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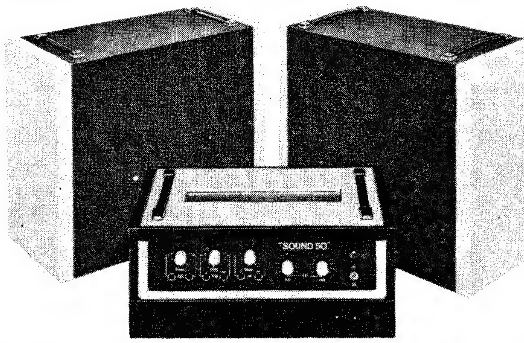

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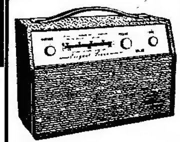

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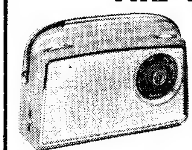

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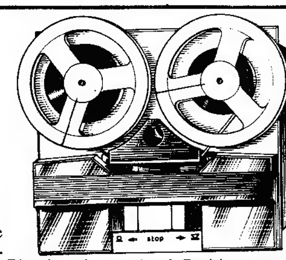

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MARK 3

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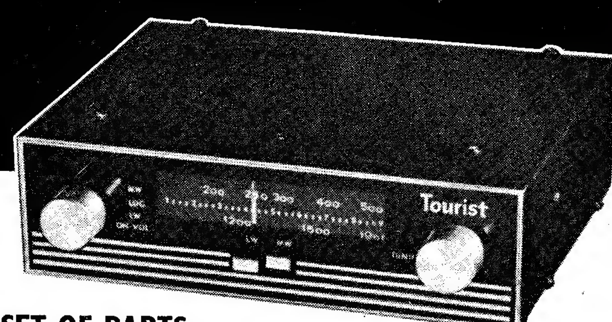

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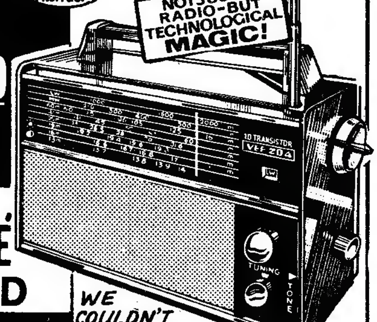

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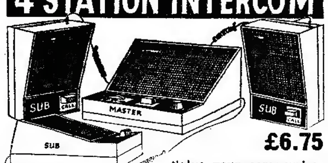

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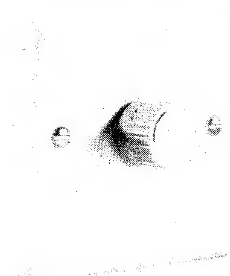

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Teleton TSF50	£53·00
Teleton F2000	£31·50
Wharfedale 100-1	£114·00

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Shure M55	£9·20
Shure M75E	£14·50
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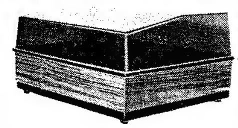

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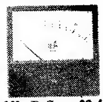
50–0–50µA	£3·37½	50V. D.C. ..	£2·97½
100µA	£3·37½	300V. D.C.	£2·97½
100–0–100µA	£3·25	1 amp. D.C.	£2·97½
500µA	£3·12½	5 amp. D.C.	£2·97½
1mA	£2·97½	300V. A.C.	£2·97½
		VU Meter ..	£3·75

BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts



50µA	£3·12½	50V. D.C. ..	£2·47½
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100µA	£2·97½	1 amp. D.C.	£2·47½
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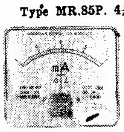
500µA	£2·62½	300V. A.C.	£2·62½
1mA	£2·47½	VU Meter ..	£3·37½
20V. D.C. ..	£2·47½		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4¼in. × 4¾in. fronts.



50µA	£3·60	50mA	£2·60
50–0–50µA	£3·10	100mA	£2·60
100µA	£3·10	500mA	£2·60
100–0–100µA	£3·10	1 amp.	£2·60
200µA	£2·87½	5 amp.	£2·60
500µA	£2·75	15 amp.	£2·60
500–0–500µA	£2·60	30 amp.	£2·60
1mA	£2·60	20V. D.C. ..	£2·60
1–0–1mA ..	£2·60	50V. D.C. ..	£2·60
5mA	£2·60	150V. D.C.	£2·60
10mA	£2·60	300V. D.C.	£2·60
		15V. A.C. ..	£2·60
		300V. A.C.	£2·60
		S Meter 1mA	£2·87½
		VU Meter ..	£3·60
		1 amp. A.C.*	£2·60
		5 amp. A.C.*	£2·60
		10 amp. A.C.*	£2·60
		20 amp. A.C.*	£2·60
		30 amp. A.C.*	£2·60

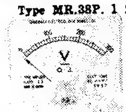
Type MR.52P. 2⅜in. square fronts.

50µA	£3·10	10V. D.C. ..	£2·00
50–0–50µA	£2·60	20V. D.C. ..	£2·00
100µA	£2·60	50V. D.C. ..	£2·00
100–0–100µA	£2·37½	300V. D.C.	£2·00
500µA	£2·25	15V. A.C. ..	£2·00
1mA	£2·00	300V. A.C.	£2·00
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter ..	£3·10
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3⅜in. × 3¼in. fronts.

50µA	3·37½	10V. D.C. ..	£2·10
50–0–50µA	£2·75	20V. D.C. ..	£2·10
100µA	£2·75	50V. D.C. ..	£2·10
100–0–100µA	£2·60	150V. D.C. ..	£2·10
200µA	£2·60	300V. D.C.	£2·10
500µA	£2·37½	15V. A.C. ..	£2·10
500–0–500µA	£2·10	50V. A.C. ..	£2·10
1mA	£2·10	150V. A.C.	£2·10
5mA	£2·10	300V. A.C.	£2·10
10mA	£2·10	500V. A.C.	£2·10
50mA	£2·10	S Meter 1mA	£2·37½
100mA	£2·10	VU Meter ..	£3·37½
500mA	£2·10	50mA A.C.*	£2·10
1 amp.	£2·10	100mA A.C.*	£2·10
5 amp.	£2·10	200mA A.C.*	£2·10
10 amp.	£2·10	500mA A.C.*	£2·10
15 amp. ..	£2·10	1 amp. A.C.*	£2·10
20 amp. ..	£2·10	5 amp. A.C.*	£2·10
30 amp. ..	£2·10	10 amp. A.C.*	£2·10
50 amp. ..	£2·37½	20 amp. A.C.*	£2·10
5V. D.C. ..	£2·10	30 amp. A.C.*	£2·10

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



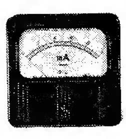
50µA	£2·00	200mA	£1·37½
50–0–50µA	£1·87½	300mA	£1·37½
100µA	£1·87½	500mA	£1·37½
100–0–100µA	£1·75	750mA	£1·37½
200µA	£1·75	1 amp.	£1·37½
500µA	£1·50	2 amp.	£1·37½
500–0–500µA	£1·37½	5 amp.	£1·37½
1mA	£1·37½	10 amp. ..	£1·37½
1–0–1mA ..	£1·37½	3V. D.C. ..	£1·37½
2mA	£1·37½	10V. D.C. ..	£1·37½
5mA	£1·37½	15V. D.C. ..	£1·37½
10mA	£1·37½	20V. D.C. ..	£1·37½
20mA	£1·37½	100V. D.C.	£1·37½
50mA	£1·37½	150V. D.C.	£1·37½
100mA	£1·37½	300V. D.C.	£1·37½
150mA	£1·37½	500V. D.C.	£1·37½
		750V. D.C.	£1·37½
		15V. A.C. ..	£1·37½
		50V. A.C. ..	£1·37½
		150V. A.C.	£1·37½
		300V. A.C.	£1·37½
		500V. A.C.	£1·37½
		S Meter 1mA	£1·60
		VU Meter ..	£2.10

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

50µA	£2·25	5 amp.	£1·50
50–0–50µA	£2·10	10V. D.C. ..	£1·50
100µA	£2·10	20V. D.C. ..	£1·50
100–0–100µA	£1.87½	50V. D.C. ..	£1·50
200µA	£1·87½	300V. D.C.	£1·50
500µA	£1·60	15V. A.C. ..	£1·50
500–0–500µA	£1·50	300V. A.C.	£1·50
1mA	£1·50	S Meter 1mA	£1·87½
5mA	£1·50	VU Meter ..	£2·25
10mA	£1·50	1 amp. A.C.*	£1·50
50mA	£1·50	5 amp. A.C.*	£1·50
100mA	£1·50	10 amp. A.C.*	£1·50
500mA	£1·50	20 amp. A.C.*	£1·50
1 amp	£1·50	30 amp. A.C.*	£1·50

"SEW" BAKELITE PANEL METERS

Type MR.65. 3¼in. square fronts.



