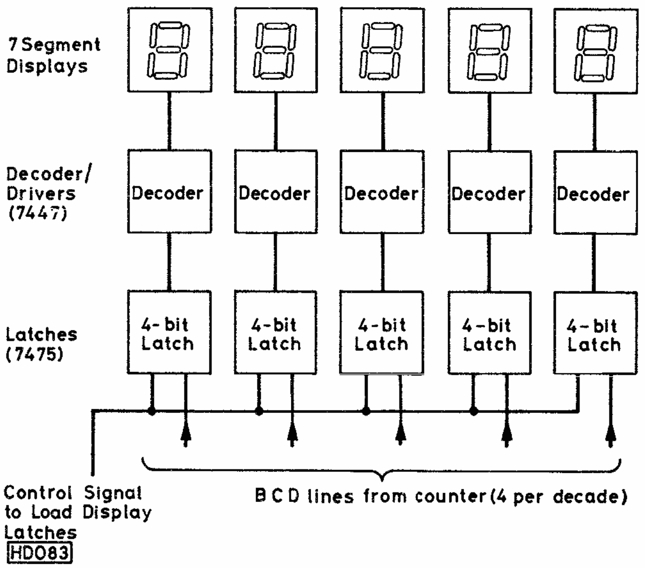


Fig. 74: Logic for the display subsystem

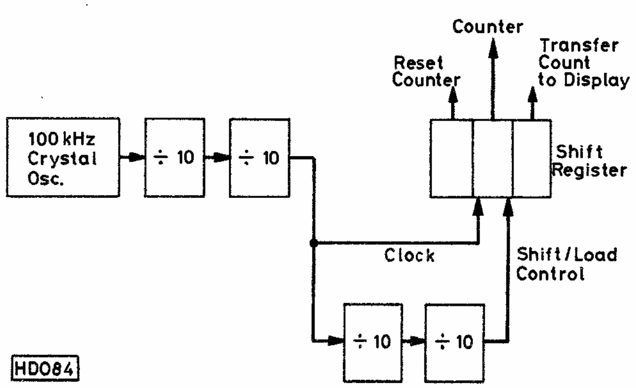


Fig. 75: Timing and control logic

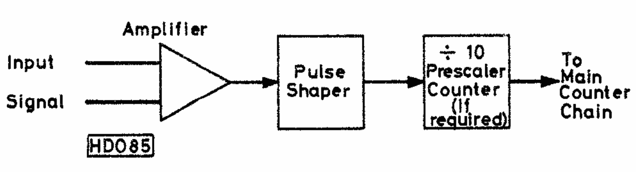


Fig. 76: Input signal processing

which the counter operates by a factor of ten in order to obtain the same total number of cycles. This prescaler approach is particularly useful if the signal to be measured is in the v.h.f. or u.h.f. range.

A simple AND gate ahead of the main counter chain is used to control the passage of the input signal pulses. When the counter is totalling up the cycles this gate will be open allowing the input pulses through to the clock input of the first stage of the counter chain. At the end of the counting period the gate closes and the count action stops.

The only other requirement for the counter chain is a common reset line to all stages of the counter to allow it to be reset to zero at the start of each measurement cycle. The resultant logic scheme for this main counter chain might be as shown in Fig. 73.

Display System

Either l.e.d., l.c.d. or Nixie tube displays could be used to provide the frequency readout. The choice will be governed largely by personal preference on the part of the designer or perhaps by the availability of a particular type of display unit. For battery-operated equipment the l.c.d. type display, with its low power consumption, has many advantages.

Apart from the displays, a set of decoder/driver logic will be needed to convert the BCD outputs from the counter chain into signals suitable for driving the display. Here the type of device required is governed by the type of display being used.

Display multiplexing could be used but with only five digits it may be found that there is no useful saving in the amount of logic required so the simple scheme shown in Fig. 74 might well be used. A latch has been included for each decade. If this were not used the display would flicker as the counter went through its counting operation.

The choice of logic type for the display system will be governed mainly by the capability of the devices to drive the displays. Speed of operation is relatively low, so all of the logic types will be suitable in this respect.

Timing and Control

To measure off the time period over which counting is carried out, an accurate clock signal is needed. This is usually produced by a crystal oscillator running at 1MHz or perhaps 100kHz. The crystal frequency is divided down in a decade divider to produce clock pulses at say 1ms, 10ms or maybe 1 second intervals and these pulses will control the measurement sequence.

The control logic needed to implement the measurement sequence can readily be produced by using a shift register with a single *1*-state travelling along it. The outputs of the successive stages of the register can then be used to control the various steps in the measurement sequence.

At the start of the cycle a *1* is loaded into the first stage of the shift register and the output from this stage is used to reset the counter chain. On the next timing clock pulse the *1* state moves to the second stage of the register and the output from this stage opens the counter gate to allow counting to occur. One time period later, counting is stopped as the gate closes and the *1* that has moved into the third stage of the shift register is used to transfer the number

Continued on page 71

the PW Sandbanks

METAL DETECTOR

P. J. Wales

Pulse Induction metal detectors have been available on the commercial market for some years and essentially their circuits remain unchanged from the original design. They have developed their own unique reputation because they have inherent features that other metal detectors do not have. They have always been very powerful machines capable of detecting a 2p coin up to 230mm underground. Because of the very low frequencies used they are insensitive to ground effects, coke, salt water, wet grass or small pieces of aluminium foil. Their sensitivity is a function of their current consumption and thus their battery life is generally poor, but their main disadvantage is their inability to discriminate between ferrous and non-ferrous materials.

The author has spent two years developing a circuit which combines good sensitivity, low current consumption and ease of use; a circuit which the enthusiast can build himself without the need for elaborate and complex test gear. The circuits have been particularly tuned to gold and silver, and they can be set up perfectly with only a meter. The unit illustrated is assembled into a case available as a kit from Ambit International Ltd.

COVER PROJECT

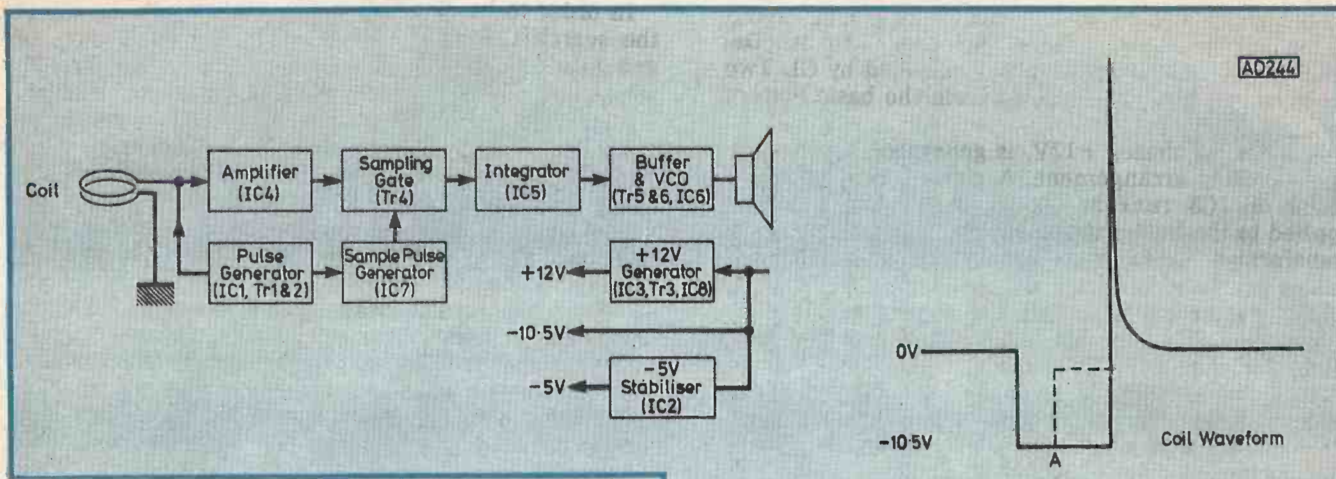


Fig. 1: (a) Block diagram of the PW Sandbanks P.I. metal detector. Except for the power supply arrangements and component references, this is typical of any P.I. machine. (b) Coil waveform

Theory

The basic principles of the PI metal detector are best understood by reference to the block diagram, Fig. 1(a).

As with most metal detectors, the heart of the machine is the coil. When power is applied to the coil it generates a magnetic field proportional to the number of turns of wire and the current passing through them. When the power is removed the voltage across the coil first drops to zero and then, as the magnetic field decays, builds up in the reverse direction as a back e.m.f. is induced into the coil. If the coil is correctly damped the back e.m.f. dies away as shown in Fig. 1(b). Should there be a piece of metal near the coil, it is affected by the magnetic field either to produce eddy currents or to be magnetised, depending upon whether the metal is non-ferrous or ferrous. In either case the result is the same in that the back e.m.f. takes longer to die away. This effect is most apparent in the time it takes to reach 0V.

Thus the detector circuits are arranged to process the area of signal where the back e.m.f. nears 0V. This is done by amplifying the coil waveform and then taking a sample of the voltage just as it gets to 0V. This sample is fed to an integrator which produces an output voltage proportional to the back e.m.f. decay time. This voltage is used to control the frequency of a voltage controlled oscillator (v.c.o.) which drives the speaker.

Circuit Description

The short negative-going pluses which are applied to the coil are generated by means of a 555 timer (IC1) operating in the astable mode. The repetition frequency is about 66 pulses per second and the duty cycle (ratio of pulse length to pulse interval) about one per cent. The output at pin 3 is amplified and inverted by Tr1 and applied to the power transistor Tr2. This transistor is run in a linear mode to increase switching speed and also reduce current consumption. The waveform on its collector follows the dotted line in Fig. 1(b) which shows that up to point *A*, Tr2 is saturated whilst the current builds up in the coil. After point *A*, the transistor goes into its linear mode, conducting approximately 0·5 amp.

Before describing the signal processing it is convenient to deal with the power supply arrangements. A 10·5V battery (seven cells) is used in the design illustrated, though any supply between 9V and 12V is satisfactory. The quiescent current consumption is about 50mA, rising to about 100mA on full detect.

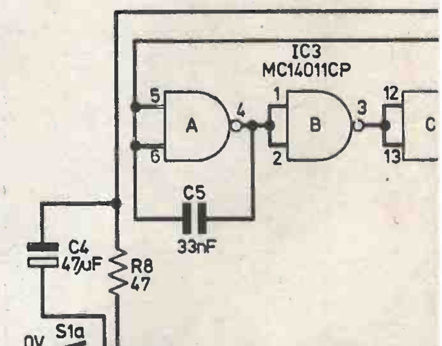
Fig. 2: Complete circuit diagram of the PW Sandbanks

★NOTE

To comply with the Wireless Telegraphy Act (1949) a licence is required to use the Sandbanks Metal Detector.

The Sandbanks has been tested and approved by the Home Office under section 1(1) of the Act (Pipe Finder/Metal Locator Licence) as operating at a frequency of 66 p.p.s.

A licence for five years costs £1·40 and an application form can be obtained from The Home Office, Radio Regulatory Department, Waterloo Bridge House, Waterloo Rd., London SE1 8UA. The completed form should make reference to the PW Sandbanks.



The positive line from the battery has been designated 0V. The other line is therefore −10·5V. Decoupling of the battery supply is provided by C1. Two other supply lines are derived from the basic battery supply.

The first of these, +12V, is generated by an oscillator-rectifier arrangement. A c.m.o.s. ring oscillator based on IC3 runs at about 30kHz. The output is applied to the buffer transistor Tr3 which has an auto-transformer T1 as its collector load. The 50V peak pulses produced are rectified by D1 and smoothed by C6. Regulator IC8 maintains the output at 12V.

It is essential that IC3 is an unbuffered "A" type, since the buffered "B" type will not work in this circuit. No attempt is made to tune T1, as tuning tends to upset the ring oscillator, making it unstable. The circuit is decoupled by R8 and C4, to prevent 30kHz ripple being fed into the amplifiers.

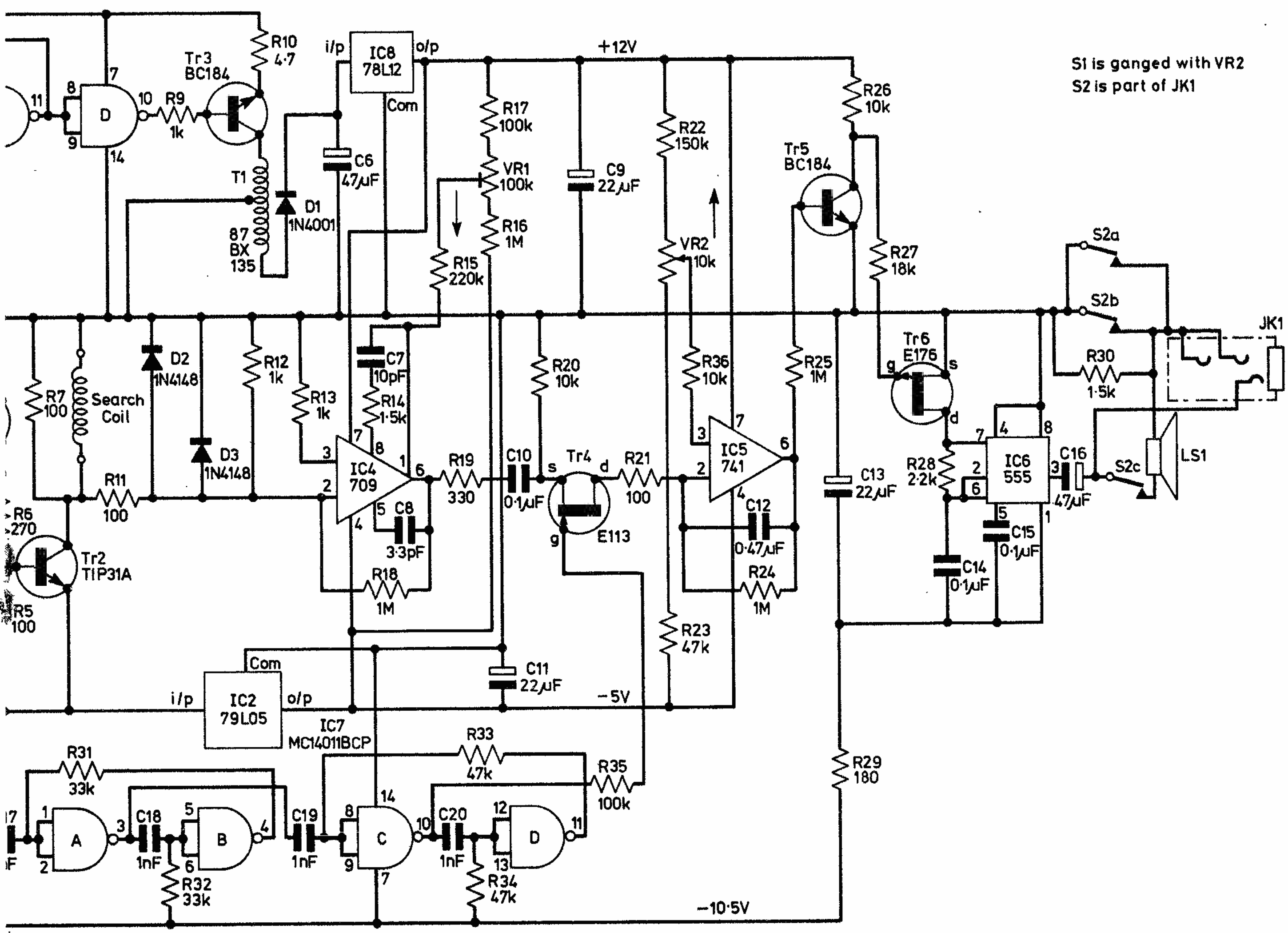
The second derived supply line is a stabilised −5V for the amplifiers. This is provided by regulator IC2.

The signal across the search coil is fed via a clipping network R11, D2 and D3, which limits the voltage swing at the input to amplifier IC4 to ±0·7V, to prevent overloading. The gain of IC4 is set to 10,000 by means of R18, and frequency compensation is designed to provide the fastest response with maximum reliability. The output offset is set by means of VR1.

In order to be able to sample the waveform across the search coil as it reaches 0V, it is necessary to generate a delayed gating pulse. This is done by IC7, which is arranged to form two monostables. The first, IC7a and b, produces a pulse 50μs wide, starting on the trailing edge of the pulse at Tr1 collector. The second monostable, IC7c and d, is triggered by the first, and generates a pulse 75μs wide, which is the sample pulse. This is applied to the gate of Tr4, turning the latter on for 75μs, 50μs after the transmit pulse ends. See Fig. 3.

When the sample pulse is on the gate of Tr4, the source-drain impedance is very low, and the voltage at the output of IC4 is transferred to the input of IC5. For the rest of the period the impedance of Tr4 is very high, and IC4 output is isolated from IC5. The small negative-going pulses are amplified and integrated by IC5/C12 to form a low-rise sawtooth waveform whose d.c. level is proportional to the width of the back-e.m.f. pulse. The output offset of IC5 is adjusted by means of VR2.

The output of IC5 is connected to Tr5 which is a low-gain inverter. When IC5 output is low, the collector of Tr5 is at +12V and Tr6 source-drain impedance is too high for capacitor C14 to charge. When the output of IC5 is high, Tr5 is switched on and the source-drain impedance of Tr6 is low. This allows C14 to charge and IC6 then functions as an



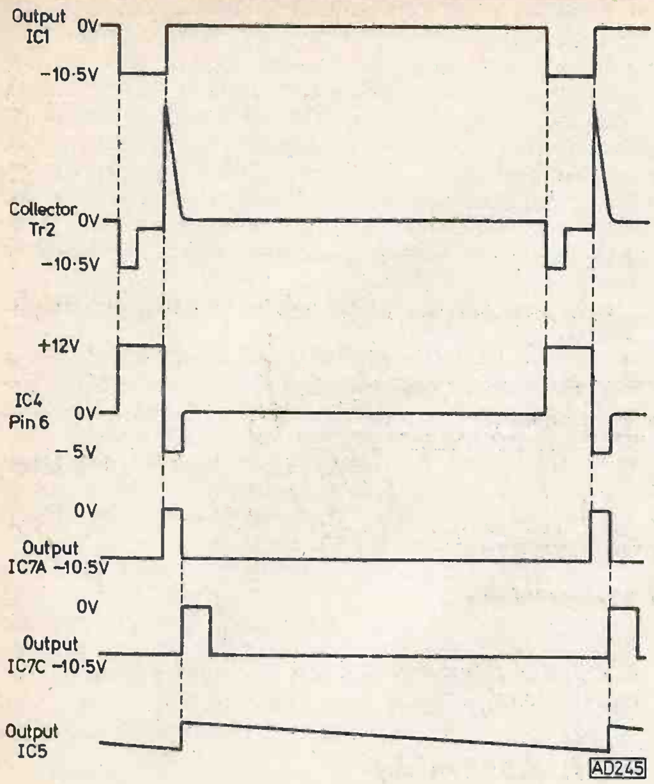


Fig. 3: Timing diagram

audio-frequency oscillator whose frequency is proportional to the amount by which the width of the back-e.m.f. pulse exceeds 50μs.

The oscillator output is applied to the internal loudspeaker, or to headphones when these are plugged into JK1.

Construction

The battery holder should first be assembled sufficiently to provide power for testing. It will be finished when the circuits are built and tested. The top adaptor should be gently tapped into the aluminium tube using a piece of wood as a buffer to protect the pvc from damage. The spade terminal which forms the negative battery connection should then be rivetted to the tube with the special rivet provided. Remove the epoxy coating from the first 15mm of the tube with a Surform tool or file and glue the battery cap holder to the tube with an isocyanoacrylate adhesive such as Cyanolit or Super Glue 3. Stretch the spring so that it is about 50 per cent longer than its original length. It should now slide easily down the tube. Bend the contact plate extensions down at right angles and clip it over one end of the spring. Fold the extensions over the spring to clamp it firmly. Bend out the last 10mm of the spring to cause it to scrape the side of the tube and push it down the tube with the batteries.

The coil is wound from 20 turns of 26 s.w.g. enamelled copper wire in a 200mm diameter circle. The coils should be secured with twists of copper wire, ensuring that they do not form a short circuit around the coil. Do not use adhesive tape for this as the epoxy resin tends to lift it away and then the coils move whilst they are setting. Feed a 2m length of 3-core

★ components

Resistors		
¼W 5%		
4·7Ω	1	R10
47Ω	1	R8
100Ω	4	R5, 7, 11, 21
180Ω	1	R29
270Ω	1	R6
330Ω	2	R4, 19
1kΩ	4	R1, 9, 12, 13
1·2kΩ	1	R3
1·5kΩ	2	R14, 30
2·2kΩ	1	R28
10kΩ	3	R20, 26, 36
18kΩ	1	R27
33kΩ	2	R31, 32
47kΩ	3	R23, 33, 34
100kΩ	3	R2, 17, 35
150kΩ	1	R22
220kΩ	1	R15
1MΩ	4	R16, 18, 24, 25
Potentiometers		
100kΩ min. horiz. preset	1	VR1
10kΩ lin. pot. with d.p. switch	1	VR2/S1
Capacitors		
Polystyrene		
10pF	1	C7
10nF	4	C17, 18, 19, 20
Sub-min Plate Ceramic		
3·3pF	1	C8
Polycarbonate, 100V		
33nF	1	C5
0·1μF	4	C3, 10, 14, 15
0·22μF	1	C2
0·47μF	1	C12
Tantalum Bead, 16V		
22μF	3	C9, 11, 13
Electrolytic, 16V p.c. mounting		
47μF	3	C4, 6, 16
1000μF	1	C1
Semiconductors		
Diodes		
1N4001	1	D1
1N4148	2	D2, 3
Transistors		
BC184	2	Tr3, 5
BC214	1	Tr1
E113	1	Tr4 (or BF256B)
E176	1	Tr6
TIP31A	1	Tr2 (or BD535)
Integrated Circuits		
MC14011CP	1	IC3 (see text)
MC14011BCP	1	IC7
78L12	1	IC8
79L05	1	IC2
555	2	IC1, 6
709	1	IC4
741	1	IC5

Miscellaneous

T1 Toko 87BX135. JK1 Switched stereo jack. PL1/SK1 3-pole connector, Bulgin P632. LS1 8Ω 2 or 2½in. Materials for case, battery holder, shaft, search coil etc. (see text).

