

JUNE  
1978

# practical WIRELESS

Australia 85c  
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South Africa 80c  
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45p



ALSO:- SIMPLE DARKROOM TIMER  
STATESIDE CALLING

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### TANK BATTLE GAME



## T.T.L. 74 I.C.s by TEXAS, NATIONAL, I.T.T., FAIRCHILD Etc

7400 14p	7413 30p	7437 25p	7460 15p	7481 75p	74121 30p	74139 100p	74155 75p	74173 150p	74188 350p
7401 14p	7414 30p	7438 25p	7470 30p	7482 45p	74122 40p	74141 60p	74156 70p	74174 100p	74189 350p
7402 14p	7416 30p	7440 15p	7472 25p	7483 40p	74153 60p	74142 27p	74157 70p	74175 75p	74190 140p
7403 14p	7417 30p	7441 65p	7473 30p	7485 60p	74125 50p	74143 27p	74160 90p	74176 100p	74191 140p
7404 14p	7420 15p	7442 65p	7474 30p	7486 70p	74126 50p	74144 27p	74181 90p	74177 100p	74192 120p
7405 14p	7422 20p	7445 80p	7475 30p	74100 35p	74130 130p	74145 75p	74162 90p	74178 140p	74193 120p
7406 40p	7423 25p	7446 85p	7476 30p	74184 40p	74131 100p	74147 230p	74183 90p	74179 140p	74194 100p
7407 40p	7424 25p	7447 75p	7477 30p	74105 40p	74132 85p	74148 100p	74184 125p	74180 100p	74195 100p
7408 20p	7426 25p	7448 70p	7483 70p	74107 30p	74135 100p	74150 120p	74185 125p	74181 200p	74196 100p
7409 20p	7427 25p	7450 15p	7485 100p	74108 50p	74136 80p	74151 65p	74186 125p	74182 75p	74197 100p
7410 15p	7428 40p	7451 15p	7486 30p	74110 50p	74137 100p	74152 65p	74187 325p	74183 150p	74198 185p
7411 20p	7430 15p	7453 15p	7489 250p	74118 50p	74138 125p	74153 120p	74188 200p	74184 150p	74199 185p
7412 20p	7432 25p	7454 15p	7490 35p						

## SEMICONDUCTORS by MULLARD, TEXAS, MOTOROLA, SIEMENS, I.T.T., R.C.A.

10 for AD161 350p	10 for BC183L 160p	10 for BC547B 100p	10 for BD135 350p	10 for BF199 220p	10 for E430 1150p	10 for TIP23B 380p	10 for TIP34A 720p	10 for 1N4005 45p	10 for 2N3705 90p
AD162 350p	BC184 80p	BC548 90p	BD136 350p	BF200 280p	MPSA65 250p	TIP23C 465p	TIP34B 800p	1N4006 50p	2N3706 90p
BC107 90p	BC184L 160p	BC549 120p	BD137 350p	BF204 150p	MPSA66 250p	TIP30 350p	TIP34C 2000p	1N4007 60p	BYX94 70p
BC108 90p	BC212 90p	BC549C 100p	BD139 350p	BF205 150p	MPSA67 250p	TIP30A 380p	TIP34D 580p	1N4008 70p	SCR PUTS ETC.
BC109 90p	BC212L 100p	BC549C 120p	BD140 350p	BF244B 300p	MJE340 440p	TIP30B 425p	TIP41B 630p	2N3709 150p	2N2546 450p
BC147 90p	BC213L 100p	BC556 100p	BF180 280p	BF257 150p	TIP29A 350p	TIP31A 380p	TIP42A 790p	2N3830 150p	2N6072 450p
BC148 90p	BC214 90p	BC557 120p	BF181 280p	BF258 250p		TIP31B 435p	TIP42B 770p	2N2906 150p	BR101 300p
BC149 90p	BC214L 100p	BC557B 140p	BF182 280p	BF259 280p		TIP32 500p	TIP2955 700p	2N2907 180p	BRV39 380p
BC157 90p	BC237 90p	BCV70 130p	BF183 280p	E100 400p	ARE FOR ANY TYPE OR MIX OF 10 AND INCLUDE POST AND VAT	TIP32A 550p	TIP3055 550p	2N3053 200p	BRV58 320p
BC158 90p	BC328 100p	BCV71 125p	BF184 90p	E204 430p		TIP32B 750p	1N4001 40p	2N3055 550p	BT101 1250p
BC159 90p	BC338 100p	BCV72 140p	BF195 90p	E300 450p		TIP32C 800p	1N4002 40p	2N3702 90p	BT106 1250p
BC182 90p	BC516 450p	BD131 330p	BF196 90p	E310 500p		TIP33A 620p	1N4003 40p	2N3703 90p	GT107 1250p
BC182L 100p	BC517 450p	BD132 350p	BF197 90p	E420 1140p		TIP33B 720p	1N4004 40p	2N3704 90p	TS88A 230p
BC183 90p	BC547 90p	BD133 450p	BF198 220p						

### LINEAR I.C.s

CA3130 100p
CA3140 100p
CA3076 200p
CA3085 85p
CA3088 190p
CA3089 210p
CA3090A Q 400p
CA3130 100p
LM300T D5 170p
LM301AN 85p
LM307N 85p
LM308T D5 130p
LM308DIL 130p
LM309K 100p
LM310T D5 160p
LM311T D5 260p
LM317K 325p
LM324 150p
LM348N 200p
LM350N 110p
LM351 180p
LM555 25p
LM710T D5 60
LM710DIL 65p
LM723T D5 75p
LM793DIL 75p
LM733 180p
LM748 45p
LM1303N 155p
LM1458 100p
LM3900N 90p
MC1310P 185p
ML741 14 Pin 30p
MM5514 430p
MM5518 550p
NE5200 150p
NE555 25p
NE556 100p
NE552B 400p
Mullard BTY87 100R 100V 8-5A 3817 DFC Clock £1 00
Chp £6 50
SN75003N 180p
SN75013N 180p
SN75013ND 125p
SN75023N 180p
SN75023ND 125p
SN75027N 180p
SN75028N 180p
SN75066N 100p
TAA300 150p
TAA350 190p
TA A550 50p
TA A851B 140p
TA A700 350p
TAD100 160p
TAD110 130p
TBA120S 80p
TGA120T 125p
TBA350 240p
TBA390Q 215p
TBA340 230p
TBA340Q 240p
TBA550Q 335p
TBA550C 335p
TBA841A12 250p
TBA720 250p
TBA800 110p
TBA810S 110p
TBA820 180p
TBA990 280p
TCA270Q 250p
TCA270S 250p
XR2206 675p
XR2207 450p
XR2216 850p
ZN414 120p
7805 140p
7812 140p
7815 140p
7818 140p
7824 150p

### DECODER BOARD CONTAINS

18 x 74158 £4.80  
2 x 74153 each  
1 x 74180 No technical details  
1 x 74150 details  
1 x TIP32 available

### EDGE CONNECTORS

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ONE VALUE £1 00

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10,000 for £400.00

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LP1153  
LP1165  
LP1166 400p  
LP1168 each  
LP1181  
LP1173 400p

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1A 100V 30p  
1A 200V 36p  
1A 400V 35p  
1A 600V 40p  
2A 50V 35p  
2A 100V 50p  
2A 200V 55p  
2A 400V 60p

### ELECTROLYTIC CAPACITORS

uF/V	5p	uF/V	15p
47/25	5p	330/25	15p
1/16	5p	330/35	16p
1/25	5p	330/50	18p
1/50	5p	470/10	12p
2-2/25	5p	470/25	16p
2 2/35	5p	470/35	18p
3-3/25	5p	470/50	22p
4-7/10	5p	1000/16	25p
4-7/16	5p	1000/35	26p
4-7/25	5p	2200/10	28p
4-7-50	5p	2200/16	35p
6-8/25	5p	2200/63	75p
10/10	5p	2200/100	120p
10/16	5p	3300/16	40p
10/25	5p	3300/25	42p
10/35	5p	3300/63	80p
10/50	5p	4700/25	45p
22/6V3	5p	4700/40	50p
22/10	5p	4700/63	120p
22/16	5p		
22-25	5p		
22/35	5p		
22/50	5p		
33/6V3	5p		
33/16	6p		
33/25	6p		
33/40	6p		
33/50	7p		
47/10	6p		
47/16	6p		
47/25	6p		
47/35	6p		
47/50	7p		
100/10	6p		
100/16	6p		
100/25	6p		
100/50	6p		
100/63	10p		
125/15	6p		
200/10	6p		
280/25	12p		
220/50	12p		

### POLYESTER CAPACITORS

Mullard or Erie	uF/V	5p
	-001	5p
	-0022	5p
	-0033	5p
	-0047	5p
	-0068	5p
	-01	5p
	-022	5p
	-033	5p
	-047	5p
	-1	6p
	-22	7p
	-33	9p
	-47	12p
	-1-0	20p
	-2-2	25p
	-4-7	35p
	-6-8	40p

### MURATA ULTRASONIC TRANSDUCERS MA40 L1R

£2 50 each. 2 for £4 00.

1200 uF 63V	2 for £1 00
2200 uF 63V	2 for £1 50
3300 uF 63V	2 for £1 60

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7410 10 for 100p
7412 10 for 150p
7420 10 for 100p
7430 10 for 100p
7440 10 for 250p
7474 10 for 200p
7476 10 for 250p
7483 10 for 700p
7486 10 for 450p
74107 10 for 350p
74121 10 for 250p
74153 10 for 400p
74161 10 for 800p

MM2102 AN-4L  
1024 x 1 BIT. 450n sec  
STATIC RAM  
£1.60 each  
4/£6.00. 8/£11.60

8218 8 BIT IN/OUT PORT £3.00 each  
PHONE FOR QUANTITY PRICE

AYS-1013 UAR/T £8 00

FUTABA 5LT02 DISPLAY £5 50

BD144 165p
B 2018B 250p
BU 205 220p
GDJ 32 250p
AU 100 180p
R 2008B 210p

### LEDS

RED .125 15p
GREEN .125 25p
YELLOW .125 25p
RED .2 15p
GREEN .2 25p
YELLOW .2 25p
DL 747 Display 280p

### CMOS

4000 14p	4030 55p
4001 14p	4082 95p
4002 14p	4083 120p
4006 90p	4047 100p
4007 16p	4048 55p
4009 55p	4049 40p
4011 14p	4050 40p
4012 14p	4054 120p
4013 50p	4055 140p
4015 90p	4056 135p
4016 40p	4060 120p
4017 90p	4066 55p
4018 90p	4069 20p
4020 100p	4071 16p
4022 90p	4072 16p
4023 16p	4081 18p
4024 65p	4082 18p
4025 16p	4510 150p
4026 16p	4511 120p
4027 50p	4516 110p
4028 30p	4518 130p
4029 110p	4528 100p

### TEXAS

T15 88A  
V.H.F. FET  
10 for £2-30  
100 for £20 00

555 TIMER  
10 for £2-50p

741 OP. AMP.  
10 for £2-00

### BYX 94

DIODES  
1250 PIV 1 Amp  
100 for £8 00

### BOB07/608

COMP. POWER  
£1 50 pair

### DIL SOCKETS

8 Pin 13p
14 Pin 14p
16 Pin 15p

### LIMITED OFFER

BC237  
100 for £3 00

### SPECIAL OFFERS

BC147  
BC148  
BC149 100  
BC157 FOR ASSORTED £8 50

### POTENTIOMETERS

1K LIN-2M LIN  
5

# practical WIRELESS

ISSUE 856

JUNE 1978 · VOLUME 54 · NUMBER 2

**BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR**

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Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins. Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors of the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

**THE KIT COMPRISES EVERYTHING NEEDED**  
 Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions

NOTE—Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.95 inc. VAT, post & packing.

Electronics Design Associates (Dept. PW6),  
 82 Bath Street, Walsall WS1 3DE.

Electronics Design Associates, Dept. PW 6  
 82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 614791

Name \_\_\_\_\_  
 Address \_\_\_\_\_

Phone your order with Access or Barclaycard

inc. V.A.T. and P.P.

QUANTITY REQD.

X4 KIT	£14.95	£12.95
TACHS PULSE SLAVE UNIT	£3.95	
Access or Barclaycard no.		

I enclose cheque/PO's for

£ \_\_\_\_\_  
 Cheque No \_\_\_\_\_

Send SAE if brochure only required.

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# MINIATURE SOLDERING IRONS AND ACCESSORIES



	RETAIL PRICE each inc. v.a.t.	POSTAGE extra.
18 WATT IRON inc. No.20 BIT	£3.78	22p
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" 10'	26p	4p
LOWMELT 10'	65p	9p
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Subject of Interest \_\_\_\_\_

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## THERMOSTATS



Refrigeration as illustrated with 36" capillary £1-62.  
**Limpet Stat** must be mounted in close calibrated 90°-190°F 15 amp contact £1-62.  
**Appliance Stat** fix like a volume control—15 amp contact 30°-80°F 85p.  
 ditto but for high temps £1-25.  
**Oven Stat**—with sensor and capillary 85p.

## MAINS OPERATED SOLENOIDS



Model TT2—small but powerful 1 1/2 in. pull—approx. size 1 1/2 x 1 1/2 in. £2-00.

Model 4001—1 1/2 in. pull. Size 2 1/2 x 2 x 1 1/2 in. £2-50.

Model TT10—1 1/2 in. pull. Size 3 x 2 1/2 x 2 in. £4-50.

Prices include VAT & postage.

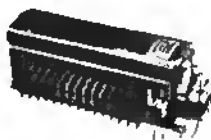


## DELAY SWITCH

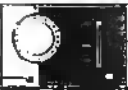
Mains operated—delay can be accurately set with pointers knob for periods of up to 2 1/2 hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact 95p.

## MOTORISED DISCO SWITCH

With 10 amp change-over switches. Multi adjustable switches are rated at 10 amps. This would provide a magnificent display. For mains operating. 2 switch model £3-25. 10 switch model £5-75. 12 switch model £6-75.



## SMITHS CENTRAL HEATING CONTROLLER



Push button gives 10 variations as follows: (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating only for 2 periods during the day (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off. A handsome looking unit with 24 hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over £15. We offer these while stocks last at £6-95 each INCLUDING VAT and Postage.

## LOW R.P.M. MOTORS



Made by Crauzet-Smiths—SAIWA—Vanner and similar famous companies—all supplied ready for 230/240v 50hz mains working at £2-75 each. Following speeds in stock when preparing this advert.

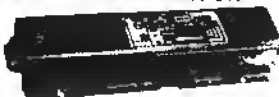
1 rev per day 6 rev per day  
 1 rev per hour 12 revs per hour  
 1 rev per min  
 2 rpm 1 1/2 rpm  
 4 rpm 15 rpm 15 rpm 25 rpm 30 rpm

## TRACTOR FAN



Ex computers—made by Woods of Colchester. Ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5" or 6 1/2" dia. £5 and £8.

## FLUORESCENT TUBE INVERTOR



For camping—car repairing—emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer inverter for 21" and 33 watt miniature tube for only £3-75 with tube and tube holders as well.

## MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—10000cps—11 instant ranges measure: DC volts 10, 50, 250, 10000. AC volts 10, 50, 1000. DC amps 0-1 mA and 0-100 mA. Continuity and resistance 0-150K ohms.

Complete with insulated probes, leads, battery, circuit diagram and instructions. Unbelievable value only £8-90

## FREE

Amps ranges kit enable you to read DC current from 0-10 amps directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send £1-50.

## MULLARD UNILEX

A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Finest speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.



## UNISELECTORS

These are pulse operated switches as used in automatic telephone switchboards etc. The pulse moves the switch arm through one position. Except where indicated the selectors are 25 position types and 50v Coil is standard. 24v or 12v operation extra at £2 per switch.



3 pole £4-00  
 6 pole £7-02  
 10 pole £10-50  
 3 pole 50 way £10-50

4 pole £5-94  
 8 pole £8-72  
 12 pole £12-95  
 4 pole 50 way £12-74

## 24 HOUR TIMERS

The one illustrated is 'E' controls this uses the Smiths mechanism as in their autoset. 2 on/off's per 24 hours 13 amp contacts. override switch £8-50. Smiths 100 amp model one on/off per 24 hours £10-50, extra contacts £1-00 per set. AEG 50 amp model with clockwork standby, one on/off per 24 hours £8-50, extra contacts £1-00 per set.



## INDUCTION MOTORS

One illustrated is our reference MM11 made for ITT 3" stack 1 1/2" spindle £2-25. 1" stack model £1-75. 1" stack £2-75. 1 1/2" stack £3-25.



## MAINS TRANSFORMERS

5v 1 amp £1-00. 12v 1 amp £1-00.  
 20v 1 amp 20w auto 25v £1-00.  
 18v 1/2 amp £1-75. 6-3v 2 amp £1-75.  
 25v 1 1/2 amp £2-25. 24v 3 amp £2-50.  
 50v 2 amp £4-50. 9v 1 amp £1-50.  
 3-5v-0-8 5v 1/2 amp £1-50. 100w auto 230-115v £2-00. 8-5v £3-50.



Many more, send for list.

## MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied. Model 1933 500mW power output £1-00 including Post & VAT.  
 Model 1172 1W power output £1-85 including Post & VAT.  
 Model EP0000 4 watt power output £2-00 including Post & VAT. EP 6001 twin channel or stereo pre-amp £2-00 including Post & VAT.



## THIS MONTH'S SNIP

Japanese made FM tuner and matching decoder. Two items for less than average price of the tuner only £1-20 the two. Don't miss this, stocks will not last long. Wooden case with glass dial £15-50.



## RELAYS

12 volts two 10 amp changeover plus in 15p. 12v three 10 amp changeover plus in £1-25. 12v two changeover miniature wire ended 95p. 12 volt open single screw fixing two 10 amp changeovers £1-25. 12 volt open three 10 amp changeovers £1-25. Latching relay mains operated 2 c/o contacts £2-11. Mains operated three 10 amp changeovers open type one screw fixing £1-25. Many other types with different coil voltages and contact arrangements are in stock, enquiries invited.



## MICRO SWITCH BARGAINS

Rated at 5 amps 250 volts. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for £1-00. VAT and post paid.



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## IT'S FREE!

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

## MAINS TRANSFORMERS

All these have 230/240v 50Hz Primary			
VOLTAGE	CURRENT	REF.	PRICE
5v	2 amp	TM 1	£1-04
2-4v	5 amp	TM 2	£1-02
4v	7 amp	TM 30	£2-70
6v	1 amp	TM 3	£1-05
6-5v	1/2 amp	TM 37	85p
6-5v	200 ma	TM 31	£1-02
6-5v-0-6 5v	100mA	TM 21	£1-02
6-5v-0-6 5v	100mA	TM 7	£2-10
6-5v-0-6 5v	100mA	TM 33	£1-02
6-5v	2 amp	TM 4	£1-09
6-5v	1 amp	TM 12	£1-02
8-5v + 8-5v sep winding	1/2 amp	TM 12	£1-02
9v	1 amp	TM 5	£1-02
9v	1 amp 'c' core	TM 8	£1-06
9v	3/4 amp	TM 11	£2-70
9v	5 amp	TM 38	£3-24
10v	25 amp	TM 15	£4-00
10v-0-10v	12 1/2 amp	TM 15	£4-00
12v-0-12v	4 amp	TM 27	£4-32
12v	1/2 amp	TM 9	£1-05
12v	1/2 amp	TM 7	£2-10
12v	1/2 amp	TM 10	£1-09
12v-0-12v	30mA	TM 19	£1-02
14v-0-12v	1 amp	TM 41	£3-24
18v tapped 9v	2 amp	TM 11	£2-70
18v	7 amp	TM 27	£4-32
18v-0-15v	3 1/2 amp	TM 27	£4-32
18v-0-15v	3 1/2 amp	TM 38	£4-00
17v	1/2 amp	TM 12	£1-02
18v	1/2 amp	TM 13	£1-00
20v	1/2 amp	TM 14	£1-02
20v	5 amp	TM 27	£4-32
20v	12 1/2 amp	TM 16	£4-00
20v-0-20v	8 amp	TM 16	£4-00
13v	100mA	TM 1	£1-02
24v	1 1/2 amp	TM 16	£2-12
24v	2 amp	TM 17	£2-70
24v + 2v 7 amp	2 amp	TM 39	£2-87
24v	4 amp	TM 40	£3-70
25v	1 1/2 amp	TM 18	£2-43
25v	1/2 amp	TM 29	£2-86
25v	1/2 amp	TM 27	£4-32
25v tapped 24, 20, 15 & 12	3 1/2 amp	TM 27	£4-32
30v	8 amp	TM 15	£4-00
32v	37 amp	TM 34	£31-80
40v tapped at 30v, 20v & 10v	6 amp	TM 15	£4-00
50v-2 amp with 6-3v shrouded	5 amp	TM 22	£4-00
50v	8 amp	TM 29	£11-85
50v	5 amp	TM 29	£11-85
75v-3 amp with 6-3v shrouded	5 amp	TM 23	£4-00
75v	4 1/2 amp	TM 24	£7-02
80v tapped 60v & 75v	4 amp	TM 24	£7-02
100v	1 amp	TM 25	£7-02
100v-0-100v	1/2 amp	TM 25	£7-02
130v tapped 120v	1/2 amp	TM 25	£3-78
320v	1 amp	TM 35	£7-02
250v-0-250v with 6-3v 2A	50 mA	TM 36	£2-70
250v	100 mA	TM 36	£2-70
500v	50mA	TM 38	£2-70

350mA 6 Volt Mains Unit. Ideal for power 6 volt equipment, cassettes, tape recorder or amplifier or other appliances requiring more than the average amount of current. This is a really well made unit in plastic case made for Crown Radio intended originally to clip into position, this has external battery type contacts but it is a simple matter to solder leads straight onto these contacts and this unit employs full wave rectification and is recommended in every way. Price £4-30

Calculators. By famous makers like Texas. Intended originally to be sold at quite high prices new and unused. Type 1. Basic functions—add, subtract, multiply, divide etc. Price £5-15. Type 2.—again basic functions but with rechargeable nickel batteries. Price £7-02. Battery Chargers for same £2-70. Type 3.—basic functions but with memory £3-10. Type 4.—basic functions, memory and rechargeable batteries. Price £11-34 + 84p.

AM/FM Radio. Complete chassis, has tuning scale with pointer, volume control, on/off etc. Controls have edgewise knobs. These radios can be mounted on or just inside extension speaker, then you have a first class 'musical while you work' receiver. Reception on both AM/FM is better than average and even in areas where FM is notorious bad, good results have been obtained. The output also is above average, the speaker power is probably around 1 1/2 watts. They can be powered by 6v batteries or 6v power supply. In fact the Crown Radio one mentioned above is ideal, would no doubt function as an AM/FM Tuner—real bargain at £5-50 + 84p.

UV Tubes (Philips Atomic). Useful for bringing out water marks in stamps and special colours in rocks, similar specimens. We have these in two sizes 9" 6v price £1-50 + 12p. Post 50p + 4p. 2 1/2 20 watt £2-00 + 15p. Post 75p + 6p. 4 Pole 15 Way Switch. For digital displays the 10 positions being evenly spaced through the 360 turn, and there is no stop. Silver plated contacts are rated at 5 amps, normally an expensive switch but offered at 85p each.

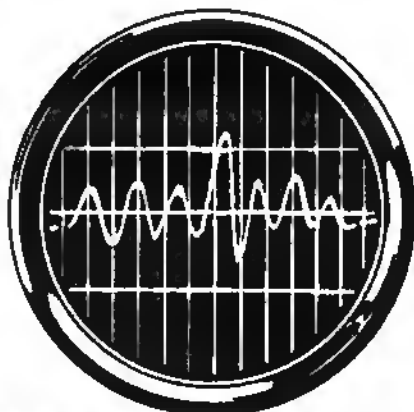
Morse Key. This is well designed, fully adjustable key, suitable for beginners. Our Ref. MK1. Price £1-15. Professional Morse Key. Heavy cast base of metal construction, this is high speed key with fine adjustments. Price £3-35. Our Ref. MK2. Terminals. Very good quality, British made, screw down type, top accepts a 4mm plug. The screw down section also has a hole through which solid wire may be passed, with insulators for metal panel mounting, 5 popular colours. Price 15p each, Ref. TS1, or 10 in bag for £1-30. Ref. TS1/10. Spring Trigger Terminals. Red and black terminals mounted on insulated panel approximate size 2 1/2" x 1". These terminals grip like a vice but connection in the first place is quick and simple. Hold back the trigger—push in wire—let go of trigger, definitely a time saver. Price 54p the pair. Shrouded Plug-Stat. Miniature size 2-2k, 10 for £1-00 + 12p. Relay Base. 14 pin standard for many plug-in relays 54p + 4p. AC Mains Relay. Plug in to standard base, three 10 amp changeover contacts. Price £1-00 + 14p. but 2 x 10 amp c/o contacts £1-25, bases 35p extra. Heavy Duty 15v Relay. This has 3 pairs of changeover contacts which are rather bigger than usual and look capable of dealing with 15 amp loads. Ditto but 4 Volt Coil. Price £2-16 + 16p.





# LOOK! Here's how you master electronics.

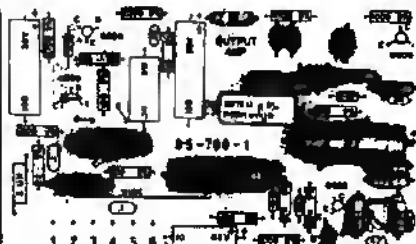
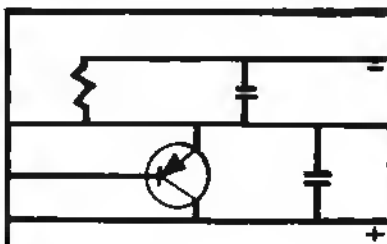
...the practical way.



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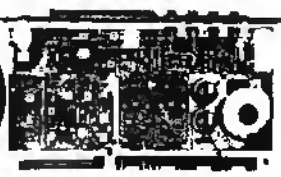
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**KM10** Extended range, total 550 resistors from 1R to 10M £8.30

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**KM12** As above but 5 of each value £8.70

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T-DEC Breadboard £2.95

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Professional quality two tone grey polystyrene with threaded inserts for mounting PC boards

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2N929	0-37	2N3417	0-25	2N4082	0-20	2N9245	0-37	AF108	0-89	BC182L	0-15
2N930	0-37	2N3439	0-25	2N4121	0-21	2N9246	0-44	AF109	0-82	BC183A	0-12
2N1101	0-32	2N3441	0-22	2N4122	0-21	2N9247	0-44	AF114	0-78	BC183LA	0-13
2N1303	0-86	2N3442	0-45	2N4123	0-19	2N9248	0-44	AF115	0-70	BC184	0-12
2N1105	0-80	2N3455	0-25	2N4124	0-19	2N9401	0-44	AF118	0-70	BC184L	0-13
2M1801	0-35	2N3566	0-25	2N4225	0-19	2N5418	1-05	AF124	0-70	BC205	0-15
2N1613	0-35	2N3587	0-25	2N4226	0-19	2N5447	0-16	AF139	0-75	BC212A	0-17
2N1637	0-72	2N3588	0-17	2N4235	1-35	2N5448	0-16	AF200	0-70	BC212LA	0-18
2N1890	0-29	2N3589	0-30	2N4236	1-85	2N5449	0-38	AF201	1-30	BC213B	0-16
2N1883	0-34	2N3627	0-40	2N4237	1-85	2N5457	0-31	AF239	0-70	BC213LA	0-17
2N1991	1-10	2N3682	0-25	2N4240	1-70	2N5458	0-35	AF240	1-25	BC214	0-17
2N1893	0-30	2N3683	0-29	2N4250	0-20	2N5553	0-63	AF279	0-88	BC234L	0-18
2N194	0-42	2N3702	0-14	2N4260	0-32	2N5890	0-55	AF280	0-85	BC237B	0-15
2N2217	0-55	2N3703	0-14	2N4264	0-32	2N6122	0-44	AF281	1-35	BC238B	0-13
2N2218	0-25	2N3704	0-14	2N4268	0-32	2N6123	0-48	AF282	1-35	BC239C	0-17
2N2219	0-36	2N3705	0-14	2N4269	0-32	2N6124	0-45	AF283	1-35	BC239E	0-17
2N2221	0-23	2N3707	0-14	2N4287	0-32	2N6125	0-47	BC108	0-16	BC237A	0-18
2N2222	0-23	2N3707	0-14	2N4288	0-32	2N6126	0-45	BC109	0-16	BC238B	0-24
2N2270	0-45	2N3708	0-12	2N4302	0-31	2N6127	0-30	BC115	0-22	BC239B	0-18
2N2398	0-27	2N3709	0-12	2N4303	0-33	2N7303	3-85	BC114	0-22	BC281A	0-25
2N2399	0-27	2N3710	0-12	2N4342	0-60	40232	0-80	BC115	0-22	BC282B	0-25
2N2483	0-36	2N3711	0-12	2N4401	0-20	40311	0-55	BC118	0-22	BC283B	0-25
2N2484	0-36	2N3712	0-12	2N4402	0-20	40312	0-55	BC135	0-22	BC284B	0-18
2N2485	0-36	2N3714	1-35	2N4403	0-20	40383	1-43	BC135	0-22	BC287B	0-18
2N2486	1-10	2N3716	1-70	2N4403	0-20	40389	0-70	BC138	0-21	BC288B	0-18
2N2904	0-31	2N3794	0-21	2N4822	0-83	40408	0-82	BC137	0-22	BC290C	0-19
2N2905	0-31	2N3819	0-36	2N4870	0-59	40440	0-78	BC138	0-44	BC297	0-22
2N2906	0-25	2N3820	0-39	2N4871	1-58	40912	1-70	BC140	0-39	BC328	0-29
2N2907	0-23	2N3821	0-35	2N4901	1-85	40994	0-80	BC141	0-35	BC337	0-29
2N2923	0-17	2N3827	0-27	2N4902	1-85	40995	0-80	BC142	0-35	BC414	0-17
2N2924	0-17	2N3854A	0-30	2N4902	1-85	40973	0-30	BC147	0-32	BC415	0-16
2N2925	0-19	2N3855	0-30	2N4903	1-75	AC120	0-48	BC148	0-15	BC416	0-17
2N3011	0-37	2N3856A	0-19	2N4904	1-85	AC127	0-48	BC149	0-15	BC417A	0-13
2N3020	0-25	2N3858A	0-20	2N4905	2-40	AC128	0-48	BC153	0-39	BC447B	0-13
2N3063	0-76	2N3859A	0-22	2N4921	1-40	AC131	0-45	BC154	0-39	BC448	0-13
2N3064	0-72	2N3860	0-18	2N4922	1-40	AC132	0-48	BC157A	0-16	BC449	0-14
2N3065	0-76	2N3861	1-85	2N5087	0-30	AC133	0-58	BC158B	0-17	BC450	0-13
2N3108	0-76	2N3901	0-30	2N5088	0-30	AC135K	0-58	BC159B	0-15	BC459	0-15
2N3133	0-56	2N3904	0-18	2N5089	0-30	AC176	0-54	BC180	0-38	BCY54	2-40
2N3242	0-68	2N3905	0-18	2N5129	0-42	AC176K	0-90	BC187B	0-13	BCY58	0-27
2N3290	0-25	2N3906	0-16	2N5130	0-22	AC187	0-59	BC188B	0-13	BCY70	0-21
2N3301	0-49	2N3982	0-85	2N5131	0-22	AC187K	0-85	BC199B	0-13	BCY71	0-21
2N3302	0-39	2N4031	0-65	2N5137	0-22	AC188	0-54	BC170B	0-18	BCY72	0-21
2N3392	0-17	2N4002	0-30	2N5143	0-22	AC188K	0-85	BC171B	0-17	BCY78	0-42
2N3394	0-17	2N4033	0-85	2N5190	0-58	ACV17	1-80	BC172C	0-15	BD121	2-20
2N3397	0-19	2N4036	0-72	2N5190	0-85	ACV22	0-85	BC173C	0-17	BD131	0-33

AY-3-8900	0-50	CA3082	3-75	LM341P248-80	LM923	0-50	LM78L05CZ	SN78018KE	1-80
CA3000	3-30	CA3085	1-10	LM348N	0-95	LM1303N	1-15	SN78033N1	1-80
CA3001	4-25	CA3088	3-80	LM358N	0-60	LM1304N	1-32	SN78033N2	1-80
CA3002	3-30	CA3070	1-90	LM360N	3-00	LM1305N	1-32	SN78033N3	1-30
CA3003	2-50	CA3071	1-90	LM370N	3-00	LM1307N	1-22	SN78033N4	1-30
CA3006	4-80	CA3072	1-90	LM371M	2-35	LM1310N	2-10	SN78033N5	1-30
CA3007	4-15	CA3075	1-70	LM350K	0-45	LM1351N	1-30	SN78033N6	1-30
CA3008	2-35	CA3076	1-12	LM373N	3-35	LM1458N	0-45	SN78033N7	1-30
CA3019	1-85	CA3080	1-85	LM374N	3-35	LM1498N	1-87	SN78033N8	1-30
CA3021	1-85	CA3082A	1-10	LM375N	2-40	LM1499N	1-84	SN78033N9	1-30
CA3014	2-20	CA3086	0-50	LM378A	4-25	LM1812N	0-20	SN78033N10	1-30
CA3018	0-75	CA3088F	1-87	LM380NS	0-90	LM1829N	1-15	SN78033N11	1-30
CA3018A	1-10	CA3089E	2-99	LM380N141	0-80	LM1829N	1-15	SN78033N12	1-30
CA3020	2-50	CA3090A	4-40	LM381AN	2-70	LM1829N	1-15	SN78033N13	1-30
CA3021	2-50	CA3130	1-86	LM381N	1-80	LM1841N	1-80	SN78033N14	1-30
CA3022	2-50	LOBST1	2-25	LM382N	1-37	LM1841N	1-80	SN78033N15	1-30
CA3023	2-20	LM114H	2-75	LM384N	1-35	LM1849N	1-90	SN78033N16	1-30
CA3026	0-90	LM301AH	5-0	LM388N	4-90	LM1889N	4-90	SN78033N17	1-30
CA3028A	0-90	LM301B	5-0	LM387N	1-18	LM2907N	0-80	SN78033N18	1-30
CA3028B	0-90	LM301C	5-0	LM388N	1-18	MC1495L	5-10	SN78033N19	1-30
CA3029B	1-25	LM304	2-80	LM389N	1-90	MC1495L	5-10	SN78033N20	1-30
CA3029A	0-80	LM308H	1-20	LM389N	1-90	MC1495L	5-10	SN78033N21	1-30
CA3033	1-50	LM308N	0-45	LM389N	1-90	MC1495L	5-10	SN78033N22	1-30
CA3030A	2-20	LM309KC	1-95	LM389N	1-90	MC1495L	5-10	SN78033N23	1-30
CA3033	3-75	LM317K	3-35	LM389N	1-90	MC1495L	5-10	SN78033N24	1-30
CA3034	2-70	LM318N	2-15	LM389N	1-90	MC1495L	5-10	SN78033N25	1-30
CA3035	1-95	LM320T	2-15	LM389N	1-90	MC1495L	5-10	SN78033N26	1-30
CA3036	1-25	LM320T12	1-15	LM389N	1-90	MC1495L	5-10	SN78033N27	1-30
CA3038	2-60	LM320T12	1-15	LM389N	1-90	MC1495L	5-10	SN78033N28	1-30
CA3038A	0-70	LM320T24	1-15	LM389N	1-90	MC1495L	5-10	SN78033N29	1-30
CA3039	4-11	LM300MP	5-0	LM389N	1-90	MC1495L	5-10	SN78033N30	1-30
CA3040	3-75	LM320P	2-15	LM389N	1-90	MC1495L	5-10	SN78033N31	1-30
CA3041	1-85	LM320P12	1-15	LM389N	1-90	MC1495L	5-10	SN78033N32	1-30
CA3042	1-85	LM320P15	1-15	LM389N	1-90	MC1495L	5-10	SN78033N33	1-30
CA3043	2-20	LM320MP15	1-15	LM389N	1-90	MC1495L	5-10	SN78033N34	1-30
CA3045	1-50	LM320MP24	1-15	LM389N	1-90	MC1495L	5-10	SN78033N35	1-30
CA3046	0-70	LM320P	2-15	LM389N	1-90	MC1495L	5-10	SN78033N36	1-30
CA3047	2-20	LM320P	2-15	LM389N	1-90	MC1495L	5-10	SN78033N37	1-30
CA3047A	3-70	LM320K	0-95	LM389N	1-90	MC1495L	5-10	SN78033N38	1-30
CA3048	2-48	LM320K	0-95	LM389N	1-90	MC1495L	5-10	SN78033N39	1-30
CA3049	1-85	LM340T	5-88	LM389N	1-90	MC1495L	5-10	SN78033N40	1-30
CA3050	2-86	LM340T120	88	LM389N	1-90	MC1495L	5-10	SN78033N41	1-30
CA3051	1-83	LM340T150	88	LM389N	1-90	MC1495L	5-10	SN78033N42	1-30
CA3052	1-78	LM340T240	88	LM389N	1-90	MC1495L	5-10	SN78033N43	1-30
CA3053	0-77	LM341P5	8-80	LM389N	1-90	MC1495L	5-10	SN78033N44	1-30
CA3054	1-10	LM341P10	8-80	LM389N	1-90	MC1495L	5-10	SN78033N45	1-30
CA3059	2-18	LM341P150	88	LM389N	1-90	MC1495L	5-10	SN78033N46	1-30

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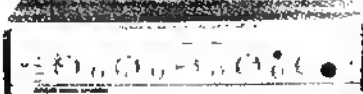


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Specially designed by RT VC for cost conscious hi fi enthusiasts, these kits incorporate two leak simulate enclosures, two 8" 13" x 8" (approx.) woofers, two tweeters and a pair of matching crossovers. Supplied complete with an easy to follow circuit diagram and crossover components.