25µA	£3·50	500mA	£1·75
50µA	£2·37½	1 amp.	£1·75
50–0–50µA	£2·25	5 amp.	£1·75
100µA	£2·25	15 amp.	£1·75
100–0–100µA	£2·25	30 amp.	£1·75
500µA	£2·10	50 amp.	£1·75
1mA	£1·75	5V. D.C. ..	£1·75
1–0–1mA ..	£1·75	10V. D.C. ..	£1·75
5mA	£1·75	20V. D.C. ..	£1·75
10mA	£1·75	50V. D.C. ..	£1·75
50mA	£1·75	150V. D.C.	£1·75
100mA	£1·75	300V. D.C.	£1·75
		30V. A.C.*	£1·75
		50V. A.C.*	£1·75
		150V. A.C.*	£1·75
		300V. A.C.*	£1·75
		500mA A.C.*	£1·75
		1 amp. A.C.*	£1·75
		5 amp. A.C.*	£1·75
		10 amp. A.C.*	£1·75
		20 amp. A.C.*	£1·75
		30 amp. A.C.*	£1·75
		50 amp. A.C.*	£1·75
		VU Meter ..	£3·10

*MOVING IRON— ALL OTHERS MOVING COIL

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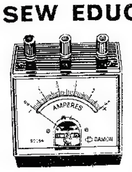
SEW EDUCATIONAL METERS



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

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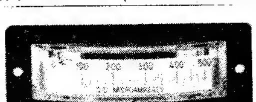
100µA	£4·25	50V d.c.	£3·97
1mA	£3·97	300V d.c.	£3·97
50–0–50µA ..	£4·25		
1–0–1mA....	£3·97	Dual range	
1A d.c.	£3·97	500mA/5A d.c.	£4·25
5A d.c.	£3·97	5V/50V d.c...	£4·25
10V d.c.	£3·97		



EDGWISE METERS

Type PE.70. 3 17/32in. × 1 15/32in. × 2¾ in. deep.

50µA	£3·00	500µA	£2·60
50–0–50µA	£2·87½	1mA	£2·37½
100µA	£2·87½	300V. A.C.	£2·37½
100–0–100µA	£2·75	VU Meter ..	£3·25
200µA	£2·75		

Send for illustrated brochure on SEW Panel Meters—discounts for quantities.

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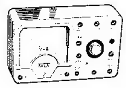
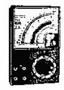
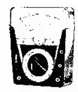


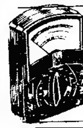
TECH PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V. A.C. and D.C. 0/1/100/500mA. D.C. 0/100K. **£1·97½.** P. & P. 12½p.



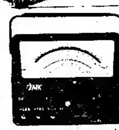
MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000 V.D.C. 0/10/50/250/1,000 V.A.C. 0/50 uA/250 mA. 0/60K/6 megΩ. −20 to +62 db. **£3·75.** P. & P. 15p.



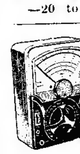
MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200v. D.C. 0/6/30/120/600/1,200v. A.C. 0/30uA/3/30/300mA. 0/16K/160K/1.6M/16 Meg Ω. **£5·50.** P. & P. 15p.



MODEL TE-12 20,000 O.P.V. 0/0.6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60µA/6/60/600mA. 0/6K/600K/6Meg./60 Meg. Ω 50pF. 0.2mFd. **£5·97½.** P. & P. 17½p.

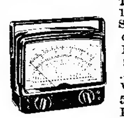


MODEL PL436 20kΩ/Volt D.C. 8kΩ/Volt AC. Mirror scale. .6/3/12/30/120/600V D.C. 3/30/120/600V A.C. 50/600uA/60/600 mA. 10/100K/1 Meg/10 MegΩ. −20 to + 46db. **£6·97½** P & P 12½



MODEL 500 30,000 O.P.V. with overload protection. mirror scale 0/·5/2·5/10/25/100/250/500/1,000v. D.C. 1/2·5/10/25/100/250/500/1,000v. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60K/6 Meg./60 Meg Ω. **£8·87½.** Post paid.

TMK MODEL TW-20CB FEATURES RESETTABLE OVERLOAD BUTTON. Sensitivity: 20K Ω/Volt D.C. 5K Ω/Volt A.C. D.C. Volts: 0–0.5, 2.5, 10, 50, 250, 1,000V. A.C. Volts: 0–2.5, 10, 50, 250, 1,000V. D.C. Currents: 0–0.05, 0.5, 5, 50, 500mA. Resistance: 0–5K. 50K, 0–500K. 5 MEGΩ. Decibels: −20 to +52 db. **£11·50.** P. & P. 17½p.



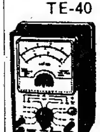
TMK LAB TESTER. 100.000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K Ω/Volt A.C. D.C. Volts: .5, 2.5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100uA, 10, 100, 500mA, 2.5, 10 amp. Resistance: 1K, 10K. 100K, 10MEG, 100 MEGΩ. Decibels: −10 to 49 db. Plastic Case with Carrying Handle. Size 7½in. x 6⅜in. x 3¼in. **£18·90.** P. & P. 25p.

270° WIDE ANGLE 1mA METERS

MW1-6	60mm	square	£3·97½
MW1-8	80mm	square	£4·97½

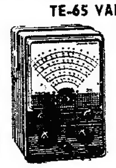
P. & P. extra

TE-40 HIGH SENSITIVITY A.C. VOLTMETER



10 meg. input 10 ranges: 01/·003/·1/·3/1/3/10/30/100/300V. R.M.S. 4cps.-1-2 Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. **£17·50.** Carr. 25p.

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5–1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation. Complete with probe and instructions. **£17·50.** P. & P. 30p. Additional probes available: R.F. **£2·12½**; H.V. **£2·50.**

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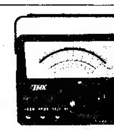
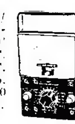


SKYWOOD SW-500 50KΩ/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. DC Current 20uA/6/600mA Resistance 10K/100K/1 Meg/10 Meg. Decibels — 20 to +57 db. **£7·50.** P. & P. 15p.



MODEL AS-100D. 100K Ω/Volt. 5in., mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10uA/6/60/300MA/12 Amp. 0/2K/200K/2M/200MΩ. −20 to +17 bB. **£12·50.** P. & P. 17½p.

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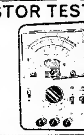

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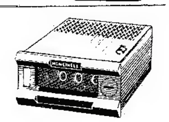

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ± 0.2, ± 1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999) Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60-cycles. Overall size: 5⅝in. x 2 13/16in. x 83/16in.

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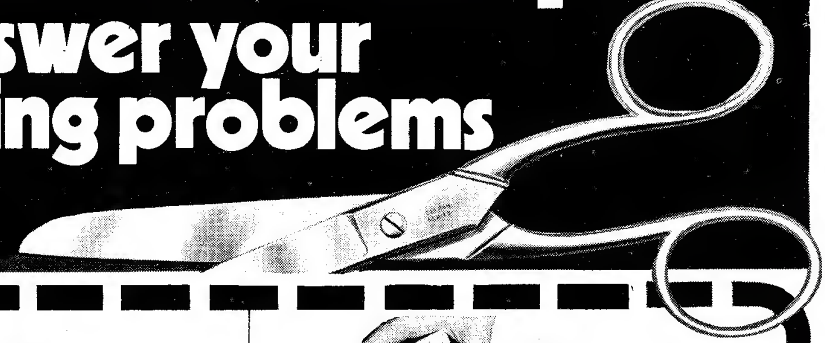

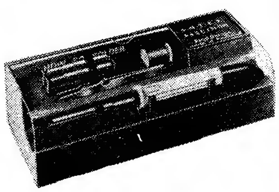

SK1 SOLDERING KIT

In rigid plastic "tool box" containing Model CN - 15 watts - 240 volts miniature iron fitted $\frac{3}{16}$" bit. Spare bits $\frac{5}{32}$" and $\frac{3}{32}$". Reel of resin-cored solder, heat sink, cleaning pad, stand and booklet "How to Solder".