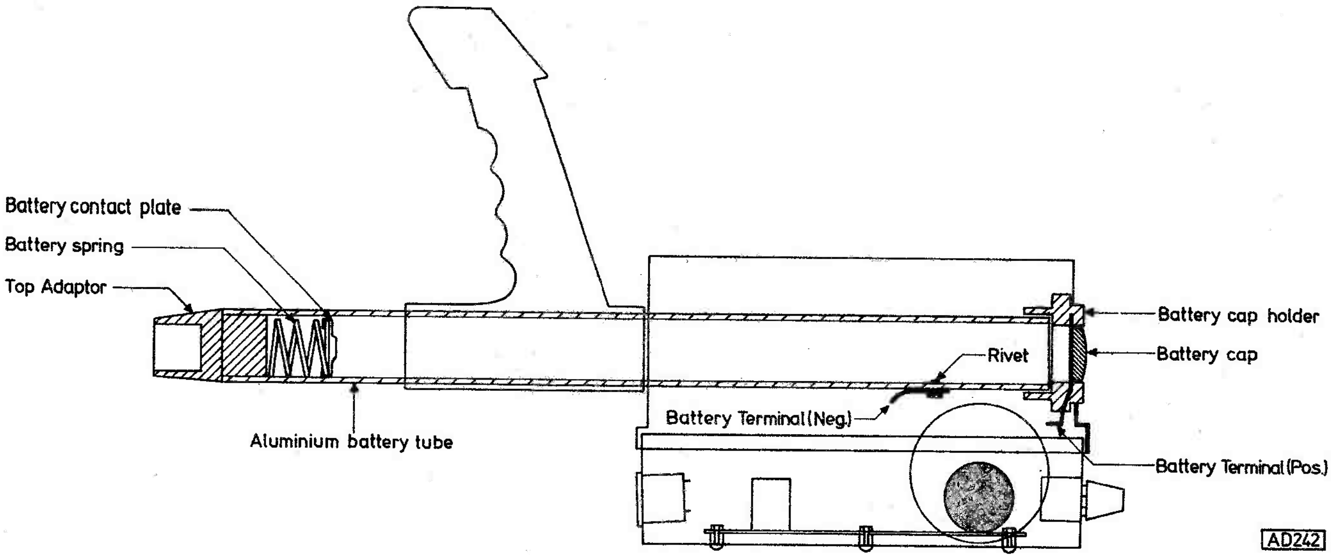


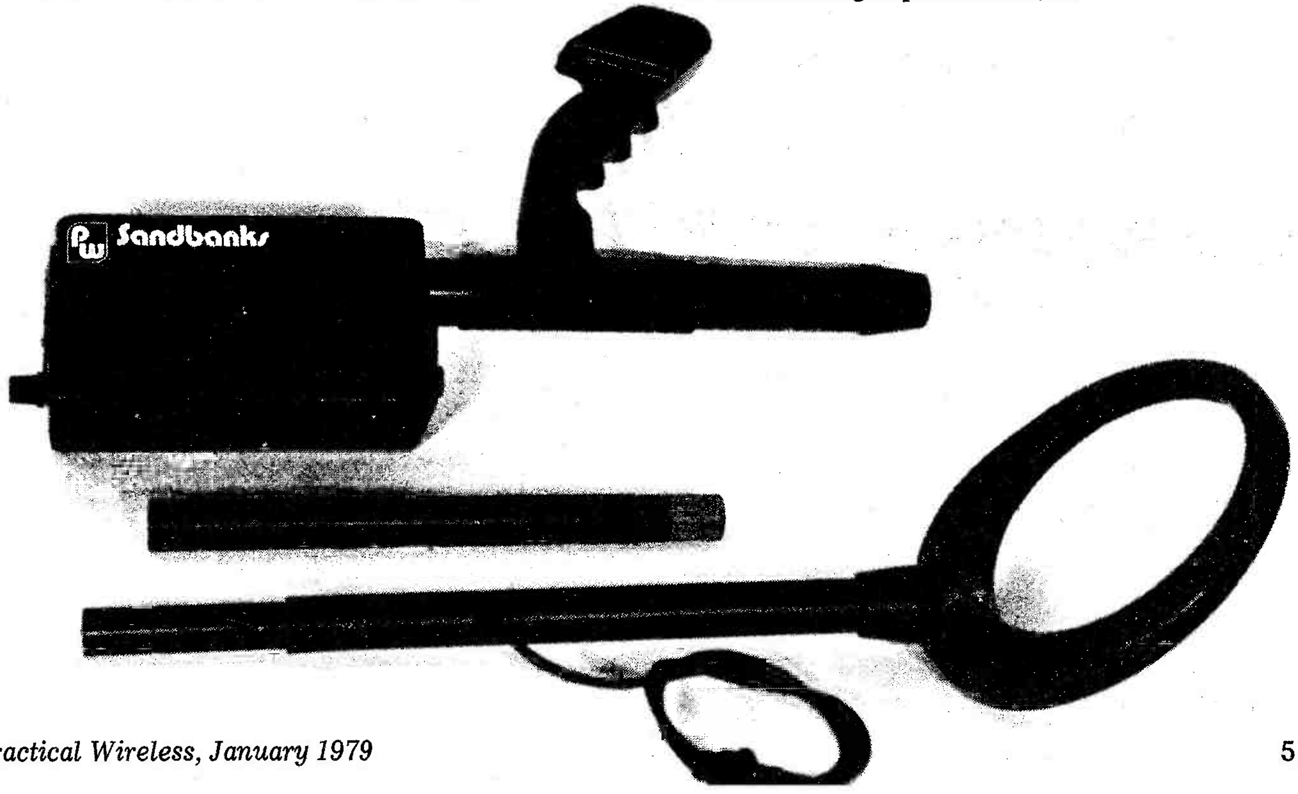
Fig. 4: Details of the case assembly

miniature mains cable into the hole in the side of the bottom tube and out of the machined end. Strip it and solder the blue and the brown to the ends of the coil. Glue the bottom adaptor into the coil with Cyanolit and leave it to set hard.

Place the coil in the moulding and shape it to lie as flat along the bottom as possible, ensuring the minimum resin used and the lightest coil. Seal the wire into the adaptor with Seccomastic to prevent the resin from leaking past the wire. Chock up the moulding until the top surface is horizontal and ensure that it is firmly supported. The epoxy resin in the kit has resin and hardener in one plastic bag, separated by a plastic clip. Remove the clip and mix thoroughly for at least five minutes. Snip off the corner of the bag and carefully pour it over the coil using only enough to cover it. If any resin is spilled, do not wipe it off the moulding as it comes off easily when it is set. Leave to harden for 24 hours minimum. An alternative printed circuit coil is available from Ambit International.

PCB Assembly

Very few of the components are critical but to avoid problems it is advisable to use only new, best quality parts. The circuit has been designed so that a working unit can be set up perfectly using only an Avometer. Due to the complexity of the circuit, it is recommended that each stage is built and tested before progressing to the next. Accordingly a loading sequence is given for each part of the circuit followed by a testing and fault finding guide. Each part of the circuit **must** be working correctly before progressing to the next stage. It is inadvisable to try to build this circuit on Veroboard as the layout is fairly critical, and at least a double-beam 'scope will be necessary for fault finding if problems occur.



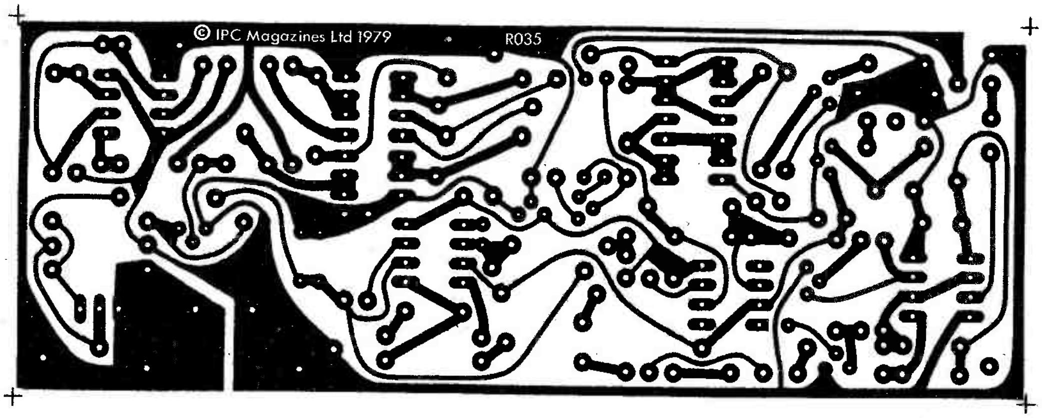


Fig. 5: Foil pattern of the p.c.b., shown full-size

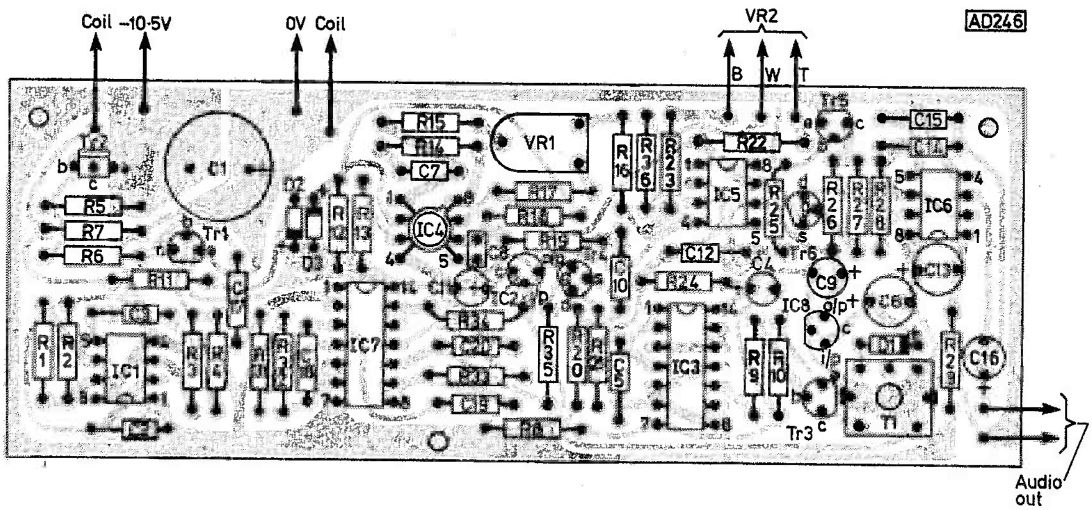
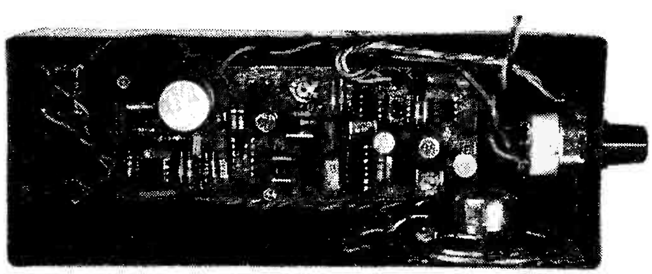


Fig. 6: Component layout on the p.c.b.



Pulse Generator: Load IC1, C1, C2, C3, R1 and R2 Check, crop and solder. Wire the p.c.b. to the battery spade sockets via S1 (part of VR2). Connect the spade sockets to the battery holder terminals. Switch on and measure the output at pin 3 IC1. It should be one per cent of 10·5V, i.e. 105mV. Switch off.

Power Stage: Load R3, R4, R5, R6, R7, Tr1 and Tr2. Check, crop and solder. Switch on and measure the voltage between Tr1 collector and the **negative rail.** It should be the same as IC1 output, i.e. 105mV. Switch off and solder the coil temporarily into the p.c.b. Make up an improvised peak-reading probe for the meter by wiring a 1N4001 diode between the positive test clip and its lead (positive or white end of the diode towards the lead) and a 0·1μF capacitor across the leads. Switch on again and measure the voltage between the collector of Tr2 and 0V (meter negative to 0V). This can be anything between 12V and 50V, this being the peak back e.m.f. voltage. Switch off.

Want to know more about metal detectors and how to use them? Read our special feature on page 35.

Minus 12V Supply: Load R8, C4, C5, IC3, R9, R10, Tr3, D1, C6, IC8, C9 and T1. The usual precautions must be taken while handling the c.m.o.s. IC3. Damage may result if a static charge is applied to its pins. Check, crop and solder. Switch on. The output of IC8 should be +12V. If it is not, check that R8 has at least −7V on it and that pin 10 of IC3 has half of the voltage at R8. If not, then the i.c. is suspect. If so, then check the positive end of D1 which should have more than +15V on it. If not, suspect Tr3. Switch off.

Minus 5V supply: Load IC2 and C11. Switch on and measure the output of IC2, it should be −5V. Switch off.

Amplifier: Load R11, D2, D3, R12 to R19 inclusive, C7, C8, IC4 and VR1. Check, crop and solder. Move the coil away from any metal and turn on. Adjust VR1 to give an output voltage of +0·5V on pin 6 of IC4. Move the coil to a large piece of iron and the voltage should go up to 0·7V or so.

If the output cannot be set to 0·5V then check the voltages on pins 2 and 3. They should be nearly the same at 0V. If not, fit a new 709. If they are correct solder a 100kΩ resistor across R15 and check that the 709 output can be adjusted. If not, fit a new 709 but if so, replace R15 with the largest resistor that will allow the output to be adjusted from rail to rail. Set the output to +0·5V and switch off.

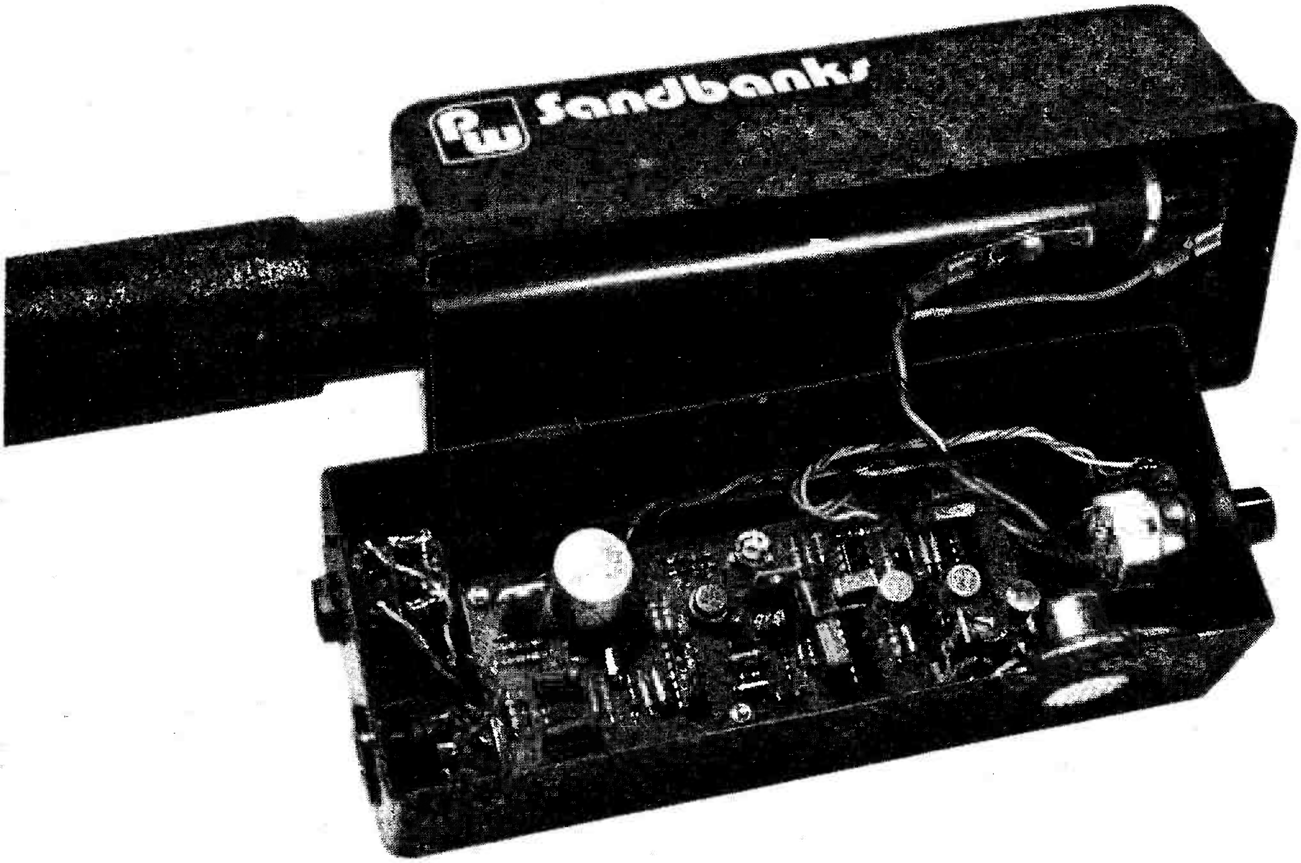
Sample Pulse generator: Load C17 to C20 and R31 to R35 inclusive. Ensure that IC7 is a buffered type and insert it carefully. Check, crop and solder. Switch on and try to measure the output of IC7 at pin 10. As the waveform is a square wave of duty cycle 0·1 per cent the voltage should be very close to −10·5V. Switch off.

Sample Circuit and Integrator: Load C10, Tr4, R20 to R24 inclusive, R36, C12, IC5 and wire up VR2. Check, crop and solder. Switch on with the meter between pin 6, IC5 and 0V. Move the coil away from metal and set VR2 so that the output is about 0V. Move the coil near metal and the voltage should rise to almost +12V. If the output cannot be set to 0V measure the input voltages on pins 2 and 3. Pin 2 should be slightly negative and pin 3 should be adjustable to either side of it. If the voltages are wildly out suspect IC7. If they are very near, alter the value of R22 or R23 to bring the range of VR2 to the correct point. Switch off.

Buffer and VCO: Load R25, Tr6, Tr5, R26 to R29 inclusive, C13 to C16 inclusive, IC6 and wire temporarily to the speaker. Check, crop and solder. Switch on with the coil away from any metal. Ensure that with VR2 right down the speaker is silent, and with VR2 right up and the coil near metal, the tone is at its highest pitch. This can be adjusted slightly by altering VR1, keeping the output of IC4 within the limits of 0V to +0·5V.

Final Assembly

When the circuit is working correctly, fix the coil plug PL1, jack JK1 and potentiometer VR2 into the bottom tray, and leave flying leads from the p.c.b. Mount the p.c.b. from 3 screws through the case with suitable spacers, and solder the leads to PL1 and JK1



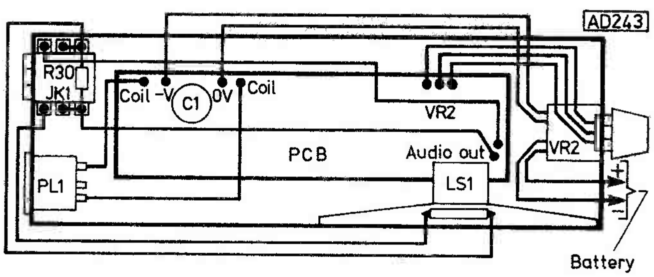


Fig. 7: Wiring details for the case assembly

as shown in Fig. 7. Solder R30 across the jack and glue the speaker into the case with Evostik. Slide the battery tube through the top half of the case and glue the battery cap to the case with Cyanolit. Cement the tube to the inside of the case and the battery cap to the case with ABS cement. Fit the bottom half of the case into position and drill 4 holes for self-tapping screws, avoiding the speaker.

Assemble the complete detector and wind the lead from the search coil around the shaft as shown in the photographs to keep it tidy. Cut the lead to a suitable length, then strip it and connect it to the free socket SK1.

Alternative cases

As mentioned previously, this circuit can run from a supply between 9V and 12V without modification, so the battery used is up to the builder. A PP9 will last up to 15 hours, HP2s up to 80 hours and MN1300s up to 200 hours. Should the constructor decide to build his own case then a visit to the local builders' merchant will secure most of the necessary items for the shaft and handle.

The coil should be wound as detailed but it could be glued to a piece of glass fibre p.c.b. material with all of the copper etched away. The coil must be rigid and waterproof so it is best to cover it with Araldite. The shaft and handle can be made from ¾in water-pipe but the best material in ¾T which has a thick wall suitable for threading. There are a number of proprietary brands of case available to house the electronics. The part of the shaft nearest the coil **must** be non-metallic.

In use

Whether you use a kit or make your own, the way to use the machine is exactly the same. Best results will be obtained when the user has experience with his machine.

Switch on and turn up the control until the speaker is at its highest pitch. Back the control off until the speaker has just stopped clicking. If the control is set too close to the quiet point then as the coil changes direction through the magnetic field of the earth, it will give an output, so set it back just a fraction more. The best point will be found with lots of practice.

If you are sure there is something to detect and know roughly where it is then the machine can be set with the speaker just clicking at about 1Hz. Search very slowly and listen for a change in the rate of clicking. The machine is at its most sensitive at this point. When you are very familiar with your machine you may wish to alter the value of C14 to 47nF which increases the sensitivity to small objects but makes the control more critical. ●

Follow-up to PW 'purbeck' OSCILLOSCOPE

Dick Ganderton

The *PW* Purbeck oscilloscope probably rates as the most complex project published in this magazine for some time, and as such it is only to be expected that there would be some problem areas to be ironed out.

Although several errors and omissions occurred during the six months the series ran, as far as we know only one 'catastrophic' error occurred and the author has built another model using the kit of parts supplied by Watford Electronics and following the instructions published to the letter. I understand that this instrument failed to work first time due to errors in his work, not in the text. Clearing these faults allowed the scope to work perfectly. This should give renewed heart to constructors who found that on switch-on their scope also failed.

In this article I will try to cover those points which, if readers' letters are anything to go by, have given the most problems.

Y Input Low

By far the largest number of queries received have asked the question, 'where does pin 8 board 3 go to?' Both the author and myself thought that the description 'Y Input Low' would be understood by everyone. Well, we were both proved wrong. The term 'Y Input Low' refers to the low side of the Y signal input. Now the next problem arises with the very high bandwidth of the 'Purbeck'. The scope will look at signals at 21MHz, at a reduced trace height of course, and at this sort of frequency you have to watch out with earthing arrangements. This means that the Y amplifier input low side must be taken right back to the Y Input socket on the front panel to avoid picking up any unwanted currents passing along the other earthing connections.

Ground Planes

This also accounts for the author's use of Ground Planes on the X and Y amplifier boards.

This technique baffled a few readers, but is really quite simple to use as far as construction is concerned. However, it is vital that the wiring layout shown is followed closely. If you choose to ignore it then you will almost certainly have instability problems. It is also vital to ensure that the components are firmly pushed against the copper side of the p.c.b. and that the wire connections are also made cleanly and as close to the board as possible. The use of i.c. sockets is also taboo, so obviously care will have to be taken when soldering to the i.c. pins.

Power Supplies

After the Y Input Low problem the next most common difficulty was with the power supplies. Here there are several different problems which, if more than one of them occurs in a supply compounds the troubles.

The transformer specified was specially designed for this project by Barrie Electronics and no design details have been given to avoid the possibility of constructors using a transformer with unsuitable characteristics. The way in which the winding resistances are distributed is of vital importance in this instrument and so it was decided that only the Barrie transformer would be specified.

Unfortunately the transformer supplied by Watford Electronics with their kit does not meet the original specification with regard to winding resistances and so if you are using a Watford tranformer you will need to make several modifications to the power supply boards.

If you measure the '250V' output of a Watford transformer on load you will find that it is only about 235V. As this is the input to the tripler circuit it is obvious that the 15V loss becomes 45V at the tripler output. To compensate for this R103 should be replaced by a shorting link and also R101 should be reduced to around 120Ω (still 5W wire wound).

It must be stressed that these changes must only be carried out if you are using a Watford transformer. If you have the correct Barrie transformer then these resistor values must be left as originally specified.

Watford have told us that they will be supplying a correctly specified transformer with future kits and that these will have a 220V extra primary tap, as on the Barrie version. This will probably be the only means of identification between the two types.

Stabilisers

The −800V stabilised supply proved to be a problem, with several readers not being able to achieve the full output. Assuming that you have 250V going into the tripler then if you cannot get −800V at pin 7 of board 1 the first thing to check is the voltage across each of the five BZX61C160 zener diodes. If you find that one or more are below the nominal 160V then you can reduce the value of R104 until −800V is achieved. If the voltage across any of these diodes is zero or very low then the diode is faulty and should be changed.

The +150V stabilised supply also gives some trouble, especially if you like to test each circuit as you build it. The author designed this regulator to cope with short circuit conditions but forgot the open circuit conditions. If the supplies are tested off load then the +300V raw supply rises to around +370V and the voltage across R203 rises to around 220V with the result that it can no longer cope with the power and overheats. The answer is to replace R203 with a small wire wound type and replace D201,202 with BZX61C75 types. This will allow the supply to cope with open circuit conditions for a reasonable length of time.

With correct voltages at the outputs of the power supplies we can turn to the more exciting parts of the instrument.

Amplifiers

The two amplifier boards have been discussed earlier in this article in general terms but there are several points to note if problems arise.

If you have any form of instability in the Y amplifier, which will show up as an unwanted trace on the screen, the first thing to check is that you have followed the wiring layout and have not missed out any connections or joined up the wrong pins. If the board is correct then check your earthing system. Note particularly that Pin 8 Board 3 goes direct to the tag under the Y input socket on the front panel, that the third (ground plane) flying lead at the end of the board opposite to the edge connector goes via a short length of wire to a tag under the clamp holding C20 to the chassis and that the paint is cleaned away to bare metal at each earthing point.

The resistors and chokes fitted into the flying leads from the X and Y amps to the tube plates must be mounted as close to the boards as possible and kept separate from each other.

If you still have instability occurring make another check on all your wiring.

It has been found that in some cases the LM304 regulator oscillates feeding a saw-tooth waveform down the supply rails. The cure is to add a 400pF polystyrene capacitor to Pin 4 of IC304 and ground.

Voltages at various points on the Y amp. are given in Table 1 and these should help with fault finding. The trace should be centred and a 20kΩ/V meter used for measuring the potentials. To avoid instability in the Y amp. a 10kΩ resistor should be inserted in each test lead when measuring the Y output voltages.

The X Amp. seems to have given a lot less trouble than the rest of the scope but Table 2 gives d.c. potentials at various points. As a large part of this board is digital in nature then it is a simple matter to check potentials at the input and outputs of the various gates.

If you have had trouble in getting the trace length down to the specified length of 10 divisions R434 can be increased until it is possible to adjust the trace length with VR408 to just below or above 10 divisions.