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STEREO PAIR Input 15 watts rms, 30 watts peak each unit. Cabinet size 20" x 11" x 9 1/2" (approx.).  
SPEAKERS AVAILABLE WITHOUT CABINETS.

It is the units which we supply with the enclosures illustrated. Size 13" x 8" (approx.) woofer. (LMI 2 1/2 app) **£1700** per tweeter, and matching crossover components. stereo pair Power handling 15 watts rms, 30 watts peak. + p & p £3.40



### 20 x 20 WATT STEREO AMPLIFIER

Superb Viscount IV unit in leak finished cabinet. Silver fascia with aluminium rotary controls and push buttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick ups, tape, tuner, and auxiliary Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse. 20 + 20 watts rms, 40 + 40 watts peak.

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Size approx. 13 1/2" x 5 1/2" x 6 1/2"  
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Size approx. 14" x 4" x 10"  
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. 70 watt (PFL) lets YOU hear next disc before fading. 100 watt in. VU meter monitors output level.  
Output 100 watts RMS 200 watts peak. 100 watt **£65**

### COMPACT FOR TOP VALUE

These infinite ballie enclosures come to you ready mixed and professionally finished. Each cabinet measures approx. per stereo pair 12" x 9" x 5" deep, and is in wood simulate.

Complete with two 8" (approx.) speakers for maximum power handling of 7 watts. 8Ω. + p & p £2.20

**£850**

SPEAKERS Two models. Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18 1/2" x 12 1/2" x 7 1/2" (approx.) Duo III, 20 watts rms, 40 watts peak, 27" x 13" x 11 1/2" approx. PER PAIR **£17** Duo III **£52** p & p £7.50

### DECCA 20 WATTS STEREO SPEAKER

stereo pair This matching loudspeaker system is hand made. kit comprises of two 8" diameter approx. base drive unit, with heavy die cast chassis laminated cones with rolled P.V.C surrounds, two 3 1/2" diameter approx. domed tweeters complete with crossover network. 8Ω. £4.00 p & p **£20.00**

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Designed for the experienced D.I.Y. man. This kit comprises of a tape transport mechanism, ready built and tested record replay electronics with twin V.U. meters and level control for mating with mechanism. Specifications: Sensitivity Mic, 0.85 mV ± 20K OHMS Din, 40mV ± 400K OHMS Output 300mV RMS per channel, 1KHz from 2K OHMS source. Cross Talk - 30db. Tape Counter - 3 Digit, Resetttable. Frequency Response 40Hz 8KHz ± 6db. Deck Motor 9 Volt DC with electronic speed regulations. Key Functions - Record, Rewind, Fast Forward, Play, Stop & Eject. Opt. extras: Mains transformer to suite **£2.50** + £1 p & p. **£19.95** p & p £2.50

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Record changer with cue, stereo ceramic cartridge. p & p **£2.00**

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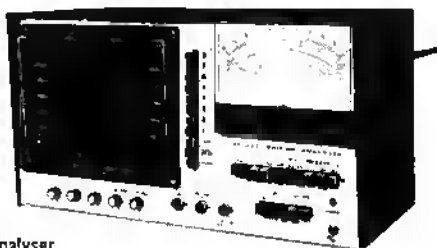
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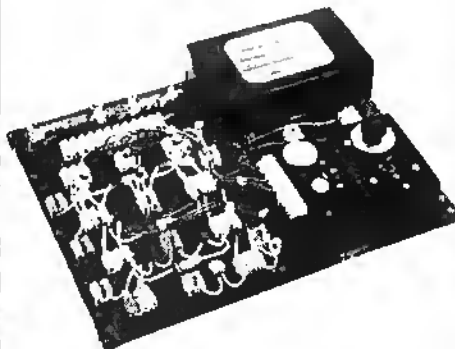
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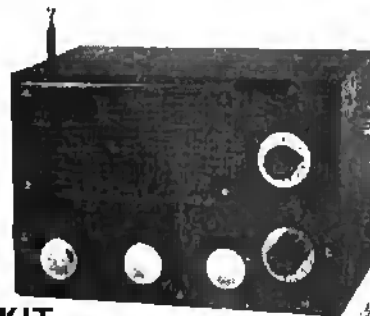
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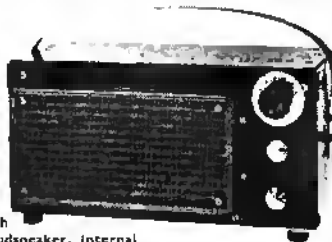
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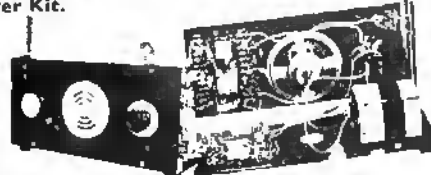


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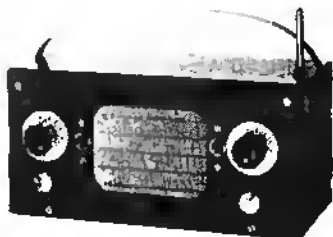
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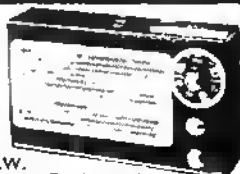
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- 21 Capacitors
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- 3 Knobs
- Ready Wound Ferrite Rod
- 6 1/2 yards of wire
- 1 yard of sleeving, etc.
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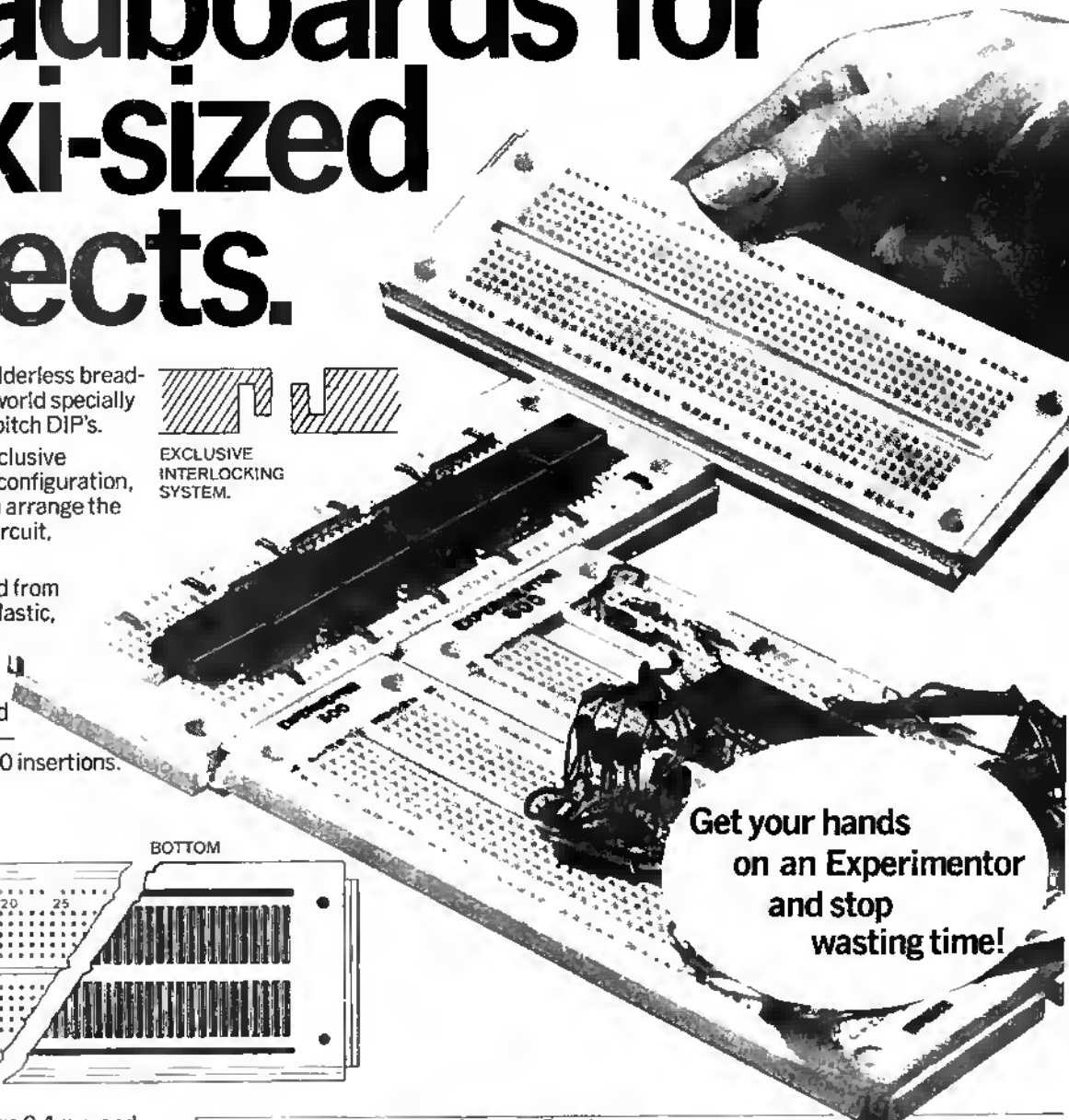
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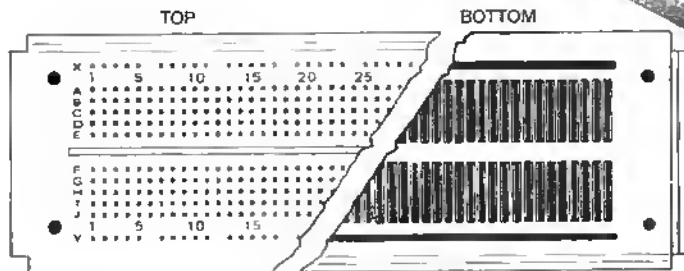
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Model	Length"	Width"	Centre channel"	5-way tie points	Bus	Price	All units are 0.330" deep. Prices include VAT (8%) and p & p f UK Orders. Add 5% to all orders outside UK. All prices and specifications correct at the time of going to press.
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EXP600	6.0	2.4	0.6	94(470)	2(80)	£7.88	
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**AUDIBLE ALARM SYSTEM** with Transistors and I.C. Made for Car Seat Belts No Details at 75p.

**GENERAL PURPOSE P CHANNEL FETs** with circuits 10 for 75p.

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Includes 150 sq. ins. copper clad 1/8 board, 1 lb ferric chloride, 1 Dalo etch resist pen, abrasive cleaner, 2 mini drill bits, etch tray and instructions only £5-30.

150 sq. in. fibre glass board £2-00

Dalo pen. 90p.

1 lb ferric chloride to mill spec. £1-25.

5 lbs ferric chloride to mill spec. £5-00.

Instruction sheet 20p

Miniature mains transformers, fully shrouded. 240V. In 5-0-6V at 100ma out.

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100 mixed diodes IN4148, etc. £1-50.

100 mixed diodes including zener, power and bridge types £3-50.

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# 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 4.7k $\Omega$  at 1kHz;

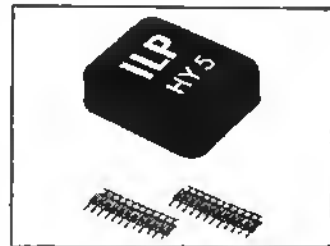
**OUTPUTS:** Tape 100mV; Main output 500mV R.M.S.

**ACTIVE TONE CONTROLS:** Treble  $\pm$  12dB at 10kHz; Bass  $\pm$  at 100Hz.

**DISTORTION:** 0.1% at 1kHz. Signal/Noise Ratio 65dB.

**OVERLOAD:** 30dB on Magnetic Pick-up. **SUPPLY VOLTAGE**  $\pm$  18-30V.

**Price** £5.22 + 65p VAT P&P free.



## HY30 15 Watts into 8 $\Omega$

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** 16W R.M.S. into 8 $\Omega$ ; **DISTORTION** 0.1% at 1.5W.

**INPUT SENSITIVITY** 500mV. **FREQUENCY RESPONSE** 10Hz-10kHz—3dB.

**SUPPLY VOLTAGE**  $\pm$  18V.

**Price** £5.22 + 65p VAT P&P free.



## HY50 25 Watts into 8 $\Omega$

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

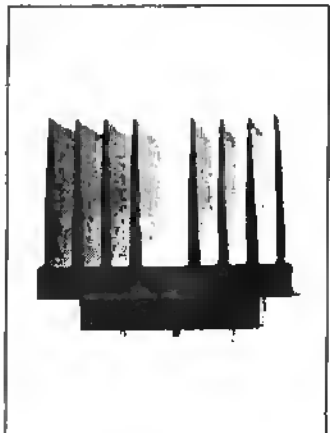
**OUTPUT POWER** 25W RMS into 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.04% at 25W

at 1kHz

**SIGNAL/NOISE RATIO** 75dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB

**SUPPLY VOLTAGE**  $\pm$  25V **SIZE** 105 80 25mm

**Price** £6.82 + 65p VAT P&P free.



## HY120 60 Watts into 8 $\Omega$

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 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.04% at 60W

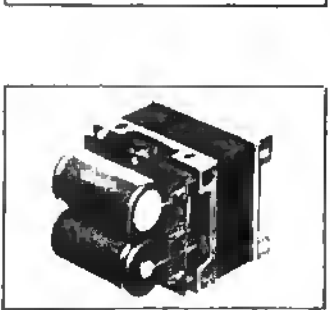
at 1kHz

**SIGNAL/NOISE RATIO** 90dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB

**SUPPLY VOLTAGE**  $\pm$  35V

**SIZE** 114 50 85mm

**Price** £15.84 + £1.27 VAT P&P free.



## HY200 120 Watts into 8 $\Omega$

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 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.08% at 100W

at 1kHz

**SIGNAL/NOISE RATIO** 90dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB

**SUPPLY VOLTAGE**  $\pm$  35V

**SIZE** 114 50 85mm

**Price** £23.32 + £1.67 VAT P&P free.

## HY400 240 Watts into 4 $\Omega$

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4 $\Omega$ ! 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 4 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.1% at 240W

at 1kHz

**SIGNAL NOISE RATIO** 94dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB

**SUPPLY VOLTAGE**  $\pm$  35V

**INPUT SENSITIVITY** 500mV **SIZE** 114 100 85mm

**Price** £32.17 + £2.37 VAT P&P free.

## POWER SUPPLIES

PSU58 suitable for two HY30's £5.22 plus 65p VAT. P/P free.

PSU59 suitable for two HY50's £6.82 plus 65p VAT. P/P free.

PSU70 suitable for two HY120's £15.75 plus £1.19 VAT. P/P free.

PSU90 suitable for one HY200 £12.95 plus £1.61 VAT. P/P free.

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# BOOKS AND COMPONENTS

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1in OBA	840	£0.75	3/4in 4BA	847	£0.25
1in 2BA	842	£0.65	3/4in 6BA	848	£0.40
1in 2BA	843	£0.45	3/4in 6BA	849	£0.21
1in 2BA	844	£0.52	3/4in 6BA	850	£0.26
1in 4BA	845	£0.44			

BA NUTS - packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
OBA	856	£0.72	4BA	857	£0.30
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Type	No.	Price	Type	No.	Price
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ZBA	860	£0.12	6BA	862	£0.12

SOLDER TAGS - hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	£0.40	4BA	853	£0.22
ZBA	852	£0.28	6BA	854	£0.22

## SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.11*
DPDT standard slide	1974	£0.14*
Toggle switch SPST 1 amp 250V a.c.	1975	£0.33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0.42*
Rotary on-off mains switch	1977	£0.50*
Push switch - Push to make	1978	£0.13*
Push switch - Push to break	1979	£0.18*

**ROCKER SWITCH**  
A range of rocker switches SPST - moulded in high insulation. Material available in a choice of colours ideal for small apparatus

Colour	No.	Price
RED	1980	£0.22*
BLACK	1981	£0.22*
WHITE	1982	£0.22*
BLUE	1983	£0.22*
YELLOW	1984	£0.22*
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Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0.50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0.55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0.65*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0.85*
Push button SPST, 2 amp 250V a.c.	1962	£0.65*
Push button SPST, 2 amp 250V a.c.	1963	£0.68*
Push button DPDT 2 amp 250V a.c.	1964	£0.80*

**MIDGET WAFER SWITCHES**  
Single-bank wafer type - suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make before-break contacts. These switches have a spindle 0.25in dia. and 30° indexing

Description	Order No.	Price
1 pole 12 way	1985	£0.48*
2 pole 6 way	1966	£0.48*
3 pole 4 way	1967	£0.48*
4 pole 3 way	1968	£0.48*

**MICRO SWITCHES**  
Plastic button gives simple on-off action. Rating 10 amp 250V a.c. Button gives 1 pole change over action. Rating 10 amp 250V a.c.

Description	Order No.	Price
	1969	£0.20
	1970	£0.25

## FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	508	£0.07*
1 1/2in x 1/2in chassis mounting	507	£0.12*
1 1/2in car inline type	508	£0.15*
Panel mounting 20mm	509	£0.20
Panel mounting 1 1/2in	510	£0.30

**QUICK BLOW 20mm**

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1.5A	616	4A	620
500mA	613	2A	617	5A	621
800mA	614	2.5A	618	All 5p each	

**ANTI-SURGE 20mm**

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630
All 7p each					

**QUICK BLOW 1 1/2in**

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634
All 7p each					

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
1.6A	636	3A	639	5A	642
2A	637	All 5p each			

## CASES AND BOXES

**INSTRUMENT CASES.** In two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5 1/2in	3in	£1.52*
156	11in	6in	3in	£2.12*
157	8in	4 1/2in	1 1/2in	£1.30*
158	8in	5 1/2in	2 1/2in	£1.76*

**ALUMINIUM BOXES.** Made from bright all., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5 1/2in	2 1/2in	1 1/2in	62p*
160	4in	4in	1 1/2in	62p*
161	4in	2 1/2in	1 1/2in	62p*
162	5 1/2in	4in	1 1/2in	74p*
163	4in	2 1/2in	2in	64p*
164	3in	2 1/2in	1in	44p*
165	7in	5in	2 1/2in	£1.04*
166	8in	6in	3in	£1.32*
167	6in	4in	2in	86p*

**MIDGET WAFER SWITCHES**

Description	Price
1965 - 1 pole 12 way	40p*
1966 - 2 pole 6 way	40p*
1967 - 3 pole 4 way	40p*
1968 - 4 pole 3 way	40p*

## TRANSFORMERS

**MINIATURE MAINS Primary 240V**

No.	Secondary	Price
2021	6V-0-6V 100mA	80p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

**MINIATURE MAINS Primary 240V with two independent secondary windings**

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1.50*
2025	MT150-0-12V, 0-12V RMS	£1.50*

**1 AMP MAINS Primary 240V**

No.	Secondary	Price	P. & P.
2025	6V-0-6V 1 amp	£2.50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2.00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2.80*	P. & P. 55p
2029	15V-0-15V 1 amp	£2.75*	P. & P. 66p
2030	30V-0-30V 1 amp	£3.45*	P. & P. 86p

**STANDARD MAINS Primary 240V**  
Multi-tapped secondary mains transformers available in 4 amp 1 amp and 2 amp current rating. Secondary taps are 0-1R 25 33-40-50V

Volts available by use of taps:  
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25 0-25V.

No.	Rating	Price	P. & P.
2031	1 amp	£5.50*	P. & P. 86p
2032	1 amp	£6.60*	P. & P. 86p
2033	2 amp	£8.90*	P. & P. £1 10

## AUDIO LEADS

107	FM Indoor Ribbon Aerial	
113	3.5mm Jack plug to 3.5mm jack plug Length 1.5m	£0.75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0.85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0.85*
116	Car aerial extension. Screened insulated lead fitted plug & ski.	£1 10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0.68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1 05*
119	2+2 pin DIN plug to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0 80*
120	Car stereo connector. Variable geometry plug to fit most car cassette. 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0 80*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1 50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.75*
127	5 pin Din plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1 30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£1 06*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1 05*
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.68*
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0.83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0.98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0.78*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0.68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0.68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1.75*
178	AC mains lead for calculators etc.	£0.68*

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# BI-PAK

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# High quality audio modules for Stereo and mono

## \$450

**STEREO FM TUNER**  
Fitted with phase lock-loop  
**£22.30**  
+ 40p p&p  
+ 12½% VAT



FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3.0 µV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22.5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	90 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm x 110mm x 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage, Vari-Cap diode tuning, Switched AFC LED Stereo Indicator.

## Stereo 30

**COMPLETE AUDIO CHASSIS**  
**£18.95**  
+ 40 p&p  
+ 12½% VAT



OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than .5% (Typically .3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dB
STONE CONTROL RANGE	± 22 dB at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	290mm x 130mm x 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifier and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

## AL60

**AUDIO AMPLIFIER MODULE**  
25 Watts RMS  
**£4.55** + 25p p&p  
+ 12½% VAT



OUTPUT POWER	25 Watts RMS
SUPPLY	30-50 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dB
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0.1%.

## AL80

**AUDIO AMPLIFIER MODULE**  
35 Watts RMS  
**£7.15\*** + 25p p&p  
+ 12½% VAT

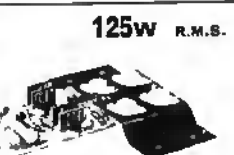


OUTPUT POWER	35 Watts RMS
SUPPLY	40-60 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dB
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0.1%.

## AL250

**POWER AMPLIFIER**  
**£17.25\*** + 40p p&p + 8% VAT



OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80 V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz to 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION	0-1% into 4 ohms 0-06% into 8 ohms

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

## AL30A

**AUDIO AMPLIFIER MODULES**  
**£3.75** + 8p p&p  
+ 12½% VAT



MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than .25%
LOAD IMPEDANCE	8-16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	30 Hz-25 kHz ± 3 dB
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm x 63mm x 28mm

These low cost 8 and 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

## SPM80

**STABILISED POWER SUPPLY**  
**£4.25** + 12½% VAT  
+ 12½% VAT



INPUT A.C. VOLTAGE	85-45V
OUTPUT D.C. VOLTAGE	35 V nominal
OUTPUT CURRENT	10 mA-1.8 amps
OVERLOAD CURRENT	1.7 amps approx.
DIMENSIONS	108mm x 63mm 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

## PA100

**STEREO PRE-AMPLIFIER**  
**£15.80**  
+ 40p p&p  
+ 12½% VAT



FREQUENCY RESPONSE	20 Hz to 20 kHz x 1 dB
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .07%)
SENSITIVITY	1. TAPE 100 mV/100 K ohms 2. RADIO TUNER 100 mV/100 K ohms 3. MAGNETIC P.U. 3-8 mV/60 K ohms
EQUALISATION	75 mV for full output Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dB at 75 Hz
TREBLE CONTROL RANGE	+ 10-20 dB at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dB (All inputs)
INPUT OVERLOAD	Better than 26 dB (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 x 90 x 33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

## MPA30

**MAGNETIC CARTRIDGE PRE-AMPLIFIER**

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.  
**£2.95**  
+ 25p p&p  
+ 12½% VAT

SENSITIVITY	3-5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—earth
DIMENSIONS	110 x 50 x 25mm (inc DIN socket)

## PA12

**STEREO PRE-AMPLIFIER**

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T638 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.  
**£7.10**  
+ 30p p&p  
+ 12½% VAT

FREQUENCY RESPONSE	20 Hz-20 kHz (-3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	-60 dB
SIGNAL/NOISE RATIO	-45 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm x 54mm x 25mm

## PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538.  
**£1.30**  
+ 25p p&p  
+ 12½% VAT

INPUT VOLTAGE	17-20V AC
OUTPUT VOLTAGE	27-30V DC
OUTPUT CURRENT	800mA
SIZE	60mm 43mm x 25mm

## GE 100 NINE CHANNEL MONO-GRAPHIC EQUALIZER

The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12dB. Max Voltage handling 2 V RMS, T.H.D., 0.05%, input impedance 100K. Output impedance less than 10 K. Frequency response 20 Hz-20 kHz (±3dB). The nine gain controls are centre at 50, 100, 200, 400, 800, 1,600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders (not supplied with the module) See Paks S31 and 16192.  
**£22.00**  
+ 25p p&p  
+ 12½% VAT

**SG30 POWER SUPPLY BOARD** for GE100 15-0-15 VOLT **£3.50** + 12½% VAT + 25p p&p

## SIREN ALARM MODULE

American Police siren powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer breakdown and other security purposes. Order No. S15, No. BP124.  
Only **£3.50** + 8% VAT + 25p p&p

## MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following Bi-Pak modules, 2 x AL60 amps, 1 x PA100 pre-amp, 1 x SPM80 stab. power supply, 1 x BM780 trans. giving 17 watts RMS per channel STEREO. All modules covered by the Bi-Pak satisfaction or money back guarantee. Details of the above modules are in this ad.  
Price **£32.50** + 12½% VAT + 60p p&p

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A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Neon, etc. Ideal for the MA60, Size. 425mm x 900mm x 95mm  
Price **£19.95** + 12½% VAT + 80p p&p

## TRANSFORMERS

T536 For use with S.450 AL30A MPA30  
Order No. 2038 Price: **£3.30** + 8p p&p + 12½% VAT  
T638 For use with Stereo 30  
Order No. 2039 Price: **£3.20** + 8p p&p + 12½% VAT  
BM780 For use with AL60 SPM80  
Order No. 2034 Price: **£5.40** + 8p p&p + 12½% VAT  
BM7250 For use with AL250  
Order No. 2035 Price: **£1.35** + **£1.10** p&p + 12½% VAT

**BI-PAK**  
DEPT. PW6, P.O. Box 6, Ware, Herts

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## BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

In a recent lecture entitled "Tomorrow's Broadcasting—The Technical Possibilities", Dr. Boris Townsend, head of the Engineering Information Service of the Independent Broadcasting Authority, highlighted some examples of the pitfalls in trying to forecast future developments in engineering. In 1924 for example, Campbell Swinton, talking to the RSGB, dismissed the topic of television (or as he called it then, seeing at a distance) as "... probably scarcely worth anybody's while to pursue". In more recent times, a well-known television engineer swore an affidavit to the FCC in America, that the shadow-mask colour display tube could not be mass-produced!

In making his forecasts, Dr. Townsend saw the biggest advances in broadcasting coming from the ever-widening use of sophisticated microcircuits. Their use in signal-processing circuitry would allow good quality TV pictures to be produced from scenes with low lighting levels, and reproduced from small, cheap videotape recorders. The adoption of microprocessor-based control systems has already allowed the IBA to operate and maintain 400 transmitters with the same number of staff as were needed for only 40 transmitters some dozen years ago. The introduction of similar systems into studios is also having far-reaching effects.

Sticking my own neck out, I foresee that the domestic TV receiver itself is likely to undergo a change of use over the coming years. The growing popularity of TV games, such as the Tank Battle which we feature in this issue, is the first step in this process. The broadcast Teletext services, Oracle from the IBA and Ceefax from the BBC, are already established and hopefully we will soon see a reduction in the price of receivers fitted with the necessary decoders. Also on the data front, the Post Office has recently announced that their Viewdata service is to be made available to the public from January 1979. All this will mean that the TV set will be used less as a source of broadcast entertainment and more as a source of information and participative entertainment. The adoption of microcircuits should also allow the domestic videotape recorder to be reduced in mechanical complexity and hence in cost, so that we may be able to view our favourite TV programmes when it suits us, rather than when the planners deem that we should.

Geoffrey C. Arnold

## PLEASE NOTE—CORRESPONDENCE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.



**Rally date**

'The Northern Mobile Rally 1978', organised by the Otley Radio & Electronics Society (G8JTD, G3XNO) is to be held at The Victoria Park Hall, Keighley on Sunday 21 May between 11.30 and 17.30.

Talk in stations on 2m f.m. S22 and 70cm f.m. SU8. There will be trade stands, films for the children, bar, refreshments and many other attractions. Further details from:

J. E. Annakin, G8DFZ, Rally Manager,  
25 Ashfield Place, Otley, W. Yorks  
LS21 3JN.

**Revival '78**

The Martlesham and Ipswich Radio Club and The Ipswich Area Civil Service Sports Association (I.A.C.-S.S.A.) are again organising an outdoor event for the Radio Amateur and his family, to be held on Sunday, 14 May 1978, at the I.A.C.S.S.A. Sports Ground, Straight Road, Bucklesham (NGR TM 222 421). Special attractions include; A v.h.f./u.h.f./s.h.f. aerial gain competition and demonstration, measurement of transmitter and receiver performance, bring and buy stands, Ad-hoc trading tables at £1 per hour for visitors and home-brew equipment competition.

The South Anglian Repeater Group, West Suffolk f.m. Group and Raynet

will be well represented and a 2m (R3 S22, 70cm) (RB4 SU8) and h.f. bands talk-in station will be in operation, probably using the call sign GB3 SWR. Further attractions include; Big name traders, demonstrations of Viewdata tv and microprocessor games, vintage wireless displays, raffle, pistol and archery ranges, flying display of radio controlled aircraft, plus many other family entertainments.

The event will start at 11.00am, admission 40p (accompanied children free). A licensed bar will be open from midday and there will be snacks, teas etc., throughout the day.

Further information can be obtained by sending a SAE to: C.P. Ransom G8LBS, 79 Camden Road, Ipswich, Suffolk IP3 8JN.

**First show**

The Dept. of Electrical Engineering Science at the University of Essex is organising the 1st Essex Electronics Exhibition on 18/19 April 1978.

Admission is by free ticket issued by either the companies exhibiting or by the Department. Further details from:

E. P. Strudwick, Dept. Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester, Essex.  
Tel: 0206 44144 Ext. 2248.

**Hi-Fi Seminar**

Latest developments in turntables and pickups, amplifiers, loudspeakers, tuners and tape recorders will be reviewed in a one day seminar being organised by the Society of Electronic and Radio Technicians. Speakers include such famous names from the audio field as James Moir, James Linsley Hood, John Borwick, Angus McKenzie and Basil Lane. The lectures will be followed by demonstrations.

The seminar will be held at the Institute of Marine Engineers, Mark Lane, London EC3 on Wednesday, 7 June 1978, commencing at 10.00 am. Fees are £15 (£10 to SERT members) and this includes a copy of the papers, coffee, lunch and afternoon tea.

Further details from: SERT, 8-10 Charing Cross Road, London WC2H 0HP.

**Can I help you!**

Are you the secretary, organiser or general dog's body of your local radio club or any other group whose functions may interest readers of *PW*. If so, let me know and I will endeavour to publicise your rally, get-together, whatever, through this column. Remember though, we compile the magazine some time ahead of publication day (e.g. this note was written in mid-March), so, the earlier I can have details, the better. Alan Martin

**KINDLY NOTE!****Radio 2 Tuner, July 1977**

On p 213, C7 is incorrectly shown as 3·3pF. This should be 3·3µF as shown in the components list.

**"Shoot", August 1977**

Certain errors in the circuit diagram on p.283 have been noted. The PCB is correct, however, VR4 should be 22k preset, and not 2·2k. Pin 14 of IC3A should be connected to +8V line as should pin 14 of IC4A and pin 3 of IC2B. Pins 1, 2, 5, 6 and 7 of IC3C should be connected to 0V line, as should pin 7 of IC4B. Under the heading "Connection" on p.282, it is claimed that the sync. output is taken from pin 16 of IC1 of "Tele-Games" unit. This should read "pin 15".

**IC of the Month, Sprague ULN-3006T Hall Effect Switch, March 1978** *PW* the second paragraph

following the heading "The Hall Effect", p. 845, and commencing "The current carriers..." is somewhat ambiguous, and should read "The current carriers in the silicon (which may be electrons or "holes") are both deflected to one side of the material, depending upon direction of current flow and magnetic field, in accordance with Fleming's Left Hand Rule."

**"Multi-Range Test Meters," March 1978**

Page 839, the paragraph commencing "The minimum measurable..." should read:

The minimum total circuit resistance necessary, if full-scale deflection is not to be exceeded, is therefore 1500 ohms. This will be made up of the meter movement resistance plus a series current-limiting resistor, both of which are internal to the instrument. External readings are from zero upwards.

**Experimenter's Corner, p. 910 April 1978.** In the circuit diagram and text for "LED Light Display", the pnp transistors are incorrectly shown as AC176 (npn). These should of course be AC128 in every case.



# AUDIO DISTORTION METER

E. A. RULE

PART 2

## Construction

In general the construction is not critical and the prototype built by the author used plain Vero matrix board as shown in the photographs. However a complete set of p.c.bs is available and the various drawings show these and the associated component placements.

Leads from the front panel controls to the boards should be of screened wire, and the millivoltmeter circuit board should have a tinfoil screen fitted around it as detailed in Fig. 8. It can be made from tinfoil cut from a cocoa tin and is held in position by two paper clips soldered to it as shown. The better the screening of boards and components, the lower the final distortion measurement limit will be.

## Initial Setting Up of the Meter

Set all pre-sets to halfway. After carefully checking that no mistakes have been made in the construction, switch on. At first the meter will swing about for a few moments and then settle down.