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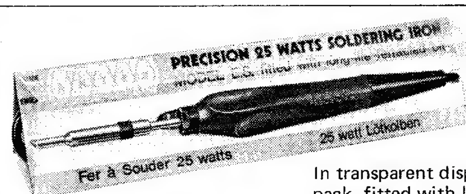

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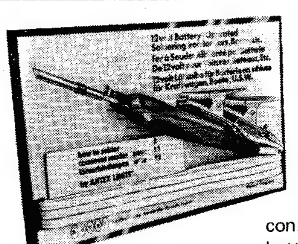

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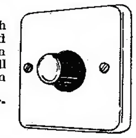

The unit comes complete with MK Ivory Front Plate and Control Knob, when used in place of Light Switch it will control your room lighting from off to full brightness. Power—up to 300 watts interference suppressed.
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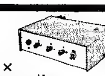

This compact unit (size 8½" × 5½" × 3" high) is connected directly across the speaker output of an amplifier, it will than convert audio signals into a spectacular three colour light display (500 watts light output each colour). Send S.A.E. for further details or call in at any branch for demonstration.
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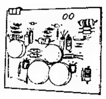

Many Resistors, Condensers, Diodes and Transistors (minimum of 4 transistors on each board).
5 BOARDS FOR **120p.**
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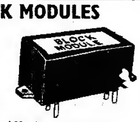

Phono pre-amp E1311 input 100k: gain 28dB max out 3 volt: max input 50mV. Tape pre-amp as above E1313. Power amp E1314 input 1,000 ohms gain 20dB 300mW. Organ tone osc E1315 tone freq. 200-1k, Hz output 80mW. All above modules 9 volt. Dual flasher E1318 flash time 1-4 secs power 6 volt. Lamp 6v 150mA. All at **£1.25** P. & P. 10p

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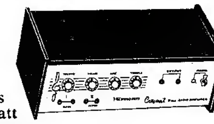

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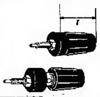

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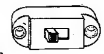

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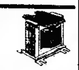

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OC81 Heat clips (double)	3p	,,
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Flex connector 2amp approx non-reversible Ideal for loudspeaker connections	8p	,,
2½ 80 ohm Speaker	33p	,,

Please include Post &Packing
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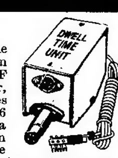

These small units contain the following components: 700 ohm DPDT relay with base, 1μF 250v. paper, 0·01μF 400v. paper, 50μF 35v. electrolytic, 3 diodes OC200 transistor, a 2N2926 type transistor unmarked, a skeleton pre-set pot, 4 pin din plug & skt., 4 foot of 4 core screen. All housed in a small neat metal box. Can be made into many timing devices. **43p** P. & P. 8p

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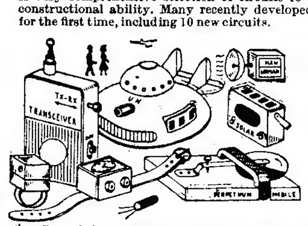

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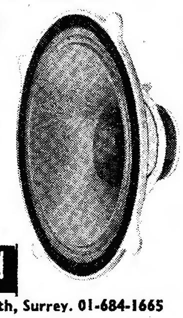

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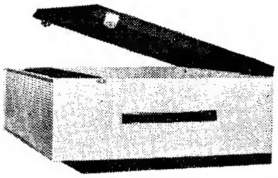

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Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13¾ × 11¼in. Above motor board 3⅛in. below motor board 2⅝in. with STEREO and MONO XTAL **£7.75** Post 25p.

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32/450V	20p	8+16/450V	20p	32+32/450V	33p
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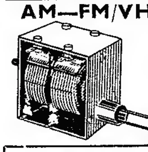
AM—FM/VHF TUNING GANG



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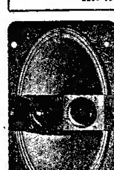

With flared tweeter cone and ceramic magnet. 10 watts. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2.25** Post 15p

Also with twin tweeters and crossover, 10 watt. State 3 or 8 or 15 ohm. (As illustrated) **£4** Post 15p

Recommended Teak Cabinet Size 16 × 10 × 9in. Post 25p **£5**

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Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 15 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE. 16½ × 10½ × 6in. Modern Design, dark grey Tygan covered baffle **£5** Post 25p

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BAKER 12in. MAJOR £9

30-14,500 c.p.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 145,000 Maxwells. Bass resonance 40 c.p.s. Rated 20 watts. Voice coils 3 or 8 or 15 ohms. Post Free

Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. **£11.50**

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'Group 25'	'Group 35'	'Group 50'
12 inch 25 watt **£7**	12 inch 35 watt **£9**	15 inch 50 watt **£19**
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK HI-FI SPEAKER CABINETS. Fluted wood front
For 12in. round Loudspeaker .... £9. Post 25p
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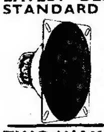
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft.

THIS ELAC CONE TWEETER IS OF THE VERY LATEST DESIGN AND GIVES A HIGHER STANDARD OF PERFORMANCE THAN MORE EXPENSIVE UNITS.



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3¾ × 3¾ × 2in. deep. Rating 10 watts. 3 ohm or 15 ohm models. **£1.90** Post 10p

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With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5½in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm imp. **£1.90** Post 10p

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10w. Large ceramic magnet. 30-12,000 cps. Ideal P.A., Systems, Columns, Hi Fi, Enclosures etc. **£4**

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TWO-WAY 3000cps CROSSOVERS 3 or 8 or 15 ohm 95p.
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SPEAKER COVERING MATERIALS. Samples Large S.A.E.
GOODMAN'S OUTPUT TRANSFORMER 5 watt push-pull for valves EL84 etc., 3, 8 and 15 ohms 85p, Post 20p.

100 WATT ALL PURPOSE POWER AMPLIFIER

4 inputs speech and music. Response 10-30,000 cps Matches all loudspeakers. A.C. 200/250V. Treble and Bass Controls Details. S.A.E. **£36** Post Free

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BARGAIN FM TUNER as above less cabinet **£7.50**

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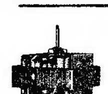
COAXIAL PLUG 6p. PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES, SURFACE OR FLUSH 25p. BALANCED TWIN FEEDERS 5p yd. 80 ohms or 300 ohms. JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 5p. Phono Socket 5p. JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 14p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 25p. DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.

E.M.I. TAPE MOTORS



120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3⅛ × 2⅝ × 2⅛in. (illustrated). **£1.25** Post 15p.

BALFOUR GRAM MOTORS

120v. or 240v. A.C. 1,200 r.p.m. 4 pole 50mA. Spindle ⅛ × 3/20. Size 2⅛ × 2⅛. × 1¼in. **85p** Post 15p

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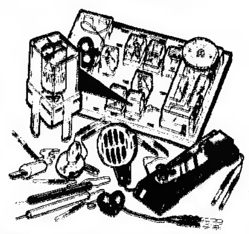
DENSHI BOARD KITS

EXPERIMENTAL AND EDUCATIONAL ELECTRONIC CIRCUIT SYSTEMS



The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises of a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are encapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value. Thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study.

DENSHI BOARD KITS comes complete with an 80 page manual of circuits and data. Manuals are available separate at 23p. Post 3p refundable if you purchase kit.

DENSHI BOARD KIT SR IA

Comprises: Base board, tuner block, 4 resistors, choke coil, transformer, 2 8A transistor for RF, 2 diodes, 3 capacitors, battery block, morse key, antenna, lead, crystal earphones, various bridge and connecting pieces. This kit permits the building of 16 basic circuits.

LASKY'S PRICE **£3·35** Post 13p

DENSHI KIT SR 2A as SR IA with these additional parts: 25B transistor for AF, 2 resistors, capacitor, crystal microphone, test probes, electrode, additional connecting pieces, 9V battery. This kit permits the building of 30 circuits.

LASKY'S PRICE **£5·25** Post 13p

SONY 8FC 59W SCOOP

DIGITAL AM/FM CLOCK RADIO

Digital Alarm Clock Radio. The digital clock shows you the time minute by minute with matchless accuracy and once set the Digimatic will wake you up at the same time every morning without having to be re-set. The radio section eatures Sony's unique sleep button, you fall gently to sleep lulled by the sweet tone of the radio, which switches itself off at a predetermined time. Available in either black, white or red (8FC-59W). Frequency range 530-1,605KHz (AM); 87-108MHz (FM). Uses 8 transistors and 8 semi-conductors, built-in ferrite aerial and 3½in loudspeaker. Power requirements: 230V AC 50Hz. Dimensions: 12¾in x 3¾in. x 5¼in.