The 'catastrophic' error occurred on Board 4 and concerns the omission of a connecting wire from the junction of R424,425,426,427 to the collector of Tr404. Without this wire there is no +12V on the resistor-pot. network associated with S401.

Several readers have commented on the slow action

TABLE 1

Y Amplifier d.c. potentials.	
IC301 pins 7, 8	+2·3V
IC301 pins 1, 14	−1·3V
Tr305, 306 emitters	+1·6V
R330, 331, 333 junction	−6·8V
Y_1, Y_2 outputs	+63V
C306	+120V
Total current from +150V supply	30mA

(All voltages measured with trace central, all supplies correctly set and using a 20kΩ/V meter.)

TABLE 2

X Amplifier d.c. potentials.	
Edge connector pin 19	+5V (Timebase in Cal. position.)
Tr411, 410 emitters	+4·5V
Tr408, 409 emitters	+0·4V
Tr407 emitter	−6·8V
X_1, X_2 outputs	+78V
Total current from +150V supply	20mA

of the brilliance control and the slight drift in the vertical position of the trace after operating the vertical shift control. The first effect is normal and one just learns to live with it. The second is caused by thermal changes in the Y Amp. output stage transistors. Increasing the size of heat sink on these and adding heat sinks to Tr305,306,307 and 308 will help to reduce the drift. By the way all these transistors run very warm in normal use. If the flyback trace is visible it is more than likely that you have the brilliance too high.

Front Panel

A couple of minor errors crept into the front panel wiring drawing in the third part of the series. Section B of S4 should go to Board 4 Pin 18. The Trig. level pot. VR1 is connected between +12V stab. and −12V stab., the annotation slipped down slightly on the drawing board. VR4 should be connected to −6V via a 680Ω resistor (instead of ground), to give equal swings on Ext. X in.

The case work should prove quite straightforward as those readers who have used the Bazelli case will have most of the work already done while it is probably fair to assume that those who decide to make their own case will at least know how. For those who do make their own case the transparent overlay is still available from the editorial offices at £2·25 including p&p. This overlay also has a fine photographically reproduced graticule, available separately at 60p including p&p, and has been in service now for over nine months on the author's scope without any ill effects.

No drawings were given for the drilling of fixing holes in the back and bottom panels as these are marked using the boards and components themselves. Remember to clean back the paint at all the earthing points.

Brackets

The small brackets shown in the last part are simple to make. A couple of errors crept in on brackets (a) and (c). In bracket (a) the length of the

Continued on page 58

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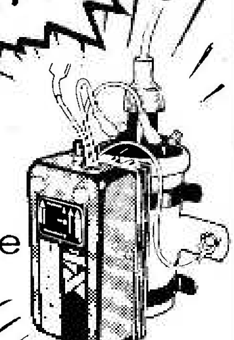

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PW Purbeck Follow-up Continued from page 56

longer arm should be 100mm while in (c) the distance between the two large holes should be 38mm at 16mm from the bottom edge.

The mu-metal shield around the tube neck is not connected to ground—or earth or 0V, as it is only needed for magnetic shielding.

The PW Purbeck offers the home constructor the opportunity to build and use a scope with a performance which is comparable to many commercial instruments selling at a much higher price. With the capability to display waveforms, at reduced amplitude, up to 21MHz the constructor has an oscilloscope which should prove to be very useful.

In conclusion I would like to thank all those readers who have written to me or the author with their problems. This feedback has helped us to sort out most of the problems as well as showing us that this project has been very well received.

For readers who have access to another oscilloscope a sheet showing waveforms at various points of the X Amplifier board is available, on receipt of an s.a.e. from the editorial offices, Practical Wireless, IPC Magazines, Westover House, West Quay Road, Poole, Dorset. ●

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Digital Audio Amplification

Pulse-width modulated (Class D) amplifiers were born and died in the sixties. Gordon J. King discusses the techniques and the problems involved, and the recent revival of interest in the Far East.

PW WINTON STEREO AMPLIFIER OF THE FUTURE

F.M. RECEIVERS
DEVICES & CIRCUITS
PART 1

M. J. DARBY

Well-designed frequency modulation receivers can provide high-quality reception, with a lower noise component than that obtained with amplitude modulation. Although narrow bandwidth f.m. transmissions are used for special purposes, good quality f.m. broadcasting demands a wide bandwidth, typically 300kHz, and this cannot be practically accommodated unless a very high frequency carrier wave is employed. An internationally agreed band between 88 and 108MHz has therefore been allocated for the purpose.

General Propagation Conditions

Transmissions at v.h.f. suffer little reflection in the upper atmosphere and are therefore normally only received at places of virtual line-of-sight distance from the transmitter. This factor may be something of a frustration to the DX enthusiast, but offers the advantage of being reasonably free from interference by other stations. Only under exceptional circumstances of atmospheric disturbance does the v.h.f. signal travel longer paths, and these "openings" will be readily apparent when they do occur.

Noise Levels

In the case of v.h.f. stereophony, using f.m. techniques, a greater signal bandwidth is required than would be the norm for an equivalent monophonic channel. However, the wider bandwidth necessary for stereophony results in an inferior signal-to-noise ratio, the degradation being in the order of 20dB. Consequently, if one is not prepared to install a quality aerial of high gain or if one is unfortunate enough to live in a particularly difficult area, then the choice may have to be made between a noisy stereo signal or more reasonable monophonic reception.

A further reduction in the noise levels of f.m. receivers is achieved by the use of h.f. pre-emphasis at the transmitter and subsequent de-emphasis within the receiver. The higher audio frequencies are therefore transmitted at an increased amplitude and reprocessed when reaching the receiver until the overall response is level at all frequencies. Any noise in the aerial or early stages of the receiver will take the form of a hiss, and the majority of this energy will therefore be at high audio frequency. This is

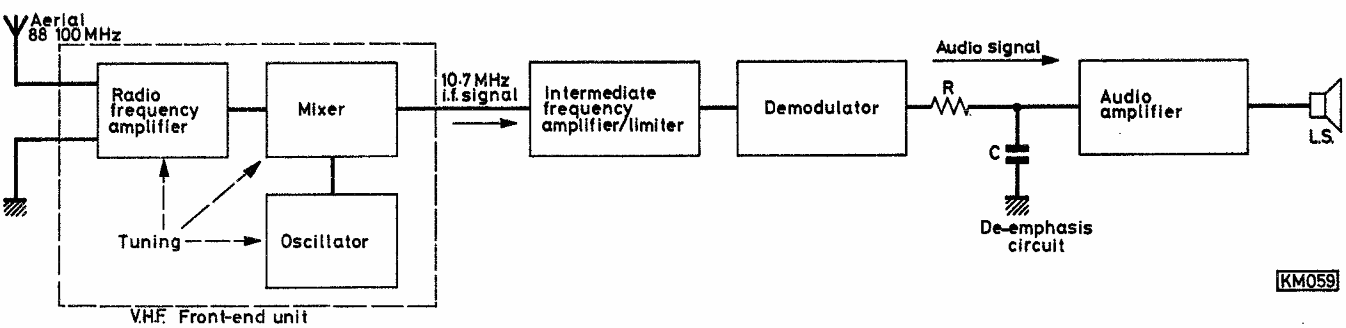


Fig. 1: Block diagram of a full monophonic f.m. receiver

ultimately attenuated by the resistance/capacitance filter which forms the de-emphasis circuitry within the receiver.

Certain overseas stations use proprietary noise-reduction systems, such as that developed by Ray Dolby. Some tests with Dolby were conducted in the UK by the IBA a short time ago, but as yet no definite steps towards adopting the system appear to have been taken. Many of the small radio stations in the United States have opted to use Dolby, however.

Frequency modulation has many other bonuses to offer, one of which is that it enables a considerable reduction in noise level to be obtained. Noise generated by vehicle ignition systems for example, is to a large extent amplitude modulated and receivers may be so designed to afford a high level of rejection, typically 45 to 65dB, to the a.m. signal.

Although the technology to broadcast stereophony on medium frequencies using a.m. (PW, March 1978, page 813; April 1978, page 891) has been around for some time, at present the sole source of regular stereophonic broadcasts is within Band 2, 88-108MHz and is invariably f.m.

Basic Receiver

In a typical f.m. receiver, the v.h.f. signal is converted to a conventional i.f. of 10·7MHz. All high-quality receivers employ superheterodyne principles due to the difficulties involved in direct amplification at these frequencies and the problem of obtaining an acceptable degree of selectivity.

The basic circuit of an f.m. monophonic receiver is given in Fig. 1. A front-end unit amplifies the incoming signal and converts it to the 10·7MHz intermediate frequency. Importance is given to the fact that the incoming signal should be amplified before the i.f. stages. Frequency changing mixer circuits are inclined to add more noise than a good amplifying stage. If this technique is employed, the signal will normally be appreciably larger than the noise added by the mixer.

The three stages of the front end must be tuned in such a way that the difference between the incoming signal, irrespective of its frequency, and the oscillator is 10·7MHz. This, of course, is the intermediate frequency.

Tuning can be carried out either with a conventional air-spaced tuning capacitor or by a variable-capacitance diode ("Varicap"). In the latter instance, frequency variation is achieved by altering the diode capacitance. This is most usually done by slight adjustment of the voltage via a potentiometer.

From the front end, the 10·7MHz signal is passed to the amplifier/limiter, which consists of circuitry designed to tailor the response to the correct characteristics. Early receivers used tuned circuits for this purpose, but the modern approach is to employ ceramic filters, which require no alignment and provide good selectivity and frequency response.

The limiter circuit controls the amplitude of its output within a constant positive and negative peak range. All the signals from the limiter therefore have the same amplitude and this greatly reduces the effects of any amplitude modulation which may also be present as a spurious signal.

The limited signal is then demodulated; this means it is converted into an audio signal. The latter is passed through a simple de-emphasis filter connected as shown in Fig. 1 and hence to an audio amplifier and loudspeaker. In Europe the de-emphasis time constant is 50μs, whereas in the USA it is 75μs. This means that in Europe the product of R and C of the filter in Fig. 1 must be 50μs or thereabouts, for example, R may be 12kΩ and C 3·9nF or alternatively R may be 4·7kΩ and C 10nF.

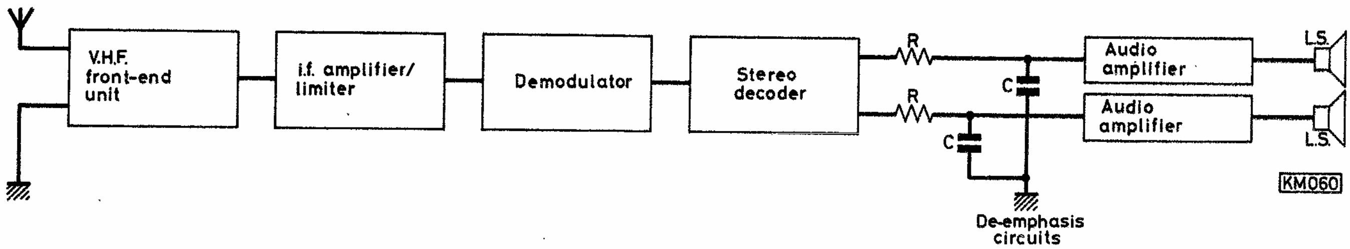


Fig. 2: A full stereo receiver block diagram

Stereo

A block diagram of a stereo f.m. receiver is shown in Fig. 2. Note that, unlike the monaural receiver of Fig. 1, no audio filter for de-emphasis follows the demodulator circuit. Two separate audio de-emphasis filters are required after the stereo decoder, the component values being calculated as indicated previously.

We will now look at the various parts of typical f.m. receivers in more detail, but only modern circuits will be covered using integrated circuits for simplicity.

The front end

The components in the front end of an f.m. receiver operate at frequencies of the order of 100MHz. At such frequencies the placing of components and the lead lengths can be very critical, so it is not especially easy for the home constructor to build a front end using either discrete components or one of the relatively few integrated circuits which have been made available for this application.

Commercially manufactured front end units are readily available, completely enclosed in their screening metal, providing the constructor with a simple way of avoiding problems associated with home construction, such as radiation from front end to a.f. amplifier, etc. The use of a commercially made front end unit makes the construction of an f.m. receiver somewhat easier than the construction of an a.m. receiver. Both ganged-capacitor tuned types and varicap tuned types are available, but the latter are now more commonly used by constructors. However, the

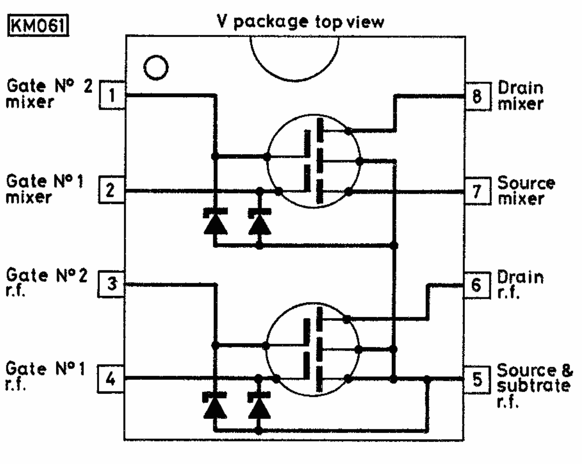


Fig. 3: Connections and internal circuit of the SD6000

use of a varicap tuned front-end involves slightly more complex circuitry, since a regulated voltage supply is essential for the tuning system. The tuning control in varicap tuned receivers is a multi-turn helical potentiometer (such as the Beckman Instruments 10-turn miniature type 7276) or a long linear potentiometer. The use of such varicap tuning systems reduces the mechanical problems associated with ganged capacitor tuned front-ends which must be provided with some form of a pointer and with a no-backlash slow motion drive. A varicap front-end can be placed where convenient, but a ganged capacitor tuned front-end must be placed in such a position that the tuning control is conveniently on the front panel.

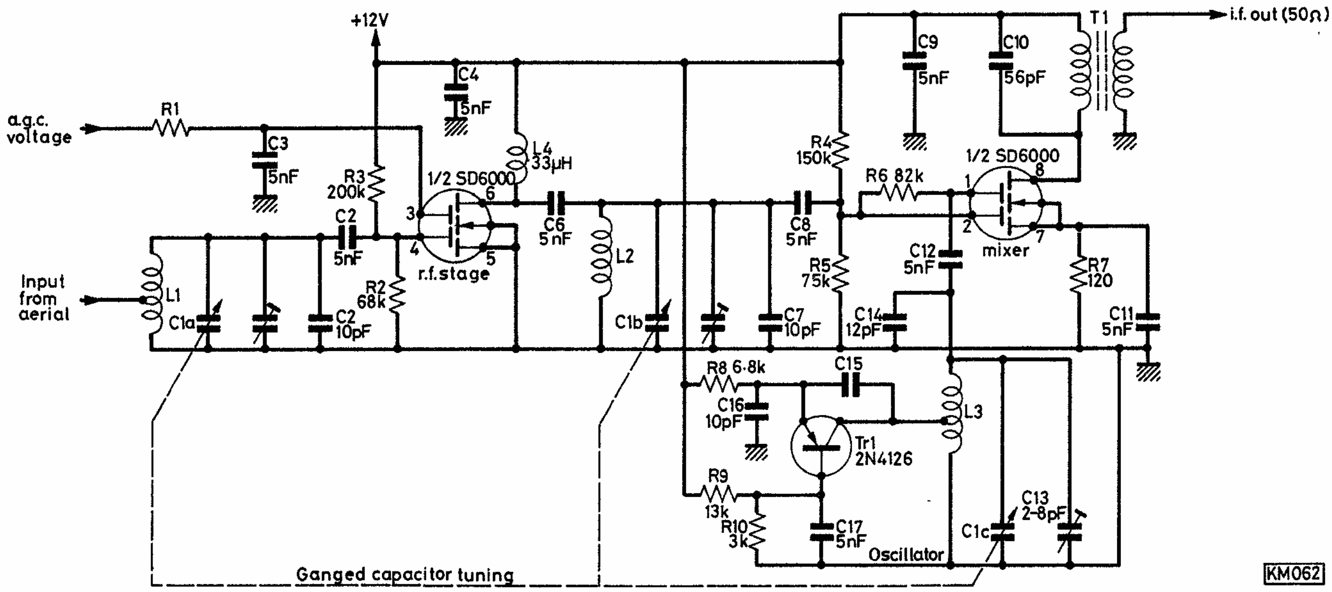


Fig. 4: Typical front end circuit using capacitor tuning

Front end Chips

At the present time only two integrated circuits are readily available for use in front-ends. These are the Signetics SD6000 and the AEG-Telefunken type TDA 1062.

The SD6000 device is encapsulated in an 8-pin dual-in-line plastic package with the connections shown in Fig. 3. It contains two Diffused Metal Oxide Silicon (D-MOS) field effect transistors for use as the signal frequency amplifier and mixer. In addition, this device contains four Zener diodes one of which is connected in the circuit of each gate electrode to protect the D-MOS devices against breakdown by the accumulation of electrostatic charge. If stray charges produce more than a certain voltage across one of the gate protecting Zeners, the Zener conducts the charge to the substrate and thus protects the D-MOS device against breakdown of the thin silicon dioxide layer by an excessive voltage.

A ganged capacitor tuned circuit using the SD6000 device is shown in Fig. 4. The signal from the aerial is fed to the aerial tuned circuit comprising L1, C1a and a small trimmer in parallel with C2. This signal is applied through a 5nF capacitor to the gate of the r.f. amplifier at pin 4 of the SD6000; a suitable bias is also applied to this device by means of the voltage divider of R2 and R3.

An automatic gain control voltage may be fed through R1 to the second gate of the r.f. stage at pin 3. As shown in Fig. 5, this voltage can provide a range of gain of 50dB, the gain decreasing as the bias falls from about +8V to 0V.

The output signal from the r.f. stage is developed across the choke L4 and is coupled through C6 to the r.f. tuned circuit comprising L2, C1b, C7 and the small trimming capacitor. It is then coupled by C8 into pin 2 of the SD6000 which is the input gate of the mixer section; R4 and R5 provide a suitable bias voltage to this gate.

A 2N4126 pnp transistor is used as an oscillator stage, this stage being tuned by L3, C1c and the trimmer C13. The oscillator voltage is coupled by C12 into gate 2 (pin 1) of the SD6000 mixer stage. The output from the mixer appears across the primary of T1 which is resonant at 10·7MHz. The secondary

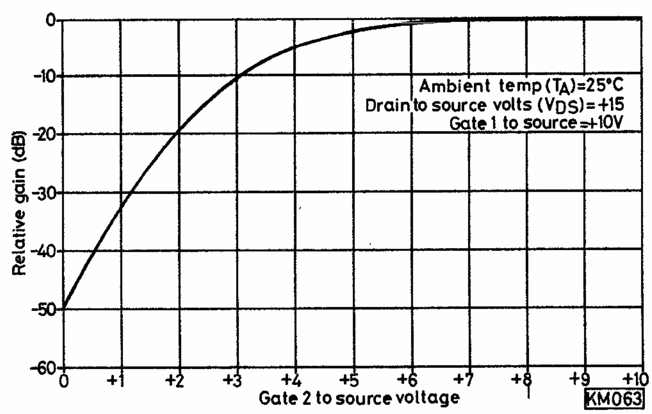


Fig. 5: Link between gain and bias level in the SD6000

of this transformer is a 50 ohm coupling winding which provides the output to the I.F. stages.

The SD6000 circuit shown can provide very low noise (noise factor about 3dB at 100MHz) and a power gain of some 30dB or more. The use of the second gate of the mixer for the oscillator voltage enables very high isolation of this oscillator frequency from the input to be obtained and prevents frequency pulling of the oscillator signal.

The TDA 1062

The TDA 1062 front-end device can be used at frequencies of up to 200MHz and is available from several suppliers. This monolithic device includes an r.f. amplifier, mixer, oscillator, a.g.c. amplifier and a voltage stabiliser on one chip, so represents a complete v.h.f. front-end.

The device itself requires a supply voltage of between 9 and 15 volts at a typical current of 30mA. A particular feature of the circuit shown in Fig. 6 is the use of BB104 double varicap diodes for tuning without any parallel trimming capacitors. This keeps the minimum capacitance very low and allows the frequency range of 88 to 108MHz to be covered with a tuning voltage of only 2V (minimum) to 7·5V (maximum).

coil L3 and the BB104 back-to-back diodes marked D2. The signal is magnetically coupled from L3 to L1, the centres of these coils being 1·3cm apart. The tuned circuit of L1 and D3 is coupled by L2 to the mixer input at pin 4.

The output from the mixer passes through an internal low-pass filter to the output at pins 13 and 14 and hence to the 10·7MHz output tuned circuit of L8 and L9. The oscillator circuit is connected by the coupling coil L6 to pins 1 and 16. The oscillator tuned circuit itself consists of L5 and the BB104 tuning diodes D4. The TDA 1062 contains an internal voltage stabiliser circuit which powers the oscillator and mixer and greatly assists thermal stability.