Allow about one minute before setting up the distortion meter as follows:—

Disconnect the bridge output lead to the millivolt meter attenuator and then connect an audio generator directly to the millivolt meter attenuator. (The point originally connected to the bridge.)

Set the output of the generator at 1kHz to give full scale deflection of the meter with the millivolt meter range switch on the 1V range. Switch to the 10V range, meter should fall to 10% of full scale. If not, adjust the pre-set 3 for more feedback and repeat test. Only the minimum amount of feedback required to obtain a linear scale should be used. When the reading drops to 10% of full scale, pre-set 2 should be adjusted so that a 5V input gives full scale on the 10V range, and 0.5V input gives full scale on the 1V range, etc.

Switch millivolt meter attenuator back to 10V range and transfer generator to the input socket. Reconnect output lead of bridge. Set/Read switch to Set. Adjust generator output for 10V and distortion meter input attenuator to maximum. Adjust VR7 in bridge circuit for full scale on meter. (If your

generator does not have 10V output, use 1V and switch millivolt meter attenuator to 1V range.)

Turn input attenuator to minimum. The residual reading on meter should be less than 0.4mV on the 1mV range with all screens etc., in place. The authors instrument has a residual noise 0.24mV on the 1mV range. This represents a 93dB measuring range for signals above 10V, i.e., down to 0.003%. Set generator to 1V output at 1kHz. Set distortion meter to 1V range and adjust input attenuator for a convenient reading about two thirds of full scale. Switch generator to 1V output at 100kHz. Adjust trimmer TC1 for the same reading on meter as before. This adjusts the frequency response of the meter for a flat response to 100kHz.

Switch generator back to 1kHz and set its output to 10V (or 1V if the higher output is not available).

After adjusting the input attenuator for full scale deflection, switch Read/Set switch to Read. Adjust bridge frequency and balance controls to obtain lowest possible reading on meter, reducing the voltage range switch as the meter readings reduce. The final lowest reading obtained is the Total Harmonic content of the Test Signal.

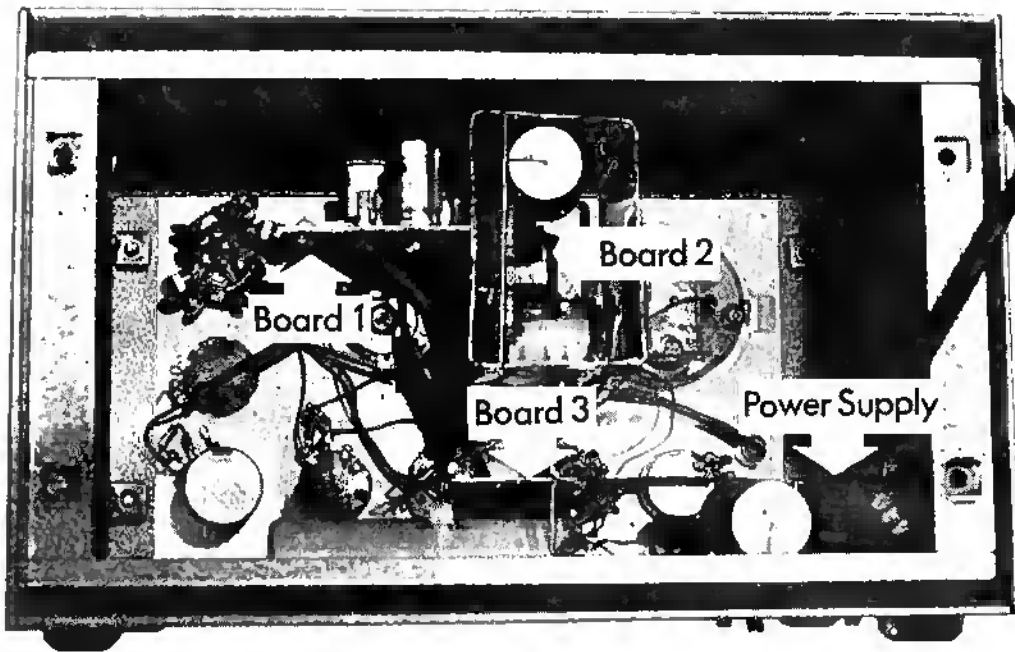
## Operation

A typical set up is shown in Fig. 13. When measuring very low values of distortion, it is very important to avoid multiple earth connections. Only the amplifier under test should be earthed. The other test equipment must have its normal mains earth removed and connected only via its connecting lead to the earth of the amplifier. Care should be taken that all test equipment is safe and fitted with mains isolation transformers or battery operated. Multiple earths can cause very high distortion readings and could be very misleading.

Before commencing a measurement, connect your generator directly to the distortion meter and measure its distortion. The figure you get from this test will set the minimum distortion you can measure. This minimum should be restricted to at least twice the direct reading obtained if reasonable accuracy is to be maintained.

To make a measurement, adjust the input signal of the amplifier under test to provide the required





Inside view of the completed instrument showing the layout of the p.c.bs and the controls mounted on the front panel. The power supply is fitted to the cabinet base and is the only board not mounted onto the front panel

output into a dummy load. Set the distortion meter millivolt switch to a suitable voltage range. Adjust the input attenuator for full scale reading (100%). Switch to "Read" and null out the fundamental signal. As the optimum bridge balance is obtained, the millivolt meter range will have to be switched to the next lower range. Read off the distortion direct from the meter when no further reduction in level is possible. Note that the frequency and balance controls are interdependent.

With an oscilloscope connected to the socket provided on the distortion meter the harmonic content of the signal can be examined. A scope sensitivity of approximately 10mV/cm is required. With inputs

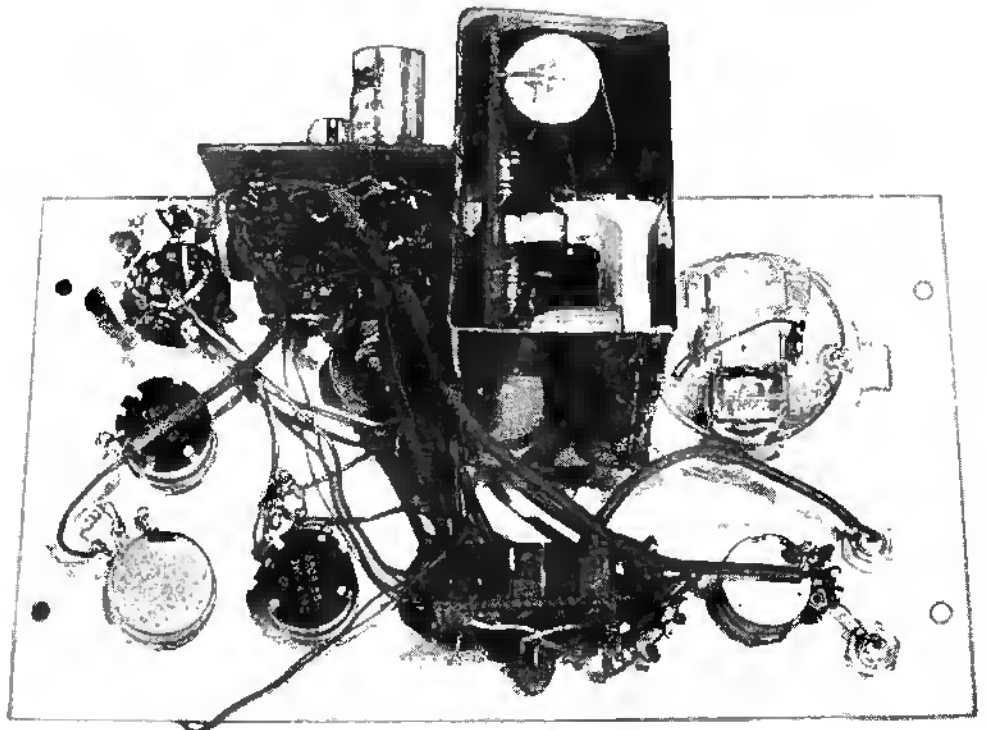
below 10V the minimum distortion readable will be reduced.

(Note: For inputs of less than 10V set the millivolt meter voltage switch to the range which will allow full scale deflection to be obtained. This range then becomes [for purpose of measurement] the 100% range and all other ranges move down by the same factor. For example, with 1V input, switch meter to 1V range, this is then 100% distortion full scale, the 0.1V range becomes 10% full scale etc.)

For accurate measurements the limits are shown in Table 1. However measurements of distortion to lower levels can be made, but with decreasing accuracy.

Nearly all pre-amplifier and tape recorders have

This view shows the components and boards mounted onto the back of the front panel. This is the prototype unit using matrix boards instead of p.c.bs



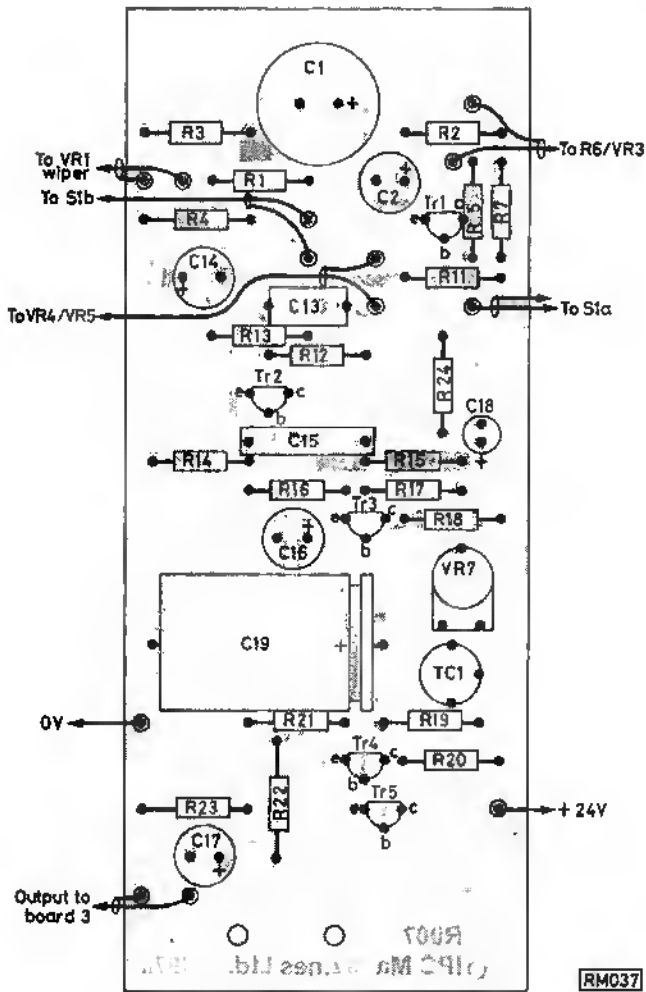


Fig. 5: Component placement drawing for the Bridge Circuit p.c.b. (Board 1)



Fig. 6: Copper track layout for Board 1. Ready drilled boards for this instrument are available from Reader's PCB Services (See page 68)

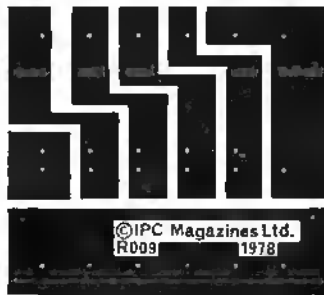


Fig. 7: Copper track layout for Board 3. Fig. 8: (Below) Component placement drawing for Board 3

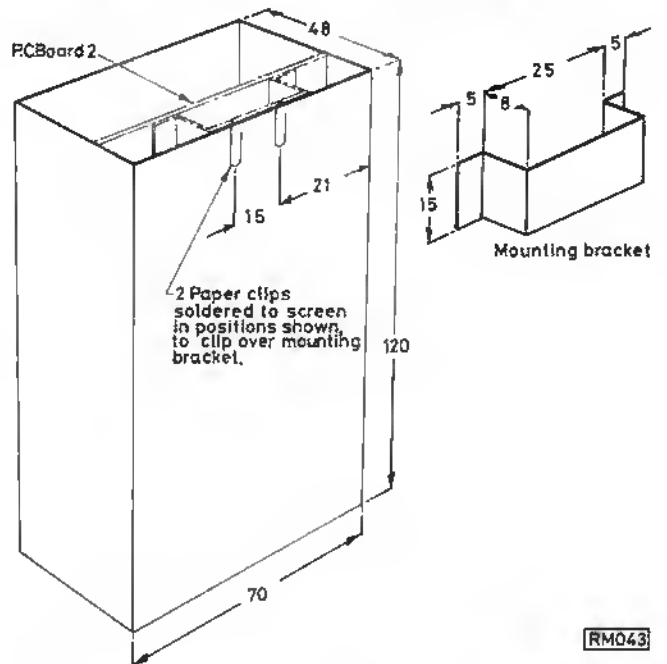
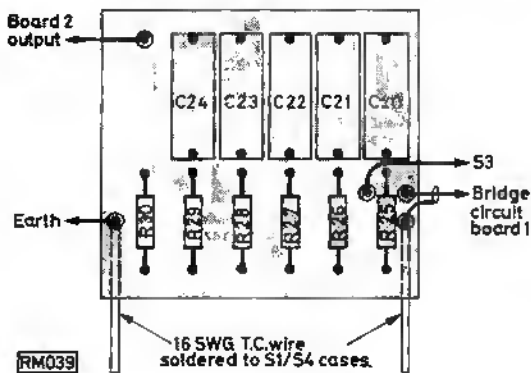


Fig. 8: Details of the tinplate screen for Board 2. The small bracket is soldered to the copper earth tracks at the top of Board 2



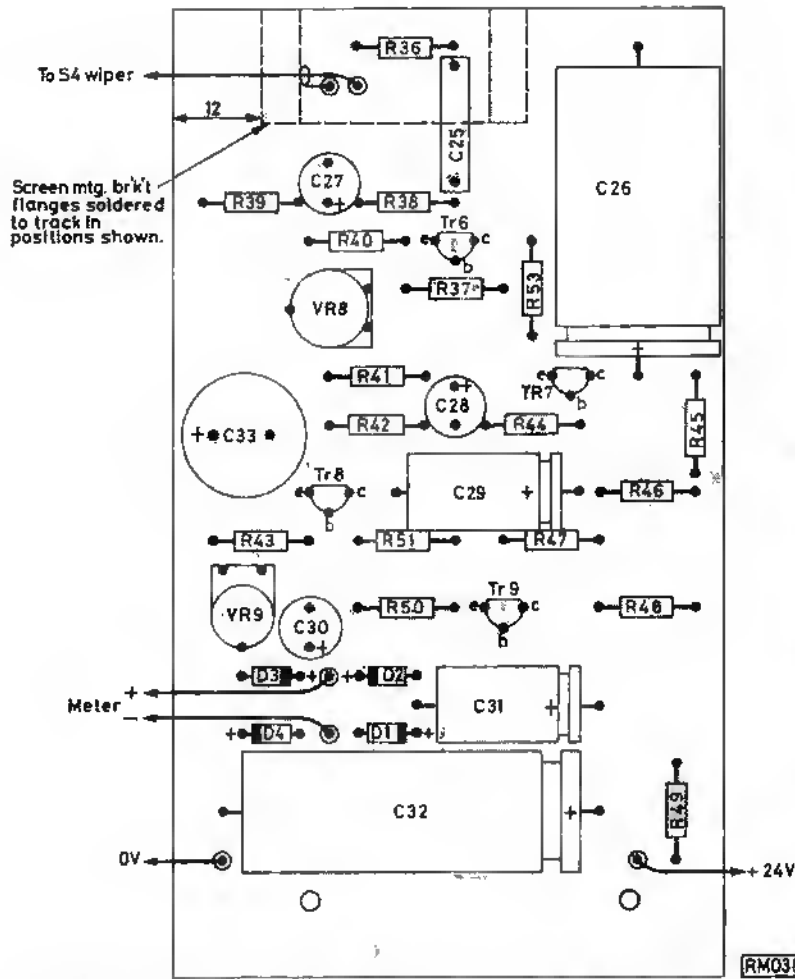


Fig. 9: Component placement drawing for the Meter Circuit p.c.b. (Board 2). Note the small finplate bracket soldered to the earth track

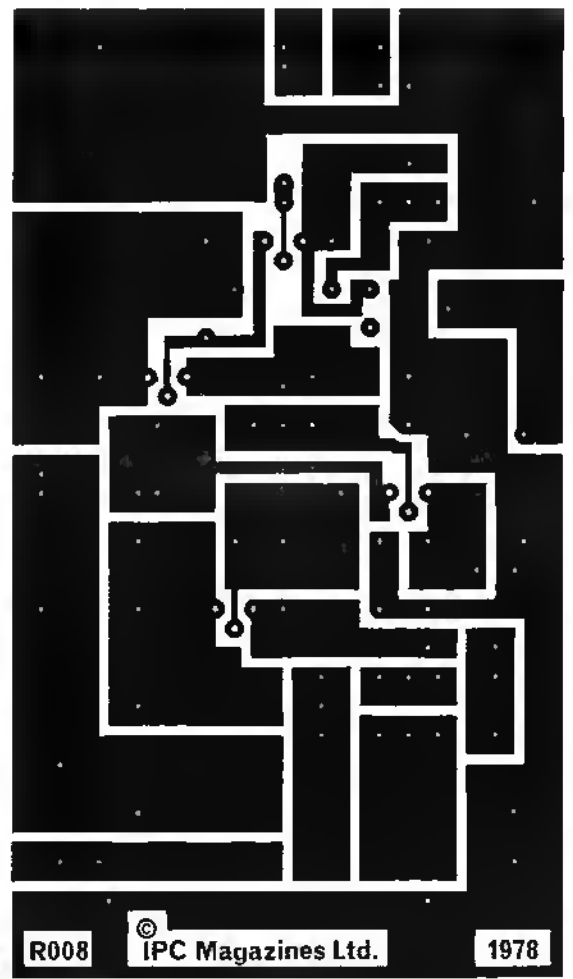
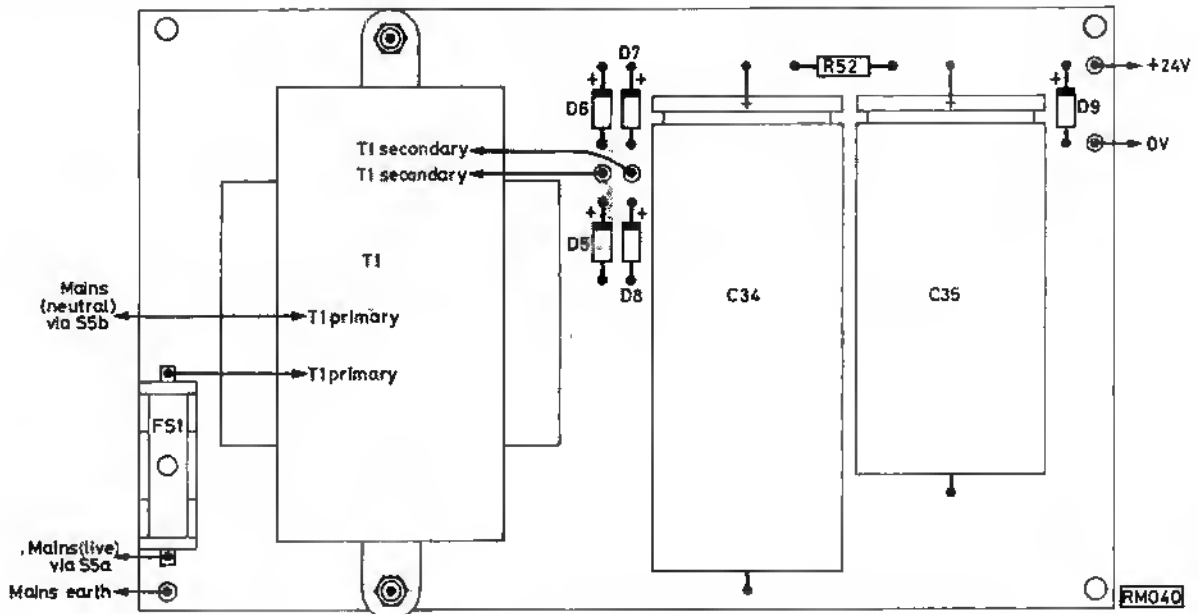


Fig. 10: Copper track layout for Board 2



Component placement drawing for the Power Supply p.c.b. (Board 4)

outputs in excess of 1V and power amplifiers of the hi-fi type will have more than 10V output. So the t.h.d. meter should enable the hi-fi amplifiers to be checked down to below 0.01% with reasonable

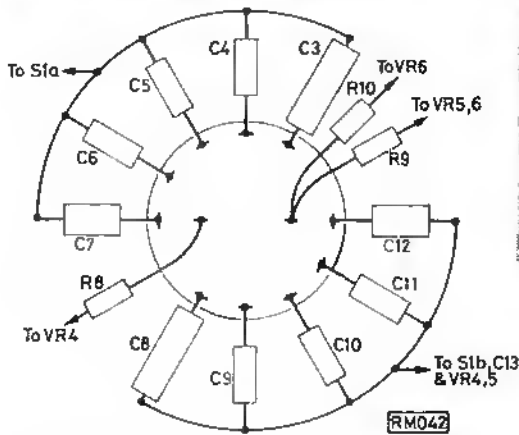
accuracy. Do not be surprised if your amplifier does not reach the lowest figures at the extremes of the audio band and do not maintain the highest frequency for longer than it takes to make a measurement.

**Fig. 11: Copper track layout for Board 4. A ready drilled set of boards for this instrument is available from Reader's PCB Service (see page 88)**



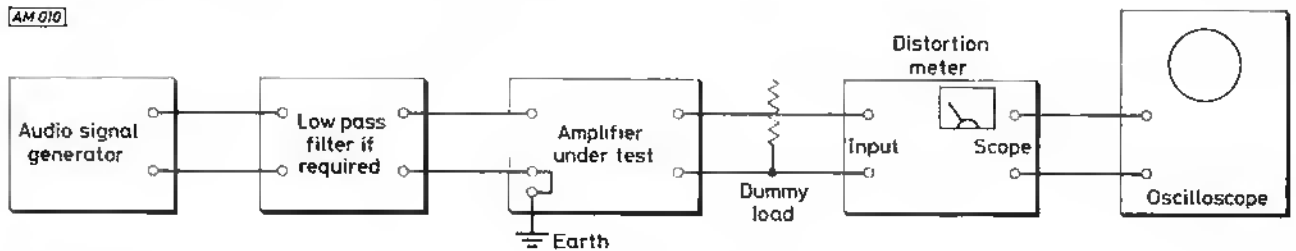
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R010 1978

**Fig. 12: Details of the components mounted directly onto S2 wafer tags. The drawing shows the components opened out for clarity; they should be arranged along the axis of the switch mechanism in a cylindrical fashion**



**Fig. 13: A typical set up for testing an audio amplifier using the Audio Distortion Meter**

AM 010



The following procedure is to assist the operator when using the distortion measuring meter for the first time. It is confined to measuring the distortion of a 1kHz signal, and should help the operator to become familiar with the basic operation.

- The controls should be set as follows:—
- Meter Range Switch on 1V range.
  - Frequency Range Switch on range 3.
  - Filter Out
  - Set/Read switch on Set
  - Input Attenuator at Zero
  - All other controls Midway

Connect a sine wave signal of 1kHz, 1V RMS to the input socket. Advance the input attenuator until meter reads 1V, i.e., full scale. Switch the set/read switch to the read position and rotate the frequency dial for minimum reading on meter. Adjust balance control to reduce meter reading further. Switch the volt meter range switch to next lower range as the signal is reduced by adjustment of the frequency and balance controls.

When no further improvement (reductions) can be obtained the distortion can be read directly from the

Minimum Input	Accurate Measurement
10V	0.01%
1V	0.1%
100mV	1%
10mV	10%
1mV	—

**Table 1.**



## ★ components

### Resistors

#### $\frac{1}{4}$ W 5% metal oxide

33 $\Omega$	1	R43
100 $\Omega$	3	R7, 49, 52
560 $\Omega$	1	R6
1k $\Omega$	1	R50
1.2k $\Omega$	1	R4
2.2k $\Omega$	3	R5, 8, 23
2.7k $\Omega$	1	R9
4.7k $\Omega$	2	R10, 45
10k $\Omega$	9	R14, 15, 16, 18, 20, 21, 36, 40, 48
12k $\Omega$	3	R3, 42, 51
22k $\Omega$	2	R40, 53
27k $\Omega$	1	R41
33k $\Omega$	5	R26, 27, 28, 29, 30
39k $\Omega$	1	R2
47k $\Omega$	3	R1, 19, 24
100k $\Omega$	5	R11, 12, 13, 25, 47
150k $\Omega$	1	R38
180k $\Omega$	1	R17
220k $\Omega$	1	R22
270k $\Omega$	1	R39
330k $\Omega$	1	R44
470k $\Omega$	1	R37

#### $\frac{1}{4}$ W 2% metal oxide

1 $\Omega$	1	R35
10 $\Omega$	1	R34
100 $\Omega$	1	R33
1k $\Omega$	1	R32
10k $\Omega$	1	R31

### Potentiometers

#### $\frac{1}{2}$ inch diameter spindles

100 $\Omega$	1	VR9
1k $\Omega$ lin.	2	VR2, 6
10k $\Omega$ lin.	1	VR8
10k $\Omega$ + 10k $\Omega$ lin.	1	VR4, 5
20k $\Omega$ lin.	1	VR3
100k $\Omega$ log.	1	VR1

#### Miniature horiz. skeleton preset

100k $\Omega$	1	VR7
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### Semiconductors

#### Diodes

OA202	4	D1, 2, 3, 4
1N4001	4	D5, 6, 7, 8
BZY88C24	1	D9

#### Transistors

BC413B	9	TR1, 2, 3, 4, 5, 6, 7, 8, 9
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### Capacitors

#### Polyester

2.2nF	2	C7, 12
0.01 $\mu$ F	2	C6, 11
0.047 $\mu$ F	2	C5, 10
0.1 $\mu$ F	1	C25
0.22 $\mu$ F	8	C4, 9, 13, 20, 21, 22, 23, 24
0.68 $\mu$ F	1	C15
1 $\mu$ F	2	C3, 8

#### Electrolytic Printed circuit board mounting

2.2 $\mu$ F	63V	3	C14, 18, 27
10 $\mu$ F	63V	6	C2, 16, 17, 28, 29, 31
100 $\mu$ F	63V	1	C30
220 $\mu$ F	63V	1	C1
470 $\mu$ F	63V	1	C33

#### Electrolytic Axial leads

470 $\mu$ F	63V	2	C19, 32
1000 $\mu$ F	63V	2	C26, 34
4700 $\mu$ F	25V	1	C35

#### Ceramic trimmer

3-35pF	1	TC1
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### Switches

Min. toggle s.p.d.t.	1	S3
2p. 6w. midget wafer	2	S1, 4
2p. 6w. miniature rotary switch	1	S2
Mains switch assy to fit S2 mech.	1	S5

### Miscellaneous

Transformer 24V 20VA Miniature  
Case RS 509-888  
Printed circuit boards (Four in set) Readers PCB Service.  
24V indicator lamp  
Knobs Sifam collet fixing type 15mm diameter  
W151 wing knob (3)  
K150 plain knob (3)  
K151 plain knob with line pointer (2)  
N150 nut covers (6)  
C150 caps (8)  
Figure dial for 15mm knobs with pointer (1)  
numbered 1-10 (1)  
Meter 1mA f.s.d. 90  $\times$  74mm approx.  
BNC 50 $\Omega$  sockets (2)  
Tinplate sheet for screen (cut from used cocoa tin or similar)  
PW Front panel overlay (Obtainable from PW Editorial Office)

meter and voltage switch.

That is, if initial full scale (100%) was 1V and final reading was (say) 6mV, then distortion is 0.6%. The low frequency filter can be switched in for measuring frequencies above 1kHz if hum is affecting the measurement.

## Other uses of the Meter

With the input attenuator at maximum, the meter can be used as a normal AC millivoltmeter with full scale range of 10 and 1V, 100, 10 and 1mV. This would make it possible for example to measure the

output of a magnetic pick-up directly.

It can also be used for measuring Hum and Noise in an amplifier. By adjusting the input attenuator for full scale on a test signal from an amplifier and then removing the test signal and shorting the test amplifier input to earth. The meter will then indicate the residue Hum and Noise of the test amplifier, for example: if full scale was obtained on 10V range with the test signal and then after removing it the reading was (say) 6mV, this represents a ratio of 1666:1, approximately 64dB.

Many other uses can be found and a few hours spent using the meter will be very rewarding. ●

# HOTLINES

## A REVIEW OF RECENT DEVELOPMENTS

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

### I spy Strangers

Some kind soul sent me a whole heap of papers from the recent International Solid State Circuits Conference and there seems to be some real goodies on the way (not available yet). One which took my eye is a single 14-pin dual-in-line package which houses a complete motion detector. It is intended for application in electronic toys. This little beastly can be made to keep an eye on a 2ft. diameter area at 8ft. The photodiode itself is actually integrated as part of the chip. An external loudspeaker is required and when connected up, the unit will emit a whooping noise whenever it senses motion within its "sight" area. It carries on making this din for a set period of time, then it goes back to sleep and waits for the next "something" to move within its sighting area. It would seem to offer great possibilities as a burglar alarm, etc.

A further nice feature of this little i.c. is that it has another mode of operation. To change it to this you need only add a single connection.

In its new mode it will "search". It does this by flashing an external bulb at some 3Hz. At the same time, it croaks out a random series of squeaks and grunts (the paper offers the more sophisticated description, "emits audible notes"). When the "thing" detects its own reflection it immediately sounds an alarm and simultaneously increases the bulb flashing rate to 25-30Hz. The chip uses two technologies; linear bipolar, and I<sup>2</sup>L.

### Hi-digi-fi

A recent report from Japan details feverish activity among audio equipment manufacturers—in the digital field. It is now virtually certain that the hi-fi systems of the future will be digital.

To date it seems that the only "standard" to emerge is a wide acceptance of a 30cm disc as the norm. Interestingly, though, the early professional systems will use tape before moving over to disc, and it is expected that the consumer scene will also follow this pattern.

But don't get too enthusiastic about digital audio. The world consensus of opinion is that it will be some four years before professional digital audio

systems really catch on, and a further six years after that the consumer market will blossom. It could therefore be some ten years before you see these systems advertised. The main hold up will be price. Initially, systems will be expensive and the first few years will be needed to gradually bring the prices down.

Why go digital anyway? It seems that analogue hi-fi has now gone about as far as it can, whereas digital is in its infancy. In terms of improvements digital technology has much to offer the audio buffs. To start with, frequency response and dynamic range are both independent of the characteristics of the tapes or discs used. It is also claimed that there is no crosstalk problem between channels. From all the specifications on systems that I've read, the responses are flat (very, very flat) right up to 20kHz, and dynamic range, even at this early stage is well over 80dB—some 20dB better than most analogue systems I read about these days.

Another advantage of the digital approach is wow and flutter—there isn't any! This is because all the signals are retimed so accurately during playback.

Various individual technologies are to be employed initially, including a laser/disc system. But the comforting thing is that despite the very different techniques, the final product, be it tape or disc is compatible in that one can convert material from tape to disc and vice versa.

Perhaps we'll all end up with a home computer to play our gramophone records on. Wonder what that dog, squinting down that trumpet/horn thinks about it all?

### Useful Chips

Another chip which could be very useful for the home constructor (when it becomes available) is a new level detector i.c. Onto the chip the manufacturers have managed (somehow) to cram five comparators, a voltage regulator, five output driver transistors, five scaling resistors and an input buffer stage with a high input impedance. By connecting five i.e.d.s (plus usual limiting resistors), each i.e.d. can be made to light as the input voltage increases in steps of 200mV, i.e. for each 200mV input,

the next i.e.d. illuminates. The open-collector outputs on the chip can handle currents up to 80mA and voltages up to 18V. In practical terms this means versatility because the ratings allow not only i.e.d.s to be used as indicators, but also filament lamps. By using suitable circuitry, the device can be made to flash the first lamp or i.e.d. continuously when the input level falls below the 200mV threshold level.

### Charge!

Charge those c.c.d. (charge-coupled devices) are in the news again—well worth keeping an eye on. This time it's a Japanese company that is using c.c.d.s in an experimental colour television camera. Each of the three c.c.d. chips (one for each primary colour has an array of 111,192 separate little sensing elements in an area 10.3mm × 9.1mm. If small is beau iful, then these devices must be fantastic.

The colour television camera, when it comes on the market (probably late next year if all goes well) will come complete with zoom lens, built-in camera control circuitry, and electronic viewfinder. Price is set at around the £500—£600 mark. Weight will be less than 2kg.

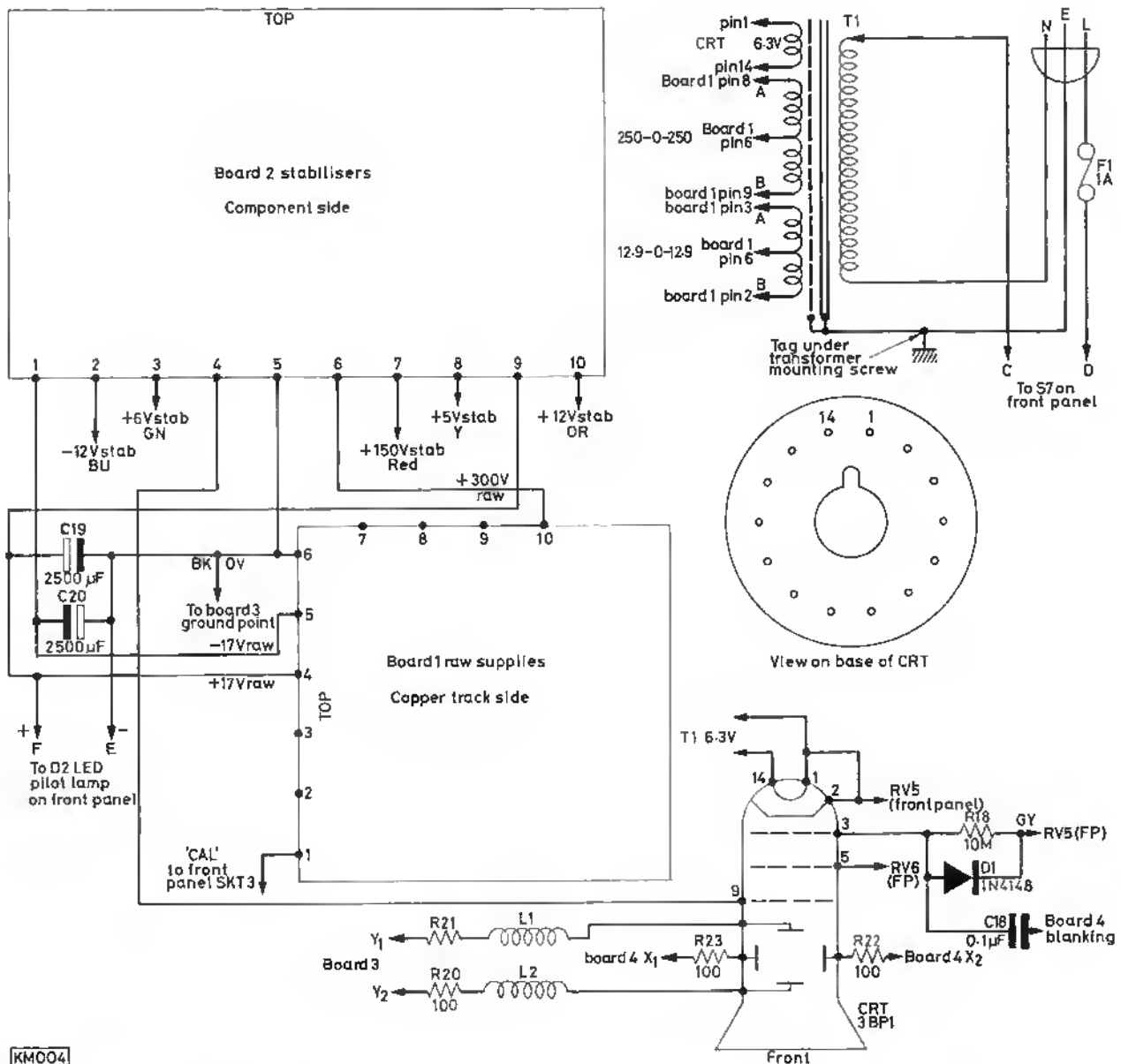
### Programmer

Microprocessors are here to stay and many are available to home constructors. One of the problems is learning how to programme these clever little electronic beasties. An answer is offered by a German manufacturer. He's marketing a little "black box" which can be used in conjunction with a black and white TV receiver. The black box has a light pen and the TV receiver is used as both input and output terminal. The box comes with a 230-page manual and costs around £280. For a further £140 (approximately) the purchaser can add a cassette control Interface for writing (and reading) memory data on standard, commercially available tape. The reading/writing rate is some 1 kilobyte in 90 seconds.