LIST PRICE £30·00

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

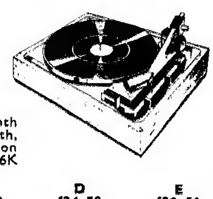
KATONE AM/AIRCRAFT PORTABLE RADIO

BATTERY/MAINS

A combined battery and mains portable of exceptionally attractive design. Housed in a leatherette covered case, size 8½in. x 5¼in. x 3¼in., fitted with an 8-section external telescopic aerial for FM and internal ferrite rod for MW wave bands, and clear easy-to-read dial with logging scale. Wave band coverage is FM 88-108MHz, AM 535-1,600KHz. A highly selective circuit using 9 transistors and 9 semi-conductors operating from either 4 x 1·5 volt torch batteries or direct from 230 volts 50Hz AC house mains, from a built-in mains unit. A socket is fitted for a personal earphone. Easy-to-use silver colour knobs, with "woodgrain" panel enhances the appearance of this fine radio.

LASKY'S PRICE **£9·95** Post 15p

BSR McDONALD MP60



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

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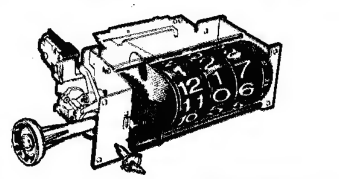

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PRACTICAL WIRELESS

VOL 47 NO 5
Issue 775

SEPTEMBER 1971

TOPIC OF THE MONTH

Electronic Vandals

A NEW generation of vandals is infesting the countryside. The scale of the menace can be judged by a report in *The Times* which says that more than 50 archaeological sites in Britain have been robbed by vandals using metal locators in the "*last three months*". These looters are urged on by irresponsible promptings such as contained in the book *A Fortune Under Your Feet,* which would not have been publicised in the article last month had the editor been aware of passages which recommend amateurs to operate metal locators on established Roman and prehistoric sites. We also condemn remarks made recently in *Coin Monthly* which, in slightly hysterical rhetoric, suggest that "an insignificant group of professional archaeologists" want to stop "those rights and pleasures" (of operating metal detectors). This technique of twisting the facts is as familiar as it is sickening.

This type of rabble-rousing emotionalism, coupled with the stimulation of the greed motive, is a ready incitement to gullible and unprincipled people to abandon whatever vestiges of conscience they may have had. It has led to a situation where our dwindling number of archeological sites are being systematically ravaged. Archaeologists are seriously considering the possibility of not releasing information of newly discovered sites—a sad reflection of the times we live in, since the main objective of such exploration is the dissemination of knowledge.

It is galling also that having developed the skill of scientific and methodical excavation to its modern level, yielding a degree of information hitherto impossible, a process made possible largely by generations of voluntary research, skilled field workers are now confronted by sites irrevocably ruined by zombies whose motivating objectives are simply personal gain. A sad, sordid picture.

There *are* laws to protect important sites and moves are afoot for heavily increased penalties for despoiling archaeological sites. Welcome as this might be, we feel that the problem is more a case of civil conscience than Acts of Parliament. Readers of P.W. can help. Avoid areas where invaluable evidence may be disturbed or destroyed. If a "casual" find looks important, contact your county archaeological society at once—and don't spread the word around; if you have discovered a site of potential importance it will require highly specialised workers and scientific treatment to interpret the findings and to extract the maximum information. This may be impossible for all time if a site is heedlessly disturbed. Moreover, if you are genuinely interested in the advancement of knowledge, coupled with the excitement of glimpses into the past,

—continued on page 418

NEWS AND COMMENT

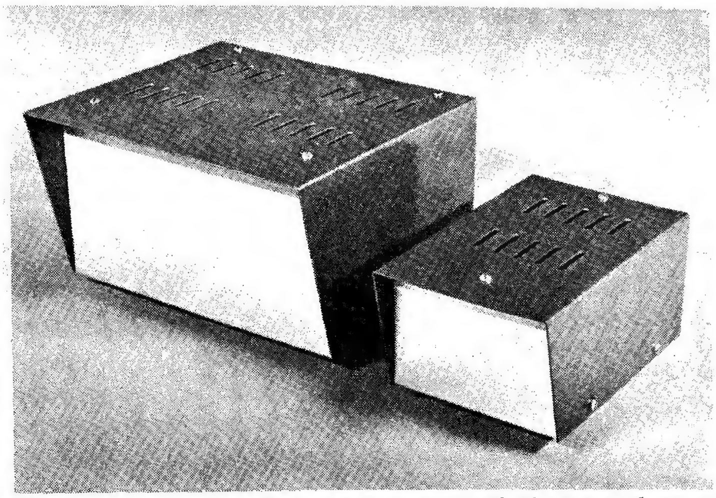
CONSTRUCTIONAL

OTHER FEATURES

OCTOBER ISSUE WILL BE PUBLISHED ON SEPTEMBER 10th

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

Impex instrument cases



The cases shown come in a standard range of 36 sizes and are of 20 s.w.g. steel with a stove enamelled green hammer finish. The passivated zinc-plated steel base is 18 s.w.g.

Detachable front and back panels are of 18 s.w.g. satin anodised aluminium and are designed to lie flat for easy piercing. Phillips screws are used throughout and each case is provided with four rubber feet.

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

Examples of prices are: $2\frac{1}{2}$in. height, $3\frac{3}{8}$in. width and depth of 5in.: £1·13 plus 15p post and packing. A case measuring 5in × $13\frac{1}{2}$in. × 5in. costs £3·19 plus 25p p.&p. and one measuring 5in. × $13\frac{1}{2}$in. × 11in. costs £6·40 with p.&p. charge of 28p.

Further details of prices of these cases, one-off jobs and rack-mounting units may be obtained from *"Impex" McArdle and Brainsby (Import & Export) Ltd., P.O. Box 2BB, Newcastle-upon-Tyne, NE99 2BB.*

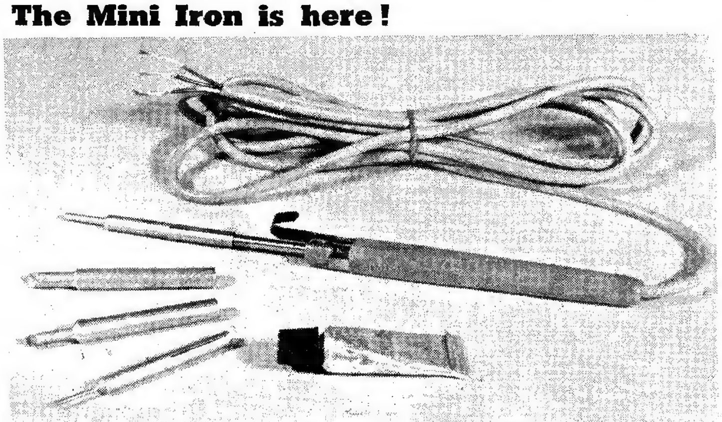
Precision hand press

The "Innovcom" precision hand press can be used for the assembly and dis-assembly of small components and the application of precise pressure to a very small surface area.

Construction is light alloy body with hollow open base, drilled for two screw attachment to bench and drilled beneath chuck to hollow cavity. Link and plunger are of mild steel. Sintered bronze Oilite bushes are oiled for life. Handle length is $7\frac{1}{2}$in. and full handle traverse of $2\frac{1}{2}$in. gives chuck movement of 0·6in. Daylight (clearance) from chuck to platform is 1in. Chuck takes 40 thou wire, nail shaft or rod.

The price is £3·45 postage and packing included and the unit is for UK distribution only. *Innovcom Ltd., Southbank, Daveylands, Wilmslow, Cheshire, SK9 2AG.*

The Mini Iron is here!



The Adamin Model 15 is a miniature soldering iron which comes complete with a set of interchangeable bits and a tube of lubricant. This iron weighs half an ounce less flex but its versatility is by no means "light weight." Used with the interchangeable bits from 0·047in. to $\frac{3}{16}$in. it is suitable for all jobs from minute hearing aid soldering to heavy "chassis bashing."