The output signal from pin 13 is also used to provide automatic gain control. This signal is coupled through the 10pF capacitor to the junction of the two 1N914 diodes which rectify it and develop a positive voltage across the 4·7nF capacitor which is proportional to the i.f. output signal. This positive voltage

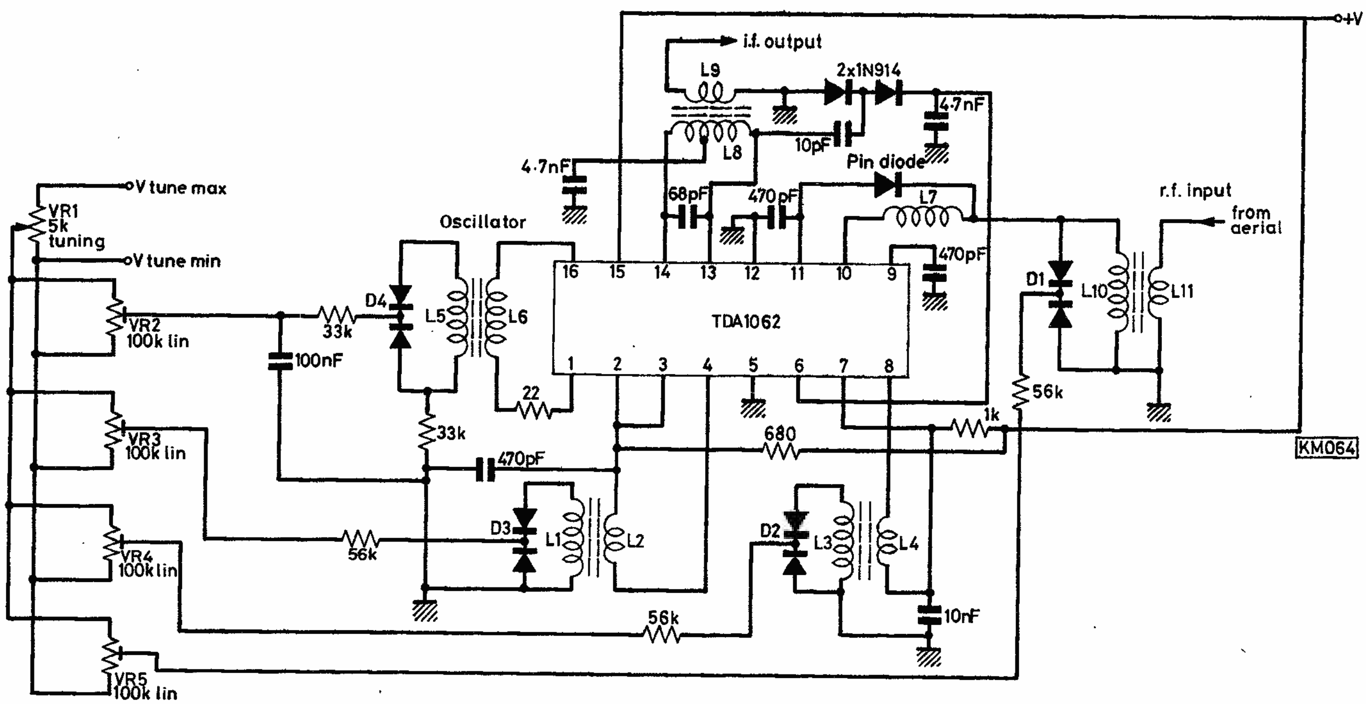


Fig. 6: A complete varicap-tuned receiver using the TDA 1062: max. tuning voltage should be 7·5V and min. 2V (regulated). Trimmers VR2-5 are adjusted for optimum tracking

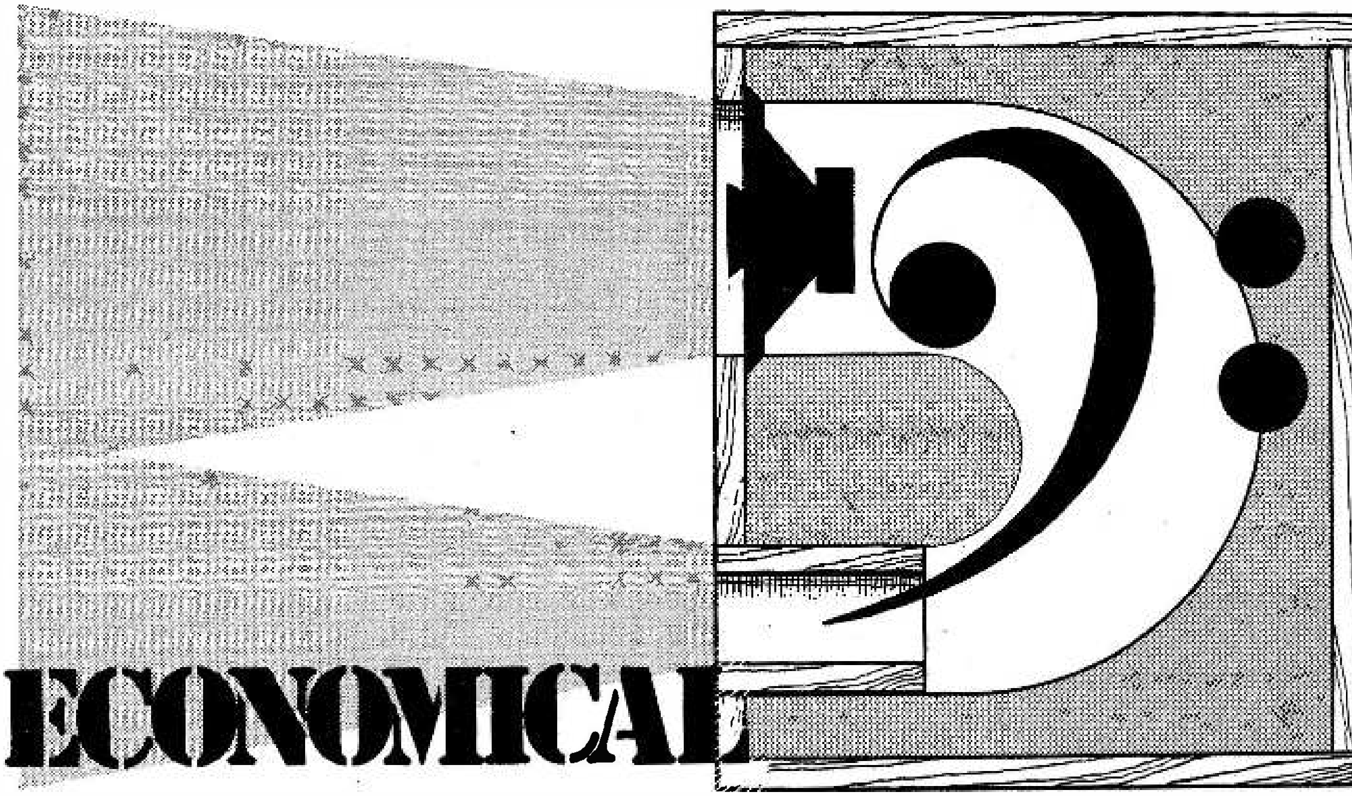
The circuit of Fig. 6 provides a power gain of typically 30dB. The typical noise figure of 5·5dB is not quite as good as that quoted for the SD6000 circuit, but is better than that of many commercially produced front-end modules. The signal frequency bandwidth is about 1·7MHz and the intermediate frequency bandwidth about 500kHz. The three signal frequency tuned circuits provide an image rejection of some 80dB, whilst the i.f. rejection is about 100dB.

The signal frequency input is coupled by L11 to the tuned circuit consisting of L10 and the BB104 diodes marked D1. The signal then passes through L7 to the radio frequency amplifier input at pin 10. The output from this amplifier appears at pin 8 and is coupled by L4 to the tuned circuit comprising the

is fed to the input of an a.g.c. amplifier at pin 6 and the output of this amplifier at pin 11 is used to feed the p-i-n diode which provides the required a.g.c. voltage to the input at pin 10.

Next Instalment

This article has considered general points about f.m. receivers and has covered some front-end circuits using i.c.s. The output from the front-end unit (no matter whether it is a commercially manufactured front-end or a home constructed unit) must be fed into a suitable intermediate frequency amplifier. The next article will deal with various i.f. amplifier circuits.



ECONOMICAL LOUDSPEAKER REFLEX ENCLOSURE

E.M.Parratt BA

Anyone with an interest in good quality audio is likely to be interested in efficiency, especially at the "business" end (the speakers) which represents the final interface with the listener. Much has been written about the advantages of particular speaker and enclosure types, and it is now common knowledge that the infinite (closed) baffle needs the greatest drive, the reflex much less, and the horn hardly any at all, but designs utilising a redundant fireplace as the exit of an underfloor horn leave a lot to be desired in terms of portability.

Specification of Prototype Enclosure

System type: bass reflex ("loaded port")
Enclosure volume: 50 litres (3000 cu. in) each unit
Overall dimensions: height 622mm, width 444mm, depth 256mm
Drive unit: Elac 8NC298—impedance 8Ω, twin paper cone, power handling 15W r.m.s.
Frequency range: 40Hz–18kHz ±3dB.

Choice of System

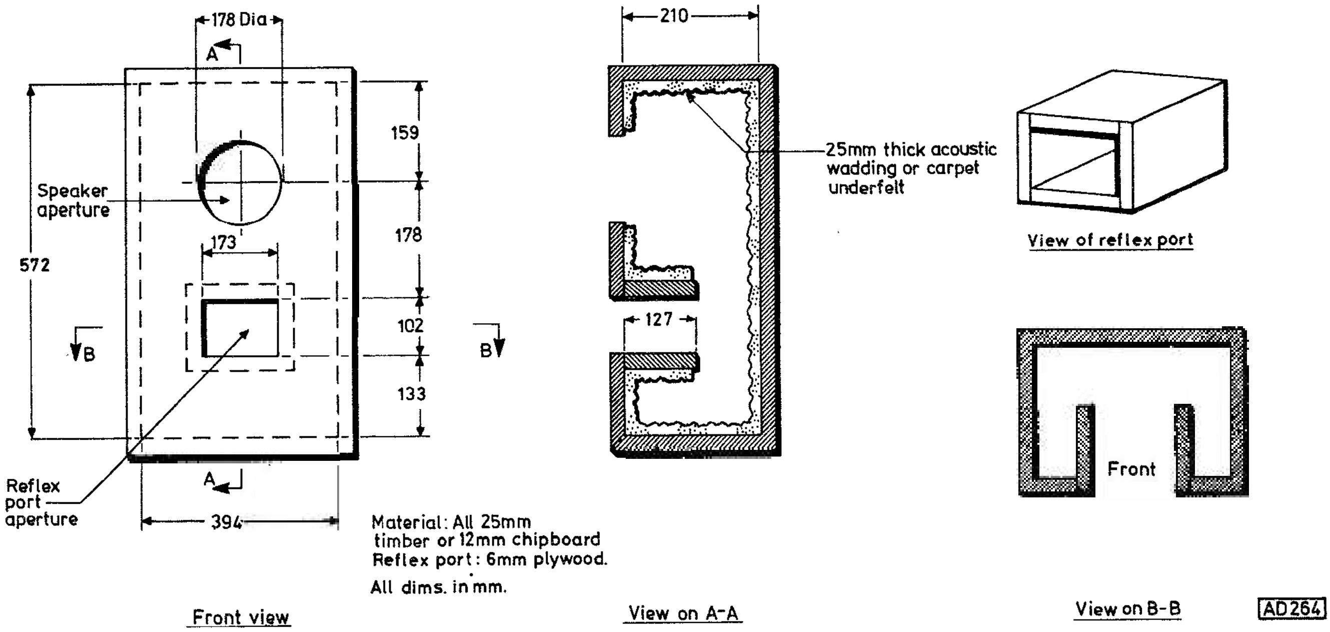
The bass reflex, properly cut, can provide a good compromise—sensitivity (efficiency) is quite high, and construction is pretty simple. The conflicting problems of dynamic range, efficiency, enclosure resonance, and the extension of bass are probably best solved by the acoustic labyrinth, or transmission line enclosure (basically a tuned resonator), but this is highly complex in construction and involves the use of several speakers in one cabinet. Further, crossover units are required, with resultant phase-shift and additional expense.

It's quite true that floor-standing reflex enclosures can sometimes present a problem in matching to the room characteristics, but this design (which is also eminently suited to the "Wimborne" Music Centre) is sufficiently compact to mount as shelf speakers, although the heavy timber construction will require *firm* shelving.

Comparisons

A "learned" article recently appeared in one of the Sunday newspapers concerning the terrors of a new Japanese assault upon the "British sound" in speaker units. It seems that £350 is regarded as a reasonable price to pay for a good Japanese pair! Whatever the advantages of such a set-up (presumably solid gold speech coil dome?), the design described here will give a reasonable performance over the range 40Hz to 18kHz ±3dB for about £25 the pair. The units are suitable for any amplifier with outputs at 8Ω and r.m.s. output levels up to about 20W.

One reason for choosing the reflex technique is that the alternative simple form (the infinite baffle) requires a much larger enclosure volume for adequate bass extension, and since the intention is to move quantities of air efficiently, the reflex type is the obvious choice.



General constructional details of the reflex closure

The Drive Unit

The Elac 8NC298 8in twin-cone unit was chosen for several reasons: (a) it's cheap, (b) it offers a wide frequency range, (c) the tweeter cone obviates the need for a separate pressure unit or dome tweeter, and (d) its relatively small cone combined with the favourable loading of the port results in a fair level of efficiency. In terms of initial cost, it seems a good unit anyway, featuring a ceramic magnet (flux density 12,000 gauss), rolled suspension surround maintaining excellent stability at low frequencies, and a specially stiffened tweeter cone. A further advantage of the twin cone approach is that there is no chance of damaging the speech coil of a typical tweeter unit by instantaneous peak h.f. levels. This is a more common occurrence than one might suppose from its lack of publicity, and the problem has increased since the advent of direct-coupled audio power stages, in some cases the amplitude of a "fast-wound" tape signal being sufficient to destroy a fairly expensive h.f. unit.

The speaker is available from Wilmslow Audio, (Dept. PW), Swan Works, Banks Square, Wilmslow, Cheshire SK9 1HF at £6·75+75p postage and packing.

Enclosure Construction

Each box is constructed from 25mm or 18mm timber or chipboard. The idea is to obtain a rigid frame so as to minimise colouration from cabinet resonance, but corner pieces *must not* be used or the internal volume will be altered, with loss of bass as the audible result of incorrect phasing with the reflex port. Glued dove-tailing is the preferred method of construction, although more troublesome of course, Evo-Stik "Resin W" or "Cascamite" are suitable wood glues.

All the inside surfaces (except for a 20mm gap around the speaker aperture) are lined with acoustic wadding or carpet underfelt to reduce reflections. The apertures may be covered with light speaker fret or left unprotected according to inclination.

Connections to the speaker unit itself are made before fitting the top panel, and a suitable hole or slot cut to take the cable through the wood. This is then packed with glue around the cable in order to obtain a good airtight seal throughout. ●

LETTERS

Sir: I was rather disappointed at the rather negative article on Norton CDAs in the October 1978 issue of *PW*. It is true that these devices are inferior in most respects to 741s say, but what most people don't appreciate is that for fifty per cent of all op. amp. applications the 741 is over-specified! For instance, the degree of accuracy in the definition of closed-loop gain that results from a very high open-loop gain is often unnecessary. If only a little more effort were made to sell the idea of CDAs to the public, the rather inflated prices being charged by most retailers would soon drop. Some retailers have in fact been offering LM3900s at 50p or less for quite some time. At these sort of prices, (about 12p per amp) their true role becomes clear. They are *cheap* substitutes for 741s in non-critical applications. In the USA this is more fully appreciated. The CDA is more often incorporated, where appropriate, in published circuit designs and the CDA/741 price ratio is about two to one, not three or four to one as over here.

The British hobbyist is as quick as any to adopt the latest Large-Scale-Do-It-All-For-You-i.c.s, but rather slow to adapt to new technology, discrete components and general-purpose i.c.s, requiring new approaches to circuit design. Magazines can help with positive articles like J. B. Dance's on *VMOS*. Retailers can help by anticipating popular interest in new technologies and keeping prices low. Between them they can help start the downward spiral in cost that results when popularity and cheapness feed on each other.

P. J. Rimmer
London N4

PRODUCTION LINES
alan martin

Mains intercom

A new f.m. Wireless Intercom Model No. LP1010 introduced by Hadley provides a three channel communication system.

No wiring between the stations is required, as connection is made when each unit is plugged into the mains.

Having three separate selective channels, the LP1010 caters for a wide variety of communication needs without the inconvenience or cost of installation work.

A system of three stations costs £120 plus VAT, additional stations cost £40 each plus VAT. Further information from: *Hadley Sales Services, 112 Gilbert Road, Smethwick, Warley, West Midlands B66 4PZ. Tel: 021-558 3585.*

Mini i.f.

Available from Ambit, the 5S i.f. transformer, probably the world's smallest fully tunable i.f. transformer for frequencies from 100kHz to 15MHz.

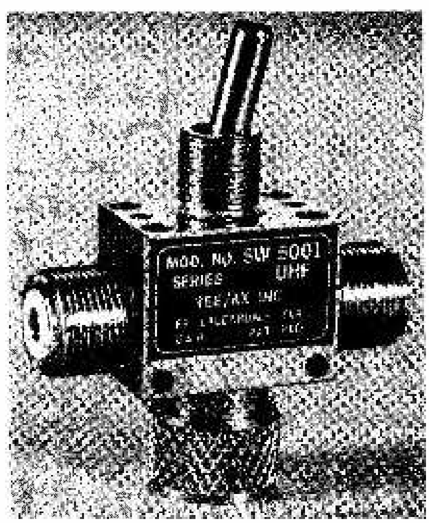
The transformers are based on values scaled down from the existing standard ranges in 10mm and 7mm format i.f. transformers.

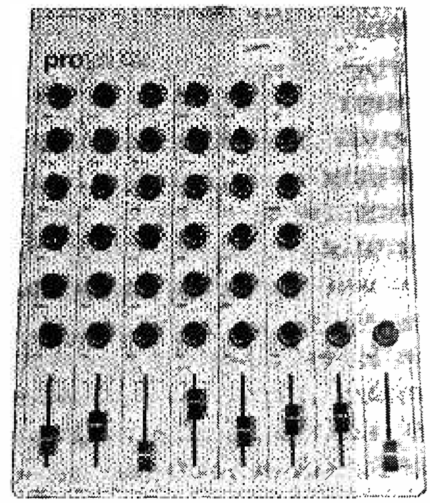
The applications of such a miniature coil are many, ranging from ultra slim broadcast and paging receivers, to miniature filter blocks, transceivers, t.v. and instrumentation applications where tunable inductors are required.

Costing 44p plus 12½% VAT and 25p P&P, the transformers and specification sheet are obtainable from: *Ambit International, 2 Gresham Road, Brentwood, Essex. Tel: (0277) 227050.*

Coaxial switches and relays

An interesting new range of coaxial switches and relays is available from the Tee/Ax Corporation of Florida. The toggle switches are also obtainable in multiple banks or ganged. Further details from the UK distributors, *IMOS Ltd., Suite 307, Shoe Lane, London EC4A 3JB. Tel. 01-353 4133.*





Mixer kit

Recently announced the introduction of the Prokit 62 mixer. The six input, stereo output unit features fully professional specifications offering line and mic. inputs, treble and bass equalisation, echo and cue busses, pan and long throw fader on each channel. A unique feature of this mixer is that it is available only in kit form. There is a 32 page manual for assembly, which covers all areas from soldering to component indentification and insertion, to, the full test and fault finding schedule. The simple to follow instructions make construction a couple of evenings work, even for a relative beginner. The unit costs £99·95 which includes VAT, a +15V, −15V power supply is also available at £15·00 which includes VAT, post and packing for either or both units is £1·50. Further details from: *Turnkey, 8 East Barnet Road, New Barnet, Herts. Tel: 01-440 9221.*

Mini-Buzz

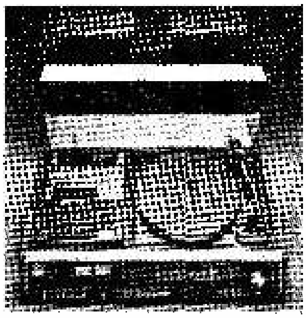
FieldTech Ltd., is able to offer a range of miniature d.c. solid state electronic buzzers, which utilize transistor oscillators and have no mechanical points to arc or require maintenance.

Six variations are available operating on 1·5V, 3V, 6V, 9V, 12V and 24V d.c. and each weighs only 10 grams. The 1·5V and 3V types have a 65dB min. output at 1m, whilst the other four have a 70dB min. output at 1m. Being solid state there is no r.f. field generated, and all types provide high reliability with minimum current dissipation.

A variety of applications include automotive warning and monitoring indicators, portable and battery operated equipment, test apparatus, timers, intercom and telephone sets, alarm devices, digital clock alarms, etc.

Further details and prices of this low cost range of miniature buzzers are available from: *FieldTech Ltd., Components Division, Heathrow Airport-London, Hounslow, Middlesex TW6 3AF. Tel: 01-759 2811.*

PROFESSIONAL KITS THAT SAVE YOU MONEY!!



MC020

AN ADVANCED MUSIC CENTRE for the experienced constructor. This unit is available as a fully wired chassis, in modular form or as a kit. It can be built in easy stages or as a complete unit. A variety of cassette decks are suitable.

SPECIFICATIONS

AMPLIFIER	Nominal
Power Output:	2 × 25 watts RMS.
Distortion:	THD @ 2 × 20 watts 0·7%
Frequency Range:	@—1·5dB 30Hz-15KHz
Tone Control Range:	
VC-20dB	18dB
Basic Electrical centre	@ 100Hz-14dB
Treble Electrical centre	@ 10KHz+8dB —14dB
Loudness Control:	
VC30dB	@ 100Hz+14dB @ 10KHz+11dB
Filters:	
VC30dB	@ 10KHz—6dB
Controls:	5 rotary: volume, balance, bass, treble tuning.
Switches:	9 push button: phono, tape, radio, aux. input, mono/stereo, loudness, filter, speaker switching, separate mains switch.
Meters:	2 signal strength: FM tuning
Sockets:	Headphones: 5 pin DIN Aux: AM aerial (ext) FM aerial (co-axial): 4 × 2 pin DIN L/S

Intermediate Frequency:	
AM	475KHz
FM	10·7KHz
Aerial input:	
AM (internal)	Ferrite Rod
AM (external)	2 pin DIN
FM (external)	Co-axial 75 ohm unbalanced!
AGC:	
For 6dB audio change	46dB
IF Bandwidth	
@ max sensitivity	± 1·5KHz @ 6dB
RF Sensitivity:	
@ 20dB S/N Ratio	
200KHz	1500μV/m
600KHz	500μV/m
1400KHz	200μV/m
FM:	
RF Sensitivity	
@ 26dB S/N (mono)	2·5μV
88MHz	
100MHz	
@ 46dB S/N (mono)	16μV
@ 46dB S/N (stereo)	125μV
Distortion:	
@ Decoder O/P	0·9%
Frequency Response:	
@ ± 1·5dB	30Hz-15KHz
Stereo Separation:	40dB
Audio Filter	Flat to 55KHz 50dB @ 130KHz

SUITABLE SURPLUS MODULES. Fully Wired

Stereo power amp 25w rms P/channel	£7·50
Low noise pre amp. Full freq correction	£5·99
RF Bald MW/LM/MPX Fet. 3 × IC	£9·99
P.S.U. £3·50 Transformer £5·50	
Selector Board 8 way	£3·99
Complete chassis massive 22 inches	£8·50

TU020

A Hi Fi tuner amplifier

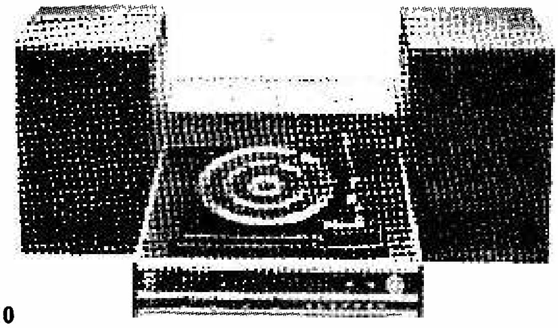
This unit can be built from our modules or as a complete kit. Input for mag cartridge, tape record/playback, MW/LW/VHF stereo, tuner. Uses the same R F Board as does the Wimborne with birdie filters, multiplex filter, varicap tuning on MW and LW.
Items from the Wimborne numbers 2 and 3 can be used for different performance specifications.

SPECIFICATIONS

Power output 25 Watts RMS per channel (both channels driven)
Total harmonic distortion 0·05%
Bass 100 Hz ± 12 dB
Treble 10 KHz ± 12 dB
Frequency response ± 1·5 dB 30 Hz—20 KHz
FM sensitivity 1·0μV for 26 dB S/N ratio
IF rejection 60 dB image rejection 60 dB
Stereo separation 40 dB
AM sensitivity 200μV at 1600 KHz 20 dB S/N ratio.

Fully wired modules, Preamplifier,	£6·99
Power amplifier	£9·50
RF Board	£33·95
Power supply unit	£3·99
Transfomer	£4·50
Magnetic PU amp	£2·99
Hardware kit	£7·99

PLEASE ADD £1 for postage and packaging for each item except the mag PU amp which is 30p.



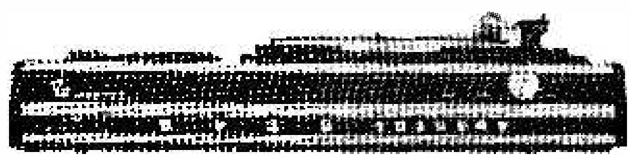
AU10

A Radio Record Player Kit which has everything you need to make a first class three band STEREO unit. Can be assembled in modular form or from scratch. A professional finish is guaranteed.

SPECIFICATIONS

Amplifier	
Output	2 × 10W RMS, both channels driven
Distortion:	1% ± 2 × 5 watts
Controls:	Four rotary 1. OFF/ON/VOLUME 2. Balance 3. Treble 4. Bass
Tone Control Range:	Bass @ 100 Hz ±9dB Treble @ 10 kHz ±9dB
Outputs:	2 × 2-pin DIN for 8 ohm loudspeakers 1 switched stereo headphone socket 1 5-pin DIN Aux. Tape in/out socket
Stereo Performance:	Frequency response @ ± 1·5dB 30 Hz—15kHz Separation 40dB Audio Filter—flat to 55 kHz—50dB @ 130 kHz
Controls:	7 Push Button: Phono, Tape, Mono, FM, MW, LW, AFC 1 Rotary: Tuning
Radio Tuner	
Waveband Coverage:	Medium Wave 525—1620 kHz Long Wave 155—280 kHz FM VHF 88—108 kHz

Price Hardware Kit	8·90	RF Board	21·95
Amplifier & Pots	8·75	Record Deck	13·95
PSU & Transformer	3·99	Dust cover	6·00



PW WIMBORNE

The most versatile music centre ever.
Complete kit price approximately £110 comparable price £180.

1 Hardware Kit, for a professional finish, trim, knobs, extrusions, sockets, top moulding 50 plus parts. **£9·95.**
2 Amplifier Module (11-14) watts RMS per channel, wired and tested, **£19·95**, kit price **£13·95.**
3 Mechanically tuned RF Board, absolutely complete and tested 1·5μV sensitivity FET front end 7 way switch, MW, LW, stereo VHF, only requires 13 VDC. **£21·95.**
4 Stereo cassette module, with CRO2 switching, low noise devices, ALC tape counter, excellent specification, incredible price **£24·95.**
5 Varicap tuned RF Board, the ultimate AM/FM Receiver kit, MOSFET front end, Deviation mute, interstation mute, fantastic performance 1·0μV sensitivity, Hitachi, AM receiver Ic, excellent MW/LW performance, complete with 7 way switch, The basis of the finest Hi Fi system, fully wired and tested. **£33·95.** Kit **£26·95.**
6 Magnetic PU Amp with LM387 or discrete (BC 149). Both **£2·99** each.
7 Wooden Plinth plus base board **£9·95.**
8 Perspex dust cover plus hinges **£6·50.**
9 Mains transformer **£2·99.**

All items include VAT. Please add £1 per item for postage and packaging, item 6 30p. For further details please send 15p.