*Ginsberg*







KMOQ4

Fig. 1: Power supply interwiring diagram and c.r.t. base connections. This drawing should be read in conjunction with Fig. 2 Front Panel wiring diagram. Please note that RV5 and RV6 should be read as VR5 and VR6

solder tag under the edge connector mounting screws.

Thus Board 4 ground plane, when plugged in, is earthed to the base of the mainframe via the edge connector mounting bracket and to the front panel via the 4BA pillar. Board 3, whilst similarly earthed, picks up the Black wire from the ribbon cable, at a point on the 16 s.w.g. earthwire adjacent to the Input Low contact and from the same point an earthwire runs to the earth point on S3 and thence to a solder tag under SKT 1 mounting screw.

This earthing arrangement is essential to avoid instability, ensure a flat Y amplifier frequency response and avoid ringing on square waves.

When making the connections between the front panel and mainframe, lay the panel down in front of the mainframe as though it were hinged at its lower edge. (This is why Fig. 2 Front Panel Wiring has been drawn the way it has.) Dress the wires from

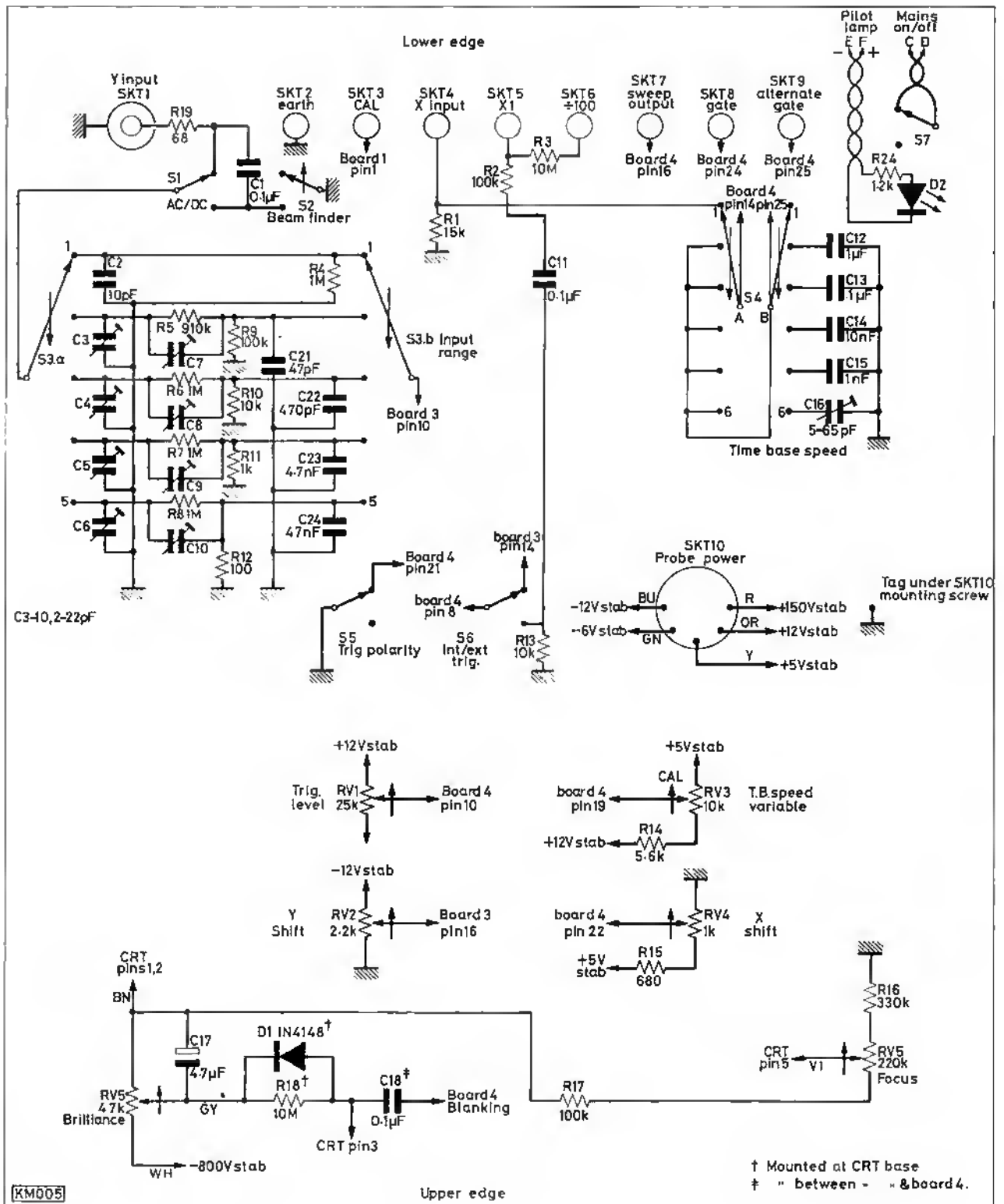
**WARNING**  
Extra care must be taken when working on any part of this instrument while power is switched on. 1100 volts can kill. When delving into the insides of the scope for any reason with power on keep one hand in your pocket

the front panel along towards the "hinge" and thence off to their destinations. This will ensure that when the front panel is offered up and secured in position, there is adequate but not excessive lead length.

Having rechecked the wiring and removed the temporary link from Board 1 pin 6 to chassis, plug in briefly and check straight away that all the stabilised voltages are correct, indicating no shorts anywhere. Check that the slider of VR5 covers the range -750V to -800V approximately and that of VR6 -350V to -600V approximately. The c.r.t. base wiring can now be completed, except for C18 and the deflection plates.

In fact, the c.r.t. and mu-metal screen can now be fitted and a simple check carried out if desired. To do this, temporarily connect one end of a 47kΩ resistor to +150V stabilised and the other end via a 100kΩ resistor to chassis.





**Fig. 2: Front panel back wiring.** This diagram has been drawn with the top edge of the front panel at the bottom so as to correspond with its orientation when placed on the bench for the purpose of wiring. Connecting wires from the front panel to other parts of the instrument should be long enough to allow the panel to be lowered to the bench in front of the mainframe. This makes for easier working conditions. Please note that potentiometers labelled RV1 to 5 should be read as VR1 to 5 and also that the 220kΩ Focus potentiometer at the bottom righthand corner of the diagram labelled RV5 should be VR6. This drawing should be used with Fig. 1 the power supplies interwiring diagram

# ★ components

## FRONT PANEL AND MAIN FRAME

### Resistors

(Unless otherwise specified 5% 1/4W carbon film)

R1 15kΩ	R13 10kΩ
R2 100kΩ	R14 5-6kΩ
R3 10MΩ 10%	R15 680Ω
R4 1MΩ 1%	R16 330kΩ
R5 910 kΩ 1%	R17 100kΩ
R6 1MΩ 1%	R18 10MΩ 10%
R7 1MΩ 1%	R19 68Ω
R8 1MΩ 1%	R20 100Ω
R9 100kΩ 1%	R21 100Ω
R10 10kΩ 1%	R22 100Ω
R11 1kΩ 1%	R23 100Ω
R12 100Ω 1%	R24 1-2kΩ

### Capacitors

C1 0.1μF 350V	C13 0.1μF 1% 63V
C2 10pF Ceramic	C14 10nF 1% 63V
C3 2-22pF	C15 1nF 1% 63V
C4 2-22pF	C16 5-65pF
C5 2-22pF	C17 4.7μF 100V
C6 2-22pF	C18 0.1μF 1000V
C7 2-22pF	C19 2500μF 25V
C8 2-22pF	C20 2500μF 25V
C9 2-22pF	C21 47pF Ceramic
C10 2-22pF	C22 470pF Ceramic
C11 0.1μF 350V	C23 4.7nF met. film
C12 1μF 1% 63V	C24 47nF met. film

### Potentiometers

20% lin. 1/4W 1/2 inch shafts

VR1 25kΩ	VR4 1kΩ
VR2 2-2kΩ	VR5 47kΩ
VR3 10kΩ	VR6 220kΩ

### Inductors

L1 See Text	L2 See Text
-------------	-------------

### Diodes

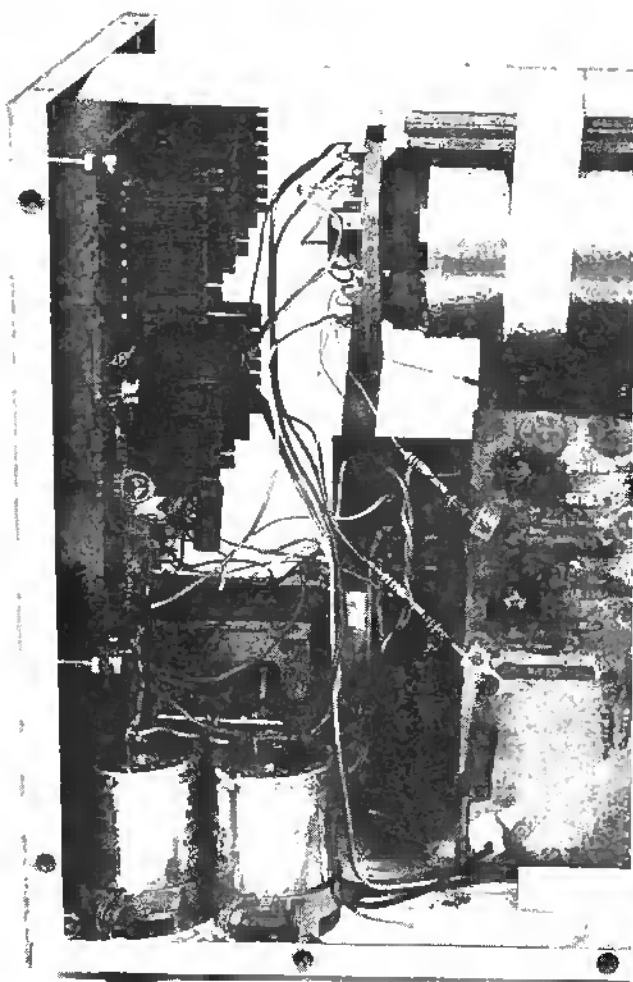
D1 1N4148	D2 Hi brightness i.e.d.
-----------	-------------------------

### Transformer

T1 250-0-250V, 6-3V, 12-9-0-12-9V, Transformer Type 7559 (Barrie Electronics)

### Miscellaneous

- F1 1/2 inch x 1/2 inch, 1A fuse and holder
- S1 Miniature s.p.c.o. toggle switch
- S2 Miniature push button p.o.
- S3 2p 5w 2 wafer (Maka-switch)
- S4 2p 6w 1 wafer
- S5 Miniature s.p.c.o. toggle switch
- S6, 7 Miniature s.p.c.o. toggle switch
- SKT1 BNC socket, round 50Ω (UG1094/U)
- SKT2 4mm socket, black
- SKT3 4mm socket, blue
- SKT4 4mm socket, white
- SKT5, 6 4mm socket, green
- SKT7 4mm socket, yellow
- SKT8, 9 4mm socket, red
- SKT10 5 pin DIN-180° (A)
- CRT 3BP1 plus base
- Case mounting clips (vert) for C19, 20
- Edge connector 0.1 inch pitch 36 way 2 off
- Knobs Sifam 15mm collet fixing with nut covers and caps.
- K150 plain 2 off
- K151 line pointer 4 off
- W151 wing and line pointer 6 off



Connect all four deflection plates to the junction of the two resistors, i.e. approximately +100V. With VR5, VR6 and VR201 all set to midtravel, switch on and allow a few seconds for the tube heater to warm up.

Adjusting VR5 should produce a spot on the end of the tube and VR6 should enable it to be focused to a small diameter. If at either side of this setting it looks elliptical, wider or taller as VR6 is adjusted, VR201 (astigmatism) should enable this to be corrected. Mind where you put your hand when adjusting VR201, it's not far from the e.h.t. on Board 1! It should be possible to focus the spot down to a pinpoint, provided the brilliance control is not advanced too far, though of course VR201 will need resetting when Boards 3 and 4 are fitted.

In fact Board 3, the Y amplifier is the next step and full details of this will be published in next month's instalment.

Several readers have enquired about the possibilities of using alternative tubes for Purbeck. We cannot advise anyone as to the suitability of components other than those specified. Not only will the mechanical construction need alteration, but revised amplifiers and e.h.t. supplies will also be required.



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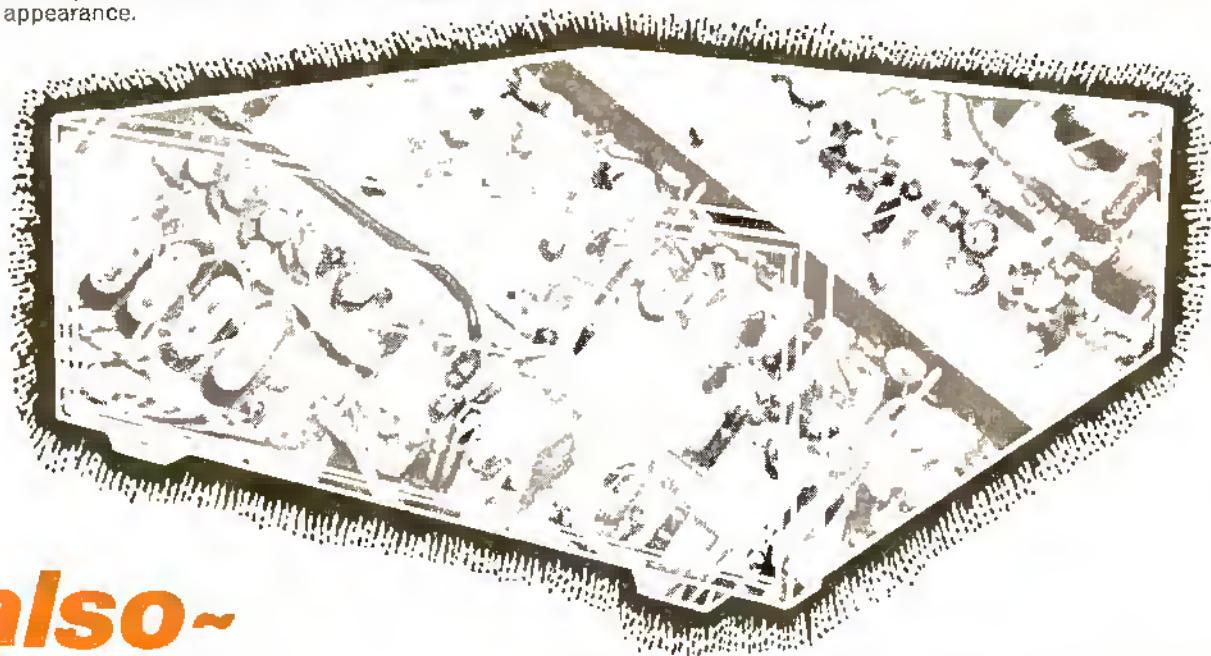
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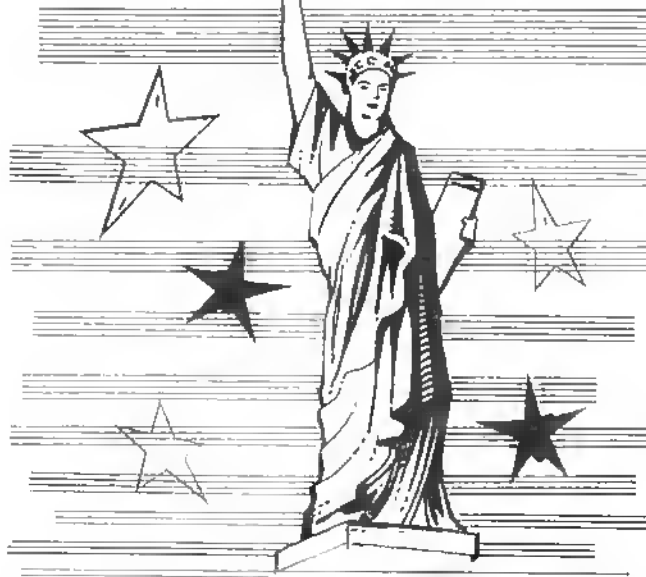


Beginning a primer in logic, which will cover gates, flip-flops and counters, characteristics of TTL and CMOS and design techniques.

### **Phase~ Locked Calibrator**

A simple circuit design which provides an accurate 200kHz output signal, phase-locked to the BBC's Droitwich transmitter, useful for calibration of receivers and digital frequency meters.

# STATESIDE CALLING



JOE KASSER G3ZCZ/W3

When one thinks of people in another part of the world, one usually imagines that their life style is almost identical to one's own. The fallacy of this concept is only obvious when one travels and is exposed to another way of life. Contrary to popular belief, radio amateurs are no different to other people and although the hobby is international, it takes on different forms in different countries. This article is an introduction to amateur radio in the United States of America.

## The Transmitting Licence

It is much easier to become a radio amateur in the USA than in the UK. There are several classes of Licence, each having different examination standards and frequency privileges, as shown in the table. In general, Novices have to pass an examination in elementary theory and a 5 w.p.m. Morse test. The examination is administered by a radio amateur volunteer on behalf of the licensing authority (which in the USA, is the Federal Communications Commission).

The Novice licence is valid for two years and until recently was distinguished by the WN prefix. It allows its owner c.w. only privileges in the 10, 15, 40 and 80 metre bands with a maximum power input of up to 250 watts.

The Technician class of licence requires slightly more technical knowledge than a Novice, and allows operating privileges similar to our Class B licence on segments of the 6 metre band and higher frequencies. The General, Advanced and Extra class licences are all allowed all-band, all-mode operation, but each class of licence (except Extra) is limited to segments of the band. The test for the General requires 13 w.p.m. c.w. and the test for the Extra requires 20 w.p.m. Increasing levels of technical knowledge are required for up-grading from one class to the next.

The licences are free and except for the Novice, are valid for five years. Separate mobile or TV licences are not required. The segments of the bands available to the different classes of licence are summarised in Fig. 1.

The band split between phone and c.w. is decided by the FCC for the amateurs, and not by the amateurs themselves as in most other parts of the world. In general the input power limits are 1kW input d.c. or 2kW input p.e.p. except on Top Band, which is segmented in both frequency and power depending on geographical location as shown in Fig. 2.

## The HF Bands

Operation on the h.f. bands is very different to that in Europe. The vast majority of the stations appear to be using the full legal limit and beam antennas. Thus the bands are crowded with strong signals all originating from the states, and it is difficult to hear non-stateside signals at times. The USA is so large that in general, any foreign station is DX.

The bands are so crowded that if you want to work the states from outside, you should get up into the General parts of the bands when they are open to the USA. You may then be giving the stations you work, their first G contact. If they want your QSL they will probably offer to QSL direct and even send you IRCs. There are many more of them than there are Gs, so if they are not in a rare state such as Utah or Delaware, let them QSL first. If they want your card, they will. If you operate in the Extra or Advanced segments of the bands the chances are greater that you will be working someone for his umpteenth G contact.

The 3-5MHz band is so wide (3.5-4.0MHz) that the c.w. part is called 80 metres, but the phone part is called 75 metres. At this point of the solar cycle, it

TABLE: US Amateur Radio Classes

Class	Morse Requirements	Technical Knowledge Required	Operating Privileges
Novice	5 w.p.m.	Hardly any	10, 15, 40 and 80m
Technician	5 w.p.m.	About RAE level	6m and higher
General	13 w.p.m.	About RAE level	All bands, some frequencies
Advanced	13 w.p.m.	A little more than RAE level	All bands, more frequencies
Extra	20 w.p.m.	As Advanced	All bands, all frequencies



offers cross continent contacts late at night. The 40 metre band has similar characteristics but is little used at night due to the vast amount of broadcast station interference. Sectors of the band allocated to broadcast stations in Europe are allocated to amateurs in the Americas and those broadcast stations come in loud and clear in the USA. The 20, 15 and 10 metre bands are pretty much the same as in Europe, in terms of distance worked, but are generally without the language barrier, because the common language in the states is English (more or less). There is thus very very little incentive for the American amateur to learn a foreign language.

## Traffic Handling

American radio amateurs have third-party traffic handling privileges. This means that they can pass messages for people other than radio amateurs. For example, a station in New York can contact a station in Los Angeles and ask that station to pass on a message to a non-amateur. He can even have him connect his radio to the telephone line via a phone patch and make a radiotelephone call, thus saving on his long distance telephone bill. There is a number of countries that have reciprocal agreements with the USA about third-party traffic; in other words they allow traffic to be passed between their country and the states. Thus on all bands one can hear a number of nets passing traffic messages. Once a year the American Radio Relay League (ARRL) organises a traffic handling contest (called Sweepstakes), in which the information exchanged simulates message traffic.

## The VHF Bands

At v.h.f. there is no 4 metre band, but there are operating privileges at 50MHz (6 metres) and 220MHz (1 $\frac{1}{4}$  metres). Six metres opens up to sporadic E much more often than 4 metres, and thus a lot of the activity is on c.w. and s.s.b. It has

properties very similar to 10 metres in terms of ground-wave communications capabilities, but DX is of course much more scarce on 6 than on 10.

The 2 metre band is 4MHz wide (144-148MHz). The top two megahertz are filled with f.m. repeaters and simplex channels spaced 30kHz apart. Small segments of localised s.s.b./c.w. activity exist close to 144 and 145MHz, but in the main the lower two megahertz comprise the wide open spaces. At the time of writing, the FCC is proposing to open some of it up for repeaters. There is OSCAR-related activity at about 145.9MHz. Thus apart from narrow and sparse areas of activity at 144, 145 and 145.9MHz the lower two megahertz is an uncharted wilderness at this time. Local s.s.b. or c.w. activity on a nation-wide basis is rare.

In most big cities, tuning the low end of the band by day will be very unrewarding with little to be heard. Even in the evenings you would be lucky to hear more than three simultaneous contacts taking place in the low half of the band, but during a contest a tremendous number of stations suddenly crawl out of somewhere and fill up the one or two hundred kilohertz. However, in the major cities the f.m. channels will be crowded. In most big cities all the repeater channels between 146 and 147MHz are in use as well as some of the 147-148MHz ones. There is no f.m. calling channel as such, just find a repeater and use it seems to be the rule.

In the states, the pioneers on v.h.f. set up repeaters to extend the range of their converted taxicab f.m. mobile equipment. As newcomers came on the band, they found the repeaters in existence and joined in. If people did not like a particular machine they were free to build and use their own on an adjacent frequency. In some parts of the country there were even repeater "wars" over choice frequencies between two repeater groups, each trying to force the other group to change frequency (this was before the days of synthesisers, when everyone was crystal controlled). Eventually voluntary frequency control was established by area-wide organisations. In the main how-

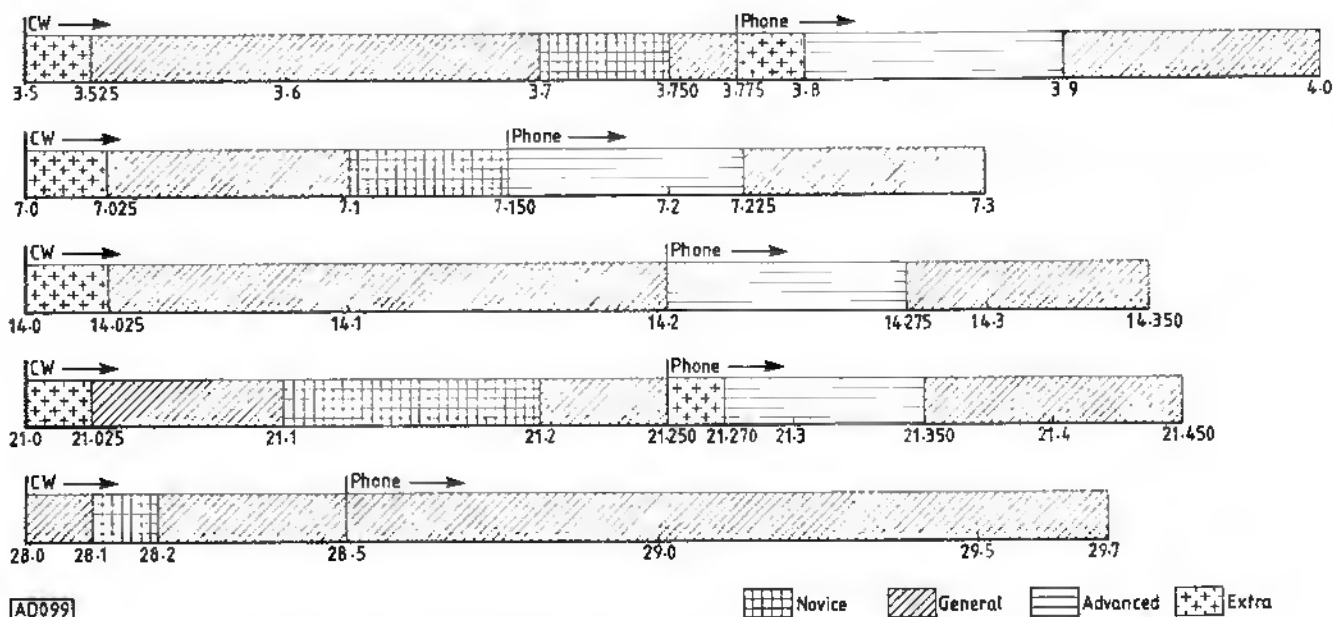
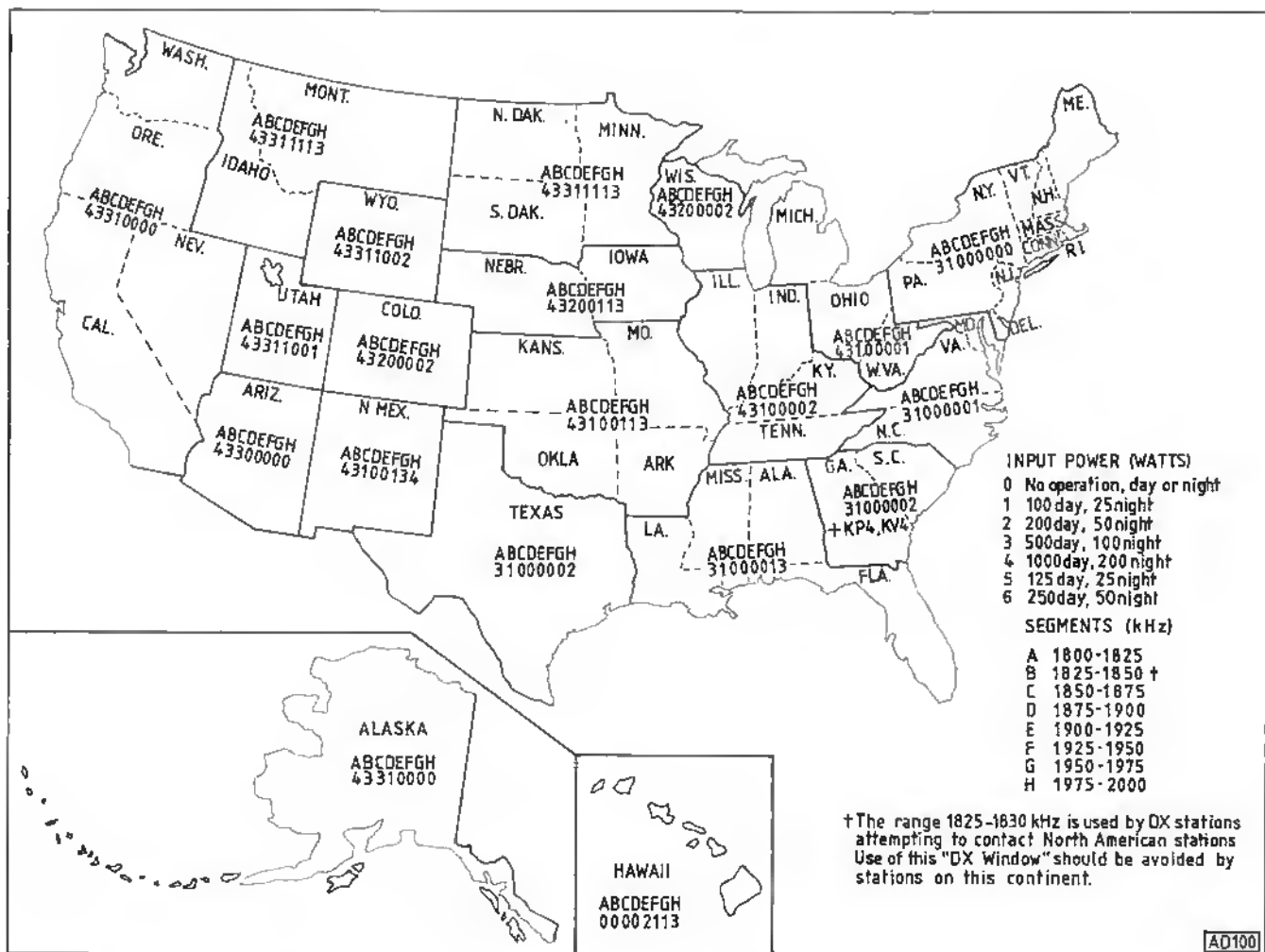


Fig. 1: HF Frequency Assignments in the USA. Note that higher class licenses have privileges in lower class segments, the table shows the lowest class allowed in each segment



**Fig. 2: Top Band frequency allocations in the USA**

ever there have been few cases of deliberate interference with repeaters, because the newcomers to v.h.f., especially to 2m, generally only used f.m. and soon learned the advantages of the extended range and continuous monitoring of the repeaters.

In the UK the situation is different, the bands were in use before the advent of the repeaters. Also the 2m band is only two megahertz wide and everyone has to fit into it. Hopefully it will take just a short while for everyone to find out the advantages of repeaters and common sense will then prevail.

The 220MHz band is similar in characteristics to 2m. There is little in the way of s.s.b./c.w. commercial equipment for the band, and hence most of the activity is f.m. The same applies to 70cm. Here, most of the activity is f.m. between 440 and 450MHz, i.e. right at the top of the band, so that conversion of surplus equipment involves the minimum of changes. The 70cm band is also used for remote control of lower band repeaters and for inter-repeater links. Activity on higher frequencies is at par with Europe, namely very rare and due to only a few individuals.

## Using Repeaters

Many f.m. repeaters are connected to telephone lines. This allows for "auto patch" facilities, whereby amateurs can actually access the telephone network via the repeater and dial calls using the tones. They can report accidents to the police, call home and ask

the wife if they should stop off at the local supermarket and pick up some groceries, or do as one radio amateur did over one of the local machines here in Washington DC; while sitting in the garden by the side of the pool, he used his walkie talkie equipped with a touch-tone pad to dial his house phone and ask his wife to bring him out another can of beer!

The number of repeaters is constantly growing. The ARRL publishes an annual directory that is free for the asking to members. The frequencies are based on a 600kHz split with a spacing of 30kHz between channels. They are known by the kilohertz values, i.e. a repeater on 146.25MHz (in), 146.85MHz (out) is commonly known as the 25/85 machine. In the 146/147MHz region the input frequency is the lower one, whilst in the 147/148MHz region the reverse is true and the higher frequency is the input channel. This was carefully arranged this way so that receivers could be peaked up at 147MHz and work with the whole range of channels. These frequencies are of course not allocated to the amateur radio service in Europe, and on my last trip to the UK, I found that some of the American repeater output channels that I had in my rig were in use by the police.

Apart from f.m. the majority of activity on 2m and 70cm seems to involve OSCAR. Project Oscar started the whole thing in California with the launch of the OSCAR I satellite in 1961, and AMSAT took over in 1969. The ARRL puts out a lot of free



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57	16	8	10.39	1.32
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80	3-0	5.20	1.14
21	4-0	7.44	1.14
51	5-0	8.37	1.32
117	6-0	9.29	1.45
85	8-0	11.73	1.64
89	10-0	13.33	1.84

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125	1-0	4.58	0.96
127	2-0	7.49	1.14
125	3-0	10.84	1.32
123	4-0	12.33	1.84
40	5-0	13.95	1.84
120	6-0	15.86	1.84
121	8-0	28.15	O.A.
122	10-0	24.93	O.A.
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151	200	11.38	1.50
152	250	12.78	1.84
153	350	16.28	1.84
154	500	19.35	2.15
155	750	29.96	O.A.
156	1000	37.50	O.A.
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21	1A, 1A	0-5-0-5	2.25	0.78
11	100	0-0-0	2.14	0.38
235	330, 330	0-0, 0-0	1.89	0.38
207	500, 500	0-8-8, 0-8-8	2.59	0.71
208	1A, 1A	0-8-0, 0-8-0	3.53	0.78
236	200, 200	0-15, 0-15	1.89	0.38
214	300, 300	0-20, 0-20	2.50	0.78
221	700 (DC)	20-12-0-12-20	3.41	0.78
208	1A, 1A	0-15-20-0-15-20	4.03	0.96
203	500, 500	0-15-27-0-15-27	3.99	0.96
204	1A, 1A	0-15-27-0-15-27	5.38	0.96
239	50	12-0-12	1.89	0.38
S112	500	12-15-20-24-30	2.84	0.78

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educational stuff about the OSCAR satellite programme, which by-the-way is available to anyone worldwide, for the asking. Worked All States via OSCAR is just possible for Eastern stations and is well within the capabilities of anyone in the continental United States west of the Mississippi river.

## Equipment

Salaries in the states are generally at between two and four times the level of the equivalent salary for the same job in the UK. Thus on a basis of hours worked, equipment is much cheaper over here. The large number of amateurs support a few manufacturers so that there is quite a variety of domestic gear available as well as the ubiquitous Japanese black boxes.

Parts for the homebrewer are also readily available by "mail". Many suppliers advertise in the various magazines, and their wares can be ordered by post, or by telephone quoting credit card numbers.

Crystals for 2m transceivers are available over the counter in most major cities and the prospective visitor can wait until he arrives in the USA to purchase the bulk of his crystals. If he is lucky the store may even have facilities for tuning the rig frequency. If you are interested in operating in the USA when visiting this country you can obtain detailed information from the RSGB, or write to the FCC, Washington DC, 20554 for an application form (Form 610A). Make sure that you send in your application at least three months before your trip, because it will take them that long to reply.