A 12V version of the iron is also available and the complete hobby pack as shown and priced at £2·30 (p.&p. free) is available from *Light Soldering Developments* at *28 Sydenham Road, Croydon CR9 2LL.*

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

Transensor kit

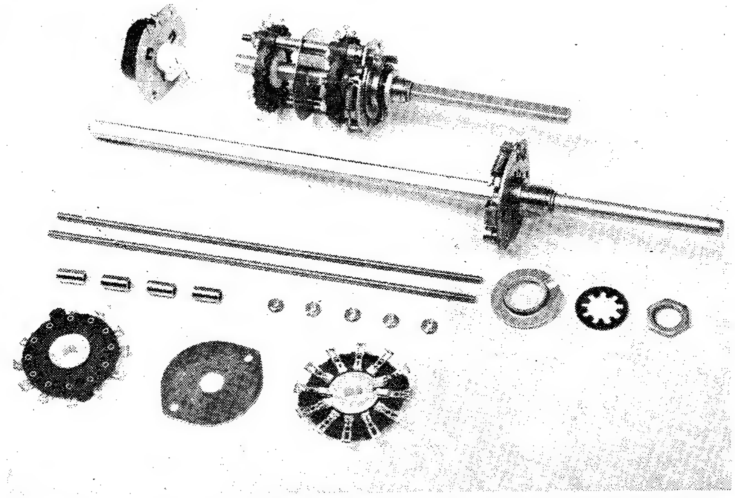
In the February 1971 issue we mentioned the Transensor slide synchroniser, which enables a cassette recorder to be used with an automatic slide projector.

The unit is now available in kit form, enabling it to be fitted by the purchaser to his own cassette tape recorder. The makers claim that some twenty or thirty improved versions of the mono cassette recorder appear on the market every year and as the Transensor S/2 kit is adaptable, it can be transferred from one machine to another as new models are introduced. The price is £18.

One other feature of the Transensor S/2 is that it allows pulses to be introduced and erased independently of the master sound track.

Further information may be obtained by writing to *Audio Visual Picture Enterprises, 17 Abercorn Place, London, N.W.8. or telephoning 01-328-1461.*

Return of the Maka Switch



Constructors who have mourned the loss of the MAKA switch will be delighted to learn that A. B. Electronic Components Limited manufacture a similar, but more versatile switch, which is available from stockists, in kit form. The size is approximately the same as the MAKA, and as can be seen from the illustration consists of a shafting unit with a six inch length shaft, wafers, screens, spacers, studding and a mains switch.

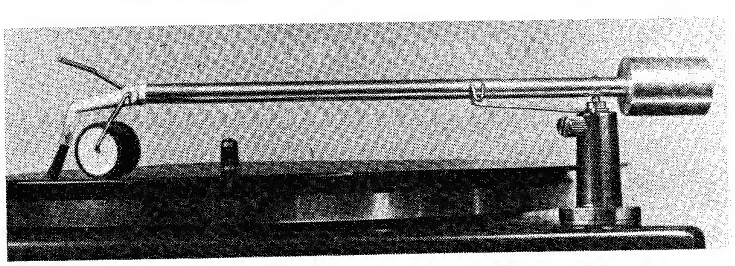
The six inch shaft length will accommodate several wafers, or it may be cut down if only one or two wafers are required. The wafers are available as follows:—"Break before Make"—one pole twelve way; two pole six way; three pole four way; four pole three way; six pole two way. "Make before Break"—one pole ten way; two pole five way.

The metal screens are a feature which have been added. These switch kits are available from these suppliers:—Crescent Radio, 40 Mayes Road, London, N.22; Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey; Servio Radio, 156-158 Merton Road, Wimbledon, London, S.W.19; Garland Bros., Chesham House, Deptford Broadway, London, S.E.8; Radioparts, 5 Market Way, Plymouth, Devon.

Bib auto record cleaner

The Bib Division of Multicore Solders Ltd., Hemel Hempstead, Herts has introduced an automatic record cleaner under the brand name Bib Groov-Kleen Model 40. Resembling a high quality miniature cartridge arm, it is finished mainly in anodised aluminium. The base is supplied with a self-adhesive disc so that it is easily fixed to the player deck. The base has a chromium-plated pivot pillar which can be raised or lowered so that the arm can be adjusted to be parallel with the turntable. The arm, which is cranked to provide better tracking, has a brush at one end and a counterweight at the other. A small roller mounted behind the brush automatically sets its own level. A swivelling arm-rest is provided to hold the arm when a record is being placed on the turntable.

The recommended Retail Price is £2·08 plus P.T. of 51p. *Bib Division, Multicore Solders Ltd., Hemel Hempstead, Herts.*



Derby Rally

The fourteenth annual Derby Mobile Radio Rally will be held on Sunday August 15th, 1971, at Rykneld School, Bedford St., Derby. There will be a band concert, junk sale, prize draw, children's events, trade stands, competitions, demonstrations, ice cream, refreshments, etc. in addition to G3ERD/A on 160 metres and G8DBY on v.h.f.

Admission and parking are free and further details may be obtained from Tom Darn G3FGY, Hon. Organiser, "Sandham Lodge," 1 Sandham Lane, Ripley, Derbys. DE5-3HE. Phone Ripley 2972.

LINEAR Ω METER

J.N.WATT

THE first item of test equipment obtained by most home experimenters is a multi-range testmeter, capable of reading voltage and, probably, current and resistance as well. One large drawback of the ohms ranges is that they are very non-linear, being open at the low end and extremely cramped at the high end, see Fig. 1.

Besides being inconvenient to read, accuracy suffers when measuring values of resistance more than, say, 100kΩ on most instruments. Moreover, increasing resistance is read at the left-hand end, the opposite to the voltage and current ranges.

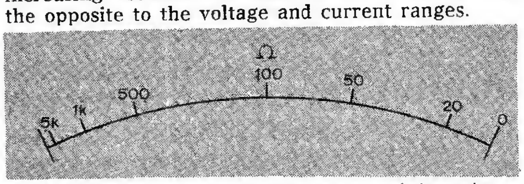


Fig. 1. Illustrating the cramped scale of a normal ohm-meter.

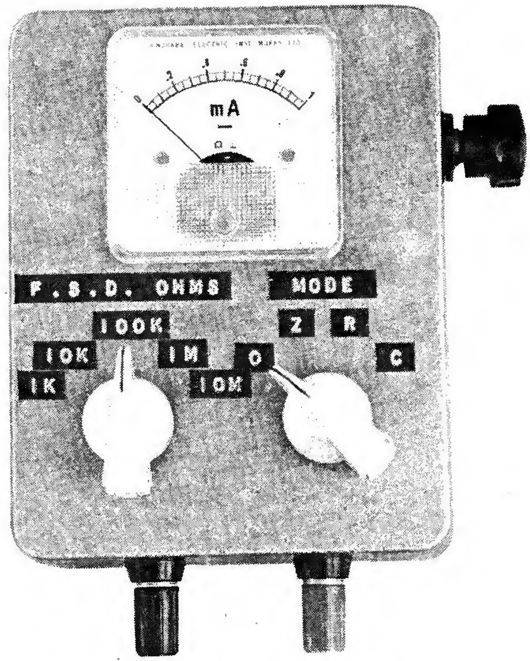
The ohm-meter described here has a linear calibration, with increasing resistance towards the right-hand end of the scale and uses five switched ranges to cover 10MΩ; the lowest value of resistance that can be measured is set by the accuracy with which the meter can be read but is about 100Ω. The possibility of extending this lower end downwards by a factor of 10 is discussed later. The ohm-meter is self-contained, although external batteries and an external moving-coil meter could be employed.

As a bonus, the form of circuitry used lends itself to adapting the instrument to test capacitors as well. Their value can be read and an indication is given of their insulation resistance i.e. leakage. The range of capacitors that can be tested in this way is about 0·1μF to 10,000μF, including electrolytics, but excluding those of less than about 8 volt rating, unless precautions are taken (see later for further details on this point.)

PRINCIPLE OF OPERATION

The principle of operation of the linear scale ohm-meter is illustrated in Fig. 2. A constant current is sent through the unknown resistance, R_X. Now, by Ohm's Law:—

$$R_x = \frac{E}{I}$$



so that if I is constant:—

$$R_x \propto E$$

and a measure of E is a measure of R_X. Thus if a linear scale voltmeter can be arranged to read R_X, this also will be read on a linear scale.