REED HAMPTON LTD.

19 CHURCH LANE, WALLINGTON SURREY. Tel: (01) 647 0851

EXPERIMENTAL ACOUSTIC DELAY LINE

M. J. HUGHES MA, C.Eng, MIERE

The advent of the "Bucket Brigade" device has opened up a whole new range of prospects to the audio experimenter. It is the possibility of generating fixed, or variable, time delays to audio signals without recourse to electromechanical components—such as tape decks or reverberating springs—that makes these new components so exciting.

Applications

This project provides the home experimenter with a versatile delay unit which can be used to create phasing effects (that strange "whooshing" sound) that are so often used in modern music or, with a change in value of one or two components, it can be used to provide a simple chorus effect and reverberation or echo. A power supply has not been included because most users will want to build such a unit into an existing piece of equipment. To get the system operating you will have to supply +12V and −12V rails but at very low current (about 12 and 8mA respectively) and therefore batteries can be used quite effectively if you just wish to experiment.

The unit has been designed to have virtually zero "insertion loss or gain" which means to say you can insert the system into an audio line without it affecting the matching that already exists between units. With its controls set to minimum effect, any sound will pass through it totally unaffected by its presence. The only proviso is that input signals should not exceed 300mV otherwise distortion will occur. It is therefore ideally suited to go into a phono line between a pre-amplifier and a power amplifier.

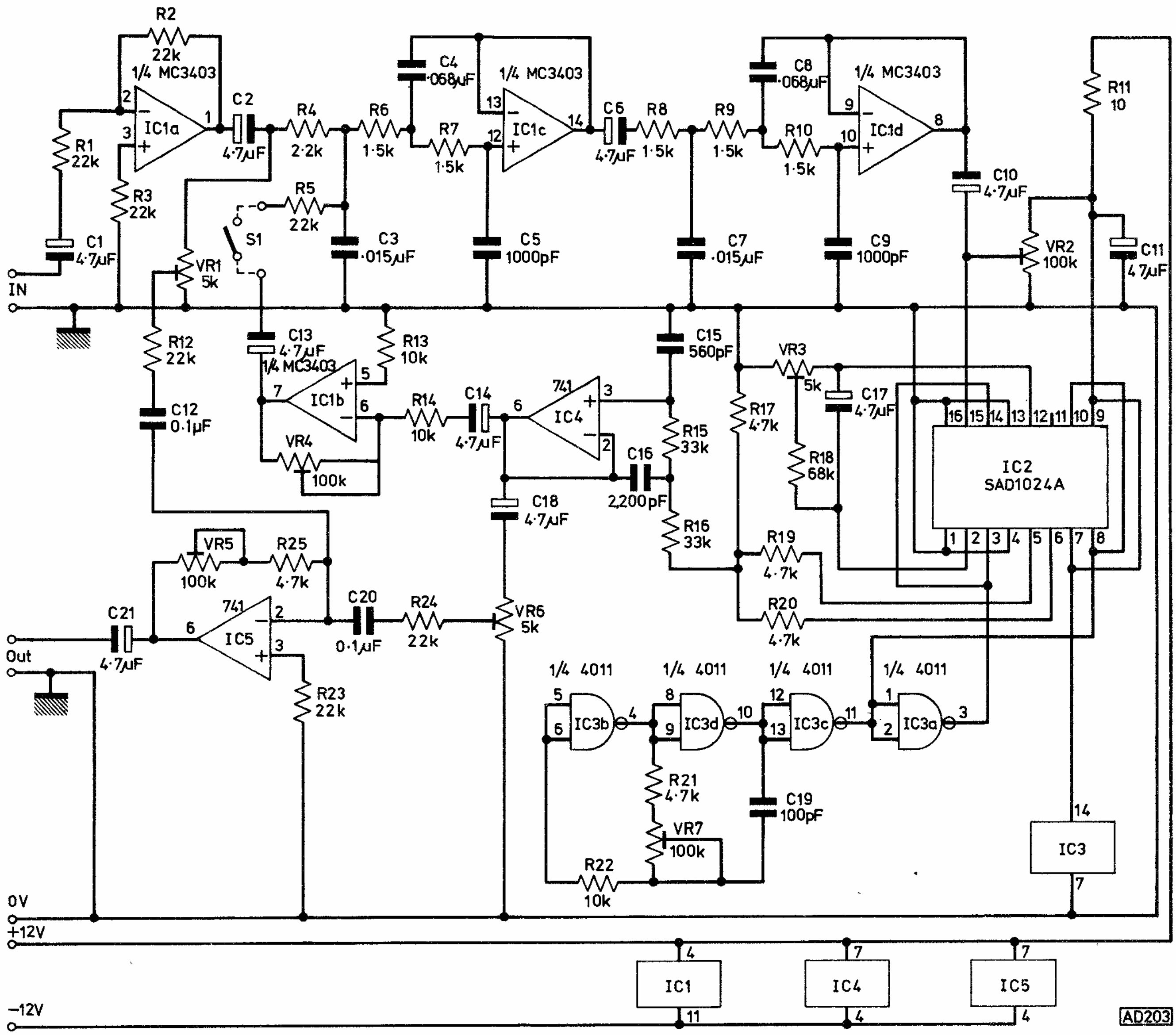
The component values shown in the circuit of Fig. 1 have been selected to give delay times in the range of one to about thirty milliseconds which are best suited to phasing effects. Let us briefly go through the circuit to explain the functions of the various sections.

Circuit Description

The input buffer stage based on IC1a has a medium input impedance and unity gain set by R1 and R2. Insertion gain can be increased by increasing the value of R2. IC1c and IC1d provide a 36dB per octave top-cut filter to limit input frequencies which are likely to clash with the internal clock frequency of the unit. IC2 is the SAD1024A bucket brigade device which contains two elements each having 512 stage delays—each stage delay is equivalent to half the period of the clock. We are using the two elements in cascade therefore we have 1,024 stages. The input signal to the SAD1024 has to be biased on a pedestal which is set by VR2 for the first element and by VR3 for the second cascaded element. The simple oscillator based on IC3 operates in the region of 50 to 100kHz; its frequency can be controlled by VR7. This oscillator provides the clock for the bucket brigade device, so the delay time can be adjusted with VR7.

The delayed output signal from IC2 has, superimposed upon it, switching "glitches" from the clock together with harmonics. These have to be removed to prevent irritating noise and distortion so the signal is passed through another top-cut filter in the form of IC4. The signal branches at the output of IC4. Part of it is fed to volume control VR6 which adjusts the level of the delayed signal and mixes it with the untreated signal fed to the mixing point via VR1. The mixed signal is then fed to IC5 which acts as an output buffer, the gain of which can be preset by VR5 so that the overall internal losses of the unit are just compensated for.

The other part of the signal from IC4 is fed through a gain-adjustable buffer IC1b and via a switch back to the input of the first top-cut filter. With S1 closed a selectable level of the delayed signal can be fed back and allowed to go through the delay over and over again. If the overall loop gain of this process is greater than unity, "howl round" will occur



—similar to acoustic feedback in a room—therefore VR4 has to be adjusted to prevent this critical situation occurring. The object of feeding back the delayed signal is to increase the reverberation effect.

Fig. 1: The complete circuit diagram of the Experimental Acoustic Delay Line. R5 should be 2·2kΩ

★ components

Resistors
¼W 10%

10Ω	1	R11
1·5kΩ	5	R6, 7, 8, 9, 10
2·2kΩ	2	R4, 5
4·7kΩ	5	R17, 19, 20, 21, 25
10kΩ	3	R13, 14, 22
22kΩ	6	R1, 2, 3, 12, 23, 24
33kΩ	2	R15, 16
68kΩ	1	R18

Potentiometers
Miniature horizontal presets

5kΩ	3	VR1, 3, 6
100kΩ	4	VR2, 4, 5, 7

Capacitors

Plate Ceramic 63V		
100pF	1	C19
560pF	1	C15
Polystyrene		
1000pF	2	C5, 9
2200pF	1	C16
Polyester 250V		
0·015µF	2	C3, 7
0·068µF	2	C4, 8
0·1µF	2	C12, 20
Electrolytic		
4·7µF 40V	9	C1, 2, 6, 10, 13, 14, 17, 18, 21
47µF 25V	1	C11

Integrated Circuits

741 (8-pin d.i.l.)	2	IC4, 5
4011	1	IC3
MC3403	1	IC1
SAD1024A	1	IC2

(Herbert Controls Ltd., Spring Road, Letchworth)

Miscellaneous

S1 s.p.s.t. switch.
Printed circuit board

Construction

All components are mounted on a single p.c.b., the track pattern of which is shown in Fig. 2. The component layout is shown in Fig. 3. We have used preset potentiometers for all controls and have deliberately laid out the board in this way to provide the experimental user with a convenient breadboard. The controls which would normally be considered to be front panel controls are VR1, VR4, VR6 and VR7. These have been positioned near the edge of the board so that you can substitute board pins and take flying leads to external controls.

Testing

When the unit is assembled and ready for test you should roughly set all potentiometers as follows:

VR1 — to the ground rail end
VR2 — approximately mid way
VR3 — approximately mid way
VR4 — to minimum resistance (i.e. wiper nearest pin 7, IC1b)
VR5 — to minimum resistance
VR6 — to ground rail end
VR7 — to minimum resistance.

Connect a signal to the input (probably best from a tape recorder phono output) and then connect the output to an external amplifier and apply power. First of all turn up VR1 and you should hear a totally unaffected signal. With VR1 set to maximum you should adjust VR5 so that the signal level is that you would have had without the unit in circuit. This sets the internal gain of the unit. Turn VR1 down and make sure that S1 is either open circuit or disconnected and then turn VR6 to maximum. If you are lucky you might hear the signal straight away but it is quite likely that you will have to adjust the pedestal biases for IC2. This is best done by adjusting VR2 a small way and then swinging VR3 from end to end until a sound is heard. You may have to go back and try a new setting of VR2 and adjust VR3 again. Keep doing this until you have a good clear signal and then make sure that both these presets are in the middle of the range that ensures a clear undistorted signal. **Note:** Adjust VR3 slowly as there is a time constant of a second or two from C17.

Once you have this signal you know that the bucket brigade circuit is working satisfactorily. While listening to the delayed signal try adjusting VR7 and you should hear a small change in frequency of music as you make the adjustment. This is a form of Doppler shift produced while you are altering the delay time. Wiggling VR7 (i.e. changing the clock frequency) will produce a vibrato effect. If, instead of using a simple oscillator, we had used a frequency modulated clock—say an NE555 suitably voltage controlled, we could have turned the unit into a true vibrato generator. Experimenters could try this by breaking the p.c.b. after pins 1, 2 and 3 of IC3 and applying a unity mark-space square wave to pins 3/14 and 8/10 of IC2. Note that complementary phases are required, i.e. a squarewave should be applied to pins 8 and 10 and its inverted form to pins 3 and 14.

You can now try to get the phasing effect. To do this adjust both VR1 and VR6 to mid positions so that you are mixing about equal proportions of raw and delayed signals. As you adjust the clock frequency you should hear the characteristic "whooshing" sound as you sweep through. The best effect is obtained when the two mixed signals are of the same amplitude so some experiment with VR1 and VR6 will help.

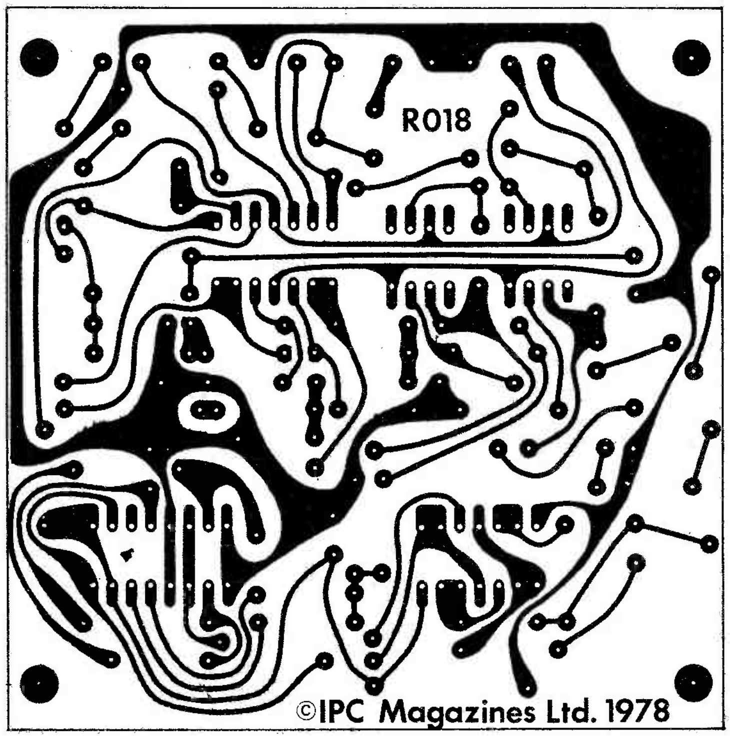
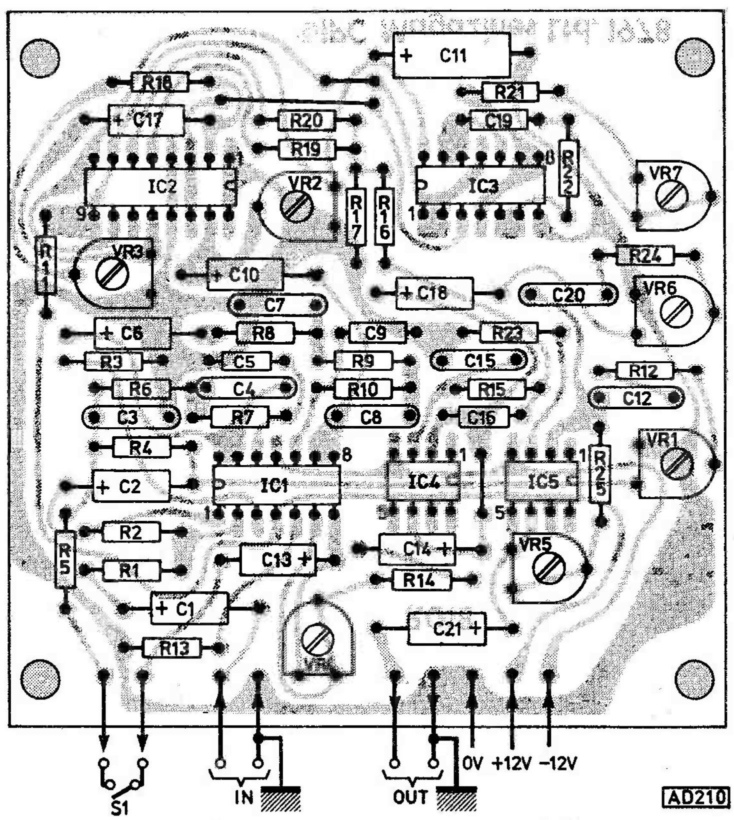
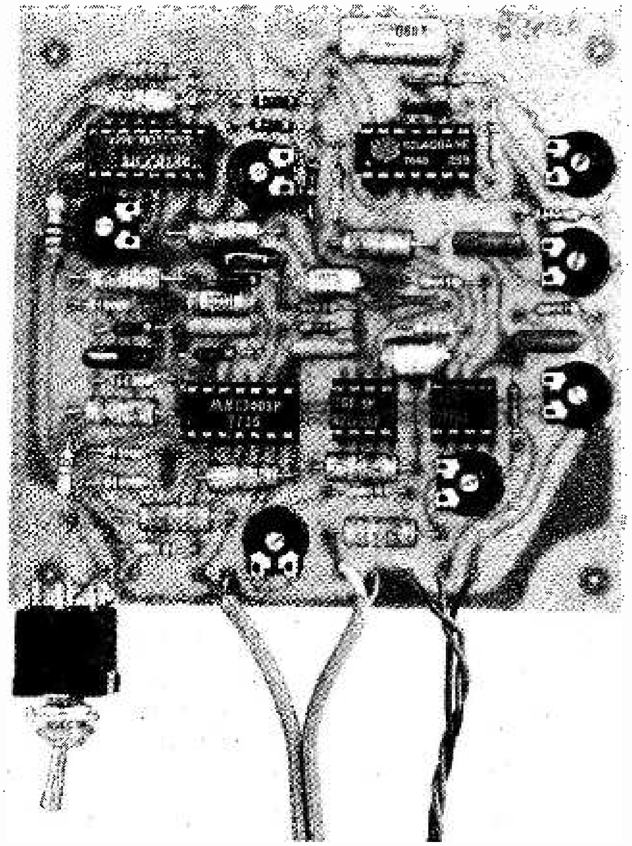


Fig. 2: Copper track layout (shown full size)

Fig. 3: The component layout



Next try to get reverberation. First set VR6 to maximum and VR1 to minimum and close S1 (or short the respective board pins together). Set VR7 for maximum delay (i.e. maximum resistance) and



slowly increase the resistance value of VR4 (i.e. increase the feedback gain). For test purposes it is best to use a voice as the input signal. At some setting of VR4 you will hear a distinct "tinniness" occurring —at high settings of feedback it might sound as if someone were speaking down a pipe. This is a form of reverberation but probably not the sort you expected! Because of the short delay the feedback loop is more sensitive to some frequencies than others and this gives the rather metallic or coloured sound. Nevertheless careful adjustment of the controls will give some interesting effects.

For a better reverberation effect you should increase the delay and this can be done by increasing the value of C19. Try values up to about 560pF. Any values above this will reduce the clock frequency below that which will clash (alias) with incoming frequencies and an element of distortion will occur. Furthermore the post filter (IC4) will not be so effective in removing the switching glitches and you will notice an increase in background noise level (hiss). You can reduce this to some extent by increasing the value of C15 up to about 2200pF.

With long delays and S1 open you can get a form of "double tracking" or short echo which, when a person is singing, makes it sound as if there are two voices.

This unit is designed simply for experiment but we hope that many people will find a useful application. To get more realistic reverberation it is necessary to have a larger number of elements operating at different delays and feeding back into the same feedback loop—this gets rid of the colouration effect. In order to get a good echo effect (up to 500ms delay) over the whole audio spectrum it is necessary to have several more elements cascaded otherwise one has to use a clock that is so slow that aliased by-products are provided, giving rise to distortions. ●

INTRODUCTION TO LOGIC—6

Continued from page 46

in the counter chain into the display latches. This completes the measurement cycle. Usually a slower signal of perhaps 10 or 20 per second derived from the timing clock will be used to initiate the measurement sequence, by loading a new *1* state at the first stage of the shift register, so that a continuously updated display is produced. For making low frequency measurements, however, a manual push button may be used to start each measurement cycle thus giving a "one shot" mode of operation. Fig. 75 shows a basic system for timing and control logic.

The frequency of the clock applied to the shift register will determine the length of the count interval and hence the scaling of the display readout. With a 1Hz shift clock the readout will be in hertz, whilst with a 1kHz clock a display of kilohertz will be produced.

Input Circuits

The general arrangement of the input signal processing circuits is shown in Fig. 76. Here the signal is amplified and then shaped to produce pulses suitable for driving the logic. A prescaler counter may be included to simplify the design of the main counter by reducing the frequency of the signals applied to it. A prescaler will usually be required if v.h.f. or u.h.f. signals are to be measured, and here the prescaler is almost certainly going to be an ECL type device, such as the ones made by Fairchild and Plessey. These ECL counters are capable of handling signals up to 300MHz or even 600MHz.

The actual logic used in a digital frequency meter may vary considerably from what we have described here, but the procedures for choosing that logic scheme will follow the same general lines as those described above. In some cases it may help to draw up a timing diagram so that it becomes clear exactly how the logic sequence must operate.

Although the arrangement of logic gates for a given logic system can be worked out by applying common sense, it may result in an inefficient use of the gates available in the circuit packages. Remember there may be three or four similar gates in each package. By rearranging the logic it may be possible to reduce the number of packages required. For instance in a 7400 where only two of the NAND gates are being used, the other two could be used as simple inverters and might replace a partially used 7404 hex inverter.

NEXT MONTH—LSI AND THE MICROPROCESSOR

KINDLY NOTE!

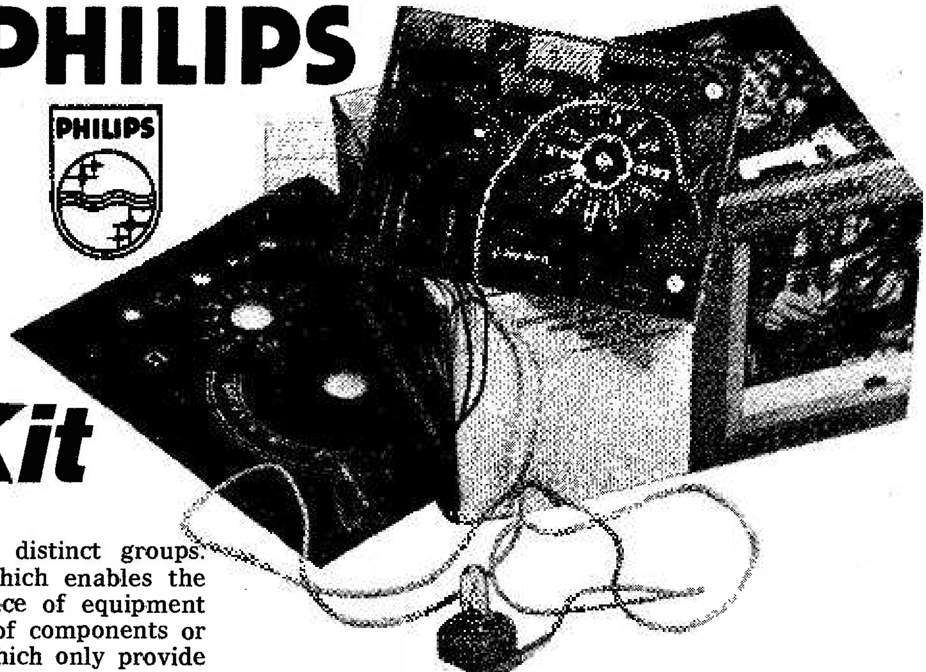
Burley p.s.u., November 1978

On the circuit diagram, C7 should read C4; on the p.c.b., C3 should read C5; chassis points (with the exception of that to the laminations of T1) should more properly be shown connected to the junction of BR1, C1 neg., C2 neg., and D1 anode.

SPECIAL PRODUCT REPORT

PHILIPS

R & C Bridge Kit



Kits can be categorised into two distinct groups. There are the complete variety which enables the constructor to build a finished piece of equipment without recourse to other sources of components or information and there are those which only provide the most difficult to make or obtain components.

The Philips Electronic Kits, released on to the UK market last year, are neither one type nor the other. On the one hand they provide all the parts necessary to make a working electronic device but stop short at providing any form of housing for the completed assembly. In fact no mention is even made of a suitable case for the unit.

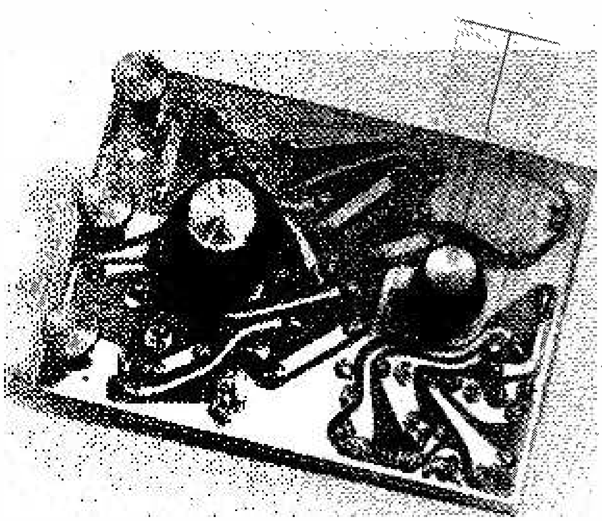
We decided to build one of the kits in the test instrument range and selected the Resistance and Capacitance Measuring Bridge.

This instrument is claimed to be capable of measuring resistances from 10Ω to 10MΩ and capacitors in the range 10pF to 10μF. There is also an 'open-bridge' facility which allows the ranges to be extended or self inductances to be compared.

Components

The instrument is built on to one glass fibre printed circuit board and the components supplied fitted with no problems.

The instruction sheets provided with the kit are comprehensive and proved easy to follow. A separate sheet gives advice on how to solder for the complete novice.