## Listening and Viewing

The receiving side of the hobby is also somewhat different. The medium waves, f.m. and v.h.f. TV bands are filled in most major urban areas. Medium wave DX-ing is a little easier than in Europe, because most of the stations broadcast in English. Stations are spaced 10kHz apart, which enables the inter-continental DX to creep in between the cracks. The majority of stations are east of the Mississippi. The FCC recognise the sky-wave effect at night and regulate the band occupancy such that many local stations are required to close down at local sunset. This allows clear-channel stations to be heard over continental distances at night. It is thus for example possible to drive through downtown Los Angeles in the evening, tune the car radio a little and listen to broadcasts from Denver, Oklahoma and Iowa, or to drive around in Washington DC and listen to stations in Montreal, Chicago and New Orleans.

The v.h.f. TV bands are also full in most cities with some additional channels in the u.h.f. bands in use. All transmissions in the Americas are 525-line 30-fields, thus there are no modifications necessary to the TV sets for their use in TV DX-ing. The f.m. band is 20MHz wide in the range 88-108MHz, with 88-92MHz being reserved for public broadcasting stations. These stations, usually run by universities or local authorities, broadcast educational programmes, classical music and selected shows from the BBC (including the *Goon Show*) as opposed to the popular music or news churned out by the commercial stations. There are three major networks in the states that broadcast commercial programmes, and each city usually has a local outlet of each as well as one or more independent stations and the public station. This allocation applies to television as well as radio. Recent broadcasts on public television have included, *I Claudius* and *Upstairs-Downstairs*.

Many of the independent TV stations broadcast old films and TV shows including *UFO*, *The Saint*, *The Prisoner*, *The Avengers* and *Danger Man*. The f.m. stations usually broadcast in stereo. Both medium wave and f.m. stations usually churn out popular music, each specialising in a particular type, and there may be one or two stations that continually broadcast news. The u.h.f. TV band is relatively sparsely populated, its growth being curtailed by cable television systems.

## Citizen's Band

Closely related to amateur radio is Citizen's Band Radio. The Citizen's Band is a small allocation of spectrum space at about 27MHz. It seems to have been originally allocated for personal communications between a fixed base station and a mobile (so that for example, a husband could talk to his wife on the way home from work) or between mobiles, so that the drivers of two cars travelling together can communicate.

Licences are now available free for the asking, with no tests involved. Power input is limited to 5 watts d.c. a.m. and equipment is cheap. A forty-channel transceiver can be purchased for about \$50. There are estimated to be millions of CB stations in service, the majority of them being unlicensed.

Homo sapiens is a creature of invention. The American branch of that species, perhaps more inventive than other branches, has devised new uses for the Citizen's Band. Lorry drivers use it to warn each other of impending police radar speed traps. Prostitutes have been known to solicit customers via CB radio. Hobby operation including QSL'ing abounds and most stations use self-given "handles" rather than their official call signs, always assuming that they have an original call sign.

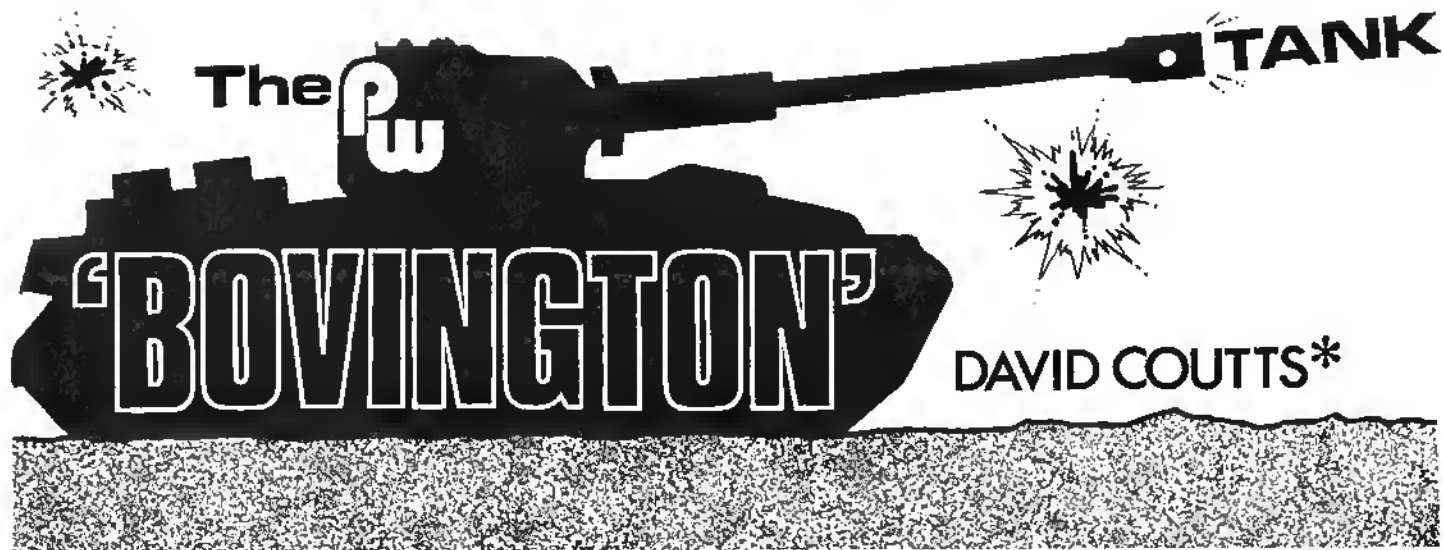
Illegal power amplifiers are often used and some operators are even equipped with amateur band equipment such as Yaesu FT101s. In the cities the channels are overcrowded and communication ranges are limited by the numbers of conversations taking place on the frequency. One channel has been set aside for emergency use (ch 9) and one is used as a calling channel (ch 19). Almost everyone monitors channel 19 when on the road unless they have QSYd for a particular reason to another channel, and contribute traffic and police location information. Hitchhikers also solicit rides over channel 19. One neighbour of mine estimated that in two weeks of use he recouped the cost of the equipment due to the timely warning he received about the locations of police radar speed traps that would otherwise have caught him. Citizen's Band is a boon if used correctly, but if abused is a mess.

## Microprocessors

The latest arrival on the electronics hobby scene is the home computer based on the microprocessor. Thousands have been sold and clubs are forming all over the country. Microcomputers can be the subject of many articles in themselves, but suffice it to say for now that their use is invading the home as well as the amateur radio shack. It is estimated that within five years the vast majority of homes in the US will contain at least one microprocessor.

This article has been an introduction to amateur radio and the electronics scene in the United States. Future articles will go into more detail about the various aspects of the hobby. ●





The General Instrument AY-38710 integrated circuit is a 625 line interlaced "TV Tank Battle Game" for two players. The "battleground" consists of white barriers and a series of black mines. There is one white and one black tank, each controlled by two single pole double throw paddle switches biased to centre off. A push button for each player controls gun firing and a push button allows the battle to be reset. Pin 22 of the i.c. is switched to control the tank traps. In the open position the tanks can drive through these barriers, in the other position (grounded) the tanks halt when they collide with them. Motor sounds are provided for each tank as well as gun fire and shell explosions, and the score is coded to each tank. The tanks are driven like real tracked vehicles, pushing both switches forward causes the tank to go forward. If the switches are held the tank automatically speeds up after a few seconds. If the switches are released the tank continues at the speed reached at the time of release. Pulling both switches back causes the tank to reverse, while holding one switch back and one forward causes the tank to rotate. To stop the tank when it is going forward momentary selection of reverse is required. The shell has a range of about two thirds of the screen and after firing there is a reload period before you can fire again. The shell can be steered during its flight by rotating the tank. The shell will pass over the mines but will explode on hitting barriers. A hit on your opponent counts one point, while running over a mine counts one against you. When one player reaches 16 hits the scores flash to show that the game has ended.

## Circuit Description

The circuit diagram is shown in Fig. 3. T1 provides 12-0-12 volts which is full wave rectified by D1 and D2 and smoothed by C1. IC1 regulates the supply VP to approximately 6.5 volts, VR1 adjusting the voltage and C2, 3 and 4 providing decoupling. IC4 a and b provide the 4 MHz clock to the AY-38710, L1 being adjustable to allow the oscillator to be set to the correct frequency. IC3 a and b, with their

associated Rs and Cs, provide the shaping for the fire and explosion sounds. IC3c does the same for the motor sounds which are all fed via IC3d to the output transistors TR1 and TR2. Switches S4, 5 and 6 control the left tank and S7, 8 and 9 control the right tank. S3 is the game reset and S2 is the tank trap switch. R2 to R4 mix the video signals and the composite video is buffered by the emitter follower TR3 and fed to the modulator.

TR4 and its associated components act as the modulator which runs at a frequency of approximately 160-170MHz, with harmonics extending into the u.h.f. band.

## Construction

Construction is relatively straightforward, most of the components being mounted on the p.c.b. It is, however, advisable to use sockets for IC2, 3 and 4. The component layout is shown in Fig. 7. Drill 6BA clearance holes for board fixing, FS1, T1 and IC1, and a 6mm hole for L1. Drill other holes to suit the component leads. Before mounting any components on the board place the p.c.b. in the box with a modulator at the front right, and the p.c.b. about 10mm from the right side of the case. Drill 4 fixing holes in the bottom of the case using the p.c.b. as a template. Also drill a 6mm hole in the bottom to line up with L1 core. Put the p.c.b. to one side and drill the box and front panel as shown in Fig. 1. Also drill a few 6mm holes in the base and rear of the case for ventilation. Stick a small piece of speaker cloth over the rear of the speaker hole on the front panel, fix the speaker in place with epoxy adhesive and mount the switches S1, 2 and 3. The sound output is controlled by VR3 which is mounted on the front panel.

Assemble the p.c.b. using the layout Fig. 7 and parts list as a guide but do not fit IC2, 3 or 4 into their sockets yet. R9 can be either a 20M $\Omega$  resistor or two 10M $\Omega$  resistors (R9a and R9b). Fit a TO5 heatsink to TR2, cut and bend a piece of aluminium sheet 60mm x 35mm as a heatsink for TR1 as shown in Fig. 4, drilling through the p.c.b., and retaining IC1 and the heatsink with a 6BA screw. Cut and bend

\*An Engineer with General Instrument Microelectronics, Glenrothes

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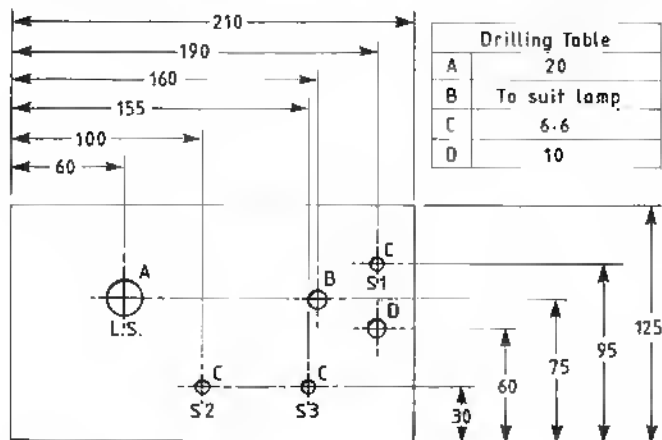
# BATTLE GAME



a piece of tinfoil (cocoa tin) as shown in Fig. 5 to form a box for the modulator screening, fit the sides and bottom by soldering to four Veropins as shown in the drawing but leave the top plate off until the

unit is working and displaying a picture on the television screen.

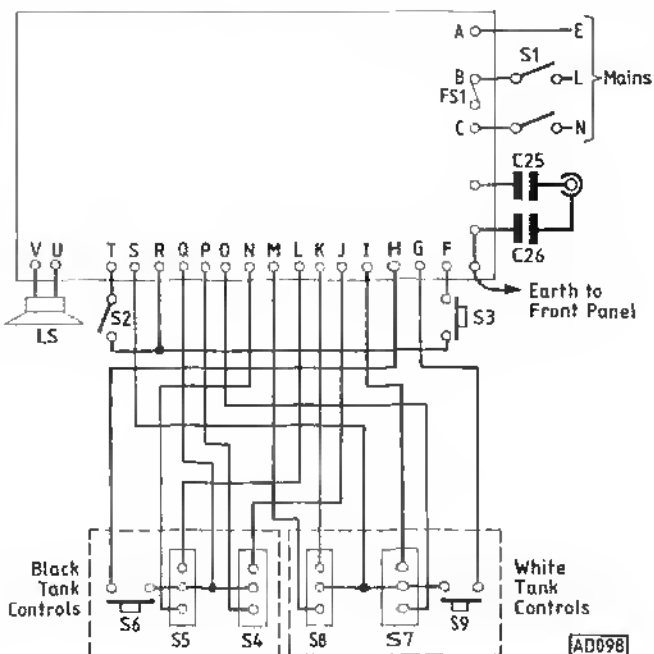
Carefully check the p.c.b. for correct assembly and freedom from inadvertent shorts such as solder



Dimensions in mm.

AD094

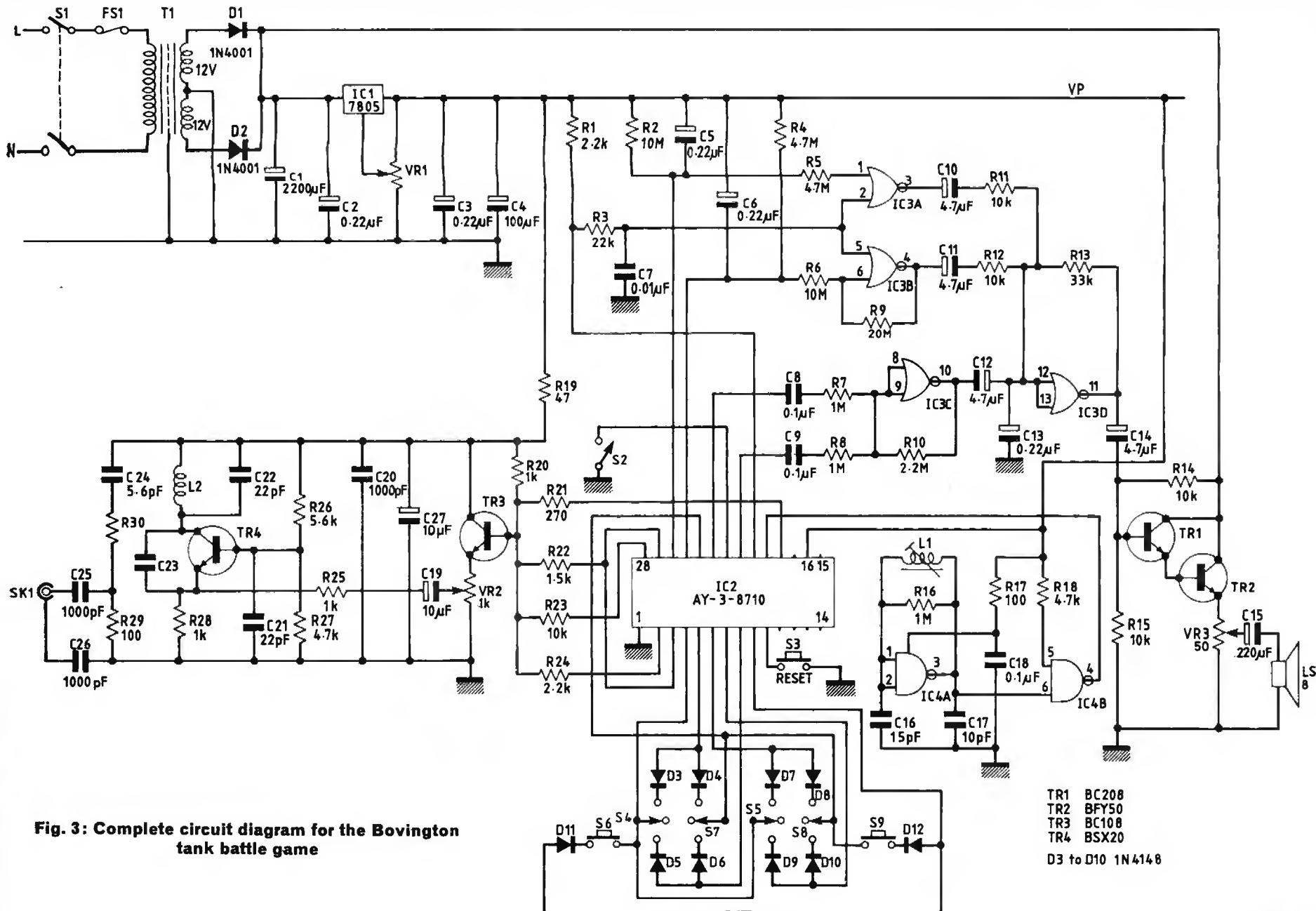
▲ Fig. 1: Front panel drilling diagram



AD098

▶ Fig. 2: Main printed circuit board connections

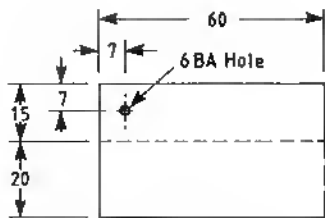




- TR1 BC208
- TR2 BFY50
- TR3 BC108
- TR4 BSX20
- D3 to D10 1N4148

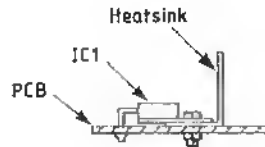
**Fig. 3: Complete circuit diagram for the Bovington tank battle game**

Tank Cct. Diagram Fig.1



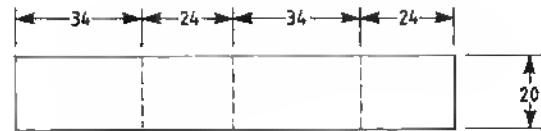
Dimensions in mm.  
Material: 16 SWG Aluminium

▲ Fig. 4: Heat sink for IC1

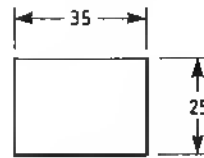


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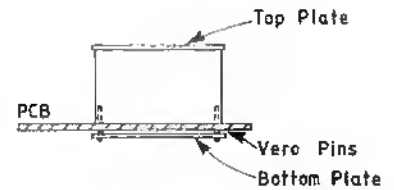
Fig. 5: Details of modulator screen ►



1 off



2 off



Dimensions in mm.  
Material: Tinplate.

AD097

bridges, set VR1 fully clockwise and VR2 to midrange and fit the unit in the case with 6BA screws through the fixing holes. Wire the unit up as shown in Fig. 2. Fix two 6 pin DIN sockets in the front of case connected to points G-Q & S on the p.c.b. to feed the hand controllers. These sockets may be omitted and the multicore wires fed through suitable holes fitted

with grommets. The hand controllers can be assembled in any convenient small plastic boxes.

Switch the power on, monitor the voltage VP across C4 and adjust VR1 to obtain 6.5 volts. If you have a scope or counter fit IC4, power up and adjust L1 for 4MHz. If not, set the top of the core of L1 approximately 6mm into the former. Fit the remaining inte-

## ★ components

### Resistors

All  $\frac{1}{4}$ W 5%

47 $\Omega$	1	R19
100 $\Omega$	3	R17, 29, 30
270 $\Omega$	1	R21
1k $\Omega$	3	R20, 25, 28
1.5k $\Omega$	1	R22
2.2k $\Omega$	2	R1, 24
4.7k $\Omega$	2	R18, 27
5.6k $\Omega$	1	R26
10k $\Omega$	5	R11, 12, 14, 15, 23
22k $\Omega$	1	R3
33k $\Omega$	1	R13
1M $\Omega$	3	R7, 8, 16
2.2M $\Omega$	1	R10
4.7M $\Omega$	2	R4, 5
10M $\Omega$	4	R2, 6, 9a, 9b

### Capacitors

Plate Ceramic

3-3pF	1	C23
5-6pF	1	C24
10pF	1	C17
15pF	1	C16
22pF	2	C21, 22

Disc Ceramic

1000pF	3	C20, 25, 26
0.01 $\mu$ F	1	C7
0.1 $\mu$ F	3	C8, 9, 18

Polyester

0.22 $\mu$ F	2	C2, 3
--------------	---	-------

Tantalum

0.22 $\mu$ F 10V	3	C5, 6, 13
4.7 $\mu$ F 10V	4	C10, 11, 12, 14
10 $\mu$ F 10V	2	C19, 27
100 $\mu$ F 10V	1	C4

Electrolytic

220 $\mu$ F 25V	1	C15
2200 $\mu$ F 25V	1	C1

### Potentiometers

1k $\Omega$ Horizontal preset	1	VR2
4.7k $\Omega$ Horizontal preset	1	VR1
50 $\Omega$ Wirewound.	1	VR3

### Semiconductors

Diodes

1N4001	2	D1, 2
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Integrated circuits

4001A	1	IC3
4011A	1	IC4
7805 regulator	1	IC1
AY-3-8710	1	IC2

Transistors

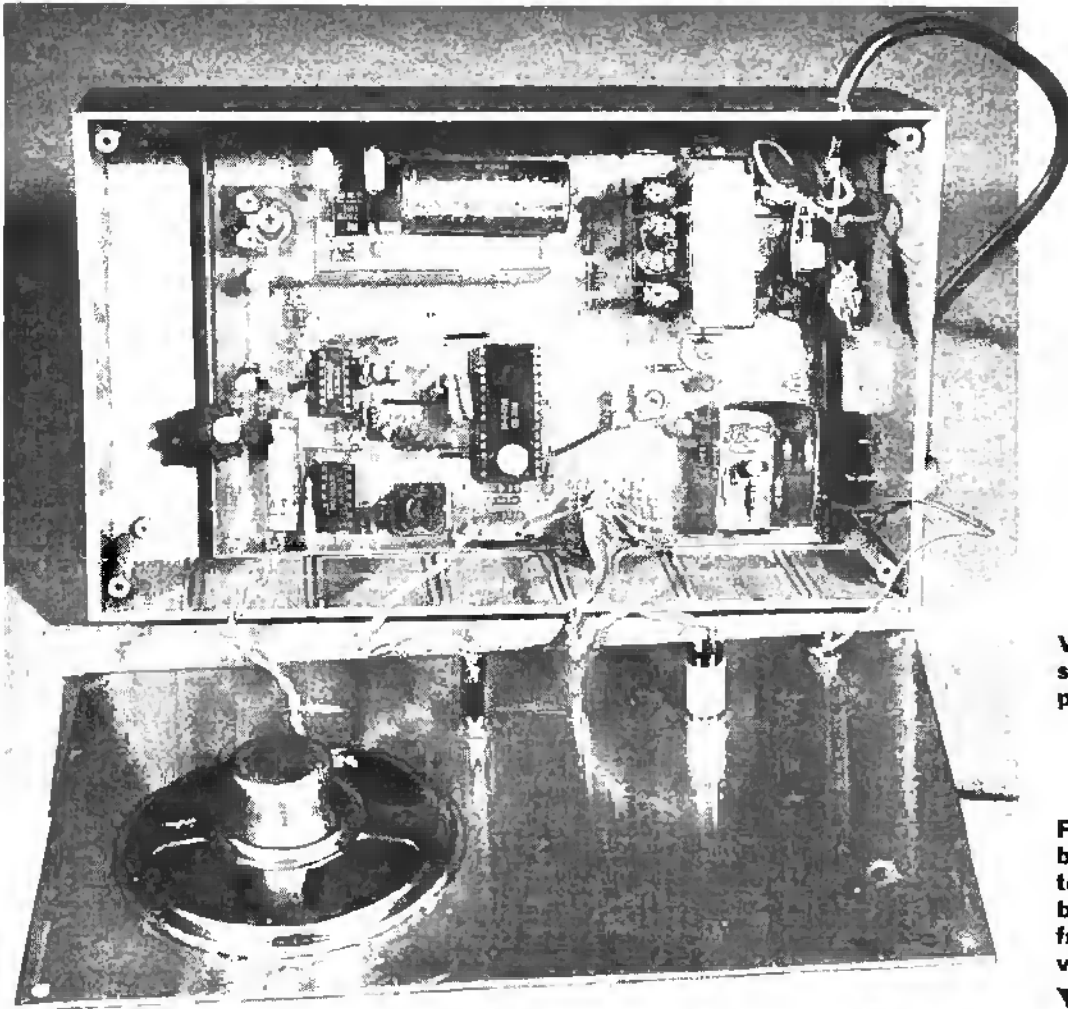
BC108	1	TR3
BC208	1	TR1
BFY50	1	TR2
BSX20	1	TR4

### Switches

Paddle s.p.d.t. (Arrow CPM3 Black)	2	S4, 5 (Biased to centre off)
Paddle s.p.d.t. (Arrow CPM3 White)	2	S7, 8 (Biased to centre off)
Push-button s.p.	3	S3, 6, 9
Toggle s.p.d.t.	1	S2
Toggle d.p.s.t. (Mains)	1	S1

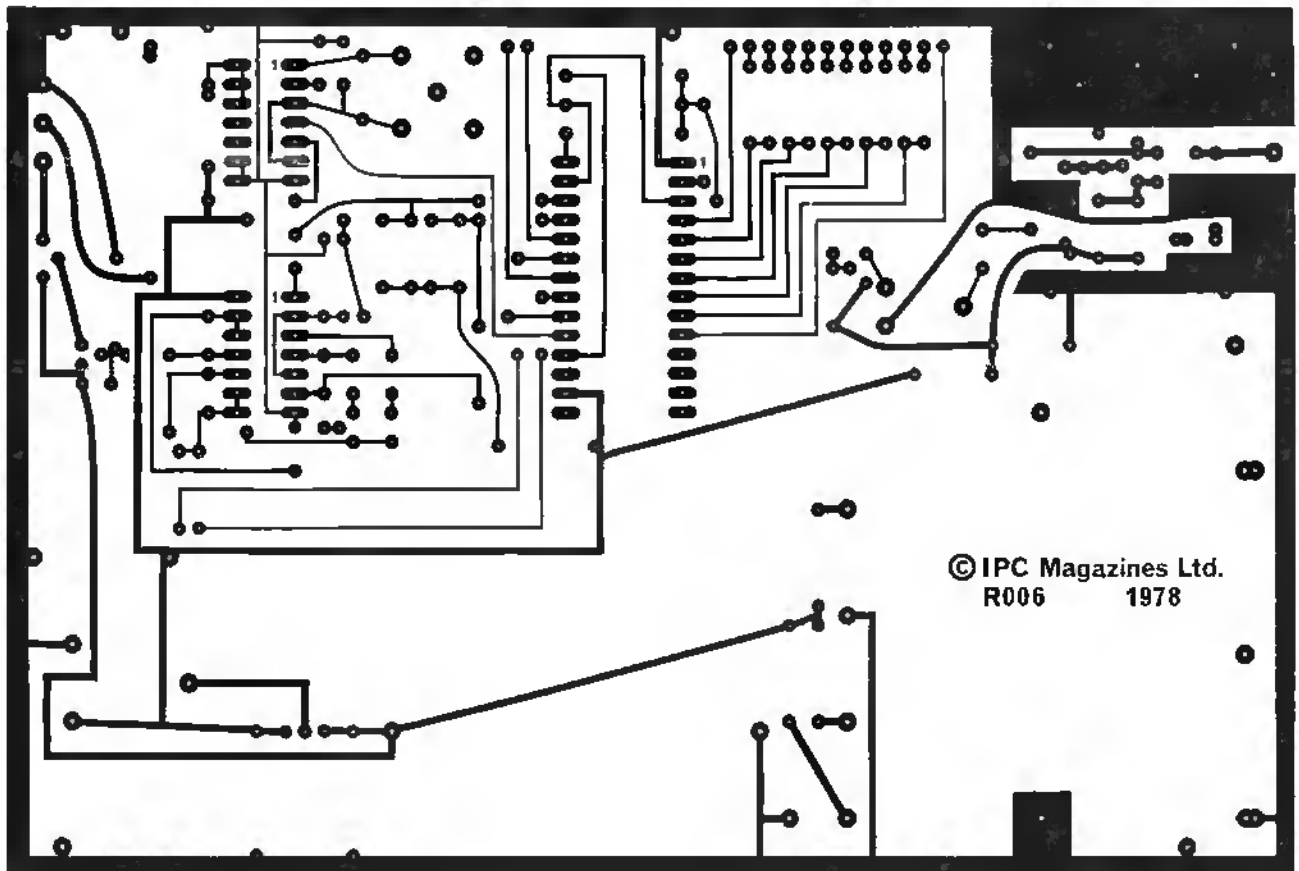
### Miscellaneous

Transformer 12V, 12V 250mA MT12 (Marshall's)
Loudspeaker 2 $\frac{1}{2}$ inch 8 $\Omega$
Case RS Type 509-608
Hand control boxes (2) RS Type 509-298
350mA fuse and holder
Miniature multicore cable (9-way) 4metres
Miniature mains cable
Indicator lamp 12V
Knob for volume control
6-way DIN plug and socket (2) Optional for hand control leads.
TO5 heat sink
Co-axial TV socket surface mounting type.
28-way d.i.l. socket (1)
14-way d.i.l. socket (2)



View of the internal construction of the main p.c.b. and case

Fig. 6: Printed circuit board copper track pattern. Ready drilled boards are available from Readers PCB Services (see page 68)



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R006 1978



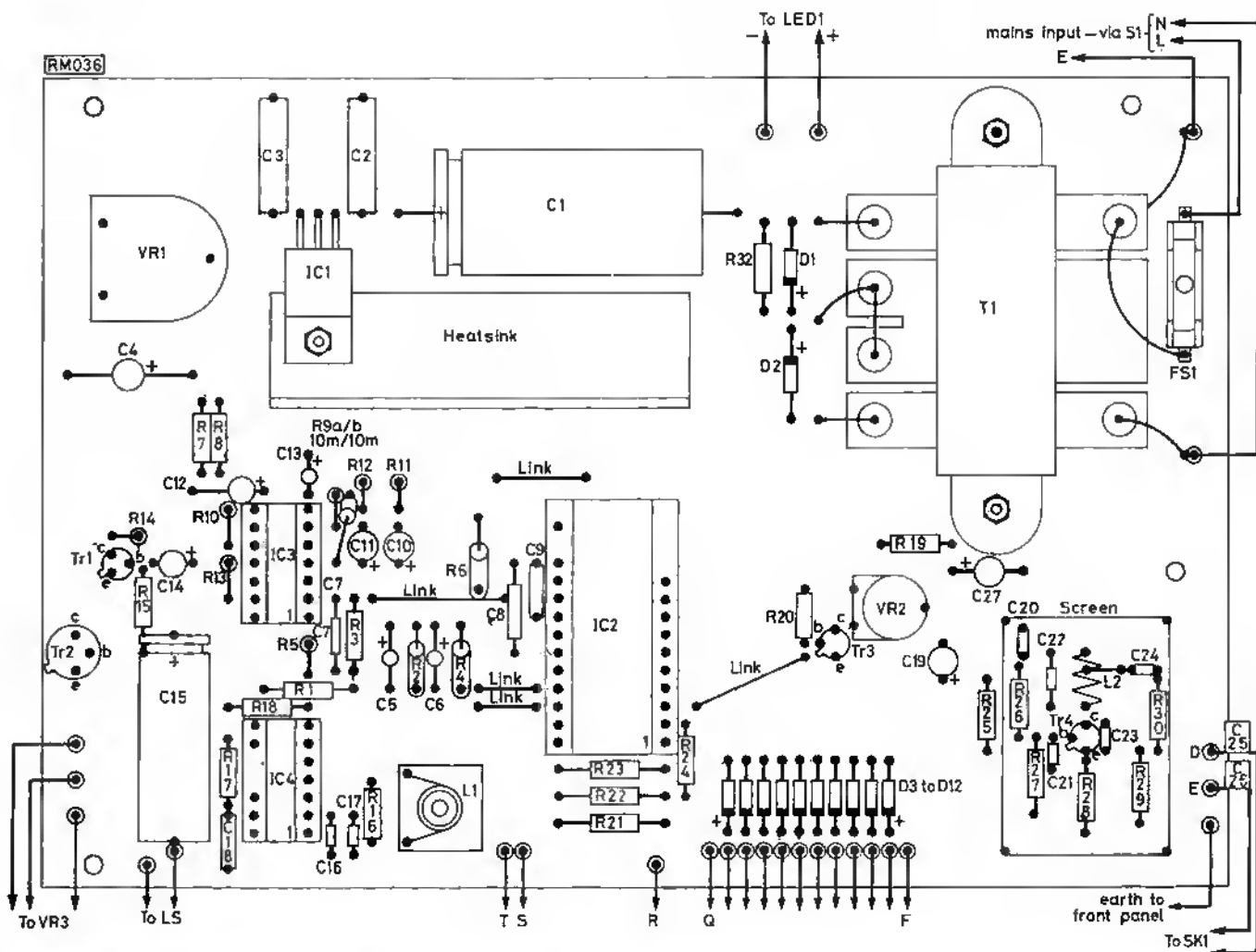


Fig. 7: Main printed circuit board component placement drawing

grated circuits, connect to the aerial input of the television and switch on. Push the reset button, release it and tune the television until a signal from the games unit is found. Several signals may be found, if so choose the best one. L1 may need to be slightly adjusted. When a good picture has been obtained adjust VR2 for the optimum picture, and fit the top cover to the modulator. Check that all the switches function as required and fit the front panel.

## Fault Finding

If the unit fails to function check all your construction carefully, then:—

1. Check that the voltage across C4 is 6.5 volts.
2. Vary VP over the range 6 to 7 volts by means of VR1, if this does not help reset it to 6.5 volts.

3. Check with a scope that pin 19 of IC2 has a 4MHz clock input and pin 16 is at 6.5 volts.
4. Check that composite sync is appearing at IC2 pin 18, pushing and releasing the reset.
5. Check for composite video at TR3 base and again at VR2 wiper. If it is appearing at VR2 wiper try again to tune the television to the game signal. If you still cannot get a picture, substitute a new transistor for TR4.
6. If the tanks only go forward under control of the switches you will probably find that one pair of wires to the switches are crossed.

## Four Players

Extra excitement and skill can be introduced into the game by splitting the tank controls between four players, two to each tank. The steering controls are operated by the "drivers" while the tank commanders have control of the firing buttons.

The modifications needed to make this a four-player game are very simple, especially if DIN plugs and sockets are used for connecting the control boxes to the main unit. The commander's firing control can be fitted into a simple box wired into the DIN plug. If a duplicate set of controls is not desirable then a permanently fitted "commander's" control can be wired into the game unit with a switch arranged to select either the firing button on the "driver's" box or the button on the "commander's" box.

### IC2 Pin Functions

1	Ground
2, 3, 18, 27, 28	Video outputs
4, 5, 6, 7, 8, 9, 24	Control inputs
10	Reset
16	VP (+6.5V)
19	4MHz clock input
20, 21, 23, 25, 26	Sound output
22	Tank trap select
11, 12, 13, 14, 15, 17	Do not connect

# PRODUCTION LINES

alan martin

## Pssst wanna watch?

When l.e.d. and l.c.d. watches first came onto the British market, they cost between £50 and £100 and any available in the £20 range were either advertised on 'Police Five' or came off the back of that proverbial lorry.

We are informed by W.K.F. Electronics, that they have a selection of watches available at very reasonable prices.

First, an l.e.d. watch (left in photograph) that features a rather novel touch sensitive operating pad to display hours and minutes, seconds, day and date, also day and month. Price £10.75 plus VAT.

Second, the standard l.c.d. watch (centre in photograph), which displays hours and minutes continuously,

press the button for day and month, press again for seconds. The watch also has a separate back-light function. Price £10.50 plus VAT.