To measure capacitance, use is made of the relationship

$$Q = VC$$

Charge Q is current x time, so

$$VC = It$$

$$\text{or } C = \frac{It}{V}$$

Remembering that C is in farads and I is in amperes, a current of 1μA flowing into a capacitor C for 10 seconds and producing a rise in potential of 10 volts means that C has a value:—

$$C = \frac{10^{-6} \times 10}{10}$$

$$= 1\mu F$$

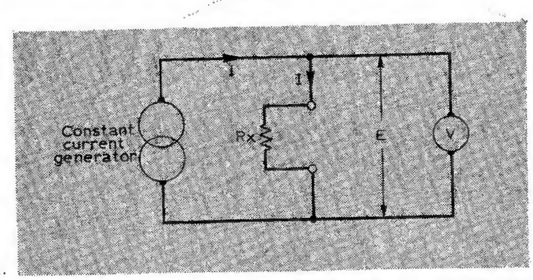
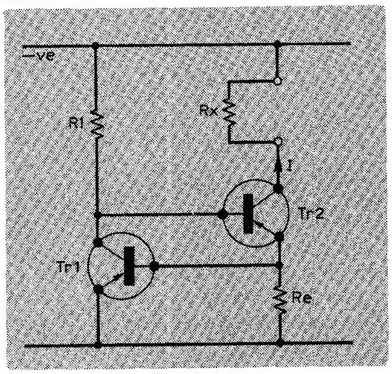


Fig. 2. Circuit to demonstrate the principle of the linear scale ohm-meter.

Similarly, 10μA for 10 seconds and a rise of 10 volts means that a capacitor of 10μF was connected, and so on.

Actual values of current used and voltage monitored are different from these examples but the principle is exactly the same.

Two difficulties now present themselves. How can we generate a constant current? How can we measure E on the voltmeter without upsetting the circuit? Remember that simple voltmeters, based on a moving coil meter and series resistors must draw some current to function at all. This latter point is best illustrated by example.



◀ *Fig. 3. Circuit of a constant-current generator.*

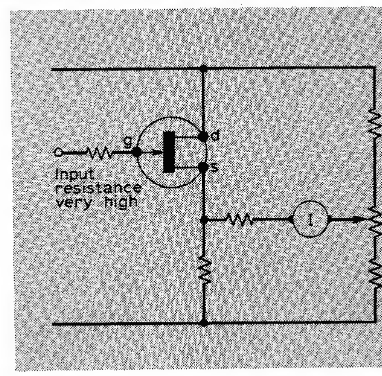


Fig. 4. Basic circuit of a very high impedance input voltmeter using an FET. ▶

Suppose R_X is 1MΩ and we have a 100μA meter, which requires 100kΩ in series to read as a 10 volt f.s.d. voltmeter; if this were placed in parallel with R_X, as in Fig. 2 then obviously it would shunt the 1MΩ to a considerable extent, and give a false reading.

To deal with the point first raised, that of generating a constant current, consider the circuit of Fig. 3. The base-emitter voltage of Tr1 is virtually constant at about 0·7 volt for a silicon transistor; hence the voltage drop across R_e is similarly constant. With a constant voltage across R_e, a constant current must flow to the emitter of Tr2 and hence, if Tr2 has a high enough current gain for base current to be ignored, a constant current will flow at Tr2 collector. This will remain so, no matter if the value of R_X varies, due to the negative feed-back loop between Tr2 base and Tr1 collector, which functions as follows.

Suppose, for any reason, I increases. Then the voltage developed across R_e will increase, and so therefore will the base current of Tr1. The resultant voltage drop at Tr1 collector will tend to reduce the base current of Tr2 and hence also reduce its emitter current, so counter-acting the original increase.

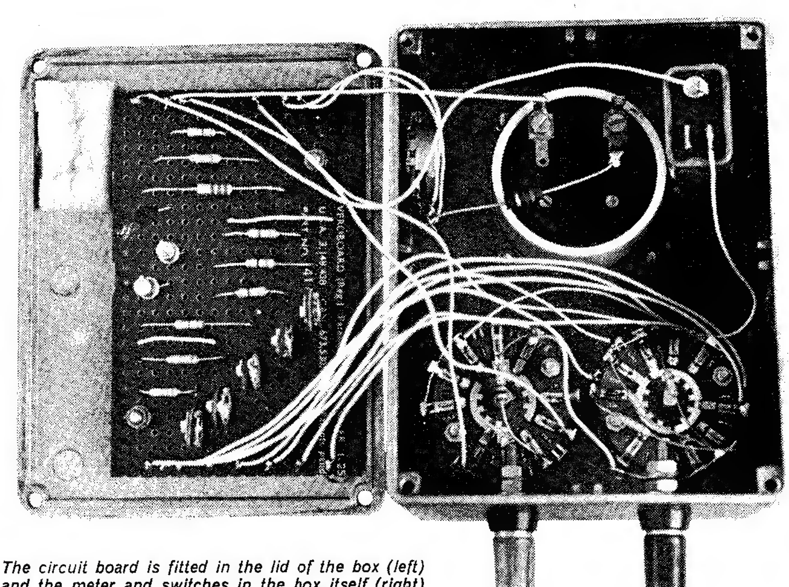
The actual value of constant current is set to that required by adjusting the value of R_e, and also by making some broad adjustment to R1. A value for R1 suitable for 1μA is no longer so when, say, 10mA is required, and so some changes in R1 are called for.

While any desired current can, in theory, be derived, obviously there are practical limitations. At the upper end dissipation in the transistors will be the deciding factor; note that maximum transistor dissipation occurs when R_X is at its lowest value, for then, for a given (constant) current, the voltage across the transistor Tr2 is greatest.

The lowest current that can be set up is limited in two ways. Adequate current gain must be available and the desired current must be large compared to the leakage current.

In the practical circuit, a lowest current of about 0·7μA is used; a BCY71 has a current gain of about 40 at this level, while leakage current is quoted as 0·05μA maximum. Should a substitute transistor be used, constructors must ensure that it is suitable from these points of view. No germanium device is likely to be a practicable substitute; BC179, BCY70 and BC157 should prove to be reasonable alternatives.

With a constant current flowing through R_x we now require a high impedance voltmeter to measure the voltage



The circuit board is fitted in the lid of the box (left) and the meter and switches in the box itself (right) Compare with Fig. 6.

drop across R_x, so giving its resistance value.

An FET seems to be called for and the ready availability of these devices at reasonable prices makes one the obvious choice.

Many circuits of high impedance voltmeters using FETs have appeared in the technical press but the one used here is based on a simple configuration published by Mullard Ltd., see Fig. 4.

The FET is arranged as a source follower; its source voltage is compared with a voltage derived from a potential divider. The series resistor in the gate circuit gives some protection against unwanted transients, which could damage the gate-source junction, by limiting the gate current. The input resistance of the circuit of Fig. 4 is many tens of megohms; in point of fact, the author was unable to measure it, it was so high—just what we require.

PRACTICAL CIRCUIT

The full circuit diagram now becomes as in Fig. 5, which includes the necessary switching.

One pole of S1 selects different emitter resistors for Tr2, consisting of a fixed and small variable in series, and this is the range switching. The other pole of S1 switches in one of three different resistors, to cover the five decades, for Tr1 collector load.

With S2 in the "Z" position, R9 is connected from the FET gate to supply negative, so permitting zero setting of the meter to be done by means of VR6. This done, and with the test resistor connected, when S2 is moved to position "R", the value of the resistor is displayed on a linear scale. This means that, for example, on the 10kΩ range, a reading of 0·7mA is to be taken as indicating 7kΩ, a reading of 0·35mA, 3·5kΩ and so on.

★ components list

Resistors:

R1	68Ω	R6	6·8kΩ	R11	4·7kΩ
R2	680Ω	R7	68kΩ	R12	2·7kΩ
R3	6·8kΩ	R8	680kΩ	R13	680Ω
R4	68kΩ	R9	1kΩ	R14	2·2kΩ
R5	680kΩ	R10	68kΩ		

All ¼W 10%

VR1 100Ω miniature pre-set
VR2 1kΩ ,, ,,
VR3 10kΩ ,, ,,
VR4 100kΩ ,, ,,
VR5 1MΩ ,, ,,
VR6 4·7kΩ (or 5kΩ) carbon potentiometer

Semiconductors:

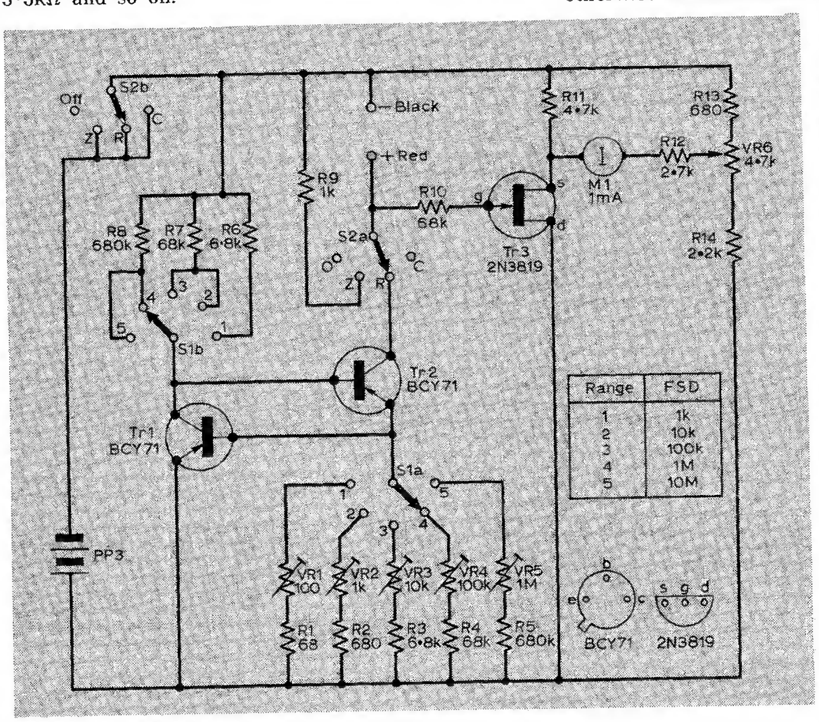
Tr 1 BCY71 Tr 2 BCY71 Tr 3 2N3819

Miscellaneous:

S1, 2 pole 5-way wafer switch. S2, 2 pole 4-way wafer switch. M1, 0-1mA moving coil meter. Diecast box 4¾ x 3¾ x 2¼in. Veroboard 0·15in matrix. Terminals, red and black. Knobs, PP3 battery, etc.

For testing capacitors, the capacitor is connected with S2 at "Z", whence R9 removes any charge on the capacitor, and, after setting of zero as before, S2 rotated to "R" for either 10 seconds or until the meter reads f.s.d. Further rotation of S2 to "C" holds the reading and enables an assessment of capacitor quality to be made; see later under 'Capacitor evaluation'.

The second pole of S2 is the supply on/off switch. Note that S2b **must** be a make-before-break switch, otherwise the instrument will be switched off between positions of S2 and this would invalidate any capacitor measurements. Should such a switch not be available, then S2b should be replaced by a small toggle or slide switch mounted conveniently; S2a can be the more usual break-before-make type.



Range	FSD
1	1k
2	10k
3	100k
4	1M
5	10M

Fig. 5. Complete circuit of the linear ohm-meter, with transistor lead-out connections.

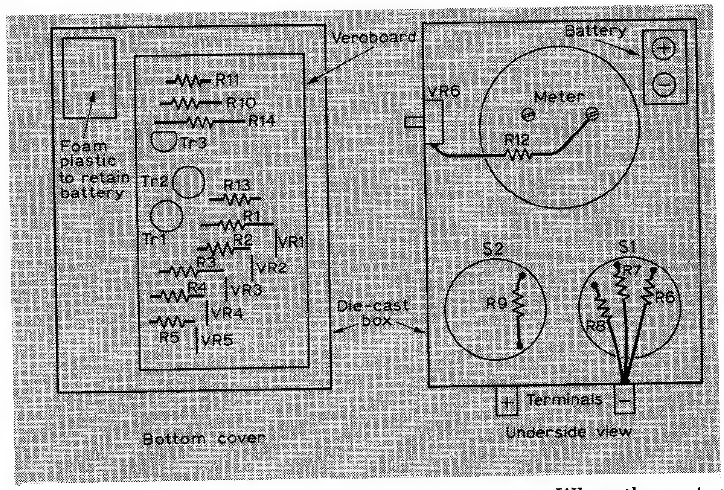
CONSTRUCTION

Having dealt with the basic theory and circuit of the linear scale ohm-meter, we can turn to constructional details.

The photographs and drawing show the layout of the prototype, which was housed in a die-cast box.

Most of the components are mounted on a piece of 0·15" pitch veroboard which is in turn mounted

Fig. 6. Suggested layout of components with the circuit board in the lid of the die-cast box.



on the inside of the box cover, using nylon nuts as insulated spacers. Connections to the switches, meter, battery and terminals are made via veropins. The small pre-set variable resistors, VR1 to VR5 are 0·1 watt components intended for 0·1″ pitch veroboard, but, by a slight bending of the terminal tags can be made to fit the board used.

A suggested layout is given, Fig. 6, but if for any reason the constructor wishes to alter this in any way, then this is in order.

The dimensions of the box used will depend on a number of factors. The meter is the most important of these; in the prototype the meter was one 2in. square. Although this may seem rather small, it is still capable of being read to about 2%, which is better than the accuracy with which the instrument can be set up by most constructors; it is also about the limit of accuracy of the meter movement itself.

A meter of such a size enables a box of $4\frac{3}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$in. to be used, provided reasonable care is taken in the choice of components.

The rotary switches shown are of $1\frac{1}{2}$in. diameter and so can be accommodated comfortably, while a PP3 9 volt battery is simply fitted by clamping it, in a vertical position, between the box and its cover. Two scraps of foam plastic, one at each end of the battery, prevent it from moving and at the same time provide insulation for its terminals. Connection to these is by soldering wires directly to them, there being no room for the usual snap connector. Since the whole instrument draws only 3 mA, plus any test current, a PP3 should last a very long time if the unit is switched off when not actually in use, and thus solder connections to the battery are no great disadvantage.

With wiring up completed, check that the voltmeter section is functioning correctly by switching S2 to "Z" and seeing that VR6 enables the meter to be brought to zero.

Actual setting up of the emitter resistors of Tr2 by means of VR1 to VR5 can only be done by making use of known values of resistance. However, even just the loan of resistors of 2% accuracy will suffice, while 5% resistors can be bought quite cheaply. Values required are 10MΩ, 1MΩ, 100kΩ, 10kΩ and 1kΩ.

Start with range 1 and fit the 1kΩ to the terminals; with S2 at "R" adjust VR1 to give a reading of 1mA on the meter. Repeat on the other ranges, using the appropriate resistors, and remembering to put S2 to "Z" before removing resistors.

CAPACITOR EVALUATION

Measurement of the value of medium to large capacitors and an indication of their leakage resistance can be considered as a bonus with the ohmmeter but can be omitted if desired.

Demonstration of this mode of use can best be carried out using a 1μF paper capacitor. With S1 on range 5 and S2 at "Z", connect the capacitor and then put S2 to "R". Note that the meter reading slowly increases at a constant rate. When the meter reads 0·8mA or so, switch to "C"; the unit is now reading the voltmeter that was developed across the 1μF by the constant current which flowed into it on "R", and if the meter reading stays constant, or almost so, then the 1μF capacitor is a good one. The implication is that the voltmeter input resistance is very many megohms and hence is extremely difficult to measure.

With this confirmation that the 1μF capacitor is a good, low leakage specimen, it is now an easy matter to measure its actual value.

First, put S2 back to "Z", so discharging the capacitor by means of R9. Then, switch S2 to "R" and commence timing, either by stop watch or a sweep second hand on a watch or clock. When 10 seconds have elapsed, or the meter reads f.s.d. which ever is the sooner, switch S2 to "C", noting the elapsed time if less than 10 seconds.

If, after 10 seconds, the meter reads 1mA, then the capacitor was exactly 1μF. A meter reading of, say, 0·8mA after 10 seconds indicates a value of

$$\frac{1}{0{\cdot}8} \times 1 \text{ or } 1{\cdot}25\mu\text{F and so on.}$$

On the other hand, if 1mA was reached after only 7 seconds, then the capacitor was

$$\frac{7}{10} \times 1 \text{ or } 0{\cdot}7\mu\text{F}$$

Whether the capacitor is actually larger or smaller than the 1μF corresponding to f.s.d. on range 5 is easily remembered by recalling that a large value capacitor will take longer to reach a given voltage at a given constant current than will a small value capacitor.

The values of capacitance corresponding to each position of S1 and 10 seconds for meter f.s.d. are as follows:—

RANGE	RESISTANCE	CAPACITANCE
1	1kΩ	10,000μF
2	10kΩ	1,000μF
3	100kΩ	100μF
4	1MΩ	10μF
5	10MΩ	1μF

Electronotes..

S. GINSBERG

WHEN someone takes an accepted practice and does exactly the opposite the results are often astounding. This has been the case in the Siemens Laboratories in Berlin. Ever since the electron microscope has been invented, everyone has employed it to peer at the most minute items, relying on the microscope, with its tremendous magnification, to give a clear and detailed image. Siemens decided it was time to try things in reverse, rather like looking through the other end of a telescope. The result is that just as the items could be magnified by very large amounts they can also be reduced. This means that it is possible to put the whole of the contents of the Bible on an area of some 0·25×0·25mm. Think of the idea as a means of storage. Around 1,000 Bible-length volumes could be stored, ready to be read by looking at them through the electron microscope the "right way", in an area of 25 square millimeters. Scotland Yard might well be interested since it is possible to store one million photographs on a piece of foil 5×5mm. They'll be fingerprinting fleas next.