Components were of good quality and their markings tied in with the components list and instruction sheet, a point which a lot of suppliers miss out on, especially with capacitors.

The unit was simple to build and worked first time. However as a piece of test equipment it leaves a lot to be desired.

The layout of the controls is very cramped, mainly as a result of attempting to put all components and controls on the one printed circuit board. The three terminals supplied are not very satisfactory and the whole unit really needs rethinking as far as front panel layout is concerned.

A printed card panel is provided which fits the layout of the controls and terminals but makes it more difficult to fit the unit into a case.

Our kit had no knob supplied for the range switch, which is unfortunate as it should really match the knob supplied for the bridge control, which has a small shoulder moulded on to it accept the piece of thin Perspex sheet provided already ruled with the fine line pointer.

Accuracy

The instrument operates on conventional bridge principles and requires the operator to find a null, by listening through the earpiece for the point at which the audio tone is a minimum. This was found to be easy and is quite sharply defined. Using known value close tolerance resistors and capacitors to check the calibration of the scale proved that this was accurate. Two close tolerance resistors are provided with the kit to enable a simple calibration to be effected.

With a little more thought on the ergonomics of this instrument it would provide a useful addition to the home constructor's equipment. However it should not be difficult to rearrange the control and terminals on to the front panel of a suitable case.

This kit is one of a range recently introduced by the Philips Industries Group and the complete range is stocked by **A. Marshall (London) Ltd., Kingsgate House, Kingsgate Place, London NW6.**

Dick Ganderton

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

I have been surprised on several occasions when a reader has written in to say that he has been "off the air" because his set has been away for repair! It hadn't occurred to me that he would do anything else but find the fault and fix it himself! Apart from the cost of the repair the opportunity of gaining some useful experience in fault-finding is lost.

Naturally I would not recommend touching a set if it is still under guarantee but usually the problem is with a valved set which is much easier to fault-find on than a solid-state one.

The first essential is the receiver's manual which should be obtained when the set is bought, so that the user can study it and become familiar with the circuitry, and, incidentally, ensure that the set is being used to best advantage. Don't wait until a fault develops before obtaining a manual.

The second requirement is for a multimeter, preferably of 20kΩ per volt sensitivity or better, so that it causes minimum upset to the operation of the circuit when it is connected to it. This is particularly important with solid-state devices. There are many good-quality imported multimeters on the market at reasonable prices but, like everything else, pay a little more than you can really afford and get some thing worthwhile.

Look for a large, open, uncluttered scale that is easy to read, and beware of the meter with a dozen scales reputed to be able to measure anything! If you want to measure anything other than voltage, current or resistance then use a separate instrument designed for the purpose.

If your pocket will run to a digital multimeter you will have the choice of a kit or a ready-built instrument. If you are not a skilled constructor then the latter should be your choice.

Most manuals have a fault-finding guide so study that carefully. Above all, be logical and don't go prodding around haphazardly or you will finish up with more faults than you started with. Remember that most receivers can be split into three sections, r.f. i.f. and audio, plus the supply lines. Analyse the fault mentally and decide in which section it is likely to be and start from there.

Newcomers to the Column

Since starting this sub-heading a few issues ago I have been pleasantly surprised at the number of extra letters I have had from people who have been reading the column for a while but not bothered to write in. We all had to start somewhere so there is no shame in admitting to being a beginner, although not all who come under this sub-heading are beginners by any means.

Terry Wilson of Peterhead, Scotland, has been interested for a couple of years now and he and others are studying hard for the RAE under the aegis of local licensed amateurs. I was delighted to know that Terry's main interest is c.w. so perhaps we may get some c.w. logs into the column in future. From Beith in Ayrshire, **Bill Steel** writes to say his knowledge of amateur radio is zero! That's candid enough! He has a Sony RP8880 which allows him to copy stuff on 20m s.s.b., which is a good start. The Guide to Amateur Radio is also to hand now so you're on your way OM.

S. Norton of Garforth, Leeds, also says he is a complete beginner but with an FR50B and the *PW* Aerial Chart the first steps have been taken. I would mention that I send a long letter to all those needing advice on how to start in our hobby and I'm glad to say that many stay the course.

A bit further up the ladder we find **C. A. Denton** of Scarisbrick, Southport, who is an electronics technician but new to our game. He has a Marconi Electra and a Mercury plus a Redifon R146 and if anyone wants info on these rather rare sets C.A. will be very glad to help as he has the manuals. Write to him at "Hardacre", Pool Hey Lane, Scarisbrick, Southport.

From Seaford, Sussex, comes a note from **Maurice Norman** BRS37920 "a comparative newcomer" who has a DX160 receiver which he hopes to improve with the aid of the Aerial Chart, so here's looking forward to some reports soon OM.

Aerial Tuning Units

A reader recently reported that he was very disappointed with the results obtained when using a 66ft long wire with his new FRG-7 receiver "especially as it is a length that you seem to recommend". Well, I do usually add "plus an aerial tuning unit" (a.t.u.), and that is the crux of the matter. So let's try and elucidate.

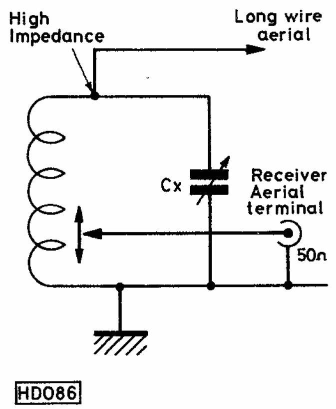


Fig. 1

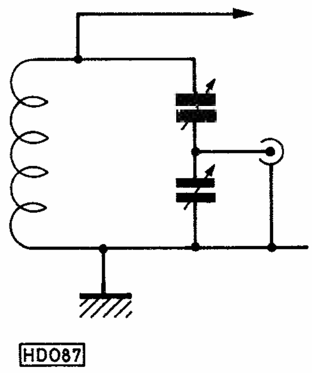


Fig. 2

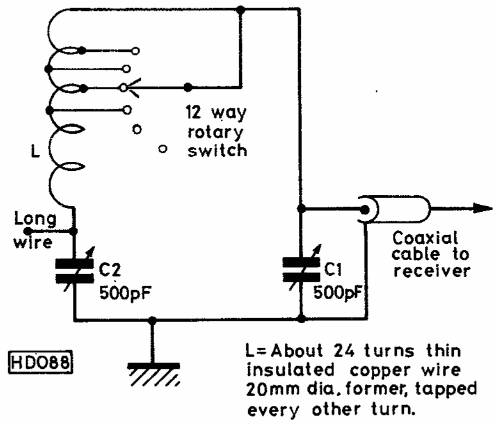


Fig. 3

The input impedance of virtually all communication receivers today is 50Ω, a low impedance compared to older sets like the HRO and AR88 which were around 600Ω, high enough to give results with a long wire connected directly to the aerial terminal.

Now the impedance of a long wire which is one or more half-waves long will be several thousand ohms. It is a matter of fundamentals that maximum power is transferred from one circuit to another when they have the same impedance, when they are said to be "matched". So if we stick the end of a long wire, which is high impedance, into the 50Ω aerial socket of a receiver we have about the worst mis-match imaginable! With a 66ft wire, which is a half wave at 40m (7MHz), the mis-match will be present on 40m and all higher frequency bands.

On 80m however, the wire is a quarter-wave long, presenting an excellent match to the receiver. An a.t.u. is not then essential, although I would recommend one in order to keep the system resonant.

In order to use an a.t.u. it is essential to understand how it works. The electrical equivalent of any aerial is a tuned circuit, and if one end of it is earthed (zero impedance) then the other end will exhibit high impedance at resonance, as does the end of the long wire, so the two can be connected together resulting in a good match.

Obviously there must be a point up the inductance where the impedance is 50Ω, to match the receiver input, if we can only find it! See Fig. 1. We can tap the coil every turn or so and use a switch for rapid selection of the right tap, indicated by a significant increase in signal strength, simultaneously keeping the system resonant using tuning capacitor C_x.

To avoid tapping the coil we can split the capacitor into two parts, Fig. 2, to form a capacitative divider but retaining sufficient effective capacitance to maintain resonance. When the capacitors have equal values we are virtually centre-tapping the coil.

For practical reasons the circuit is rearranged, Fig. 3, into the familiar arrangement where C1 is used for "loading" and C2 is used to maintain resonance. The coil is tapped to provide optimum inductance on each band. All the turns will be required for the 160m band and two or three turns for the 10 and 15m bands.

Initially, set C1 about half way and adjust the number of turns until C2 will tune the particular band. All three adjustments are inter-dependent for best results so a fair amount of juggling is called for. Once the optimum settings for each band have been found write them on a label and stick it on the a.t.u. It should be possible to resonate almost any length of wire on any h.f. or l.f. band if the a.t.u. is working properly.

Round the Bands

Bob Bell (Blyth, Northumberland) found 10m quite active after a period of quiet, with west coast Americans aplenty, while **Bill Rendell** carried on his search for new island prefixes from Truro in Cornwall. His old valved AR3 plus preselector is fed from folded dipoles on 10 and 15m but 20m is not neglected. Bill found JW7FD, as did others, from Bear Island for a new one. Seems JW has a population of just 13! J3AH on Grenada turned up again on 15m plus YB0CR on Java, with KB6EI on Baker Is on 10m to keep the pot stirring.

In Crowthorne, Berks, **Allan Stevens** has been working his *PW* Direct Conversion set on 20m and logged some 54 countries in the first couple of weeks, but he has got a PR40 preselector in front, with a half-wave aerial indoors. Best catch was HH2SD on Haiti. **Ian Marquis** A9140 doesn't get much time for listening with all his school work to be done but promises to have a go on the l.f. bands this coming

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands must be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

winter. CE0AE in Antarctica was a good one as was KG6JJH on Guam on 10m s.s.b. Ian has an FRG-7 with a 70ft wire plus a 16ft vertical and a 10m dipole.

Dave Garner BRS39645 writes from Newhaven, Sussex, to say that although he has been interested in s.w. for a number of years he is only now starting to take it seriously, studying for the RAE next year. In an all-night stint he managed 49 countries on his FRG-7 on 14MHz with a loft wire. A converter for 2m is fed by a *PW* Slim Jim aerial. Dave mentions 4X30JU a special call celebrating 30 years of Israeli independence. Dave very kindly donated his old R107 receiver to one of our young listeners and it should have reached its new home by now. Any other offers are welcome.

General Notes

Although **Dave Parker** of Elstead, Surrey, has an HQ120X receiver he still plays around making sets and has at last got one to work, but it lacks selectivity. I always advise people to get a set of some kind first of all and to play around afterwards, otherwise failure to get a set working can be very disheartening. It's nice to have a working set as well, just to prove that the bands aren't all dead! Dave has joined the RSGB but comes up with the eternal complaint about *Radio Communication* "there is nothing in it for the beginner".

Joe Porter in Belfast has 140ft of wire up in the air but reckons it is no better than a short vertical. Since it is going up and down the garden a few times I suspect the signals on the long wire are cancelling themselves out! An aerial tuning unit, as described below, might be a good idea, too Joe.

From Reading, Berks, **Paul Bown** BRS40740 reports a lack of success with his Skywood CX203 mainly because some of the r.f. wiring is missing! He's about to scrap it for spares and buy a new set. Might be the best in the long run, OM.

An appeal from **Vic Tuff** of 38 Fourth Avenue, Blyth, Northumberland, who is electronics instructor at the local ATC squadron. Vic takes old equipment and refurbishes it for use by the squadron and wonders if any reader has old service equipment or handbooks or manuals. Whatever the gear, it will be either used or put into a museum, after overhaul. Vic is also associated with the Blyth radio club that has recently been started with reader Bob Bell as one of the leading lights.

Martin Leizers of Newport writes to say his new call is GW8RKB and he is on the air with a borrowed Yaesu FT220 and the Slim Jim aerial although he has not neglected to listen on the h.f. bands, with his Realistic 160 and 150ft of wire, as his log extract shows.

Club News

The Thames Valley ARTS welcomes newcomers to its meetings on the first Tuesday of each month at Giggs Hill Green Library, Thames Ditton, Surrey. December 5th "promises a wealth of stories and experiences" from Dave Foster G3KQR, a member of the police force it seems! More info from Sec R. Blasdell G3ZNW, 92 Bridge Road, Chessington, Surrey.

The Cheltenham ARA should have its AGM on December 7th but I understand it will now be in January so check with Sec G3JJG QTHR.

Log Extracts (All s.s.b.)

M. Leizers:—40m HI8RRD HK5BKI HR1JMV; **20m** EA9FD KC4AAC KZ5ED VP2LFD VP8QI; **15m** HC5EA HK9KL; **10m** HK3AXT KH6IBA.

J. Porter:—15m VP2MAY; **10m** 8P6JQ.

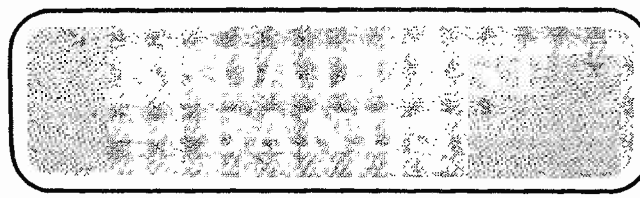
D. Parker:—40m ZL1DNQ ZL4BE; **20m** CO2FA; **15m** CE9AT.

D. Garner:—20m CT3AB JW7FD VE6BGU/SU 4X30JU.

I. Marquis:—80m EA8OZ EL2T 7X5AB; **20m** CE0AE; **15m** KH6HGP; **10m** CT2BB CT3BX KG6JJH VS6FI.

A. Stevens:—20m HH2SD ZD7SS.

W. Rendell:—20m JW7FD OY5G SU1CR VE8RR VK9XW VP2LLF XT2AE; **15m** J3AH JW7FD TU2HS YB0CR; **10m** EA8RG KB6EI VU2GAA.



MEDIUM WAVE DX

by Charles Molloy G8BUS

This issue of *PW* marks the tenth anniversary of my first contribution to the Medium Wave Column. At first I wondered if anyone read it as it was some time before the first reader's letter arrived. Since then several hundred letters from all over the world have been received, evidence that interest in the medium waves is far from dead. The hobby of DXing began on the medium and long waves with the start of broadcasting itself in the early twenties. Magazines of the day not only reported North American DX but also carried reports from readers who actually listened to the programmes. *Amateur Wireless* of November 1st, 1924, had a full page article called "A great night with WGY", which was on 380m. WGY Schenectady, New York, is still on the air on 810kHz, but is a lot more difficult to pick up than it used to be. Receivers are more powerful and selective but interference is considerably more severe and this is the challenge the band offers to the DXer—how to winkle out the DX. There are more broadcasting stations on the medium waves than on all of the short wave bands put together, a fact that most people including myself, find surprising.

Long Wave DX

Although the frequencies allocated for use on the long waves are unaltered under the new Geneva Plan, there will be quite extensive changes in channel occupancy. Incidentally, 151kHz, 180kHz, 186kHz and 251kHz were not authorised under the old plan (nor are they in the new one) and the stations operating on them should really be classified as pirates!

A number of new countries will appear on the band on or after November 23rd. Egypt is authorised to use 164kHz and 200kHz, Spain will have Madrid on 191kHz and Barcelona on 227kHz, Libya will have 236kHz, Italy will have 245kHz, Eire (Tullamore) and

Syria will share 254kHz, Bulgaria will have Plovdiv on 263kHz while Tel Aviv in Israel will be authorised to use 281kHz. After a long absence Holland will come back on the long waves with Lopik on 173; at one time Huizen was on 223kHz.

What will happen to Luxembourg? This country was not authorised to be on the long waves under the old plan and it isn't under the new one either. Radio Luxembourg started its English transmissions many years ago on 1293 metres, providing an interesting alternative on a Sunday evening to chamber music and the epilogue. The BBC are authorised to use both 200kHz and 227kHz and it was originally intended to use both channels for BBC Radio 4 with 200 for Droitwich and 227 for a new site in Scotland. The latest list from the BBC makes no reference to 227kHz so it looks as if plans for a second long-wave outlet have been shelved or abandoned.

Altogether, the long-wave band should become a more rewarding place for the DXer under the Geneva Plan. The 15 channels will be occupied by a large number of interesting broadcasters and once the full potentialities of the band are realised then it will only be a question of time before someone works out a design for a standard long wave loop.

Medium Waves and the Ionosphere

Does the weather affect medium wave DXing, asks reader Malcolm Lougharne and the answer must be that this is unlikely. The weather is confined to a region close to the earth's surface while a DX signal travels much higher, up to the ionosphere, spending the greater part of the journey well above the weather. Paradoxically, weather may have an effect on the ground wave. One can visualise a long wet spell (English summer) or a drought, producing a change in ground conductivity.

The existence of an ionosphere was suspected when broadcasting first began though there was an alternative view that a long distance radio signal just followed the earth's surface. It was left to Appleton and Barnett to prove that a reflecting layer did exist. This happened late on December 6th, 1924, when they conducted an experiment using the BBC transmitter at Bournemouth (780kHz) and a receiver at Oxford which was equipped with a signal strength meter ("S" meter).

The signal from transmitter to receiver travelled by two routes. The shorter route was the ground wave and the longer the reflected wave. The total signal applied to the receiver would depend on the phase relationship between the two. If the two signals were in step (crest of one corresponding to the crest of the other), then the total signal would be a maximum. If they were out of step (out of phase) then the total signal would be a minimum. By slowly adjusting the frequency and hence the wavelength at the transmitter, the two signals at the receiver would move in and out of phase with each other producing alternating maxima and minima on the "S" meter, providing of course that there really was a reflected wave. This is what happened. Moreover, by measuring the wavelength at two adjacent maxima it was possible to calculate the height of the reflecting layer which turned out to be about 60 miles above the earth's surface. It was called the Heaviside Layer after the man who predicted its existence but later on it was renamed the E Layer.

It is hard to believe that this elegant experiment took place within living memory. It is even more surprising to read in some current literature that the E layer disappears after sunset! This clearly is not so. The critical frequency of the E layer falls to about 500kHz some four hours after sunset and remains at this value throughout the night. This means that the highest frequency returned from low angle radiation (a DX signal) will be in excess of 2MHz and consequently it is the E Layer that is responsible for most of the DX to be heard on the medium waves. High angle radiation can penetrate the E Layer but that is another matter altogether.

Readers' Letters

Harold Emblem (Mirfield) reports that Asiatic DX has been good recently. Stations logged with his Eddystone 730 and loop were Quetta Pakistan on 750kHz (756), Hyderabad on 1010kHz (1007), Rajkot India on 1070 (1071). The frequencies in brackets are those allocated for use after November 23rd.

How should I connect a loop to my DX160 asks Mark Hallam. This receiver has terminals marked A1, A2 and GND. The loop should go to A1 and A2 and any link between A2 and GND should be removed. GND should go to earth. When using a long wire connect it to A1 and join A2 to GND which should be earthed. It is not necessary to use coaxial cable between the loop and the receiver. Plastic lighting flex of the type where the wires run parallel to one another will do instead, as it is a reasonable substitute for 75ohm flat twin feeder.

Harold Brodribb (St Leonards-on-Sea) complains about the BBC European Service transmitter at Crowborough (809kHz) which has been putting out a strong harmonic on 1618kHz. On the long waves, Radio Finland now carries a news bulletin in English over its transmitter at Lahti on 254kHz at 2015. Finally from the Isle of Wight comes a note from **William C. Savage**, who says that he received QSLs from WHAM Rochester NY, WBZ Boston and KDKA Pittsburg away back in 1928 and he wonders if anyone can predate this.

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

A letter from reader **Roy Haynes** in the October issue mentioned five countries that eluded him no matter how hard or how often he tried for them. Four of these are now reported by readers. **Mark Hallam** (Hereford) used a Realistic DX160 and an indoor aerial to pull in Radio Afghanistan in English at 1900 on 11820kHz, with slight QRM from Radio Moscow. The SLBC (Sri Lanka Broadcasting Corporation) was also heard by Mark on two frequencies with programmes in English. The All Asia Service was logged at 0100 on 15425kHz and again at 1400 on 9720. Reception on both channels was poor; not good enough for a reception report. Jeddah in Saudi Arabia is reported on 11855 at 1910 in English by **Noel Cosgrave** (Dublin) who was using a Mullard MAS 1659 receiver and a 75ft long wire. **Jim Edwards** (Bryn, near Wigan) has an FRG-7 and a 50ft long wire and he picked up Dacca in Bangladesh on 15285kHz at 1815. Only one of Roy's difficult countries remains. Has anyone heard Syria?

Keeping a Logbook

Why go to the trouble of keeping a logbook? Well, as a record of stations heard it should add to the interest and pleasure of DXing and for that reason alone it is worth while keeping one. A station log will also be of practical value for it will be a record, for future reference, of information about reception such as the best time of day or year for listening to any particular area. If the receiver has a logging scale then the reading for each station can be recorded in the logbook making it easy to tune back to a station or programme. A written record is more reliable than memory when it comes to writing a reception report.

What form should the logbook take? The DXer can please himself. I use a 9in by 7in stiff-backed notebook which has horizontal lines printed on each page. Each line is used for one entry in the log and I pencil in vertical lines to divide entries into the number of sections required. These are, starting from the left: date, time in GMT, frequency in kHz, log scale reading, programme heard, SIO rating, station heard (if identified), aerial used. The DXer can add to or subtract from this list to meet his own requirements. The date is the date at the DXers QTH; it may be different at the transmitting end. The time should be GMT as the use of summer time can cause confusion. I prefer SIO as an indication of the quality of reception but other codes such as SINPO, SINFO or SIFO can be used instead and even Excellent, VG, Good, Poor will be of value. Fill in the logbook while you are actually DXing and it will soon become a habit.

Readers' Letters

I would like to contact someone of my own age group, female, and who is interested in s.w. listening and DXing, writes **Noel T. Cosgrave** (wouldn't we all!). Noel, who is 14, lives at 102 St Josephs Road, Greenhills, Dublin DN12, Eire. There were two lady DXers among the first forty in the Sweden Calling DXers Jubilee Contest and a Norwegian DXer, Grete Osmundsen spoke recently on DX Juke Box (Radio Nederland) about Women in DXing. This brought replies from more than 40 women DXers who were in the age range 14 to 66, so you might be lucky Noel.

A problem concerning the Murphy B40 ex-WD communications receiver comes from **Roderick Williams** who has been unable to get a replacement output valve (EL22). He has managed to get the set working using the pentode section of an ECL86 but he wonders if any reader can suggest a better alternative. Has anyone any ideas?

Aerial Wire

Fairly heavy gauge copper wire is usually specified for aerials and while this type of wire will certainly give good results, especially when used for transmitting where currents of significant value are involved, it has some disadvantages for broadcast band DXing. Copper corrodes, so bare wire is not really desirable. My aerials are subjected to the full force of gales from the Irish Sea and I prefer something a bit stronger than copper. For several years I have been using the plastic covered steel wire that is on sale in gardening shops, which can be purchased in drums as well as in hanks, well aware that I might be sacrificing something to obtain mechanical strength. Recently a "small ad" in *PW* which seemed to indicate a solution caught my eye. "Aerial wire, 20swg, copper plated, steel core, tough pvc insulation". My 90ft long wire was due for overhaul anyway so it now has new wire and insulators and it has already withstood some rough autumn weather.

Why copper-plated steel wire? Skin Effect is the answer. Direct current spreads itself evenly over the cross section of the wire. So does low frequency alternating current, but as radio frequencies are reached there is a tendency for the flow to migrate to the surface of the wire as a result of interaction between the current and its own magnetic field. At very high frequencies nothing at all passes along the centre of the conductor and a tube can be used instead of wire. Steel is not such a good conductor as copper but it is mechanically strong so this is the material for the core. Copper is a good conductor so this is the stuff for the surface of the wire where the current density is high. The plastic covering protects the copper from the effects of the atmosphere and it also acts as an insulator if you want to use this wire for a downlead.

I have not noticed any spectacular improvement in reception since using the new aerial and I did not expect it, but I would hope for a weak signal to show an improvement and perhaps become resolvable. The new wire should be more effective on the higher frequencies which will be very welcome now that they are opening up. AMTEST, 55 Vauxhall Street, Worcester WR3 8PA, supply this type of aerial wire and they were advertising in *PW* at the time of writing.