Finally the chronograph l.c.d. watch (right in photograph) whilst possessing the standard watch functions of hours, minutes, seconds, day, date and month, also features a lap and continuous stop watch facility, with timing to 100th of a second. Price £18.95 plus VAT.

All the watches are supplied with an adjustable stainless steel bracelet and the two l.c.d. watches are powered by batteries costing only 42p (retail) with an estimated life of twelve months.

*W.K.F. Electronics, Fleet House, Welbeck Street, Whitwell, Workshop, Notts. Tel: 0909 720-695.*



## Vero interesting

Vero Electronics Ltd. introduce a new range of cases with their 'Series II Boxes AB 010'.

These boxes are moulded in light grey high-impact polystyrene in two parts. The anodised aluminium front panel supplied with the box is retained between the two halves, avoiding the need for fixing screws. Slots and bosses are moulded into the interior of the box, so that a choice of mounting positions, either horizontal or vertical, is available for p.c.b.'s

or component decks.

Many of the boxes have a battery compartment which is accessible without dismantling the box.

The standard range consists of fifteen boxes varying from 110mm x 68mm x 33mm to 190mm x 138mm x 91mm, and other sizes are available to special order at a minimum quantity of 100.

Further details from: *Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hampshire S05 3ZR. Tel: 042 15 69911.*



## No lick TAC-1

The Polycal TAC-1 is a pocket size, liquid crystal display, travel alarm clock. Measuring 65mm x 32mm x 11.5mm, it weighs only 45g with batteries. The 3V d.c. power input is provided by two silver oxide or manganese alkaline batteries (type GS-14, A-76 or equivalent). Power consumption is 3mW max. (with the alarm sounding). Accuracy is claimed to be ±30 seconds per month at 20°C (68°F). With a separate back-light, the multi-digit liquid crystal displays hours, minutes, clock-working sign and am/pm indication.

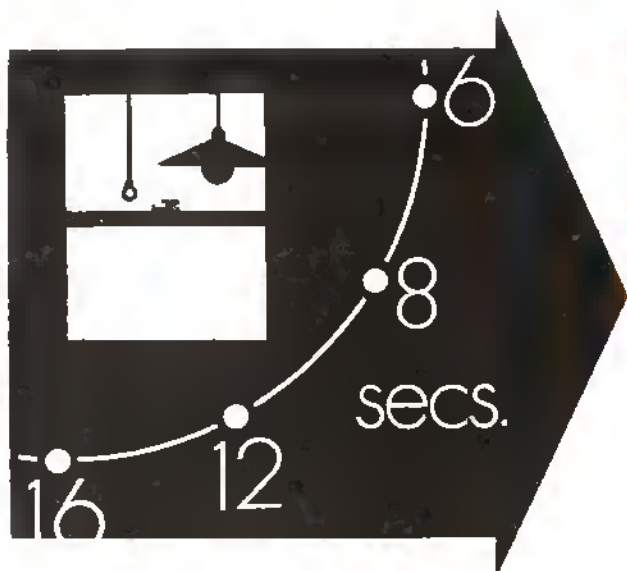
Priced at £22.50, which includes VAT and p & p, the TAC-1 is available from: *Tempus, Dept. P.W., 19/21 Fitzroy Street, Cambridge CB1 1EH. Tel: 0223 312866.*

## Rechargeable iron

A new version of the Engel B.50 Rechargeable Soldering Iron is now available from Kelgray Products Ltd. and is complete with charger unit. The iron now incorporates a built-in spotlight to illuminate the working area and uses long-life rechargeable nickel-cadmium batteries. Providing up to 100 intermittent operations (300 continuous use) without recharging, which can be achieved in about 8 hours (overcharging is impossible). A safety switch is fitted to the trigger-switch to prevent accidental operation. The iron heats up to an operating temperature of approx 350°C in about 7 seconds; a variety of bits are available.

Designed for recharging from a.c. mains, the B50 comes complete with cleaning pad, protective cover, 2 lighting fittings and screwdriver. A particular advantage of this iron is that no stray eddy currents which might damage a sensitive i.c. are generated when the iron is being used.

Priced at £16.50 which includes p&p and VAT, the B50 is obtainable from: *Kelgray Products Ltd., Kelgray House, Sandy Lane, Crawley Down, West Sussex RH10 4HS. Tel: 0342 715066.*



# SIMPLE DARKROOM TIMER

A.P. DONLEAVY

This article describes a simple timer which switches an enlarger on and off for predetermined periods. The instrument can handle exposures up to 32 seconds although this can be easily increased as will be described. The accuracy is better than 10% which is adequate for black and white printing.

The instrument uses a switch which enables the exposure time to be set by feel rather than by having to peer at some dimly lit switch setting.

## Circuit

The circuit is shown in Fig. 2. The 555 i.c. is connected as a monostable multivibrator and on application of a negative pulse to pin 2 a positive pulse emerges at pin 3. The duration of this pulse is determined by the R-C values of R1 to R8 and C1, and also by the voltage on pin 5. This pulse is applied to the gate of the s.c.r. which causes it to conduct for the duration of the pulse. The s.c.r. is essentially being used as a mains switch. If the mains were applied directly to the s.c.r. it would only conduct on the positive-going part of the cycle and the light would only have about one third of its normal intensity. A bridge rectifier is used to rectify the mains supply and thus overcomes this problem.

SW2 applies the pulse to start the timing. Pin 2 is tied to Vcc via R9 to prevent unwanted triggering. Application of a negative pulse via SW1 will prematurely terminate any timing interval.

The length of the timing pulse is proportional to the value of the resistance at pins 6 and 7. The values R1 to R8 are chosen to give sequence times of 2, 4, 6, 8, 12, 16, 24 and 32 seconds, within 10% but the values can be altered to suit the needs of the individual constructor. Every 27kΩ added to the resistor chain will give an extra two seconds time. Hence if a 48 second timing period is required, an extra 8 x 27kΩ or 216kΩ resistor would be needed to be added in series with R1 to R8. In practice a 220kΩ resistor would suffice. The final calibration is made by adjusting VR1.

The unit should consume no more than 8mA, so the power supply uses a miniature mains transformer, with a full wave rectifying circuit.



The timer is built into a small instrument case with all the controls on the front panel

## Components

Any 555 timer i.c. can be used, e.g. LM555, SN72555 NE555, and any s.c.r. and bridge rectifier that can handle at least 400V at 500mA can be used for SCR1 and D1.

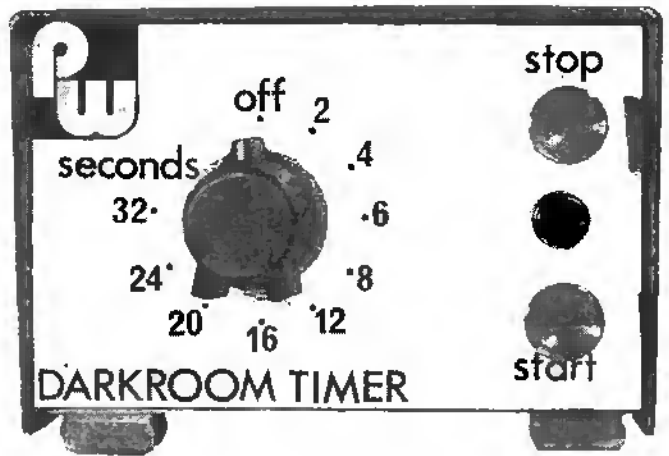
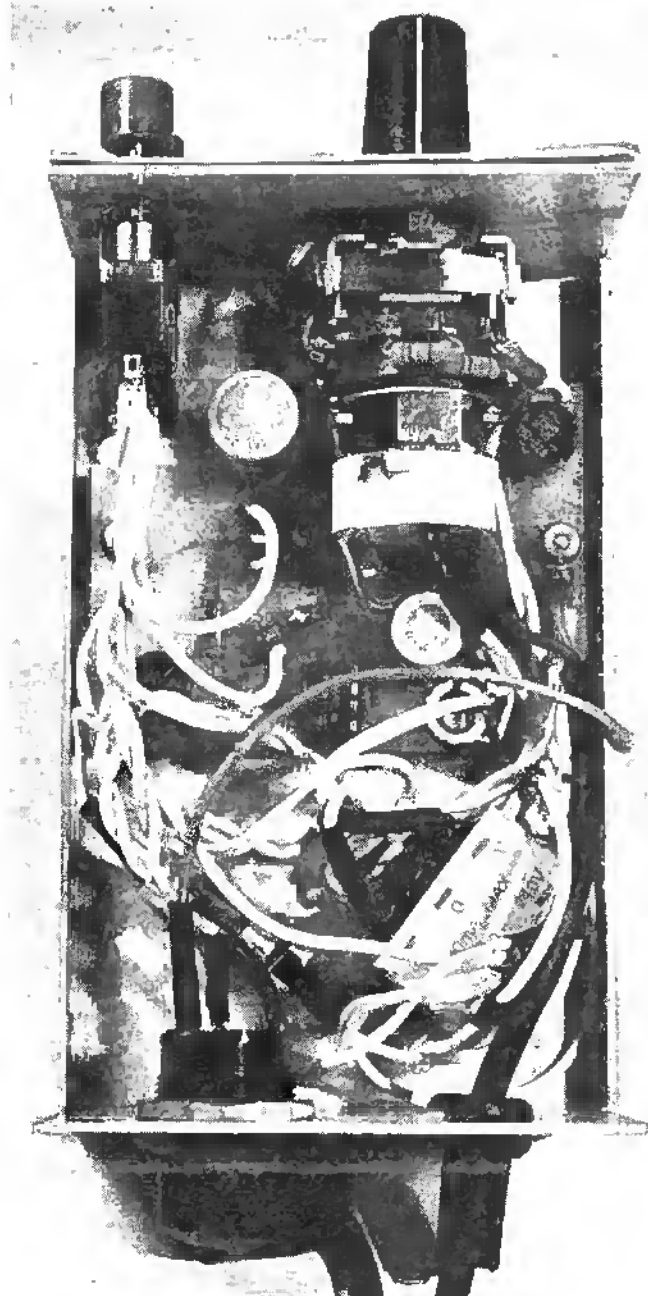
SW3 is made up from a Doram Mini-Maka switch. The minimum requirement is one pole eight way. The prototype had an open position at one end of the scale, which gives a timing pulse of almost indefinite length. This is used for leaving the enlarger permanently switched on. The mains transformer need only be capable of supplying between 6V and 15V at 50mA at the secondary.

## Construction

The unit is built on a printed circuit board 105mm x 57mm. The layout of the copper tracks is shown in Fig. 4 and the component layout in Fig. 3. The unit is housed in a metal instrument case and to complete the front panel a PW overlay is available.

The p.c.b. is supported by two short 4BA screws with a nut between the board and case bottom. Remember that some of the copper tracks carry live

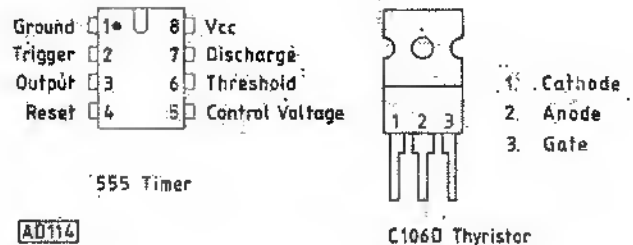




▲ Front panel layout of the darkroom timer. A transparent overlay is available from the PW Editorial Offices which will enable readers to achieve a professional finish to their equipment. The overlay is cut out and placed over the front panel, being held in place by the switch nuts and washers. A coloured background can be used behind the overlay if desired

▲ Inside view of the complete unit showing the positioning of the transformer, p.c.b. and switch

Fig. 1: Pin connections for the 555 timer i.c. and the C106D thyristor



## ★ components

### Resistors

All  $\frac{1}{2}W$  2%

R1	27k $\Omega$	R6	56k $\Omega$
R2	27k $\Omega$	R7	120k $\Omega$
R3	27k $\Omega$	R8	100k $\Omega$
R4	27k $\Omega$	R9	4.7k $\Omega$
R5	56k $\Omega$	R10	68k $\Omega$

### Potentiometers

VR1 10k $\Omega$  min. horizontal skeleton

### Capacitors

C1	47pF 16V
C2	100pF 16V

### Semiconductors

IC1	555 timer
SCR1	TIC 106D or similar 400V working
D1, D2	1A bridge rectifier 400V working

### Miscellaneous

Transformer	3-0-3V 1.2VA Sub-miniature
SW3	1 pole 12 way miniature wafer switch
SW4	Mains switch to fit SW3 mechanism
SW1 and 2	Miniature push-button push to make. Lamp output plug and socket (RS components 488-567 and 488-593). Fuse and holder 2A
Printed circuit board	Reader's PCB Services
Case	RS components. 509-715
Knob	15mm Sifam W15 collet fixing with nut cover and cap
PW Front Panel Overlay	

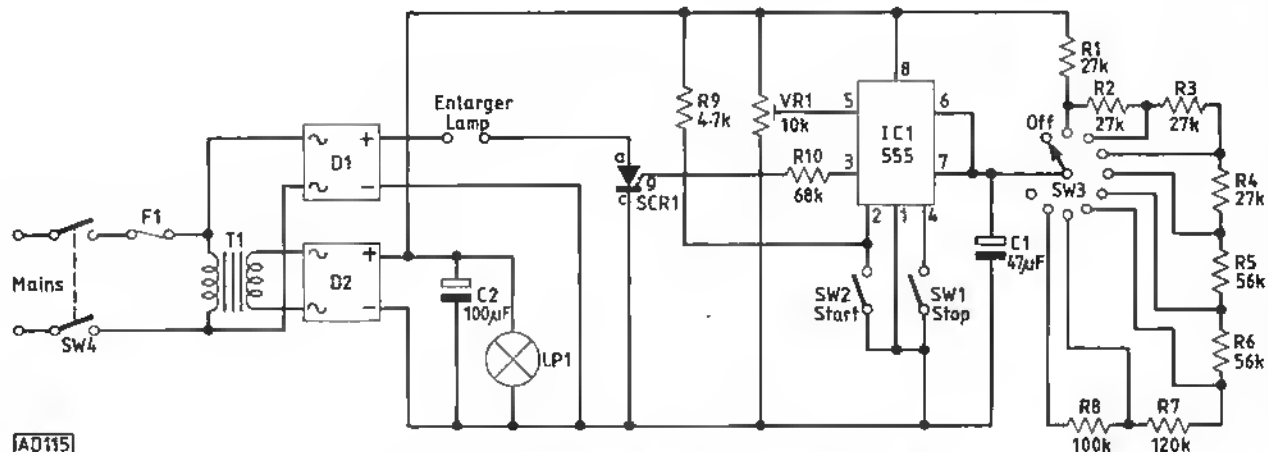
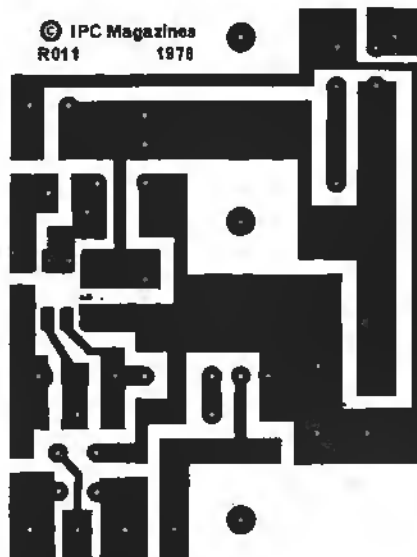
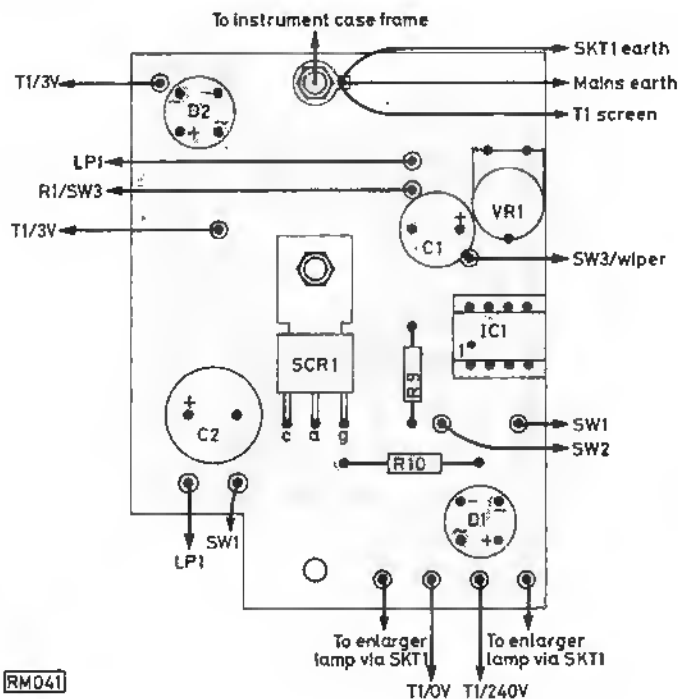


Fig. 2: Circuit diagram of the darkroom timer

**Fig. 3: Component layout diagram.** Care must be taken to avoid solder bridges or other forms of short circuits between tracks or components as mains voltages appear at several points on the board. A piece of self adhesive plastic sheet should be placed on the metal base of the case underneath the p.c.b. to avoid any possibility of component leads shorting to chassis

**Fig. 4: Copper track pattern for the darkroom timer p.c.b.** Ready drilled boards are available from Reader's PCB Service. (see page 68)



mains voltages and that these should be kept well clear of the supporting bolts.

A shielded miniature mains plug and socket are used to connect the enlarger lamp to the unit and this is fitted into the back of the case. If desired the fuse can be a panel mounting type and also fitted into the back. A mains switch is fitted to the end of

the wafer switch. Resistors R1 to R8 are soldered directly on SW3.

Switch to the maximum time period of 32 seconds, then depress SW2 and measure the period. Adjust VR1 until a 32 second period is obtained and your darkroom is calibrated. ●

# So you want to pass the R.A.E. (Radio Amateurs' Examination)?

No. 10

John Thornton Lawrence GW3JGA & Ken McCoy GW8CMY

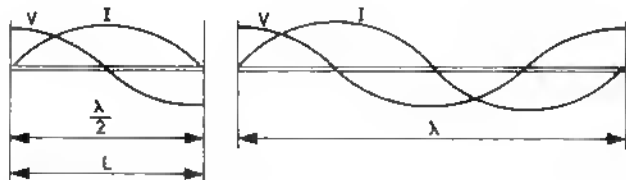
Here is the final section of this series and this month we are to consider aerials, feeders, matching and also interference. At the conclusion, we give some hints on actually sitting the examination.

## AERIALS, TRANSMISSION LINES AND MATCHING

The subject of aerials is a complex one and in the space available we will be confining our attention to basic essentials. For further information please refer to the appropriate section in the RSGB *Radio Communication Handbook* or the *Radio Amateurs' Examination Manual*.

The fundamental aerial is a length of wire which is half a wavelength long; this is known as the **half-wave dipole** and is shown in Fig. 85. The aerial is said to be resonant at a specific frequency which is determined by its length, and the distribution of voltage and current along the wire is known as **standing waves**.

The ratio of voltage to current varies along the conductor, but at the centre of a resonant half-wave dipole it gives a convenient impedance of approximately 70 ohms. If the aerial is broken here, the r.f. power can be fed into the dipole at its resonant point.



Half-wavelength

Full-wavelength

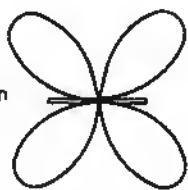
Feed Point Impedance  
Approx. 70 Ohms

Feed Point Impedance  
Approx. 5000 Ohms



Half-wave Dipole

Radiation Pattern  
Plan View



Full-wave Dipole

AD101

Fig. 85: Dipole characteristics

The full-wave resonant aerial has, as might be expected, a standing-wave pattern similar to two half-wave aerials joined end-to-end. The centre impedance in this instance is very high; inconveniently so in fact and special matching arrangements are called for, as we shall see later.

The radiation pattern of a half-wave dipole is in the form of a "doughnut" shape which in section becomes the characteristic figure "8" shape, as shown in Fig. 85.

With a full-wave resonant aerial, the radiation patterns of the two half-wave sections affect one another, producing the four-lobe shape shown.

## Dipole Length

The length of a half-wavelength in free space is given by:

$$L = \frac{300 \times 0.5}{\text{Frequency (MHz)}} \text{ metres}$$

However in practical application, due to (a) capacitance effects at the ends, (b) the velocity of the radio wave being slower in the wire than in free space and (c) the effect of the wire diameter, it has been found that the actual aerial dimensions are about 5 per cent shorter than the calculated free-space length. (Free-space length  $\times 0.95$ .)

For example, the length of a practical, resonant, half-wave dipole for 3.6MHz would be given by:

$$L = \frac{300 \times 0.5 \times 0.95}{3.6 \text{ MHz}} = \frac{142.5}{3.6} = 39.6 \text{ metres}$$

## The Vertical Aerial (Quarter wave $\lambda/4$ )

When looking at the radiation characteristics of a quarter-wave vertical aerial, it is necessary to take into consideration the reflective properties of the ground. If we consider the ground as a mirror to the radiation from an aerial, it will be seen that the vertical aerial AB, in Fig. 86 has an image BC in the ground mirror (just as in optics).

Thus, radiation leaving the aerial from point D will travel by two paths in the direction E: one direct from D and the other from the ground reflection. (The position F is a mirror-image of the aerial in the ground). The radiation pattern is similar to the half-wave dipole but being in the vertical plane it is omnidirectional in the horizontal or plan view.

Vertical aerials fitted on the roofs of vehicles for v.h.f. and u.h.f. utilise the excellent reflective properties of the metal as ground.

## Directional Aerials

The pattern and direction of the maximum radiation of an aerial can be modified by the addition of extra elements, which may be driven by feeding



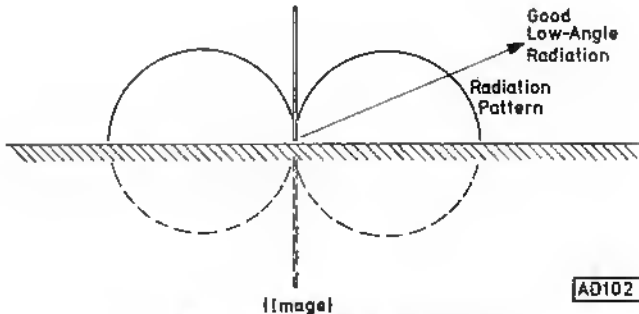
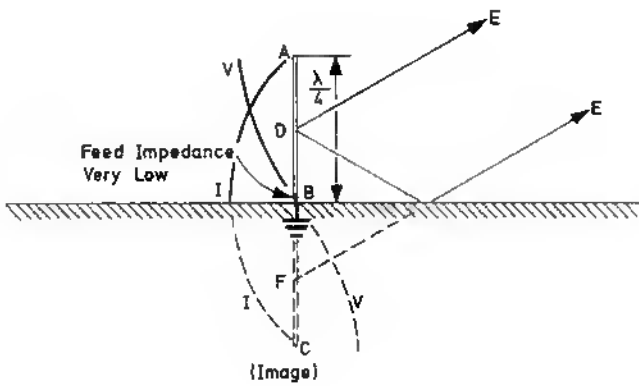


Fig. 86: The  $\frac{1}{4}$ -wave vertical aerial

power to them or parasitic, where no direct electrical connection is made.

The "Yagi" array shown in Fig. 87 has a half-wave dipole with parasitic director and reflector elements. The lengths and spacings are chosen to give increased "gain" in the forward direction and reduced gain in the reverse direction (as compared with a plain dipole).

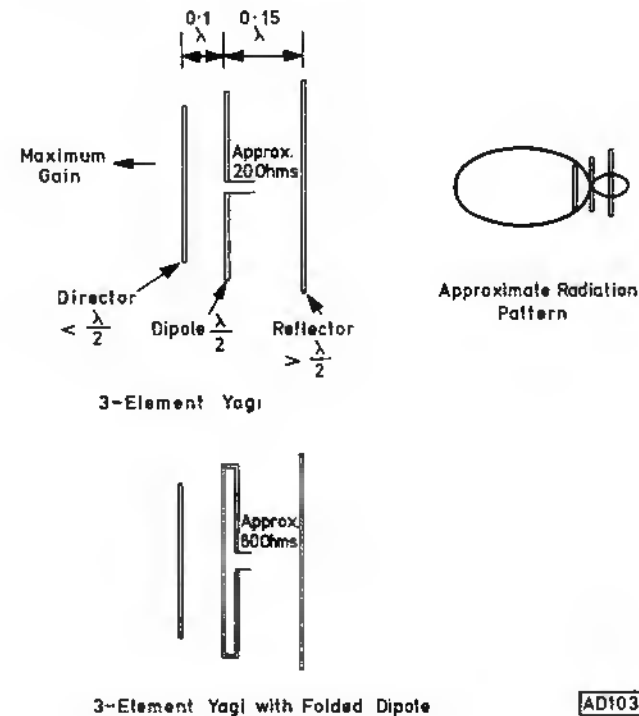


Fig. 87: Simple directional aerial arrays

One of the consequences of adding parasitic elements is that the dipole impedance becomes inconveniently low (about 20 ohms) and to overcome this a folded dipole is often used. This has the effect of transforming the impedance up by a factor of four to give a value of around 80 ohms.

## Transmission Lines and Feeders

The source of r.f. power is quite often not the place of utilisation. For convenience we need to have the transmitter indoors, but the aerial has to be outside, as high and far away from buildings as possible. In some instances it may be possible to bring the aerial directly to the transmitter but in most cases a transmission line or feeder cable is required.

## Impedance Matching

For maximum power transfer from one circuit to another the input impedance of the circuit receiving power must equal the output impedance of the circuit delivering it. The output impedance of a valve-type transmitter final amplifier is in the order of a few thousand ohms and a transistorised version would present about five ohms or less. The aerial impedance required can therefore vary between about twenty ohms and several thousand ohms, depending on the type and the point of connection.

The impedance of the transmission line or coaxial feed cable connecting the transmitter to the aerial is defined by its physical construction. Usual values for coaxial cables are 50 or 75 ohms and for twin transmission lines, 70 to 600 ohms, depending on the method of manufacture.

Some form of matching arrangement is therefore required between the various sections of the system which convey r.f. power from transmitter output stage to aerial. A typical example is shown in Fig. 88.

- There are three basic types of lines or feeders.
- Single wire feeder (which carries a true travelling wave.)
  - Coaxial feeder.
  - Parallel wire line.

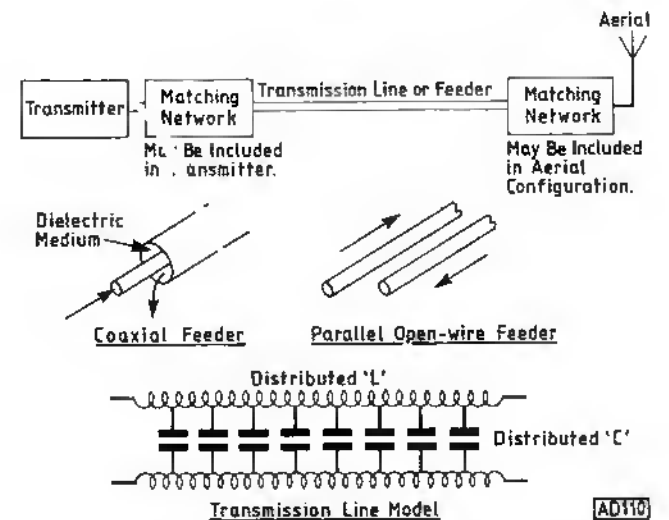


Fig. 88: Transmission lines

Single feeders (a) are not commonly used because they tend to act as radiators themselves. In the coaxial type (b) the r.f. field is restricted to the inside of the structure, whilst in parallel wires the field is confined to the immediate vicinity of the conductors.

### Characteristic Impedance ( $Z_0$ )

A transmission line or feeder may be considered as consisting of a distributed inductance with associated distributed capacitance, as shown in Fig. 88. It is the relative value of inductance and capacitance which gives the transmission line a property known as characteristic impedance ( $Z_0$ ). When a transmission line is connected to, or terminated with, a pure resistance which is equal to the characteristic impedance, a current travelling along it does not see any change in conditions when it meets the load. In other words, a short transmission line terminated in a purely resistive load equal to the characteristic impedance of the line, acts as though it were of infinite length. Such a line is said to be matched, and here power travels outwards from the r.f. source until it reaches the load, where it is completely absorbed. Let us look at what happens if the transmission line is terminated by its characteristic impedance and then by an impedance other than  $Z_0$ . This is shown diagrammatically in Fig. 89.

Where the line is terminated in its characteristic impedance ( $Z_0$ ) the voltage or current will have the same value at any point along it. (a) If however it is terminated with (b) an open circuit or (c) a short circuit, then standing waves are produced along the feeder as shown. This is because the power is not being absorbed at the end of the line but is being reflected: the reflected wave adds to the incoming wave and produces a standing-wave pattern along the line. These examples are extreme cases, but any mismatch produces a resultant standing-wave pattern.

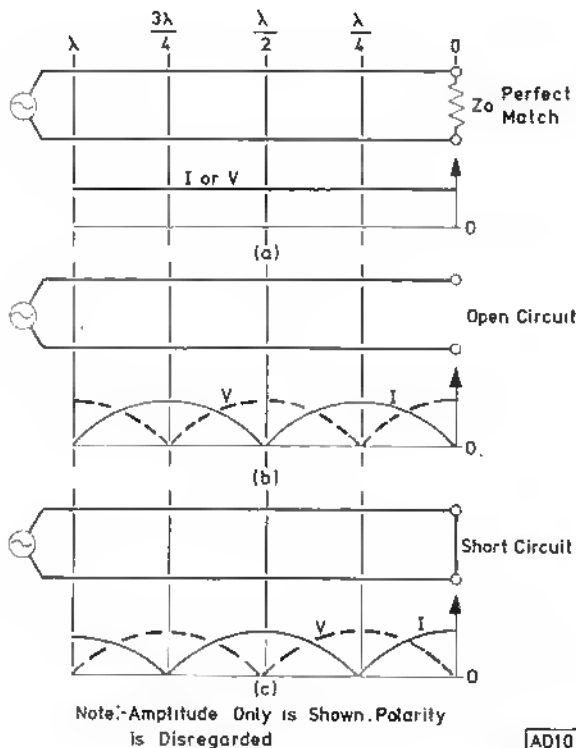


Fig. 89: Transmission line terminations

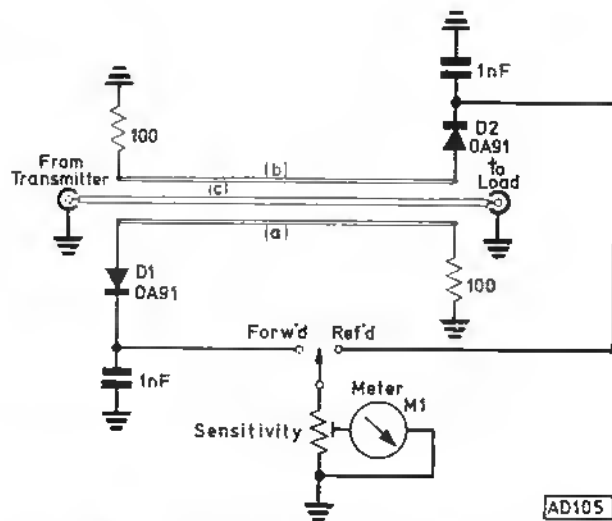


Fig. 90: A simple standing wave ratio meter

The ratio of the maximum value of the standing-wave to the minimum is known as the standing-wave ratio (s.w.r.). Values will vary from unity (matched condition) to infinity (complete mis-termination).

### Standing Wave Ratio Meter

A useful device for looking at the s.w.r. in a coaxial feeder cable is shown in Fig. 90. Loops of wire, (a) and (b), sample forward and reverse power passing through the centre conductor (c). The voltages developed in the coupling loops are rectified by D1 and D2 and the resulting d.c. output deflects the meter M1, thereby giving an indication of the forward and reverse (reflected) power.

The s.w.r. meter is particularly useful when making adjustments to aerial matching and tuning. Constructional details for a v.h.f. unit were carried in the May 1978 issue of PW.

### Matching

Most transmitter and aerial matching circuits are of the resonant type and are tuned to the operating frequency. We have already described the "Pi" matching network for a valve output stage (PW March 1978, p. 821), shown again in Fig. 91(a); an "L" type network for transistorised output stages is shown in Fig. 91(b). This configuration allows for more convenient component values when working at the low output impedances encountered.

In both circuits the impedance transformation is adjusted by the relative capacitances of C1 and C2, whilst maintaining resonance at the operating frequency. It is usual in this instance to arrange for the transmitter network to provide an output impedance which matches the characteristic impedance of a readily available type of coaxial cable, e.g. 50 ohms or 75 ohms.

When the coaxial cable is operated with a low s.w.r., losses within it are also low, so it is very convenient to fit any filters necessary here.

Some aerials, such as the dipole, have a characteristic impedance at the feed point which will match directly the characteristic impedance of the feeder cable and an aerial matching network is therefore unnecessary. However, if a symmetrical or balanced aerial such as the dipole is fed by coaxial cable, a

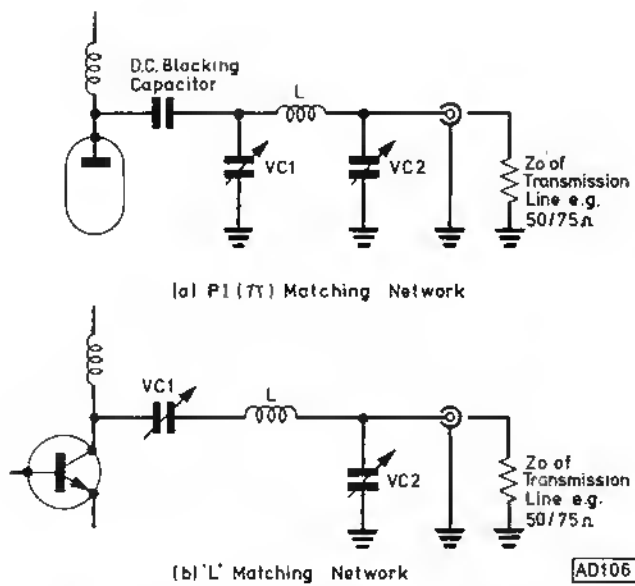


Fig. 91: Transmitter output matching networks

state of imbalance will exist, because one arm of the dipole is connected to the centre conductor whilst the other is connected to the outer shield. The currents flowing in the shield cannot be cancelled by those in the centre conductor which it surrounds.

### Balance to Imbalance Transformer (Balun)

Diagrams of balun transformers are shown in Fig. 92. In (a) a quarter-wavelength coaxial sleeve surrounds the coaxial cable and in (b) a quarter-wavelength of rod, forming a "stub", balances the output to the aerial. For low frequencies, it is more convenient to wind the balun transformer on a ferrite ring. This type is less frequency-conscious and may be used over a wide range.

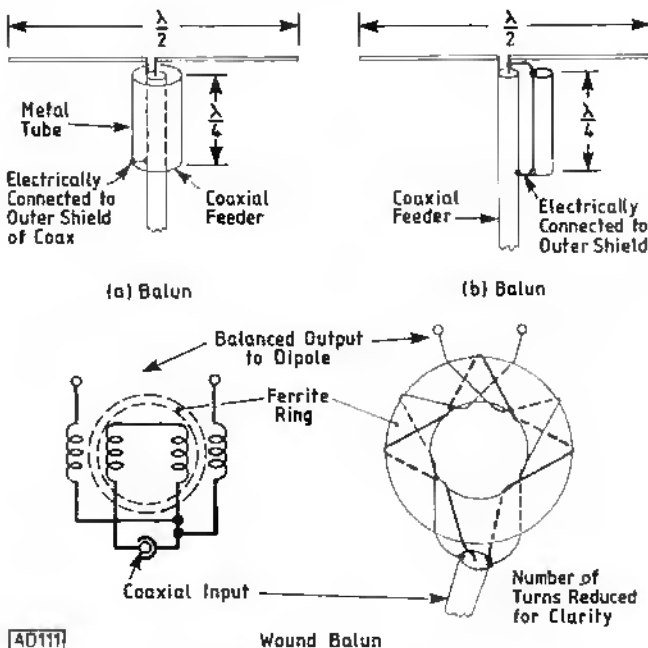


Fig. 92: Balun transformers

### Quarter Wave Transformer

Where it is necessary to transform an aerial impedance to match a particular feeder cable, use can be made of a quarter wave "stub" as shown in Fig. 93. Here, a full-wave aerial is to be fed in the centre (where the impedance is around 5,000 ohms) with twin feeder whose characteristic impedance is 72 ohms. If the quarter-wave stub is made to have the correct characteristic impedance then the aerial impedance is transformed down by the stub to match that of the feeder.

$$Z_m (\text{matching stub}) = \sqrt{Z_{\text{aerial}} \times Z_{\text{line}}}$$

$$= \sqrt{5000 \times 72}$$

$$= 600 \text{ ohms}$$

(An open-wire line of 16 s.w.g. conductors spaced 112mm (4 1/2 in) apart would have a Zo of 600 ohms).

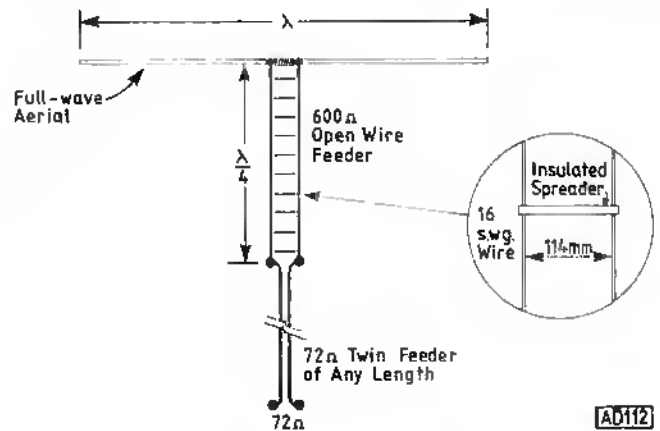


Fig. 93: A 1/4-wave transformer

### Interference

Non-interference with other radio users, whether they be military, commercial, amateur or domestic, is a condition of the Licence.

An understanding of the way in which interference is caused and how it can be avoided or cured is needed, not only for the RAE, but later on, when you obtain your licence; you will then be in a position to maintain a good clean transmission and live in peace with your neighbours (and the Home Office Inspector).

No practical transmitter is absolutely perfect and in addition to its correct output, is bound to radiate some spurious signals, however small. If these are not kept to a very low level, interference with receivers (TV or radio) operating nearby may result.

Similarly, no practical receiver is absolutely perfect, so when it is tuned to a particular frequency it may be subjected to interference by strong signals on other frequencies, as may be the case if it is situated in close proximity to a radio transmitter.

Interference can also be caused to audio systems, etc., when subjected to strong r.f. fields. Here, the signal enters the equipment and is then rectified or amplitude demodulated, usually by the emitter-base junction of a transistor in the audio pre-amplifier stages, resulting in breakthrough. An increasing number of hi-fi systems employing transistors are prone to interference of this nature.



## TVI, BCI, AND AFI

Interference can usually be separated into three main categories: television (t.v.i.), radio broadcast (b.c.i.), and audio (a.f.i.).

Television and radio broadcasting are "protected" services and the Post Office may be called upon to investigate cases of interference with these and other authorised transmissions. Audio amplifiers, on the other hand, are not intended to be radio receivers and so will not be afforded the same facilities.

In general, all interference results either from deficiencies in the transmitter or the apparatus being interfered with. Let us look initially at the transmitting end.

## DEFICIENCIES AT THE TRANSMITTER

### Design and Construction

It is important that the various r.f. signals present within the transmitter are not allowed to radiate directly. Efficient screening is essential, as is the filtering of h.t. and other power supplies, particularly the mains input. A suitable mains filter is shown in Fig. 94. Decoupling and bypass capacitors should be of mica or ceramic, having low inductance properties. (See section on capacitors.) Wiring should be short and direct to minimise stray inductance and capacitance.

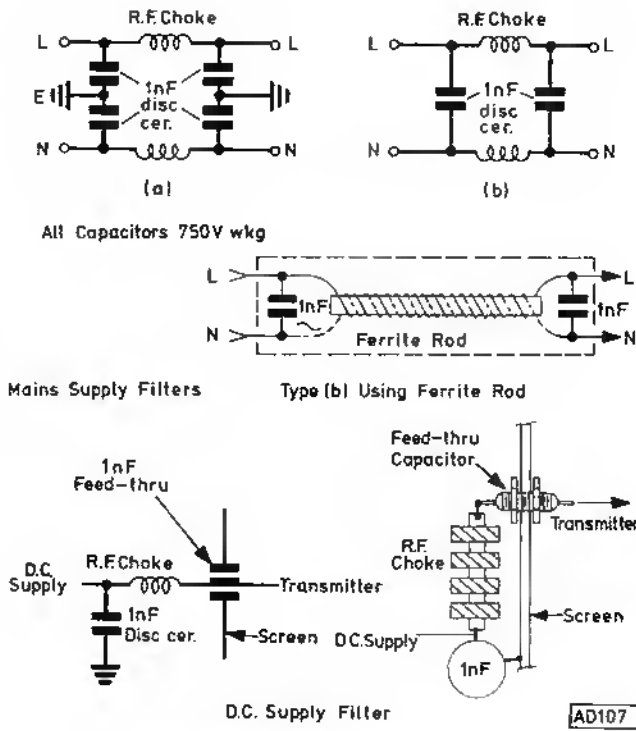


Fig. 94: Power supply filters

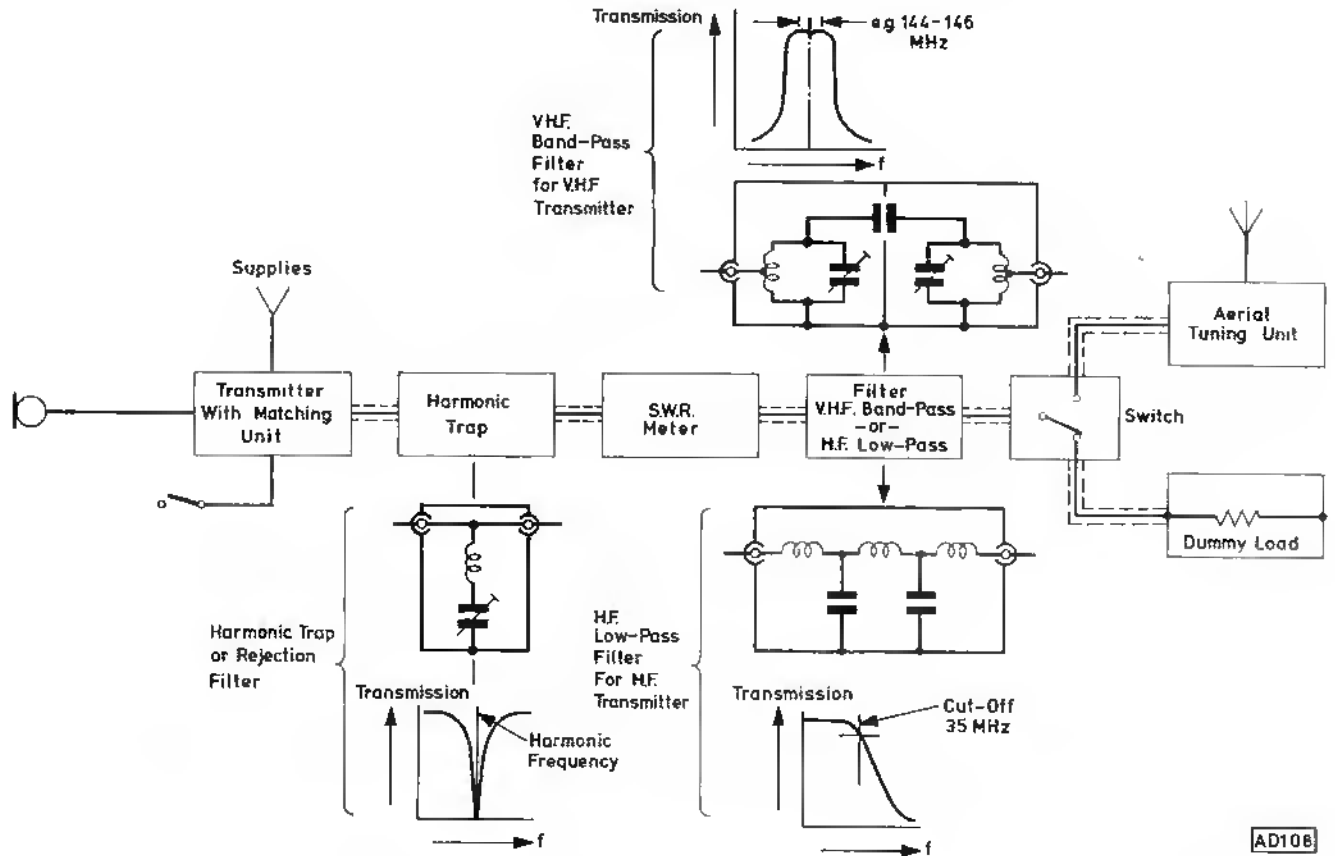


Fig. 95: Block diagram of a well-screened transmitting station

Tuning capacitor spindles protruding through front panels are often a source of spurious signals and should therefore be of an insulated material or have an insulated coupling.

The cut-out for a panel meter can often cause problems and a screening can over the rear of the meter is desirable. In general, try to ensure that the case of the transmitter is radiation-proof. Commercially made transmitters, including those for the amateur market, already incorporate most of these features and the maker's data sheet usually quotes the level of spurious emissions one may expect.

The block diagram of a well-screened transmitting station is shown in Fig. 95. The transmitter is well protected and its supply leads filtered, ensuring negligible direct radiation. The output passes via a coaxial cable to a harmonic trap, which usually consists of a series-resonant circuit, housed in a screened box and tuned to the particular harmonic likely to cause interference. For example, it might be tuned to 42MHz, attenuating the 3rd harmonic of 14MHz which could be the source of t.v.i. in a Channel 1 reception area. The output then passes via a coaxial cable to the standing-wave ratio (s.w.r.) bridge, which indicates relative forward and reflected power levels.

From here it is fed through a filter, again housed in a screened box which, in the case of a transmitter operating on bands up to 30MHz, would be of the low-pass type, attenuating spurious signals above this frequency. For a v.h.f. (2m) transmitter, a band-pass filter attenuating spurious signals either side of the pass-band frequencies, would be used.

In practice, the transmitter tuning would first be adjusted into a dummy load. The output would then be switched to an aerial tuning unit which is used to provide optimum matching to the aerial with the minimum of reflected power (indicated on the s.w.r. bridge).

Note: All interconnecting coaxial cables and terminations should be well soldered.

## Aerial and Feeder

The aerial should be sited as high as possible away from neighbouring buildings, TV and radio aeri- als, etc.

A vertical transmitting aerial is more likely to induce strong fields into nearby equipment than a horizontal one. This is due to the fact that it relies on a ground connection which can cause interfering currents in nearby conductors. In addition, vertically polarised signals are much more likely to be picked up by vertical down-leads, such as those used for television aeri- als.

It is important that all the transmitter power should be radiated by the aerial proper and that no emission should take place from the feeder cable itself. This means that the currents in each conductor of the feeder should be equal and opposite.

Where a dipole aerial is fed by an unbalanced coaxial cable, there is significant imbalance in the current distribution and some radiation from the feeder results. The feeder, usually being vertical, readily causes interfering currents to be induced into nearby television down-leads. To overcome this problem, a balance-to-unbalance transformer (balun) is connected at the centre of the dipole, as shown in Fig. 92. In other types of aeri- als and feeders, correct adjustment of the tuning unit is all-important in reducing feeder radiation to a minimum.

## Operation

Excessive drive in any of the transmitter stages will increase the level of harmonics, so power should be kept to the minimum consistent with efficient operation.

Tuning of the final power amplifier and adjustment of the aerial tuning unit will have a considerable effect on the amount of spurious signals radiated. When tuning the transmitter power amplifier into a dummy load, increase the coupling only until the correct power level is obtained. Do not overcouple the transmitter or the Q of the p.a. tank circuit will be reduced, with a consequent increase of spurious emissions. This also applies when adjusting the aerial tuning unit.

An abrupt keying characteristic causes excessive side frequencies, so check each side of your transmission for key clicks (see page 819).

Overmodulation produces excessively wide sidebands and causes splatter; always monitor the modulation level and ensure that overmodulation does not occur (see page 925).

The audio bandwidth necessary for good speech communication is about 3kHz. The modulation circuit of the transmitter should therefore have a rapidly falling response above 3kHz in order to avoid the radiation of excessive and unnecessary sidebands.

## Summary

Let us summarise the requirements for keeping deficiencies at the transmitter to a minimum:

1. Use correct components in the transmitter, well laid out.

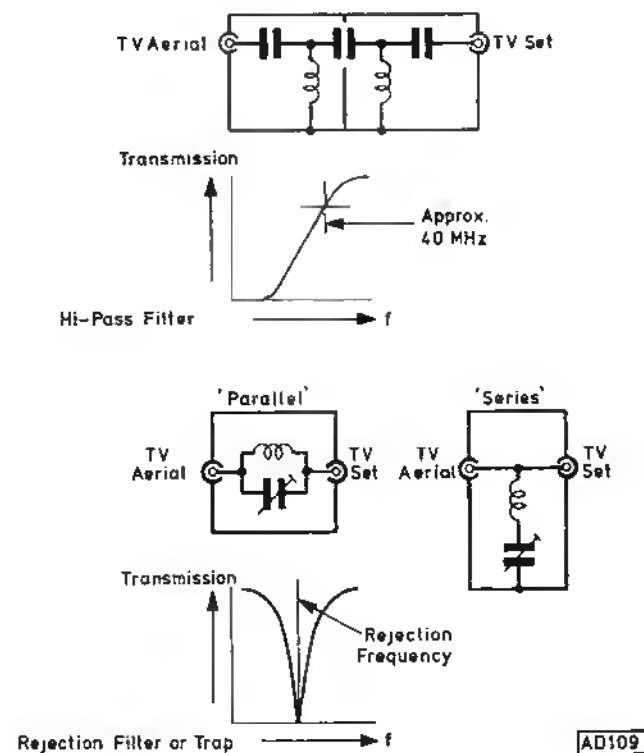
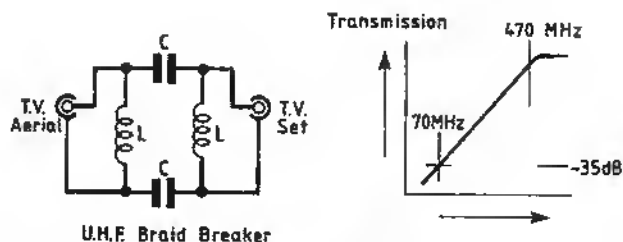


Fig. 96: TV interference rejection filters

2. Prevent direct radiation from the transmitter and associated leads by screening and filtering.
  3. Use appropriate filters in the transmitter output.
  4. Use a dummy load for tuning up and a suitable aerial tuning unit. Do not overcouple.
  5. Keep aerials in the clear and avoid radiation from the feeder cable (balun transformer).
  6. Tune up carefully: do not overdrive or overmodulate.
- Check your transmission regularly.



## DEFICIENCIES AT THE RECEIVER

The latest statistics (for 1976) indicate a dramatic fall in the number of complaints regarding transmitter interference. However, the greater proportion of those made were attributed to deficiencies in receiver design.

In many instances, interference is the result of a receiving installation of poor standard; e.g. indoor aerial, aerial incorrect type for area, downlead incorrectly installed, receiver incorrectly installed, excessively long mains leads or speaker leads, etc. etc.

Considering the problem of t.v.i., strong signals can enter the receiver via the aerial and cause interference by cross-modulation in the r.f. or subsequent stages. A high-pass or rejection filter for the frequency concerned must be fitted in the aerial lead, as shown in Fig. 96: the series-tuned filter being generally more effective.

Masthead amplifiers are a notorious cause of interference as they have broadband input characteristics, some extending from 10MHz to 1,000MHz. Cross-modulation and swamp effects are common. A high-pass filter should be fitted between the aerial and the input to the amplifier, but in practice difficulties arise here because the aerial has to be taken down and the filter made weatherproof.

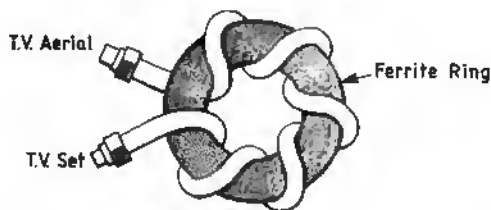
However, the most common method by which r.f. will enter the receiver is by the presence of "braid" currents in the aerial downlead. These r.f. currents flow through earthy parts of the receiver causing r.f. voltages to be produced in susceptible parts of the circuit.

A "braid breaker", suitable for u.h.f. television, is shown in Fig. 97. The reactance of the series capacitors is high at frequencies up to 30MHz, effectively "breaking" the downlead, but at u.h.f. it is low, resulting in negligible attenuation of the television signal.

Where "braid currents" in the downlead cause interference at h.f. and v.h.f., an alternative circuit can be used. Here a short length of the coaxial downlead cable is wound on a ferrite ring, increasing the inductive reactance of the outside braid without affecting the signals within. An alternative to the ferrite ring, and almost as effective, is to wind the co-ax around a ferrite aerial rod.

If the interference is entering the receiver by way of the mains lead, a mains filter as shown in Fig. 94 should be installed. In the case of hi-fi systems, it can also be picked up on speaker leads, so decoupling these with a disc ceramic capacitor of 1nF to 10nF is often effective. A ferrite ring may be required in addition, if the problem is really severe.

It is unwise to incorporate modifications inside the receiver, as you may invalidate its warranty and be held responsible for any subsequent malfunction. In difficult cases it would be wise to consult the dealer or manufacturer.



Ferrite Ring Filter  
(The tv. feeder is made into a coaxial choke)  
Also useful on mains & loudspeaker leads

AD133

Fig. 97: "Braid-breakers" for u.h.f. and h.f./v.h.f.

## Summary

1. Check that the receiving installation is of adequate standard for the reception area.
2. If the interference is entering via the aerial lead, fit a high-pass or rejection filter.
3. If cross-modulation occurs in a mast-head amplifier, fit a high-pass filter in the aerial feed to it.
4. If the interference is entering via the downlead braid, fit a ferrite ring or capacitive braid-breaker.
5. If the interference is entering via the mains lead or other cables, fit a mains filter or ferrite ring.
6. If the problems are caused by direct radiation, try repositioning the aerials, feeders, etc. Wherever possible, avoid making internal modifications to receivers or audio systems. In difficult cases, refer to manufacturer.

## Note:

An excellent series of articles on interference appeared in *Radio Communication*, May 1975. Some back-issues are available from the Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE. Alternatively your local Radio Club or a nearby radio amateur may be able to help with a copy.

## SITTING THE R.A.E.

It is a good plan to set yourself regular revision two or three nights a week prior to the examination. Allocate specific subjects each night so that everything is covered in good time and practice answering specimen questions in writing and time yourself.

It is best to leave the night before the exam relatively free from commitments. This is a good time for collecting together the things you need, including your thoughts!

Take with you, two pencils and a pencil sharpener, two pens (in case one runs out), ruler, symbol stencil (if you have one), eraser and your examination card. Calculators are permitted provided they are of the electronic, battery-operated type. There are no restrictions on the functions the machine will perform.

You should receive your card at least a week before the examination. If not, contact the Examination Centre/Night School immediately and confirm that you are, in fact, registered.



When going to the Examination Centre, allow plenty of time; your bus may be delayed, you may have difficulty in parking your car. Aim to be in the building at least 30 minutes before the start. Locate the examination room, and be seated well before the examination commences.

When appropriate, your invigilator will distribute the papers: do not look at them until he gives the signal. Timing will begin from the point at which you are allowed to turn the paper over—don't panic! Give yourself at least ten minutes to read things through carefully and note any special instructions.

If, through no fault of your own, you arrive late, apologise to the invigilator then settle into your place quietly and attempt as many of the questions as you are able in the period remaining.

Remember, the paper is divided into two parts; Part 1 has two compulsory questions on licensing conditions (15 marks) and interference (15 marks). Part 2 requires six questions from a choice of eight to be answered (10 marks each). Failure in either section will regretfully result in failure of the examination as a whole.

Give yourself about twenty minutes for each of the eight questions and this will allow a little time at the end to look through your answers. The answers should not be over-elaborate or padded out: make your point as quickly and as clearly as possible, there is no time to waste. It is probably best to tackle the compulsory questions in Part 1 first and then move on to Part 2 where you have a choice. Here you can answer the easiest first and so gain a little extra time.

With answers containing calculations, it is a good idea to set out all the steps in detail. Then if a slip is made in the arithmetic, the examiner will see the correct formulae and methods have been used, and will mark accordingly.

Hints and tips on the drawing of diagrams were given earlier in this series (February 1978, page 764), but remember drawings take time, so keep them simple. You are not being examined in grammar or indeed spelling but neatness and cleanliness are relatively important, if only to avoid ambiguity. The examiner will not be impressed by illegible writing, scribbled diagrams, etc. If you make a mistake, cross it out with a single ruled line; it will then be ignored and you will not lose marks.

A few minutes before the end, stop, read through your answers and correct any minor omissions. Make sure all are numbered and lettered correctly and that your examination reference is quoted.

We wish you every success and hope to meet some of you on the air in the near future.

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## NOTE

The syllabus and examination pattern for the R.A.E. are changing in 1979. We plan to publish a follow-up article to update this series

TRAN-SISTORS		11p BC114		13p BD135		14p BF273		14p OC72		45p 7447A		16 Pin DIL:		ZENER DIODES:		PRECISION POLY-CARBONATE CAPACITORS	
AC107	30p BC110	11p BC184	13p BD136	14p BF338	14p OC75	45p 7450	20p 1+	22p 400mW + - 5% 3V-33V	All High Stability—extremely Low Leakage		440V Value (µF)	A.C. RANGE Dimensions (mm)	Price each				
AC117	32p BC125	11p BC188	13p BD139	14p BF357	14p OC77	45p 7453	20p 10+	1W 10p each: 10/80p	L D		0.1	27	12.7	£1.34			
AC128	32p BC128	11p BC187	13p BD140	14p BF458	14p OC81	45p 7460	20p 50+	3V3-200V 16p each: 10/41.75	SKELETON PRESETS:		0.15	27	12.7	£1.52			
AC127	32p BC132	11p BC186	13p BD141	14p BF459	14p OC82	45p 7470	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	(Vertical or Horizontal)		0.22	33	15	£1.66			
AC125	32p BC134	11p BC185	13p BD142	14p BF458	14p OC81	45p 7473	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	18 Pin DIL:		0.25	33	16	£1.78			
AC126K	32p BC135	11p BC182	13p BD143	14p BF459	14p OC82	45p 7474	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.33	33	16	£1.92			
AC141K	44p BC137	11p BC212L	14p BD182	14p BF431	14p TIP29	54p 7475	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.47	33	19	£2.04			
AC142	44p BC138	11p BC213	14p BD187	14p BF431	14p TIP31A	55p 7476	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.6	33	19	£2.24			
AC142K	44p BC139	11p BC214	14p BD188	14p BF431	14p TIP32A	57p 7482	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.68	50-8	22	£2.48			
AC153K	44p BC140	11p BC214	14p BD188	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.0	50-8	22	£2.64			
AC163	44p BC142	11p BC214B	14p BD188	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.5	50-8	23.4	£3.14			
AC178	35p BC143	11p BC214L	14p BD188	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		2.0	50-8	23.4	£3.74			
AC178	44p BC147	11p BC235	17p BF111	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.1	27	12.7	£1.34			
AC178	44p BC147A	11p BC235	17p BF111	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.15	27	12.7	£1.52			
AC178	44p BC147B	11p BC235	17p BF111	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.22	33	15	£1.66			
AC187K	42p BC148	11p BC232C	17p BF117	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.25	33	16	£1.78			
AC187	42p BC148	11p BC232C	17p BF117	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.33	33	16	£1.92			
AC188K	42p BC149	11p BC232C	17p BF117	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.47	33	19	£2.04			
AC193K	41p BC149B	11p BC231A	17p BF121	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.6	33	19	£2.24			
AC194K	41p BC149C	11p BC231A	17p BF121	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.68	50-8	22	£2.48			
AC194K	41p BC149C	11p BC231A	17p BF121	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.0	50-8	22	£2.64			
AC194K	41p BC149C	11p BC231A	17p BF121	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.5	50-8	23.4	£3.14			
AC194K	41p BC149C	11p BC231A	17p BF121	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		2.0	50-8	23.4	£3.74			
AD140	84p BC153	11p BC232A	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.1	27	12.7	£1.34			
AD142	84p BC153	11p BC232A	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.15	27	12.7	£1.52			
AD143	83p BC157	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.22	33	15	£1.66			
AD149	80p BC157A	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.25	33	16	£1.78			
AD161	85p BC159	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.33	33	16	£1.92			
AD162	84p BC159B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.47	33	19	£2.04			
AF114	32p BC159	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.6	33	19	£2.24			
AF115	32p BC159B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.68	50-8	22	£2.48			
AF116	32p BC159C	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.0	50-8	22	£2.64			
AF117	32p BC161	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.5	50-8	23.4	£3.14			
AF118	30p BC167B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		2.0	50-8	23.4	£3.74			
AF121	30p BC168A	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.1	27	12.7	£1.34			
AF124	34p BC168B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.15	27	12.7	£1.52			
AF128	34p BC168C	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.22	33	15	£1.66			
AF127	38p BC170	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.25	33	16	£1.78			
AF139	45p BC170B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.33	33	16	£1.92			
AF174	84p BC170C	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.47	33	19	£2.04			
AF179	74p BC171	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.6	33	19	£2.24			
AF179	74p BC171A	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.68	50-8	22	£2.48			
AF181	75p BC171B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.0	50-8	22	£2.64			
AF182	36p BC172	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.5	50-8	23.4	£3.14			
AF239	45p BC172B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		2.0	50-8	23.4	£3.74			
AF279	80p BC172C	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.1	27	12.7	£1.34			
ASV67	61p BC173	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.15	27	12.7	£1.52			
AU110	61p BC173B	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.22	33	15	£1.66			
AU113	48p BC176	11p BC232C	17p BF122	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.25	33	16	£1.78			
BC107	12p BC117	11p BCY31	13p BF195	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.33	33	16	£1.92			
BC107A	14p BC177A	11p BCY38	13p BF199	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.47	33	19	£2.04			
BC107B	14p BC178	11p BCY42	13p BF199	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.6	33	19	£2.24			
BC108	12p BC178A	11p BCY70	13p BF200	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		0.68	50-8	22	£2.48			
BC108A	14p BC178B	11p BCY71	13p BF204	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.0	50-8	22	£2.64			
BC108C	14p BC178A	11p BCY72	13p BF224	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		1.5	50-8	23.4	£3.14			
BC109C	14p BC179B	11p BCZ11	13p BF240	14p BF431	14p TIP33	59p 7490	20p 100+	100 ohm to 1M—7p each: \$0 for 63 50p, 100 for £5 50p	4 Pin:		2.0	50-8	23.4	£3.74			

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# ON THE AIR

## AMATEUR BANDS

by Eric Dowdeswell G4AR

Our SSTV expert Paul Barker of Sunderland has now become G8OVD and soon will be able to look back at the other chaps! Paul studied at home for the RAE and had only the RSGB's RAE manual and a few library books to see him through. He managed to "copy" three VKs on 20m SSTV so completing his SAC! Best of luck on the air OM. Likewise John Overton did the trick in Milngavie, Glasgow and so sports GM4GUA now, having already passed the code test. He's using an HW32A on 20m s.s.b. for the time being but a KW2000B is on the way.

Brian Smith is well away in Barry, Glam, with his new FRG7. Having been disgusted with what he has heard of the CB band just below 28MHz he says he'll get stuck into the RAE studies and get a proper ticket! After a spell of ten years away from the amateur bands Ken Proctor of 35 Hertford Close, Eastfield, Scarborough, Yorks, is active again and would like to hear from old friends including Bernard Hughes BRS25901 who contributes to this column. Ken has a Trio 9R59DS and 90ft of wire and covers all the bands.

The note on David Greenhalgh in the February column resulted in G3SHW of Stockport coming up with a Lafayette HA350 for him which illustrates a little of the fine spirit of amateur radio. David, in Poynton, Cheshire is delighted and hopefully he'll be contributing to the column in future.

After using a domestic portable for a while J. Goodier of Marple, near Stockport, acquired an FRG7 and really found out what the amateur bands are all about. He wants a good prefix list and so, as ever, the answer is Geoff Watts of 62 Belmore Road, Norwich who will deliver the goods for just 40p. From Newport, Gwent comes a first report from Martin Llezers and a note on his local ARS, reported later. He has 250ft of wire on his Realistic DX160 and an 8ft rod aerial for "the h.f. bands". I've suggested that he try the long wire on those bands too!

Now here is an interesting letter from Bill Land BRS34761, 7 Wellbrook Road, Bishops Clare, Cheltenham, Glos, who admits to being 72 years young and an addict of RTTY for which he has a Creed 7B printer running from his Eddystone 750 and Trio 9R59DS. Bill wants to hear from others using this mode and can help with a list of parts for the 7B. Another old-timer is John Whiting of Fareham, Hants, who started with crystal sets in 1922 but now sports an FRG7, listening mainly on 10m for the moment. He can cope with the code test so is contemplating studying for the RAE.

Fame at last! Bob Griffiths writes for the first time to say we have a keen young reader on the Isle of Wight! He, too, has had a lay-off of 14 years but is now back in the swim again but with a lot of pertinent remarks on the plethora of UA stations! Must come as a shock after the relative hush of the bands in days gone by. Bob uses an EA12, AR88D plus converters for 2m and 70cm. His aerial farm consists of 132ft wire, 20m ground-plane, 20m V-dipole and a vertical for 80m.

From Morpeth, Northumberland comes John Hodgson again with DX heard on his Realistic DX160 and long wire. He has received QSL cards from CB'ers in Sweden and Norway! John is keen on RTTY so suggest he writes to Bill Land mentioned above. Bob Bell of 5 Byron Avenue, Blyth, Northumberland can't be too far from John just quoted above and they ought to get together since Bob would like to start a club in the area. Bob is yet another FRG7 owner, having been SWLing for some 25 years and worked his way through a number of sets.

**CLUB NEWS** Geoff Cole G4EMN, secretary of the Wessex ARG, oft mentioned here, had applications for membership from a couple of readers situated a long way from Wessex. Although flattered, he says that this is not quite the ideal! So, anyone who wants to join a club, try to locate your local group or write to the RSGB, 35 Doughty Street, London WC1 for the address. Geoff rightly says that every reader of this column ought to belong to a club.

**Blackwood and District ARS** GW8GW meets every Friday 1930hrs at Oakdale Community College, near Blackwood, Gwent. On May 12th GW8LJJ talks on *Practical Construction* and the 19th is film night, *Printed Circuit Manufacture*. Write to Steve Cole GW4BLE, 10 Llanthewy Road, Newport.

**Mid-Warwickshire ARS** first and third Mondays 2000hrs at 61 Emscote Road, Warwick with G3UDN on the air. They'd like to see PW readers, particularly Nick Smith A9050 and C. J. Roe of this column.



Contact Norman Read G8CXL, 86 Telford Avenue, Leamington Spa.

**Bury RS G3BRS**, every Tuesday at Mosses Centre, Bury at 1930hrs with RAE courses, code training, local c.w. nets, new local repeater GB3MA on 70cm. Whew! It's all go! Hon. Sec. is Eric Thirkell G4FQE, Mosses Community Centre, Cecil Street, Bury.

**Stevenage and District ARS** get together at 2015hrs on first and third Thursdays at Staff Canteen, Hawker Siddeley Dynamics. Morse classes and RAE course at local college by G3SJR. May 18th is the date for a lecture by members of London UKFM Group, while on June 1st G3AGP talks on *Electronics in Medicine*. Contact Trevor Tugwell G8KMV, 11 The Dell, Stevenage, Herts.

**Silverthorn RC** produces a ten-page newsletter "Spurious" so they're pretty active, meeting every Friday 1930hrs at Friday Hill House, Simmons Lane, Chingford, London E4. Contact C. J. Hoare, Hon. Sec., at this QTH.

**Newport ARS** meets Mondays 1930hrs at Brynglas House Community Centre, Newport with RAE and code classes coming up. Write to Martin Liezers, 32 Barrack Hill, Newport.

## Log extracts

**B. Smith:**—80m C5ABC (Gambia) 4U1ITU 20m C5AAF FC9UC JY5HH ZL2AM 15m CE3BPC C31LU

**K. Proctor:**—80m EA8QJ ZB2G PJ8CO KL7AVX ZL3BX CO7RS 9Y4NP 40m CO4DC HP1XYA ZL1BAQ ZL2BDP ZL3RD 20m VP8PT HP3XKB HL1JI HK0BBF 15m FP8DX KL7JEJ JA9IWN 10m FG7BA

**J. Hodgson:**—80m J3AAG OY5NS PJ8CO 8P6FV 40m TG4NX YV5APF 20m FM7WV HK1NR VE8RCF VK7AE VP2DAW 15m HK0QA KL7GRP ZS2MI (Marion Is) ZB2G 10m EA9FL HH2MC VU2DK.

**J. Whiting:**—10m CT2AX EA8BS SV1HX.  
**B. Land:**—RTTY 20m DK6RY EA3ABU IT9BWT JY5KR K6XP OE2KO SM6HUG YU2BOR W2WIX.

**M. Liezers:**—80m KZ5JM ZB2G 5B4DI 20m HK0QA KM6FC YB0HH 15m KL7GRP VP1AB 10m C5ABC EP2RL.

**J. Goodier:**—20m CT4YN FC9UC.

All s.s.b. except where stated otherwise.

## VHF BANDS

by Ron Ham BRS15744

**Richard Staples**, G8MME, Lymn, Cheshire, is active on both 2m and 70cm s.s.b. On 2m he runs 400 watts from a pair of 4-250A valves to a couple of 10-element parabees, at 40ft a.g.l., and on 70cm, his 2m exciter, TS700G, drives a Microwave Modules Transverter and a home-brew 4CX250B amplifier producing 250 watts to a 48-element multibeam, mounted above his 2m array. Richard is looking for s.s.b. skeds on 70cm and will be reporting on future activity in the north-west of England. **Vic Hartopp**, G8COB, Northampton, uses an IC201 transceiver for all modes on 2m and has

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, Ashted, 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, Greytlars, Storrington, Sussex RH20 4HE.

recently been enjoying himself rebuilding a Mohican receiver, and listening to the American CBers on his HRO.