DX and News

More news of DX on the 11m band comes from **Harold Brodribb**, of St Leonards-on-Sea, who reports hearing Radio Tirana Albania on 25290kHz (out-of-band) on several occasions between 1700 and 1800 using his AR88LF and a loft multiple dipole. **George E. Lee** (Osset, West Yorks) reports that Radio Australia on 11800kHz at 1800 is a very good signal, better than on 9570 at 0700 which is intended for reception in the UK. **David Wyatt** (Oswestry) has built an a.t.u. for use with his home-brew 6-transistor receiver and this makes a tremendous difference when connected to his 100ft long wire. Recent DX includes the Voice of Chile on 17800 at 2200.

A Vega Spidola connected to the TV aerial is the rig employed by **Andrew Rogers** (Bristol), who reports hearing Radio Grenada on 15105 at 2000 while **Mark Hallam** has picked up Radio Yugoslavia on 9620kHz at 2200 which has eluded him for some time. A number of out-of-band transmissions are reported by **Bob Bell** of Blyth. These are India on 11620kHz at 2015, Pyongyang on 11535 at 2010, Peking on 11445 at 2005, Pakistan on 11675 at 1745 (not listed) and USSR on 25590 (probably a harmonic). There are quite a few stations to be found in between the standard s.w. bands and it can be an interesting diversion to dig out some of them. Broadcasting out-of-band is likely to increase, partly as h.f. bands are being used less for commercial use and partly in anticipation that the World Administrative Conference 1979 will award additional space for broadcasting.

VHF BANDS

by Ron Ham BRS15744

There should be a law against DX coming at meal times, or during working hours, as did the extensive aurora which manifested during a Friday afternoon in September, or the super-strong signals from Japan, on 10m, during breakfast and the crop of international beacon signals at lunch time. However, through the vigilance of my readers, each making an observation when possible, I can piece together an interesting and scientifically valuable report.

Aurora

The intense aurora borealis which began around noon on September 29th was brought to my attention by **Alan Baker**, G4GNX, Newhaven, Sussex, who was on holiday at the time. During the event, which ended about 1730, **John Branegan**, GM8OXQ, Saline, Fife, used a hand elevated 8-element Yagi to establish the elevation angle for maximum auroral signals. Although his results suggested that the auroral reflector was about 15 degrees from his QTH, John finds this hard to explain because of the strong signals on 2m coming from France and Luxembourg. At the other end of the UK, Alan Baker found that his beam headings were 020 to 070 degrees with a peak at 040.

I cannot add to this because I monitored the early part of the event with a vertical dipole feeding my R216 receiver, from which I heard signals from several mobile radio stations around 72MHz, about 17 continental carriers in Band II and some 30 rough signals between 50 and 75MHz, all bouncing off the aurora. John Branegan heard his own 29MHz OSCAR-8a down-link signals go auroral and heard tone-A signals from the 2m beacons in Cornwall, GB3CTC, Northern Ireland, GB3GI, Lerwick, GB3LER and Wrotham, GB3VHF as well as from amateur stations in DJ, EI, F, G, GI, GW, LX, ON, PA0, and SM. Down south, Alan Baker heard signals from GI, GM, GW, LX, SM and SP, worked his first EI on 2m, EI5BH, G2DUP, Cornwall, GW2HIY, Anglesey, and G4CJG, Durham, who was the most consistent auroral c.w. signal in the south. Alan also worked G4CLA, Manchester, whose auroral s.s.b. was the strongest in Sussex, but his real prize was an auroral QSO with his friend, **Roy Bannister**, G4GPX, in nearby Lancing, Like many others Roy had a good haul of DX during the event. Less prominent auroral disturbances took place around 1700 on September 25th and 27th.

The 10 Metre Band

One of the most consistent signals on 10m between September 20th and October 18th was A9XC, the International Beacon Project station at Bahrain, closely followed by the Cyprus beacon, 5B4CY. John Branegan also heard A9XC consistently and 3B8MS in Mauritius occasionally. Like myself, Alan Baker, **Gordon Goodyer**, BRS 37345, Petworth, Sussex, **Harold Goble**, G4FDQ, Lancing, and **Graham Lay**, West Chiltington, Sussex (a new reader) using an AR88D receiver, have all noted the good conditions on 10m during the first 3 weeks in October, bringing extra strong signals from the far east during the early mornings and the same from the Americas, Canada and many other countries during the afternoon and early evenings. Towards the end of September Harold Brodribb, St Leonards-on-Sea, heard North American CB stations calling their counterparts in W. Germany and at one time thought W5UAW, Mississippi, was going to burst his loudspeaker. **Martin Liezers**, Newport, Gwent, reminds me that in mid-August 10m was also open to S. America until about 2000 on several days, so the band has perked up consistently in recent months.

Solar

John Branegan is now making regular observations of the sun and like **Cmdr Henry Hatfield**, Sevenoaks, Kent, **John Smith**, Rudgwick, Sussex, and myself recorded solar noise between 136 and 147MHz on September 22nd and 23rd. From 1130 to 1330 on the 23rd, **D. S. Jones**, GW3XYW, Pontardulais, Swansea, using an 18ft dish aerial noted a large increase in solar noise at 432MHz while he was testing his EME gear which I hope to hear more of in the future. Henry Hatfield, using his spectrohelioscope counted 24 sunspots on September 21st, saw the remains of a ribbon flare on the 23rd, a bright plage on the 29th, about 20 spots in 8 groups with lots of tiny filaments on October 12th and the remains of a ribbon flare on the 13th, following a large burst of radio noise at 1237 which lasted for about an hour. Solar noise was also recorded on October 3rd, 5th, 9th, and 11th.

Sporadic-E

In our November issue I asked for gen about a caption which read "Granada Television International"' well, **Frank Luman**, Glasgow, says "It is most likely RTVE, from Madrid (E2). Many BBC and ITV programmes go on to Spanish TV. I've seen the *'Muppets'*, *'Starsky and Hutch'* and a situation comedy put out by Thames TV". Frank agrees that things are quieter now the sporadic-E season has finished and reminds me that bands II, III, IV and V are affected by tropospheric disturbances and require high gain systems and pinpoint rotation of the aerial to resolve the DX. Like Frank and his fellow DXers in Scotland, I am looking forward to some good tropo openings this winter.

OSCAR

Our satellite specialist, John Branegan, says "The QSL cards for my first two months of satellite work are now rolling in, 41 in one week with 10 countries confirmed. Best DX K9KB, Fort Wayne, Indiana, but best of all, DD1QS, confirming my first QSO via OSCAR's mode J". To date John has worked 23 countries on mode J, the most recent being CT, LX, and OH.

Microwaves

As usual, **Ern Downer**, G8GKV, Worthing, and **Ern Hoare**, G8BDJ, Southwick, Sussex, were operating portable on Chanctonbury Ring, near Worthing on October 1st for the fifth and final leg of the RSGB's 10GHz Cumulative Contests for 1978. They spent most of the day in low cloud and the water was streaming off their dishes. At 0900 the Alderney 10GHz beacon was about 30dB above the noise but gradually dropped away during the morning and disappeared completely by early afternoon.

They both worked two new stations, G4ETU/P and G8JVE/P also on the South Downs, two home based stations, G3JVL and G8DIC in Hayling Island, G3IFF/P near Portsmouth and G3JHM/P near Alton, Hants. The two Erns also heard signals from F6DLA/P but conditions were rock-bottom for 10GHz and no complete QSOs were made with French stations. Ern Downer said "although we have survived some atrocious weather during the five legs it will not deter us from going portable whenever anyone wants to carry out tests".

Tropospheric

During the late evening of September 21st I heard continental signals coming up in Band II and by 0700 on the 22nd it was obvious that a tropospheric opening had begun. While I heard strong signals from GW mobiles through the Bristol Channel repeater, R6, French stations through the Kent repeater, R4, strong pictures from Lichfield on Channel 8 and a 539 signal from the Sutton Coldfield beacon, GB3SUT on 70cm, **Martin North**, G8HKK, Bath, had a 59 f.m. QSO with G4GNX, Newhaven, on S16. At 0700 on the 23rd, French stations were working through the Hampshire, GB3SN, Kent, GB3KR and Malvern Hills, GB3MH repeaters, strong pictures were coming from Lichfield, many French broadcast stations were audible in Band II and while Band V TV was upset, GB3SUT was 559 on 70cm in Sussex. During the late evening, **John Cooper**, G8NGO, Cowfold, Sussex, and G4GNX worked into France on 2m and G4GNX also worked GJ and, to his delight, LX. Early on the 24th, G4GNX, G8NGO and David Coble, G8HDF, Lancing, worked into DJ, and David, using a Liner-11 with an HB9CV mini-beam in the loft also had QSOs with stations in GU, ON and PE. Changes in the atmospheric pressure coupled with the remarkable fine weather unsettled the v.h.f.s from October 10th to 14th, because, early on the 10th, **Mike Gaskin**, Croydon, heard Hilversum 1 and 2 and several German broadcast signals in Band II and on the 12th Continental stations were again heard between 88-100MHz by **Ian Rennison,** Horsham and myself. **Peter Penfold**, West Chiltington, Gordon Goodyer and Alan Baker all commented about the large number of French stations working through the southern England repeaters. **Guy Stanbury**, Chelmsford, Essex, is now in contact with **John Ding**, Suffolk, **Rodney Sixe**, Cornwall, **Des Walsh**, Co Tipperary, and **Martin Warburton**, Wiltshire, who, like myself, are all Band II enthusiasts and I shall look forward to hearing from them all in the future.

Club News

On September 21st, the Sussex Repeater Group held a mammoth junk sale in Brighton in aid of funds and the organisers were overwhelmed with the results and wish to thank everyone who supported them.

Fifteen members of the Brighton and District Radio Society visited Cmdr Henry Hatfield's observatory on September 30th and were fascinated by the intricate workings of Henry's spectrohelioscope.

Several of our readers attended the first open day of The Chalk Pits museum at Houghton, Sussex, on October 15th and looked in at the site radio building where the early radio collections of David Rudram, Worthing, and myself are on display. This new industrial museum, which should open next May, covers more than 30 acres, so, to assist the organisers and the thousand or so visitors, Cadet Wireless operators with six v.h.f. sets from Flt/Lt John Keegan's 2464 (Storrington) Squadron, ATC, maintained the day's communications.

The Chichester and District Amateur Radio Club have conferred the title of Honorary Life Member upon one of our original readers, **Russell Ward**, G8AFT, for past services to the club.

Russell, now 78 years old, became interested in radio in 1922 when he was a member of the first ever radio club at RAF Cranwell. Although he left the RAF in 1924, he remained on the reserve and was recalled during World War 2, serving as a Flt/Sgt Electrical Fitter.

Unfortunately, through ill health, G8AFT spends much of his time in bed, so fellow club members have installed a 2m transceiver by his bedside to keep him in touch with his many friends in the world of amateur radio.

From Down Under

Anthony Mann, Applecross, Western Australia, says "August was rather poor, with nothing above 41MHz. A rapid improvement was noted since early September with 36MHz US v.h.f. in almost daily, and Far East m.u.f.s in the 45-50MHz region. Consequently E2 Malaysia and R1, 49·75MHz, China/USSR have been seen several times". Anthony received strong pictures on Chinese R1 between 1700 and 1800 on September 16th, 1500 on the 17th, and 1700 to 1900 on the 18th, but on the 30th, Chinese R1 was seen around 0930 which was the first time that Far East DX has been in so early. On September 29th, signals from the Hawaii 6m beacon, 50·104MHz, were received in Adelaide, S. Australia, and during the morning of October 1st, there was a strong 52MHz opening to Japan.

Thank you all for your most interesting letters and the support you have given my column throughout the past year, I wish you all a merry Christmas and look forward to hearing from you again in 1979.

Stop Press

Some super long-distance v.h.f. reception is reported in a letter just in from Anthony Mann in Australia. Channel B1 BBC TV sound on 41·5MHz was received there on October 13, 14, 16 and 19th with the companion vision channel on 45MHz also present on the 13th. French Channel F2 sound on 41·25MHz was heard on October 16th.

VHF PERSONALITY

Flt. Lt. JOHN KEEGAN *by RON HAM*

At the age of 14, John Keegan's interest in radio was stimulated by the variety of signals he heard on the short-wave bands of a domestic broadcast receiver. Very soon he became a keen home constructor and well remembers the thrill of his first home-brew receiver, comprising a 1T4 valve, Repanco coils and a pair of headphones which he later replaced with an amplifying stage and a loudspeaker.

In 1962, John, then living in Liverpool, became a Civilian Instructor with 611 Squadron, Air Training Corps, and used the famous R1155/T1154 equipment on the ATC's national h.f. network. The ATC became a major part of his life. In 1966 he was commissioned as Pilot Officer and in 1968 was promoted to Flying Officer. Later, moving to Nottingham, he joined 1359 Squadron and served there for two years.

John is a regular reader of *Practical Wireless* and has a complete set dating back to 1961. His interest in v.h.f. radio, fostered by the ATC, is maintained in the air, because, as a civilian pilot, he holds a v.h.f. aeronautical operator's licence. In 1974 he moved to Steyning, to take up the post of Principal Development Engineer, Human Factors, with a Sussex firm who build flight simulators, and the ATC posted him to 2464 Squadron in nearby Storrington. Promotion to Flt. Lt. and to Commanding Officer of 2464 Squadron followed in 1976, since when he has devoted a major part of the Squadron's training programme to v.h.f. radio.

In the picture with John Keegan (back left) is Flt. Sgt. Maynard, one of the Squadron's senior radio operators, Cpl. Nigel Golds (back right) a keen broadcast and short-wave listener and (seated) Cadet David Sopp, a trainee wireless operator.

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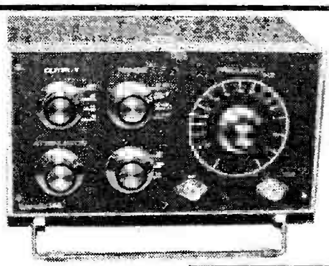

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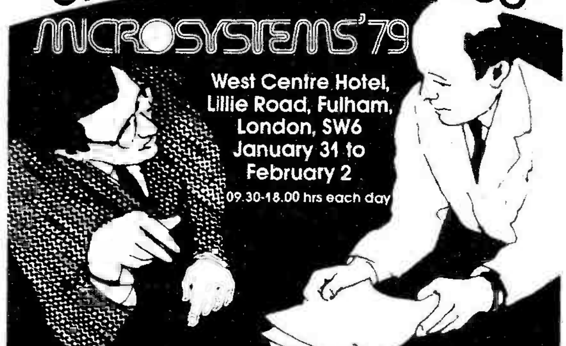

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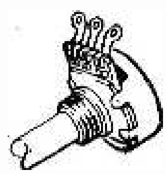

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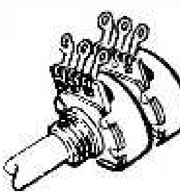

P20 lin.	100Ω to 4M7
P20 log:	220Ω to 2M2
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JP20 log:	4K7 to 2M2

DP20 made to order in any values available in P20. State front (near bush) and rear tracks clearly.

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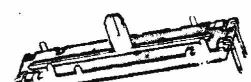

PG58 lin.	4K7 to 1M
PG58 log:	10K to 1M
C1PG58 lin	4k7 to 1M
C1PG58 log	4K7 to 1M
C1PG58ST lin:	4K7 to 1M
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Log stereo matching ± 2dB @ 10%R; ± 3dB @ 3 2%R; ± 4dB @ 1%

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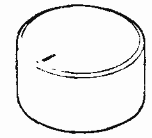

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K492 37mm	**46p**
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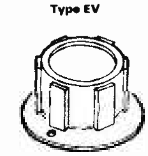
K382 dial 270° 0-10	**22p**
K389 dial 300° 0-10	**22p**



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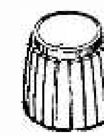


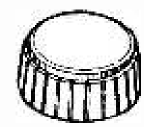
K5

Caps 15mm

C150	**3p**
C151 with line	**5p**
C152 w. spot	**5p**

Caps 21mm

C210	**3p**
C212 w. spot	**5p**



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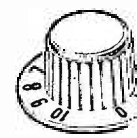

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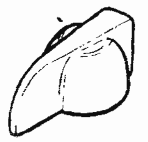

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K6 25mm	**25p**
NK 36mm SK	**37p**
PK 36mm SP	**37p**
SK6 41mm SK	**36p**
K7 19mm B/W	**20p**
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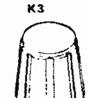

Si Fam Collet

K8

S skirted
M metal insert
P pointer
Sk skirt, 0-10
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992	89 x 35 x 30	**1.24**
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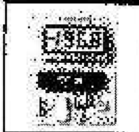

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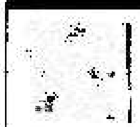

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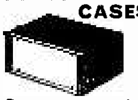

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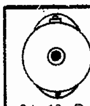

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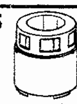

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I enclose Cheque/P.O. for £.......................

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PRACTICAL WIRELESS,
GMG, Classified Advertisement Dept., Rm. 2337,
King's Reach Tower, Stamford Street,
London SE1 9LS **Telephone 01-261 5846**

Rate
22p per word, minimum 12 words. Box No. 60p extra.

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WATFORD ELECTRONICS

33/35, CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW. FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 30p* TO ALL ORDERS UNDER £10·00. OVERSEAS ORDERS POSTAGE AT COST. SEND 50p FOR OUR CATALOGUE.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked *. To the rest add 12½%.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/Br. Rail Station: Watford High Street. Open Monday to Saturday 9 a.m.–6 p.m. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type. (Values are in µf). **400V:** 0·001, 0·0015, 0·0022, 0·0033 **7p**; 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p**; 0·022, 0·033, **10p**; 0·047, 0·068, **14p**; 0·1, **15p**; 0·15 0·22, **22p**; 0·33, 0·47 **39p**; 0·68 **45p**. **160V:** 0·039, 0·15, 0·22 **11p**; 0·33, 0·47 **19p**; 0·68, 1·0 **22p**; 1·5 **29p**; 2·2 **32p**; 4·7 **36p**. **DUBILIER: 1000V:** 0·01, 0·015 **20p**; 0·022 **22p**; 0·047 **26p**; 0·1 **38p**; 0·47 **53p**; 1·0 **175p**.

POLYESTER RADIAL LEAD (Values in µf). **250V:** 0·01, 0·015, 0·022, 0·027 **5p**; 0·033, 0·047, 0·068, 0·1 **7p**; 0·15 **11p**; 0·22, 0·33 **13p**; 0·47 **15p**; 0·68 **18p**; 1·0 **24p**; 1·5 **27p** 2·2 **31p**

FEED THROUGH CAPACITORS 1000pF/350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). **500v:** 10 **40p**; 47 **63p**; **250v:** 100 **65p**; **63v:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8, 10, 15, 22, **8p**; 47, 32, 50, **11p**; 63, 100, **27p**; **50V:** 1·0, **7p**; 50, 100, 220, **25p**; 470, **50p**; 1000, **62p**; **40V:** 22, 33µF, **7p**; 100, **11p**; 2200, 3300, **62p**; 4700, **64p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; 1000, **49p**; **25V:** 10, 22, 47, **6p**; 80, 100, 160, **8p**; 220, 250, **13p**; 470, 640, **25p**; 1000, **27p**; 1500, **30p**; 2200, **41p**; 3300, **58p**; 4700, **64p**; **16V:** 10, 40, 47, 68, **7p**; 100, 125, **8p**; 220, 330, **14p**; 470, **16p**; 1000, 1500, **20p**; 2200, **34p**; **10V:** 100, **6p**; 640 **12p**; 1000, **14p**.
TAG-END TYPE: 70V: 2000, **98p**; 4700, **121p**; **50V:** 10,000 **245p**; **40V:** 2500, **65p**; 3300, 4700, **70p**; 15,000, **450p**; **25V:** 4700, **48p**; 2000, **37p**; **40V:** 2000+2000, **95p**.

TANTALUM BEAD CAPACITORS **35V:** 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8, **25V:** 1·5, 10. **20V:** 1·5µF **13p** each. **10V:** 22µF, 33, **6V:** 22µF, 47, 68, **3V:** 100µF **20p** each. **10V:** 100µF **30p**. **16V:** 47, 100µF **40p**

MYLAR FILM CAPACITORS **100V:** 0·001, 0·002, 0·005, 0·01µF **6p**; 0·015, 0·02, 0·03, 0·04, 0·05, 0·056µF **7p**; 0·1µF, 0·2 **9p**. **50V:** 0·47µF **11p**

CERAMIC CAPACITORS 50V. Range: 0·5pF to 10nF **3p**; 15nF, 22nF, 33nF, 47nF, **4p**. 100nF **6p**

POLYSTYRENE CAPACITORS: 10pF to 1nF, **8p**. 1·5nF to 47nF, **10p**.

POTENTIOMETERS (AB or EGEN) Carbon Track, 0·25W Log & 0·5W Linear values

500 Ω, 1K & 2K (LIN ONLY) Single	27p
5KΩ–2MΩ single gang	27p
5KΩ–2MΩ single gang D/P switch	60p
5KΩ–2MΩ dual gang stereo	70p

SLIDER POTENTIOMETERS 0·25W log and linear values 60mm track

5KΩ–500KΩ single gang	70p
10KΩ–500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	22p

PRESET POTENTIOMETERS

0·1W 50Ω–2·2M Mini. Vert. & Horiz.	8p
0·25W 100Ω–3·3MΩ Horiz. } larger	10p
0·25W 250Ω–4·7MΩ Vert. } larger	10p

SILVER MICA (pF) 3·3, 4·7, 6·8, 10, 12, 18, 22, 27, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 200, 250 **9p** each. 300, 330, 360, 390, 600 & 820pF **16p** each. 1000, 2200pF **20p** each.

S-DEC	325p*
T-DEC	425p*
U-DEC 'A'	450p*
U-DEC 'B'	695p*

RESISTORS–Erie make 5% carbon Miniature High Stability, Low Noise

	RANGE	Val.	1–99	100+
0·25W	2·2Ω-4·7M	E24	1·5p	1p
0·5W	2·2Ω-4·7M	E12	2p	1·5p
1W	2·2Ω-10M	E12	5p	4p
2% Metal Film 10Ω–1M			6p	4p
1% 0·5W 51Ω–1M		E24	10p	8p

JACKSONS VARIABLE CAPS.

Dielectric	
100/300pF	140p
500pF	165p
6:1 Ball Drive 4511/DAF	115p*
Dial Drive 4103 6:1/36:1	650p*
Drum 54mm	30p*
0-1-365pF	245p
00 2 365pF	275p
0 2 365pF with slow motion Drive	325p
00 208/176	285p
,, ,, with slow motion drive	325p
C804–5pF; 10; 15; 25; 50pF	175p*
100, 150pF	215p*
'L' 3x310pF	495p
00-3x25pF	430p

COMPUTER HARDWARE:–

2101	99p	4027	190p
2102	100p	4047	750p
2111	175p	74S188	165p
2114	650p	74S262	875p
2516	TBA	74S287	325p
2532	TBA	74S470	325p
2708	650p	74S475	825p
27LO8	995p	81LS95	70p
2716	1650p	81LS96	70p
3064	TBA	9900	£35
TMS6011	325p	9980	TBA

TRIMMERS mini 2·5–6pF; 3–10pF; 3–30pF; 10–40pF **22p**; 5–25pF; 65pF; 88pF **30p**

COMPRESSION 3–40pF; 10–80pF **22p**; 25–200pF **33p**; 100–500pF **45p**

AUDIBLE Warning Buzzers 6V or 12V **65p***

RF CHOKES 1µF, 4·7, 10, 22, 47, 100, 220, 470, 750, 1mH, 2·5, 5, 10mH **35p**

CRYSTALS

100KHz	385p
455KHz	385p
1MHz	323p
1·80MHz	385p
1·6MHz	395p
3·2768MHz	323p
4·0MHz	323p
4·032MHz	323p
4·433619M	135p
5·0MHz	355p
8·083333M	275p
18MHz	395p

TRANSFORMERS* (Mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 100mA **95p.**
8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V ·25A 15V-·25A **195p.**
12VA; 4·5V-1·3A 4·5V-1·3A; 6V-12A 6V-1·2A 12V-·5A 12V-·5A; 15V- ·4A 15V-·4A 20V- ·3A 20V-·3A (20p p&p) **220p**
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A (45p p&p) **290p**
50VA: 6V-4A 6v-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A (50p p&p) **350p.**
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A (60p p&p) **650p**
(N.B. P&P charge to be added above our normal postal charge.)

DENCO COILS Dual Purpose 'DP' VALVE TYPE
Ranges: 1–5 Bl. Yl. Rd. Wht. **86p**
6–7 B, Y, R **75p**
1–5 Green **92p**
'T' type (Transistor Tuning).
Ranges: 1–5 Bl. Yl. Rd. Wht. **92p**

B9A Valve Base	25p
RDT2	92p
RFC 5 chokes	91p
RFC 7(19mH)	96p
1FT 13/14/15/16 17	85p
1FT 18/1·6 or 465	99p
TOC1	86p
MW 5FR	82p
MW/LW 5FR	103p

TRANSISTORS

	p
AC107*	23
AC117*	35
AC125*	20
AC126*	20
AC127*	20
AC128*	20
AC141*	24
AC141K*	38
AC142*	24
AC142K*	38
AC176*	18
AC187*	20
AC188*	20
ACY17	35
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
AD149*	70
AD161*	42
AD162*	42
AF106	70
AF114*	25
AF115*	25
AF116*	25
AF117*	25
AF118*	55
AF121*	48
AF124*	55
AF125*	35
AF126	55
AF127*	35
AF139*	35
AF178*	70
AF180*	70
AF239*	42
AFZ12	126
ASY26*	40
ASY27*	45
ASY50*	95
ASY76*	85
BC107*	9
BC107B*	10
BC108*	9
BC108B*	12
BC108C*	12
BC109	9
BC109B*	12
BC109C*	12
BC113	17
BC114	19
BC115	19
BC116	19
BC117	15
BC118	11
BC119*	26
BC134	19
BC135	20
BC136	18
BC137	20
BC140*	28
BC142*	25
BC143*	25
BC147	7
BC147B	10
BC148	7
BC148B	11
BC148C	11
BC149	8
BC149C	10
BC153	14
BC154	14
BC157	10
BC158	11
BC159	11
BC160*	27
BC167A	11
BC168C	12
BC169C	10

	p
BC170	17
BC171	11
BC172	10
BC173	12
BC177*	17
BC178*	17
BC179*	17
BC182	9
BC183	9
BC184	9
BC182L	10
BC183L	10
BC184L	10
BC186	21
BC187*	28
BC212	9
BC212L	10
BC213	9
BC213L	11
BC214	9
BC214K	14
BC214L	10
BC307B	14
BC308	13
BC327	15
BC328	13
BC338	12
BC441*	30
BC461*	30
BC477*	25
BC547	11
BC548	11
BC549C	13
BC557	13
BC558	12
BC559	20
BCY30*	57
BCY34*	75
BCY39*	80
BCY40*	78
BCY42	48
BCY43	75
BCY58	22
BCY59*	22
BCY70*	15
BCY71*	17
BCY72*	17
BCY78*	20
BCZ10	145
BCZ11	145
BD112	95
BD115*	62
BD121*	95
BD123*	98
BD124*	115
BD131*	38
BD132*	38
BD133*	43
BD135*	36
BD136*	37
BD137*	36
BD138*	36
BD139*	45
BD140*	50
BD142*	59
BD144*	190
BD145*	198
BD181*	85
BD205*	110
BD222	60
BD378*	65
BD434	42
BD517*	85
BD695A*	75
BD696A*	75
BDY11	220
BDY17*	195
BDY56*	156
BDY60*	110
BDY61*	165
BF115*	22
BF154*	23
BF158	29
BF160	30
BF161	60

	p
BF167	25
BF173*	25
BF177*	24
BF178*	25
BF179*	30
BF180*	20
BF181*	30
BF182*	30
BF183*	30
BF184*	30
BF194	10
BF195	10
BF196	10
BF197	10
BF198	18
BF199	18
BF200*	32
BF224A	18
BF244	24
BF244B	30
BF256*	50
BF257*	26
BF258*	30
BF259*	32
BF336	30
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29*	26
BFX84*	24
BFX85*	24
BFX86*	28
BFX87*	23
BFX88*	24
BFY18*	50
BFY50*	20
BFY51*	20
BFY52*	20
BFY53*	28
BFY55*	45
BFY64*	40
BFY71*	20
BLY83*	649
BSX20*	18
BSX26*	75
BSX29*	45
BSX78*	55
BSY95A	25
BU105*	140
BU205	190
BU208	228
E421	96
MD8001	158
ME1120	25
ME4102	10
ME6002	14
MJ400*	90
MJ491*	190
MJ2955*	95
MJE340*	50
MJE370*	55
MJE371*	60
MJE520*	45
MJE521*	65
MJE2955*	99
MJE3055*	70
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	24
MPSA06	24
MPSA12	42

	p
MPSA55	24
MPSA56	24
MPSA70	34
MPSU02	58
MPSU05	48
MPSU06	54
MPSU52	65
MPSU55	53
MPSU56	56
MPU131*	39
OC23*	150
OC25*	120
OC26*	150
OC28*	99
OC29*	160
OC35*	80
OC36*	99
OC41*	48
OC42*	32
OC43*	55
OC44*	31
OC45*	20
OC46*	28
OC70*	19
OC71*	25
OC72*	30
OC74*	45
OC75*	45
OC76*	36
OC77*	76
OC79*	76
OC81D*	28
OC82D*	48
OC83*	48
OC84*	44
OC122*	48
OC123*	48
OC139*	85
OC140*	85
OC141*	85
OC170*	40
OC171*	40
OC200*	48
OC201*	75
OC202	85
OC203*	85
OC204*	85
SJE5039*	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	47
TIP30B	64
TIP30C	65
TIP31*	40
TIP31A*	40
TIP31B*	40
TIP31C*	65
TIP32*	40
TIP32A*	49
TIP32B*	70
TIP32C*	70
TIP33*	80
TIP33A*	80
TIP33B*	100
TIP33C*	105
TIP34*	85
TIP34A*	85
TIP34B*	110
TIP34C*	110
TIP35*	219
TIP35A*	225
TIP35B*	240
TIP35C*	270
TIP36*	280
TIP36A*	265
TIP36B*	300
TIP36C*	325
TIP41A*	63
TIP41B*	73
TIP42A*	64
TIP42B*	82
TIP2955*	63

	p
TIP3055*	60
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50
TIS49	50
TIS50	47
TIS60	45
TIS62	45
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	18
ZTX303	21
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250*	85
40251*	97
40311*	50
40313*	125
40315*	55
40316*	85
40317*	52
40319*	71
40320*	56
40323*	60
40324*	85
40326*	52
40327*	62
40347*	80
40348*	101
40360*	43
40361*	45
40362*	48
40406*	65
40407*	50
40408*	75
40411*	285
40412*	63
40467*	95
40594*	80
40595*	90
40603*	58
40636*	125
40673*	68
2N697*	21
2N698*	39
2N699*	39
2N706A*	19
2N707*	50
2N708*	19
2N914*	32
2N916*	27
2N918*	30
2N920*	51
2N1131*	22
2N1132*	22
2N1303*	50
2N1304*	50
2N1305*	28
2N1306*	35
2N1307*	50
2N1308*	46
2N1613*	23
2N1670*	150
2N1671B*	195

	p
2N2160*	105
2N2217*	48
2N2218A*	31
2N2219A*	22
2N2220A*	26
2N2221A	23
2N2222A*	20
2N2303*	45
2N2368*	21
2N2369A*	15
2N2483*	28
2N2484*	30
2N2646*	48
2N2784	55
2N2904*	22
2N2905A*	20
2N2906*	18
2N2907*	20
2N2907A*	22
2N2926G	10
2N3011*	24
2N3053*	20
2N3054*	49
2N3055*	55
2N3108	39
2N3442*	131
2N3563	20
2N3614*	169
2N3615*	135
2N3663*	24
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	16
2N3711	10
2N3772*	170
2N3773*	288
2N3819	22
2N3820	32
2N3823*	65
2N3824*	70
2N3866*	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037*	52
2N4041*	80
2N4058*	17
2N4061	17
2N4062	13
2N4064*	120
2N4069	45
2N4236	145
2N4286	20
2N4289	20
2N4427*	75
2N4859	65
2N4922*	55
2N5135	42
2N5136	42
2N5138	20
2N5172	24
2N5179*	60
2N5180*	60
2N5191*	65
2N5305*	24
2N5457	32
2N5458	32
2N5459	32
2N5485	32
2N5642*	750
2N5777	86
2N6027	40
2N6109	45
3N128	85
3N140	85

Matched Pair 10p extra

LINEAR IC'S

702	75
709C 8 pin	35
723* 14 pin	45
741* 8 pin	22
747C 14 pin	70
748C 8 pin	38
753 8 pin	150
810	150
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	305
AY-1-5050	180
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500*	390
AY-3-8710*	850
AY-5-1224A*	260
AY-5-1230*	450
AY-5-1315	580
AY-5-1317A	830
AY-5-3500*	510
AY-5-4007	650
AY-5-8100*	735
CA3011*	82
CA3014*	137
CA3018*	68
CA3020	170
CA3023	170
CA3028A*	80
CA3035	240
CA3036	110
CA3043	180
CA3045	140
CA3046	70
CA3048	200
CA3075	175
CA3080E*	70
CA3081	180
CA3089E	210
CA3090AQ	375
CA3123	200
CA3130*	85
CA3140	70
ICL7106*	752*
ICL7107*	975
ICL8038CC*	335
ICM7205*	1150
LD130*	452
LM300H	170
LM301A*	30
LM304*	240
LM308T	110
LM311H*	120
LM318H*	205
LM318S*	185
LM324A	70
LM339	80
LM348	95
LM349*	125
LM379*	375
LM380	85
LM381N	145
LM381AN	248
LM382	125
LM732	125
LM1458*	50
LM3900*	60
LM3909N*	70
LM3911*	125
M252AA*	750
M253AA*	795
MC1303	88
MC1304P	200
MC1310P	149
MC1312PQ	185
MC1488*	85
MC1489*	90
MC1495	395
MC1496L	92
MC3340P*	150
MC3360P	120
MC3401	70
MEM780	205
MFC4000B	85
MFC6040*	87
MK50362*	650
MK50398*	635
MM57160*	620
NE543K	210
NE544	185
NE555*	29
NE556DB*	60
NE560*	325
NE561*	395
NE562B*	410
NE564*	425
NE565A*	120
NE566*	160
NE567V*	170
NE571	420
RAM2102-2*	170
RC4136D	120
ROM2513*	595
SG3402*	295
SL437A	560
SN72710*	43
SN72733*	125
SN76003N	175
SN76013N	140
SN76013ND	120
SN76018*	148
SN76023N	140
SN76023ND	111
SN76033N	175
SN76115N	215
SN76131*	110
SN76227N	116
SN76477*	225
TAA621AX1	228
TAA661A	155
TAA960	300
TAD100	150
TBA120S	70
TBA540	215
TBA550Q	330
TBA641-A12/BX1 or BX11	250
TBA651	180
TBA800	90
TBA810S	99
TBA820	70
TBA920Q	260
TCA965*	120
TDA1022	575
TDA2020	320
TLO71*	70
TLO81CP*	52
TLO82CP*	96
TLO84CP*	130
UAA170	198
ZN414	90
ZN424E	130
ZN425E*	410

TTL 74* (TEXAS)

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	30
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	30
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	84
7446	84
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	30
7480	48
7481	86
7482	69
7483	72
7484	85
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74104	82
74105	82
74107	29
74109	64
74110	54
74111	68
74112	88
74116	198
74118	83
74119	119
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74141	56
74142	269
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74157	67
74159	210
74160	82
74161	92
74162	92
74163	62
74164	105
74165	105
74166	161
74167	198
74170	230
74172	625
74173	170
74174	87
74175	87
74176	75
74177	78
74180	85
74181	185
74182	90
74184	135
74185	135
74188	275
74190	115
74191	105
74192	185
74193	105
74194	105
74195	95
74196	99
74197	85
74198	150

74LS*

74LS00	18
01	18
02	20
04	20
10	20
13	38
14	75
27	28
42	98
74LS47	90
73	96
74	41
75	49
83	115
90	60
96	116
107	44
132	95
139	85
151	96
153	76
155	96
156	96
157	76
158	96
160	128
161	98
162	138
163	113
164	114
174	106
175	110
181	318
190	140
191	140
192	130
193	130
196	100
221	98
241	236
298	185
386	86

Complete LS range available

CMOS*

4000	15
4001	17
4002	17
4006	105
4007	18
4008	87
4009	50
4010	50
4011	18
4012	18
4013	42
4014	86
4015	89
4016	45
4017	89
4018	89
4019	48
4020	99
4021	91
4022	88
4023	20
4024	66
4025	18
4026	180
4027	45
4028	81
4029	99
4030	58
4031	205
4032	100
4033	145
4034	186
4035	111
4036	325
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	88
4045	145
4046	128
4047	97
4048	58
4049	48
4050	48
4051	72
4052	73
4053	72
4054	110
4055	128
4057	2570
4059	480
4060	115
4063	110
4066	58
4067	380
4068	22
4069	20
4070	32
4071	21
4072	21
4073	21
4075	23
4076	85
4077	40
4078	21
4081	20
4082	21
4085	74
4086	73
4089	150
4093	85
4094	190
4096	105
4097	372
4098	110
4099	145
4160	100
4161	100
4162	100
4163	100
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4411	1040
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	1099
4435	825
4440	1275
4450	295
4451	295
4452	
4490F	695
4490V	525
4501	17
4502	120
4503	69
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4513	206
4514	265
4515	280
4516	125
4517	382
4518	102
4519	55
4520	108
4521	183
4522	199
4527	152
4528	90
4529	165
4530	85
4531	185
4532	127
4534	788
4536	380
4538	160
4539	116
4541	150
4543	175
4549	396
4553	449
4554	152
4556	78
4557	451
4558	117
4559	388
4560	208
4561	85
4562	533
4566	150
4568	299
4569	359
4572	25
4580	604
4581	409
4585	101

INDEX TO ADVERTISERS

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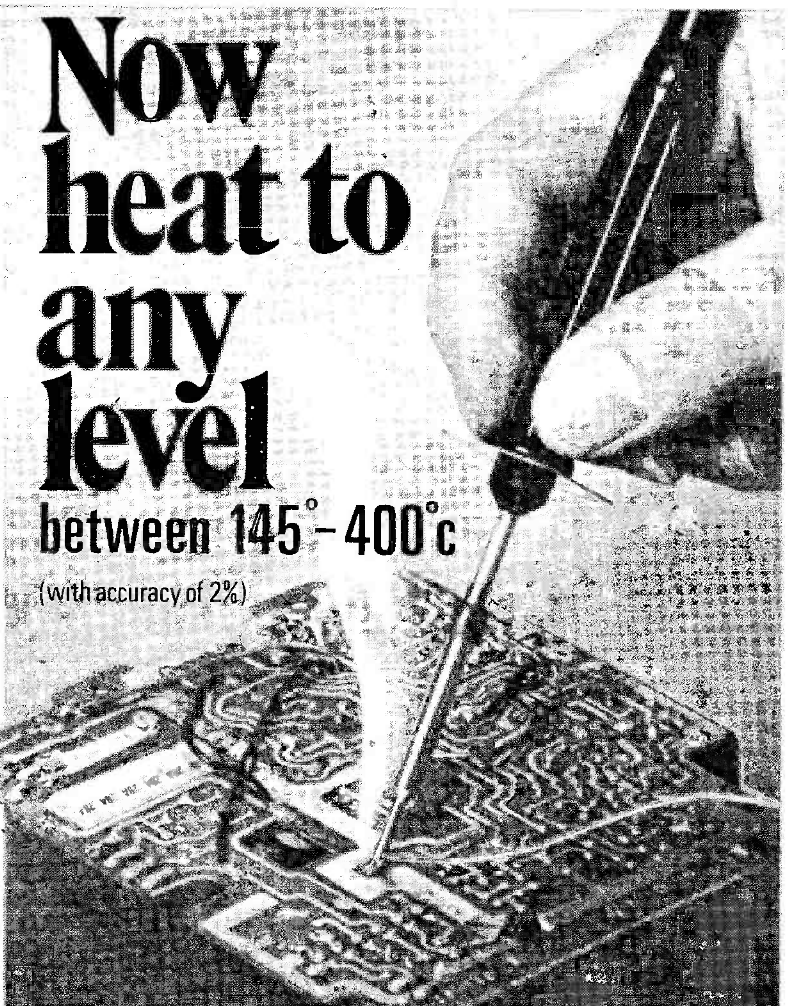
Now heat to any level

between 145°-400°c

(with accuracy of 2%)



With the Antex TCSU1 Soldering Station

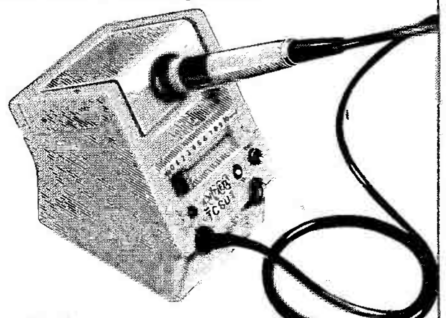
All Antex soldering irons are made on the principle of putting the heating element inside a shaft, then the desired bit is eased over the shaft, giving maximum heat transference, this is why so often a small Antex iron can do the job of a larger conventional iron. The precision made slide-on bits are slit to make them easily interchangeable.

The ANTEX multi purpose range of soldering equipment is fast becoming a must for every home. Built with precision for long life, each iron is fully tested and guaranteed.

ANTEX soldering irons are made in England to strict local and international standards of safety.

Stocked by many wholesalers and retailers or direct from us if you are desperate.

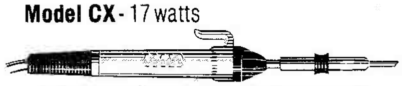
Model TCSU1 Soldering Station



CTC 35 watt –

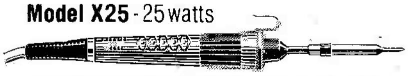
The TCSU1 soldering station with either the XTC 50 watt – 24/26 volt soldering iron or the CTC 35 watt – soldering iron for pin point precision and exceptionally fast recovery time. We have put at least twice as much power into irons which are already well known for good recovery time. The temperature control stops them from over-heating; the "fail-safe" electronic circuit provides protection even if the thermocouple fails. TCSU1 soldering station **£38.10** XTC and CTC irons **£14.85** inclusive of VAT and P.& P.

Model CX - 17 watts



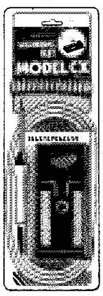
... a miniature iron with the element enclosed first in a ceramic shaft, then in a stainless steel. Virtually leak-free. Only 7½" long. Fitted with a 3/32" bit £4·37 inclusive of VAT and P.& P. Range of 5 other bits available from ⅛" down to 3/64".

Model X25 - 25 watts



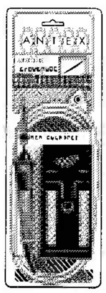
A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at £4·37 inclusive of VAT and P.& P. Range of 4 other bits available.

Model SK3 Kit



Contains both the model CX230 soldering iron and the stand ST3. Priced at £6·21 inclusive of VAT and P.& P. It makes an excellent present for the radio amateur, modelmaker or hobbyist.

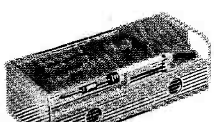
Model SK4 Kit



With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home. Priced at £6·21 inclusive of VAT and P.& P.

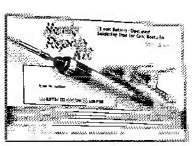
Model SK1 Kit

This kit contains a 15 watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet 'How to solder'. Priced at **£6.48** inclusive of VAT and P.& P.



Model MLX Kit

The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price **£4.83** inclusive of VAT and P.& P.



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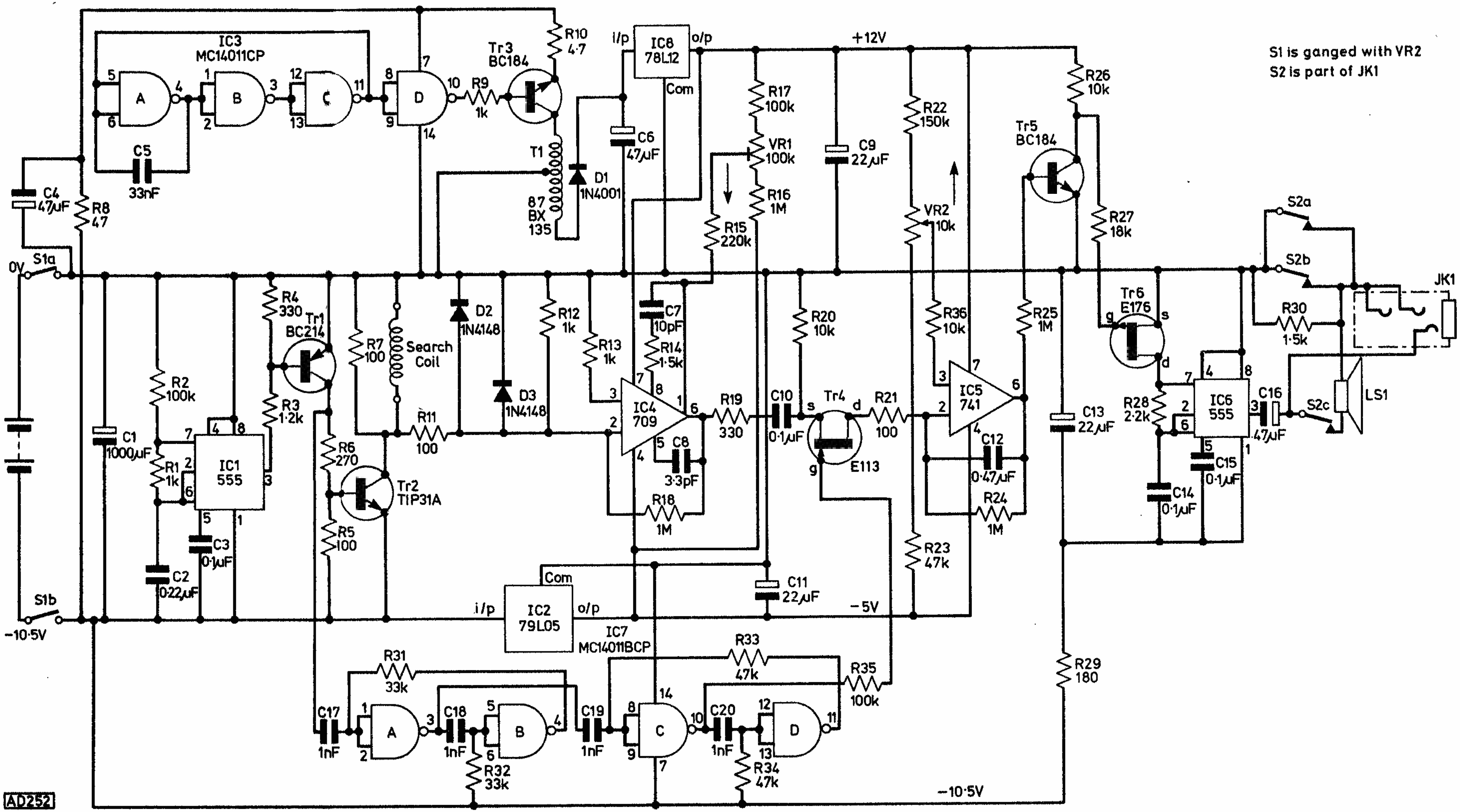
S1 is ganged with VR2
S2 is part of JK1
IC3
MC14011CP
A
B
C
D
C5
33nF
C4
47µF
R8
47
0V
S1a
S1b
−10·5V
R10
4·7
Tr3
BC184
R9
1k
T1
87
BX
135
D1
1N4001
IC8
78L12
i/p
o/p
Com
C6
47µF
+12V
R17
100k
VR1
100k
R16
1M
R15
220k
C9
22µF
R22
150k
VR2
10k
R26
10k
Tr5
BC184
R27
18k
S2a
S2b
S2c
JK1
R30
1·5k
LS1
C1
1000µF
R2
100k
R1
1k
IC1
555
C2
0·22µF
C3
0·1µF
R4
330
Tr1
BC214
R3
1·2k
R6
270
Tr2
TIP31A
R5
100
R7
100
Search
Coil
R11
100
D2
1N4148
D3
1N4148
R12
1k
R13
1k
C7
10pF
R14
1·5k
IC4
709
C8
3·3pF
R18
1M
R19
330
C10
0·1µF
R20
10k
Tr4
E113
R21
100
R36
10k
IC5
741
C12
0·47µF
R24
1M
R25
1M
R23
47k
C11
22µF
−5V
IC2
79L05
IC7
MC14011BCP
Tr6
E176
R28
2·2k
IC6
555
C16
47µF
C13
22µF
C14
0·1µF
C15
0·1µF
R29
180
R31
33k
R33
47k
R35
100k
C17
1nF
C18
1nF
C19
1nF
C20
1nF
R32
33k
R34
47k
−10·5V
AD252