A couple of newcomers to v.h.f., **Henry Hatch**, G2CBB, South Croydon, using an IC215 is working through the repeaters and **Robin Bellerby**, G3ZYE, Hove, Sussex, taking part in his first 2m opening, did not realise there could be such pile-ups of stations on the repeaters. In Littlehampton, Sussex, **Norman Langridge**, using the v.h.f. section of his Yaesu FR400-Super DX receiver with a 3-element home-brew, loft mounted beam can always hear traffic through GB3SN, but, during the opening on March 7th he heard GW mobiles working through GB3BC which has encouraged Norman to modify his aerial system. Along the coast to Worthing where **David Wakefield**, BRS39756, uses the receiver of a Pye Vanguard on 2m, with a roof mounted dipole, and CR100 and R1475 receivers, fed by a long wire aerial, on the h.f. bands. David's interest in radio is further stimulated through his activities as a Cadet Wireless Operator in the Air Training Corps.

Despite the poor conditions and the low atmospheric pressure, 29.3in, **Alan Baker**, G4GNX, Newhaven, had a 59 contact on 2m s.s.b. at 1800 on February 26th with F1ENH/P, Boulogne, both running 15 watts, and at 1730 on March 2nd, in thick fog, on Beachy Head, near Brighton, Alan heard signals from repeaters ON0HT and ON0OV and a Buckingham station working through the Kent repeater, GB3KR, R4.

The atmospheric pressure remained around 29.5in from midnight on February 27th to midnight on March 2nd when it took off and climbed to 30.4in by noon on the 6th, and, true to form, the v.h.f.s opened up as the high pressure began to fall. During the evening of the 6th, **John Kuipers**, G4GUX, Brighton, worked G8LY, in Hampshire, on 70cm, first via GB3AW, Ashmansworth, Berks, RB10, and then through GB3BR, Brighton, RB6, and GB3PH, Portsmouth, RB2. Later he heard signals through GB3BK, Upper Basildon, RB6, GB3SD, Weymouth, RB14, had a c.w. contact with ON4VN and heard 2m signals through GB3BC, R6, GB3MH, on its new channel, R3, GB3WW, Carmel, Dyfed, R7 and FZ3THF, R4.

Around 1945 on the 6th, **Ken Smith**, BRS 20001, Horsham, received several French broadcast stations in Band II and patterning on u.h.f. TV channels, and earlier, **Graham Laucht**, G8OQM, Birmingham, worked G8KSN, Ramsgate, Kent first via GB3PI, Cambridge, R6, and then direct. Like Graham, **Brian Fenwick**, G8BTC, Brighton, heard a variety of repeater signals on 2m, including Cornwall, GB3NC, R5; Brian noticed that signals were often stronger on the input frequency than from the repeater. Frequently, on the

6th and 7th, I received a good picture from Lichfield, Ch 8, 189MHz, Continental f.m. stations in Band II and strong signals from GB3BC, BM and KR, with only dipoles feeding the respective receivers. At 0125 on the 7th, I heard two Portsmouth stations, G8NUI and G8OQN/M in contact via the London repeater, GB3LO, R7, and at 2152, another pair, G4GUX and **Martin Newell**, G8KOE, both in Brighton carried out a similar test on 70cm and had a QSO via the Portsmouth repeater.

At 0900 on the 7th, G4GNX/M using his new IC-240 to a  $\frac{5}{8}$  whip aerial, heard strong signals through GB3BC, from a low point in Brighton, F1EBE, Rouen, via GB3LO, and at midday on the 6th, he received signals from the Malvern Hills, GB3MH, R3, and Paris repeaters. At 2206, from Newhaven, Alan had a c.w. contact with ON6FT and at 0011 on the 7th he worked F1EVM/P, Caen, on 2m s.s.b.

The atmospheric pressure continued falling until 1800 on the 8th when it began rising rapidly, reaching 30.4in by midday on the 10th, and then fell back to 30.0in by noon on the 12th which, as expected, caused a tropospheric opening.

At 2230 on the 8th, newly licensed G8OQM/M, using a FT227R to a  $\frac{5}{8}$  whip aerial, travelled down to Beachy Head, Sussex, and heard GB3BM, his home repeater and then had QSOs through GB3BC. From Brighton's Race Hill, at 1900 on the 9th, G4GNX/M worked F1BBZ and F3KT via FZ8THF, Vichy, R0, a distance of 320 miles. **Roy Bannister**, G4GPX, Lancing, Sussex, succeeded in accessing the Vichy repeater but owing to UK traffic on R0 he could not complete a QSO. Both Alan and Roy heard the Ghent, ON0ON, R4, and Paris, R6, repeaters and during the evening of the 10th, **Clive Penna**, G3POI, Orpington, Kent, worked EA1AB on 2m c.w. and **Mike Rowe**, G8JVE, East Preston, Sussex, heard an EA1 and worked into France and Wales on 2m s.s.b. Around 2330 on that evening, **Alan Belfield**, G4GLN, Streatham, contacted an EA on 70cm c.w.

**John Branegan**, now licensed GM8OXQ, Saline, Fife, worked his first three countries, G3GZX, G18JTS, and GW4GTE during the 2m contest weekend, March 4th and 5th. John said "there was a definite lift on March 4th, and by 2200, GI signals into Scotland were very good and they could hear the Central Scotland repeater in GI".

Throughout the period, 9th to 12th there was frequent co-channel interference in Band II and u.h.f.-TV and at 0914 on the 11th I received a 599 signal from the Emley Moor beacon, GB3EM, on 70cm with only a dipole feeding the receiver.

The 10m band has been open almost daily from February 20th to March 15th with a familiar pattern of strong signals from Russian amateurs in the morning and from north-American amateur and CB stations during the afternoon and early evening. I heard VKs during the early mornings of February 26th and March 7th and JAs on March 5th and 11th working into Europe. On most days signals averaging 539 were heard from the Cyprus beacon, 5B4CY and the project TESSA beacon, ZE2JV. During the afternoons of March 1st and 2nd, **Don Butterworth**, G3IKO, Redhill, Surrey, heard the Bermuda beacon VP9BA and I logged the Bahrain beacon, A9XC, during the afternoons of the 5th and 6th.

February 26th was a good day on 10m for **Gordon Goodyer**, BRS 37345, Petworth, Sussex, who heard both A9XC and VP9BA in the morning as well as signals from amateurs in 22 countries. Although

signals were very strong throughout the day Gordon reports a drop off in strength around midday and a quiet band from 1430 to 1515. **Roger Bunney**, DX TV columnist, using his Hallicrafters 5-10 receiver logged transatlantic signals up to 37MHz on the 26th. **Nigel Golds**, BRS 36910, West Chiltington, Sussex, noted the powerful American stations around 1730 on March 11th and the Russians during the afternoon of the 12th.

The exceptional 10m conditions observed by Gordon and Roger on February 26th were followed by ionospheric disturbances, reported by the BBC World Service, on the 27th and 28th which may well have been caused by the solar storm recorded by **Cmdr Henry Hatfield**, Sevenoaks, Kent, **John Smith**, Rudgwick, Sussex, and myself from February 21st to 26th. What's more **John Branegan**, reported auroral activity, with plenty of 2m c.w. from EI, GW and LA, from 1830 to 1912 on February 27th and from 1657 to 1912 on March 1st. John has built a projection box attachment for his 2in telescope so that he can record the number of sunspots and since 2048 on March 5th he has been monitoring the telemetry signals from the new amateur radio satellite, OSCAR-8.

Despite frequent overcast skies, **Henry Hatfield** got a glimpse of the sun through his spectrohelioscope on March 6th when, in addition to sunspots, he saw several filaments and a ribbon flare, on the 10th he counted some 15 spots in four main groups, and on the 15th he noted a bright plage on the east limb. **Henry**, **John Smith** and myself recorded solar noise at 136 and 142MHz on March 2nd, and then daily from the 6th to the 13th with noise storm conditions on days 6th, 8th, 10th and 15th.

According to comments heard both on and off the air by **Alan Baker** and myself the "Slim Jim" 2m aerial described in our April issue works well and is very popular.

Let's hope that conditions will be good to provide plenty of DX for the RSGB's HF National Field Day on June 3rd and 4th and VHF NFD and SWL contest on July 1st and 2nd. Thanks again for all your reports, and good luck if you compete in the contests.

## What do the VHF's have to offer?

The accepted part of the radio frequency spectrum known as Very High Frequency ranges from 30 to 300MHz, (10-1 metres), and is generally used for communications by aircraft (108-136MHz), amateur radio (4m, 70.05-70.7 and 2m 144-146MHz), private and business mobile radio (71-88 and 165-174MHz), shipping (156-165MHz), satellites (136-137MHz), military, various emergency services and broadcasting by f.m. radio, Band II (88-108MHz) and television, Band I (41-67MHz) and Band III (176-215MHz).

The effective range of a v.h.f. signal is naturally limited by the terrain beneath its path and the prevailing atmospheric conditions. Broadly speaking, the propagation of signals between 30-80MHz is governed by the E region of the ionosphere, and above 80MHz, by conditions in the troposphere. These bands are therefore a challenge to both the listener and the transmitting amateur, to be ready for sudden sporadic-E disturbances between April and August and at any time, for a tropospheric opening, when the weather



is fine and the atmospheric pressure is high. These v.h.f. openings are exciting, because the signals travel more than ten times their normal range and as the v.h.f. bands are shared throughout Europe, there is a mine of DX, both sound and vision, to be found among the mix-up of continental signals while the event lasts.

During sporadic-E events, very strong signals are heard in the UK from east-European broadcast stations between 65-73MHz and even stronger signals, from a variety of continental mobiles, interfere with the Band I television channels. There are two beacons in the 4m band to listen for, GB3SU, 70·695MHz and GB3SX, 70·685MHz.

The 2m band is full of surprises throughout a tropospheric opening; and like most v.h.f. enthusiasts, our readers have heard and worked amateur stations, using all modes, over a wide area from Scandinavia to the Mediterranean Sea, and all parts of the UK.

First indications of an opening can come from any of the chain of 2m beacons ranging from Cornwall, GB3CTC, 144·915MHz, to Angus, GB3ANG, 144·975MHz, and northern Ireland, GB3GI, 144·137MHz, to Wrotham, Kent, 144·150MHz. Having decided, from the number of UK beacons heard, the extent and predominant direction of the prevailing lift, it is worth looking for the continental beacons such as; DL0PR, 144·910MHz, EA3URE, 144·042MHz, FX3THF, 144·905MHz, LA1VHF, 144·860MHz, OH6VHF, 144·900MHz, OK0EB, 144·970MHz, ON4VHF, 145·990, OZ7IGY, 144·930MHz, PA0JTA, 144·148MHz, SK4MPI, 144·960MHz, SP2VHF, 144·980MHz, and YU1VHF, 145·990 to name a few. A beacon's signal is a continuous note, frequently interrupted with its call-sign.

Another good propagation indicator is the 2m repeater network, using f.m., which now provides considerable coverage of the UK and is rapidly spreading through Europe. Each repeater shares a carefully planned channel numbered from R0 through R9, covering a series of input frequencies from 145·000MHz, in 25kHz steps, to 145·225MHz. The range of output frequencies, also in 25kHz steps, is 600kHz higher, from 145·600 to 145·825MHz. In addition to handling the amateur radio traffic, these unmanned, automatic duplex transceivers periodically identify themselves by transmitting their official call-signs.

At some time during a tropospheric opening, continental f.m. broadcast stations will be heard in Band II, often stronger than the "local" BBC stations, and Band III television will suffer from co-channel interference.

Space enthusiasts can use the AMSAT-OSCAR 7 satellite which has two repeaters (transponders) aboard, 2m to 10m and 70cm to 2m. Signals received by the satellite between 145·85 and 145·95MHz are re-radiated between 29·4 and 29·5MHz and signals going in between 432·125 and 432·175MHz come out, inverted, between 145·975 and 145·925MHz. The satellite's telemetry beacon can be heard on 145·980MHz.

Every year, the RSGB, in conjunction with the IARU, arrange a number of contests, on 4m and 2m, for licensed amateurs and SWLs. These events are interesting because they are well supported by individual and group entries operating from their home QTH, or from portable or mobile locations. Should a contest coincide with an atmospheric disturbance then there is plenty of DX about.

Sections of the 2m band are used for Slow Scan TV, RTTY, the Radio Amateurs Emergency Network (Raynet), and scientifically, for moon-bounce experiments, meteor scatter and the study of auroral propagation.

I suggest that readers who are interested in v.h.f. should obtain a copy of the RSGB *VHF/UHF Manual* and talk to the v.h.f. operators in their local radio club.

## BROADCAST BANDS

### SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

Harmonics, though familiar enough to the radio amateur, may well be an unknown phenomenon to the broadcast band DXer. A harmonic in this context is a spurious transmission on twice or three times the frequency of a broadcasting station. The basic frequency is called the fundamental, twice that frequency is the second harmonic, three times the frequency is the third harmonic and so on. Harmonics occur naturally inside a radio transmitter but great efforts are made to suppress them so that they do not reach the aerial and radiate. High power transmitters are now commonplace and when connected to a directional array the effective radiated power (e.r.p.) may easily be in megawatts. Under these circumstances it is easy for a few watts of the second or third harmonic to be radiated along with the fundamental. Normally, this is not a problem as the s.w. broadcaster ought to be transmitting near to the maximum usable frequency (m.u.f.) to obtain optimum results. Harmonics would then be above the critical frequency and will penetrate the ionosphere and not come back to the earth.

Now that the higher frequencies are opening up again after the recent sunspot minimum, reception of harmonics should occur more often. Radio amateurs make world-wide contact on 10 metres using only a few watts, and reception of harmonics in the range 23 to 30MHz should occur over a similar range. Harmonic DXing is the broadcast band DXer's equivalent of QRP (low power) and as such has a challenge and fascination all its own. One snag though. Be sure you are listening to a genuine harmonic and not to a spurious signal generated within your receiver. A check for the fundamental or a check of conditions on 10 metres is a help.

From Guernsey in the Channel Islands comes a letter from George Le Couteur who heard Radio Moscow when he was tuning through the 10m band. The exact frequency was 28·350MHz which is three times 9·450 in the 31m band and sure enough he "found them putting out their usual huge signal on the frequency". The second harmonic is 18·900 and George found them on this out-of-band frequency as well. Other DX heard, on fundamental this time, is Radio New Zealand regularly around 0830 on 11820kHz, faint but clear of QRM.



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**Harold Brodribb**, St Leonards-on-Sea has also picked up harmonics of Radio Moscow, on 23·920MHz (2×11960), 24·110 (2×12055) on 29·1 (?) and 29·8 (?). Harold is now using a home-made converter with his CR100 which gives very much better results in the range 25-30MHz and he reports increased activity in the 11m broadcast band (25605 to 26095kHz) with reception of Tel Aviv on 25605 at midday and of the Voice of America (location unknown) on 26000kHz at 1800.

Short-wave crystal sets are in the news again with a report from **Rod Hunt** of Darlington who pulled in Radio Canada, Finland, Norway, Sweden, Austria and a number of others, using a home-brew crystal set and a 50ft outdoor aerial. Rod says that one definitely needs patience and persistence and it is only a matter of time until Australia is caught!

Radio Australia has attracted the attention of **George Norris** of Stowmarket (FRG7 and Windom Antenna) who says that propagation on this path at the moment seems to favour the morning between 0700 and 1000. "Try 11740kHz (25m) first and then 21680 and 21570 (13m). The former seems to hold up well most of the day with QRM at times". **William Stevenson** (Manchester) has a Vega 206 which he uses with a folded dipole in the loft for the 19m band and a 45ft Zepp with a.t.u. for the rest of the bands. His log included Radio Australia on 11705kHz at 1500 SIO 434. Fifteen-year-old **Robert Pound** of Cambourne in Cornwall is a regular listener to Radio Australia on 11740 but has been trying without success on 4920 for the 10kW VLM4 which relays the Domestic s.w. Service between 1930 and 1400. Has anyone logged this station? Robert, who uses an ex-WD receiver (type unknown) and an end-fed aerial situated in the loft, has been trying to pick up Radio Kaduna, Nigeria on 3396kHz in order to hear the talking drum interval signal. The NBC international service is also using this interval signal. **Chris Howles** of Lichfield (Vega 206 and 50ft long wire) reports hearing Lagos signing on at 1800 on 15120kHz in the 19m band and according to the *World Radio and TV Handbook* the interval signal precedes signing-on.

to listen to it until 0400. Subsequent night listening between 0100 and 0330 produced WHN New York on 1050, CHUM Toronto 1050, CFRB Toronto 1010, CHNS Halifax 960, CJYQ St John's 930, WCAU Philadelphia 1210, WOWO Fort Wayne Indiana 1190, CJCH Halifax 920. Mike now intends to obtain one of the new Yaesu Musen digital receivers and he also plans to construct a loop. A number of points arise out of Mike's letter.

Reception of North American m.w. stations is not limited to the winter. DXing is possible throughout the year. All that is required is a path of darkness between transmitter and receiver and this occurs some five hours after local sunset in the UK. Even on the longest day, sunrise occurs seven hours after sunset at this QTH though this period may vary according to location in the UK. At my QTH this means about 1½ hours DXing of NA before dawn on June 21st and much longer periods during April, May, July and August. Only stations on the eastern seaboard of North America will be heard in June but on the other hand European QRM is light as Central and Eastern Europe will be in daylight. DXing North America in summer can be rewarding. I once logged the 40 watt relay at Glovertown in Newfoundland on 1090kHz during the month of July.

Mike noticed that fade-outs lasting for periods of several days are common on the North American path and he wonders if there is any set pattern for good reception. Fade-outs do recur sometimes after 28 days, which is the period that a disturbance or spot on the surface of the sun takes to rotate and face the earth again—that is if it lasts that long. Reception is often at its best just before a fade-out so it might be possible to predict such a peak. Matters are not so simple, though, as the ionosphere is a complex medium and long range propagation on the medium waves has not been studied to any degree. After all the band is intended for local broadcasting! In any event the medium waves are never dead, there is always some DX to be heard. If North America cannot be heard at all then South America will be at its best. If you hear an American voice during a fadeout then listen carefully for it may be something special such as Puerto Rico or perhaps the American Virgin Islands. I shall give up medium wave DXing if it ever becomes possible to predict what can be heard as most of the fun will then have disappeared.

Finally, Mike offers a tip to QSL hunters. International Reply Coupons cost 25p in the UK but stamp dealers can supply unused postage stamps for most foreign countries. These are more convenient for the recipient to use and, a lot cheaper to buy (for Canada in Mike's experience). A very good idea if you know what value of stamps to obtain for a return letter.

Central and South America are often heard well during the summer. **D. R. Mayhew** (Littlehampton), who uses a Philips receiver and the PW 40in loop reports hearing Radio Managua, Nicaragua on 620kHz, La Voz de Mexico on 730, Radio Cadena el Salvador on 760, 'ROK 80' in Juarez Mexico on 800, Radio Sutatenza Colombia 810 and Radio la Versatil El Salvador on 1300kHz. More Latin American DX is reported by **Steve Whitt** (Cambridge) who used an Eddystone 940 with a 2ft square loop and the PW balanced amplifier to pull in Radio Margarita 1020 and Radio Coro 1210, both in Venezuela. "It was very interesting to receive my first South American DX, I don't know how I missed it before," writes Steve. It is very easy to pass over Latin Americans, especially during a North American fade-out, and class

## BROADCAST BANDS

### MEDIUM WAVE DX

by **Charles Molloy G8BUS**

A long interesting letter, just bursting with enthusiasm from **Mike Kuske** of Folkestone describes how he heard his first North American m.w. station. His National Panasonic GX600M had been purchased for short wave listening but after reading PW he decided to try the medium waves for, although interested in North American domestic radio, he never thought it could be heard in the UK. With 100ft of wire wound around the loft for an aerial he pulled in WINS in New York City on 1010kHz at 0045 and he continued



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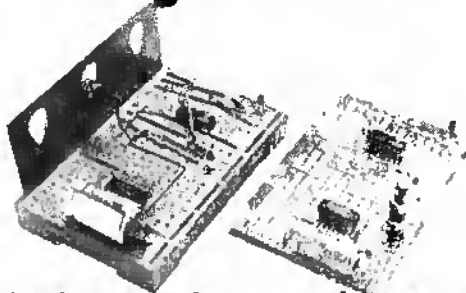
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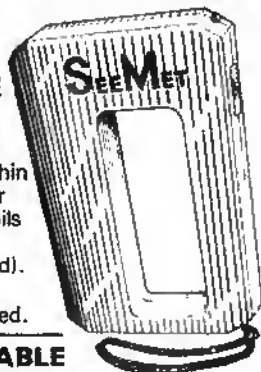


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them, as one newcomer to this column did, as unidentified Spaniards. At this time of year listen for Latin Americans after midnight, the peak occurring just before sunrise. There are very strong signals to be heard at times.

Steve asks what type of equipment is in use at my QTH. The main receiver is a GEC BRT400, a valved communications type that was designed some 25 years ago for broadcast band monitoring. Also in service is an Eddystone EC10 which is very useful as a second receiver if it is necessary to check two channels. A 90ft long wire with a.t.u., a 40in loop, crystal calibrator, audio notch filter, portable tape recorder and a home-made switching unit to switch aerials and calibrator, completes the set-up.

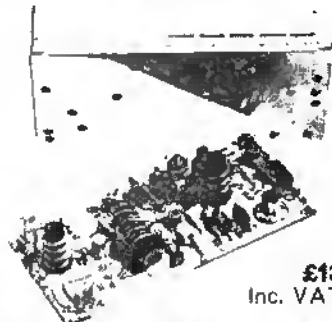
Another DXer who continues to use valved equipment is J. Gaines of Surbiton who has a Marconi CR100/8 which is giving splendid service. I used a CR100 for m.w. DXing for a number of years and it is a really first-class receiver on this band, though its performance on the short waves leaves a lot to be desired. One "mod" carried out by J. Gaines was to split the r.f. and i.f. gain controls.

This is a feature of the BRT400 that appeals to me as the r.f. gain control on many receivers controls both r.f. and i.f. gain at the same time. With the BRT400 the two are separate and there is an advantage to be gained at times by adjusting them separately. Overloading and cross-modulation occur at, or before the mixer and it is often necessary to reduce r.f. gain to eliminate this, with of course a reduction in i.f. gain as well when a common control is in use. It is in the mixer stage that the bulk of receiver noise is generated and in order to obtain a good signal-to-noise ratio, the r.f. gain should be as great as possible. Backing off the i.f. gain is the way to follow signal strength in this case, especially with the a.g.c. switched off, which should be normal practice when DXing on the medium waves. I set the r.f. gain as high as it will go without giving trouble and then I control signal strength with the i.f. gain control.

A good substitute for an r.f. gain control, if none is fitted, is an external attenuator. The simplest is a potentiometer of about 1000 ohms. The lead from the aerial goes to the central tag. One of the outer tags goes to the receiver aerial socket and the other outer tag goes to the receiver earth socket. Overloading and cross-modulation can be controlled very easily by this method.

From Farum in Denmark comes a letter from Mick Evans who describes himself as a London guy who has gone to live and work in Denmark. Mike says that PW is very expensive in DK land, working out at well over £1 a copy. Why not take out an annual subscription? This service has recently been re-introduced at £10-60 per annum to any UK or overseas address. Mike's main trouble though is a buzz spread over a portion of the medium wave band and he asks if a mains filter would help. If the buzz is being radiated by the house wiring, as seems the case, then it would be necessary to filter the whole mains supply to the house. Contact the Danish Shortwave Club International, Greve Strandvej 144, DK2670 Greve Strand, Denmark, who should know the correct body to complain to. The DSWCI incidentally, is international, it publishes a bulletin in English called Short Wave News, which contains a medium wave section, in spite of the name. Enquiries in the UK should go to Noel Green, together with a stamped addressed envelope. Noel's address is 14 Marsden Road, Blackpool FY4 3BZ.

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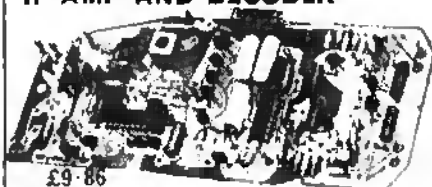
**TECHNICAL CHARACTERISTICS:**  
Output terminal for digital frequency meter;  
Antenna impedance—75 to 300 Ohms;  
Frequency ranges 87.5 to 104MHz or to 108MHz; Sensitivity—0.9uV 26dB signal to noise ratio  $\pm$ 75kHz deviation; Intermodulation 80dB Image rejection—60dB; Tuning voltage—1V to 11V; Total gain—33dB; Intermediate frequency—10.7MHz; Power supply voltage +15V; Power consumption 15mA; Dimensions 104 x 50mm.

**TECHNOLOGY:**

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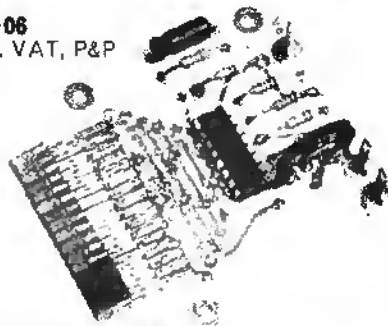
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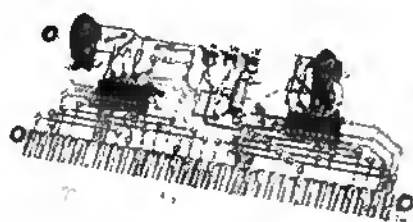
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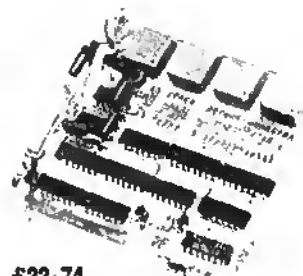


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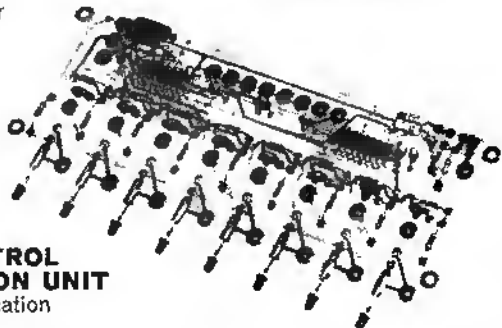
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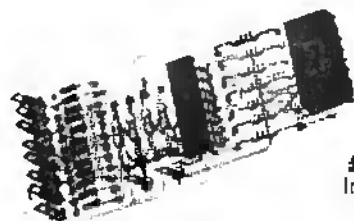
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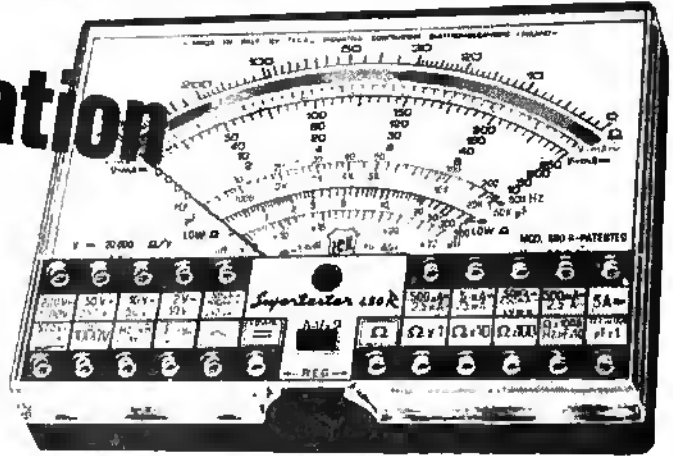




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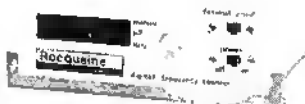
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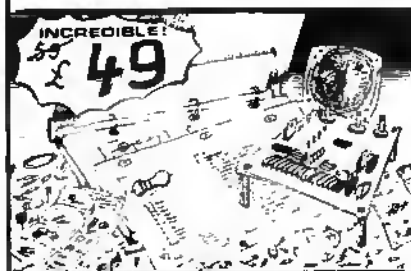
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*Practical Wireless, June 1978*

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7432	37p	74151	81p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
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7443	120p	74160	180p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
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7448	85p	74165	65p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
7450	18p	74165	180p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
7451	16p	74167	320p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
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7493	34p	74197	130p	74L399	140p	4029	120p			TIP35A	240p	2N4401/3	34p	10A 100V	140p
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0.001, 0.0015, 0.0022, 0.0033  $\mu$ F; 0.0047, 0.0058, 0.01, 0.015  $\mu$ F; 0.022, 0.033, 0.047, 0.068, 0.1  $\mu$ F; 0.15, 0.22, 0.33, 0.47, 0.58, 0.75, 1.0  $\mu$ F; 1.5, 2.2, 3.3, 4.7, 5.8, 7.5, 10, 15, 22, 33, 47, 58, 75, 100, 150, 220, 330, 470, 580, 750, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 10000, 15000, 22000, 33000, 47000, 58000, 75000, 100000, 150000, 220000, 330000, 470000, 580000, 750000, 1000000, 1500000, 2200000, 3300000, 4700000, 5800000, 7500000, 10000000, 15000000, 22000000, 33000000, 47000000, 58000000, 75000000, 100000000, 150000000, 220000000, 330000000, 470000000, 580000000, 750000000, 1000000000, 1500000000, 2200000000, 3300000000, 4700000000, 5800000000, 7500000000, 10000000000, 15000000000, 22000000000, 33000000000, 47000000000, 58000000000, 75000000000, 100000000000, 150000000000, 220000000000, 330000000000, 470000000000, 580000000000, 750000000000, 1000000000000, 1500000000000, 2200000000000, 3300000000000, 4700000000000, 5800000000000, 7500000000000, 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47000, 58000, 75000, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 100, 15000, 22000, 33000, 47000, 58000, 75000, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 100, 15000, 22000, 33000, 47000, 58000, 75000, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 100, 15000, 22000, 33000, 47000, 58000, 75000, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 100, 15000, 22000, 33000, 47000, 58000, 75000, 1000, 1500, 2200, 3300, 4700, 5800, 7500, 100, 15000, 22000, 33000, 47000, 58000, 75000, 1000, 1500, 2200, 3300000000





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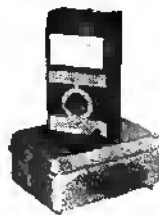
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Post £1  
80-14,500 c/s. 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 146,000 Maxwells. Bass resonance 40 cps rated 25 watts. NOTE: 4 or 8 or 16 ohms must be stated.

## MAJOR MODULE KIT

Post £1-00  
30-17,000 c/s with tweeter, crossover, baffles 18 x 12 1/2in. Price £19-00  
Plate 4 or 8 or 16 ohms.

## BAKER SPEAKERS "BIG SOUND"

Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful responses 30-13,000 cps. Bass resonance 55 cps.

### GROUP "25"

12in. 30 watt 4, 8 or 16 ohms.

£12-00

Post £1

### GROUP "35"

12in. 40 watt 4, 8 or 16 ohms.

£14-00

Post £1

### GROUP "50/12"

12in. 60 watt professional model. 4, 8 or 16 ohms.

£21-00

Post £1-00

Response = 30 - 16,000 cps.

With aluminium presence dome.

### GROUP "50/15"

15in. 75 watt 8 or 16 ohms.

£26-00

Post £1 80

Send for leaflets on Disco, P.A. and Group Gear.

## BAKER 150 WATT QUALITY TRANSISTOR MIXER/AMPLIFIER



Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4-5-16 ohm. Slave output. A/C mains. Guaranteed. Details S.A.E. £75 Carr. £1-60

## 100 WATT DISCO AMPLIFIER

MADE BY JENNINGS MUSICAL INSTRUMENTS £59 Carr. £1  
4 Speaker outputs volume, treble, bass, controls CAN BE USED AS 100 WATT SLAVE

## B.S.R. SINGLE PLAYER DECK

3 speed. Plays all size records, Stereo Cartridge, Cueing device, Ideal Disco Deck. £15-50 Post 75p



DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Will control up to 600 watts AC mains. £3-25 Post 35p

STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high medium or low gain per channel, with volume control and P.C. Board. Can be ganged to make multi-way stereo mixers. £2-95 Post 35p

## R.C.S. SOUND TO LIGHT DISPLAY MK 2

Complete kit of parts with R.C.S. printed circuit. Three channels. 600 to 1,000 watts each. Will operate from 200V. to 100 watts signal source. Suitable for home use. Cabinet extra £4. Price £17

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw Fitting 75p. Each.

## MAINS TRANSFORMERS

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50 VOLT 1.5 AMP. £2-50 40 VOLT 2 AMP. £2-95  
0-20-40-00 VOLT 1 AMP. £3-50 2 x 18 VOLT 5 AMP. 2p.

GENERAL PURPOSE LOW VOLTAGE. Voltages available at  
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1A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £0-50  
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £2-80  
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £21-00  
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £24-50

## R.C.S. BOOKSHELF SPEAKERS

13 x 10 x 6in. 50 to 14,000 cps. 12 watts rms. 8 ohms £19 pair Post £1-50

## BAKER DISCO SPEAKERS HIGH QUALITY-BRITISH MADE 2 x 12" CABINETS

For Disco or PA all fitted with carrying handles and corners. Black vinyl covered. Other cabinets in stock. SAE for leaflet

### 60 WATT R.M.S. £52

With one horn £60

With two horns £68 Carr. £3

### 80 WATT R.M.S. £56

With one horn £64

With two horns £72 Carr. £3

### 100 WATT R.M.S. £69

With one horn £78

With two horns £86 Carr. £6

## SINGLE 12inch CABS COMPLETE

30 WATT R.M.S. £32. WITH HORN £40.

40 WATT R.M.S. £34. WITH HORN £42.

60 WATT R.M.S. £41. WITH HORN £49. CARR £3 EA.

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A high quality loudspeaker. Its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register. Bass Resonance 25cps Flux Density 15,500 gauss Useful response 20-17,000cps 8 or 16 ohms models.



## "AUDITORIUM" 12in. 35 watts

A full range reproducer for high power. Ideal for Hi-Fi and Discotheques. Electric Guitars, public address, multi-speaker systems, electric organs. Bass Resonance 35cps Flux Density 15,000 gauss Useful response 25-18,000cps 8 or 16 ohms models.



## "AUDITORIUM" 15in. 45 watts

A high wattage loudspeaker of exceptional quality with level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic Instruments and the home Hi-Fi. Bass Resonance 35cps Flux Density 15,000 gauss Useful response 20-14,000cps 8 or 16 ohms models.



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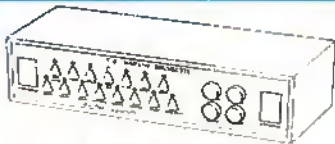
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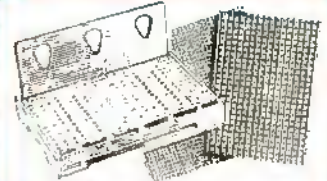
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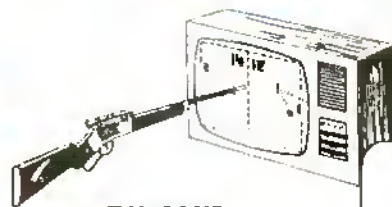
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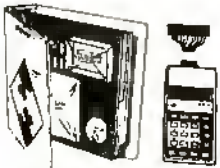
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