Valve enthusiasts, certainly those interested in generating r.f., have wagged their wise old heads for years at the transistor lovers and pointed out that when it comes to generating lots of power, the solid state devices available just aren't in the same class as their glass-encapsulated brothers. It now looks as though this is no longer true. One company has announced an h.f. amplifier which is broadband from 1·5—30MHz and thus requires no tuning. It is solid state—not a valve in sight—and will supply 1kW on all modes of radiotelegraph and radiotelephone transmissions. For the 1,000W output, which, by the way, is the continuous rating, it requires only 100mW input. The amplifier is not a delicate device. A patented level control will prevent any damage which might be caused by an antenna mismatch which can range from an open circuit to a short circuit.

Hats off to the Allen Company in America. They are making an electronic organ which uses a computer to provide tones and voices. The 22 circuits on chips half-an-inch square contain some 48,000 transistors. The various waveforms and tones are simply stored in the musical computer's memory and called out or "read" at will. The number of voices available are almost unlimited, running into millions. The electronics for the computer have been worked out in association with another American company—North American Rockwell who have done a great deal of work on aerospace digital computers.

It is essential to observe polarity when testing electrolytic capacitors.

Should these be of a very low voltage rating i.e. less than, say, 8 volts, then do not allow the meter reading to rise above about half scale. This will restrict the voltage on the capacitor to a low level. Using a charge time of 5 seconds in lieu of 10 seconds, then a meter reading of 0·4mA indicates a capacitance of

$$\frac{1}{0{\cdot}4} \times 5 \text{ or } 1{\cdot}25\mu F$$

To sum up, the value of capacitance is, in general:

$$C_x = \frac{1}{I} \times \frac{t}{10} \times C$$

where I is meter reading in mA
t is time to reach that reading
C is capacitance given in the table.

A little practice with capacitors of known value will soon make this method clear.

It is always as well to carry out a quick check first on doubtful capacitors to test for leakage. If leakage is taking place, as indicated by a falling meter reading on "C", then any capacitance values read off will of course be in error, for some of the current fed to the capacitor will have gone towards providing the leakage current and the voltage reached will thereby be less.

Whether the amount of any leakage so detected can be tolerated will depend on the application intended and no general rules can be laid down.

NOTES

If a multi-range current meter is available, it is quite instructive to use it to measure the test current on each range. No matter whether, say, on range 3, 100kΩ or a short circuit is connected, then about 60μA should flow, and, similarly, with other currents on other ranges as appropriate. The actual value of the current depends on the particular setting of the appropriate emitter resistor.

In the introduction, mention was made of the possibility of extending the lowest range of resistance measurement downwards by a factor of 10. If carried out, this would make the lowest range indicate up to 100Ω with a good indication down to 10Ω. This is not possible, however, without some alteration of transistor type.

A range of 100Ω f.s.d. requires a constant current of about 60mA and so a possible dissipation in Tr2 of about 600mW, which is too great for the BCY71 specified.

A glance at some manufacturers' data shows that a number of suitable transistors are available, such as BFX88, 2N1132 and 2N4036 and no doubt others. Not all of these have a low enough leakage current however, to enable them to give good results on the 10MΩ range and it would be as well to omit this latter if the 100Ω range is incorporated.

The author regrets that he can give no further practical details, not having tried a low resistance range; what is obvious is that a larger battery, or a small mains supply, will be needed to provide the extra current required. The care that will be called for in use should not be overlooked, for up to 600mW might be dissipated in the test resistor, and consequently testing will have to be restricted to resistors of that wattage rating or greater. ■

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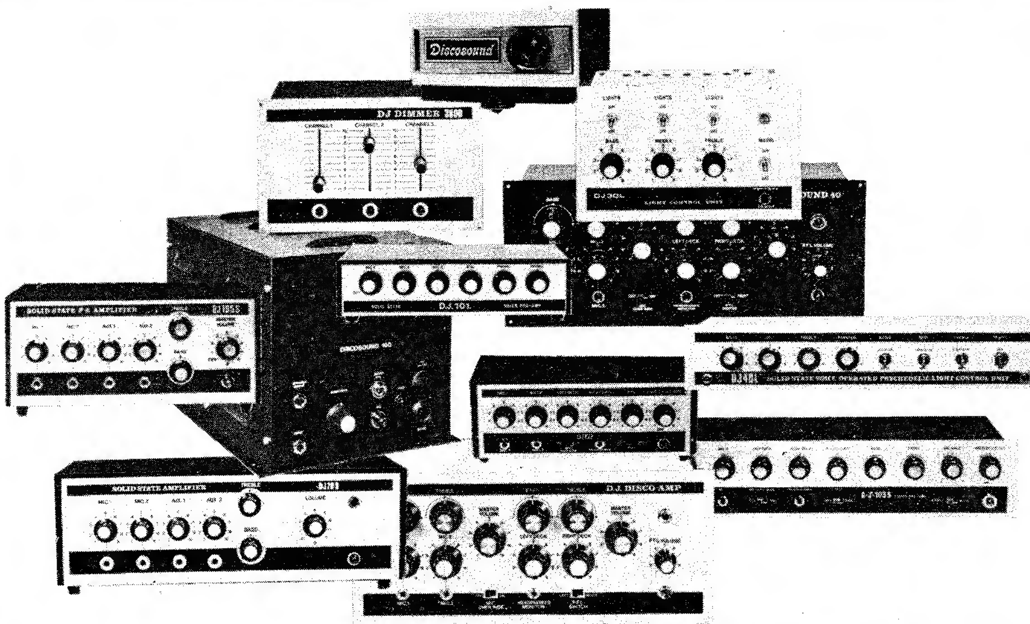

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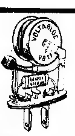

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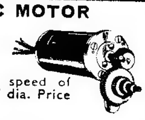

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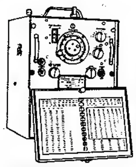

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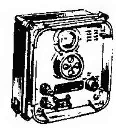

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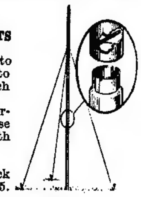

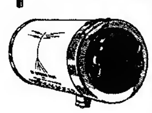

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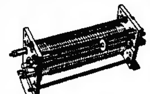

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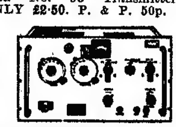

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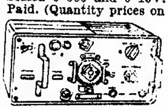

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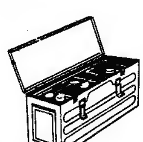

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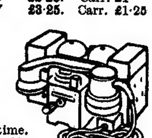

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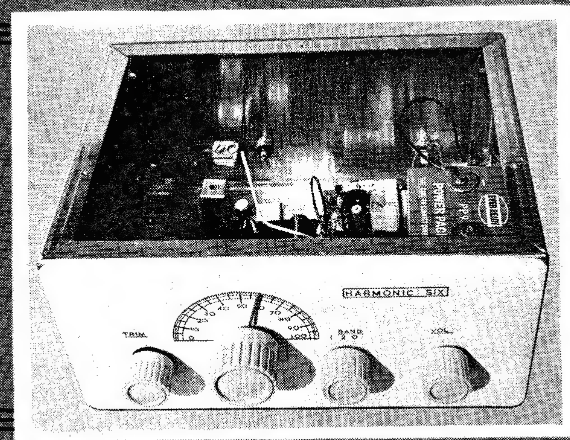

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The receiver is constructed in three sections, mixer, i.f. amplifier and audio amplifier, accommodated in a neat aluminium case which also takes the battery. A separate speaker is used, because headphones may sometimes be preferred, allowing personal short wave reception without disturbance to others.

CIRCUIT DETAILS

Mixer. Fig. 1 is the circuit which also shows the division into three parts. The mixer assembly is complete with tuning capacitor, band-switch, coils and other items, having a small sub-panel for the controls.

L1 is the aerial coil for the higher frequency range of about 11-22MHz, while L2 is for about 5·5-11MHz. S1 selects the wanted coil. Base coupling windings for Tr1 are in series, and thus require no switching.

L3 is the oscillator coil, the values of C6 across the coil and C7 in series with the oscillator tuning capacitor VC2 allowing this circuit to tune from approximately 6MHz to 11·5MHz. When L2 is in

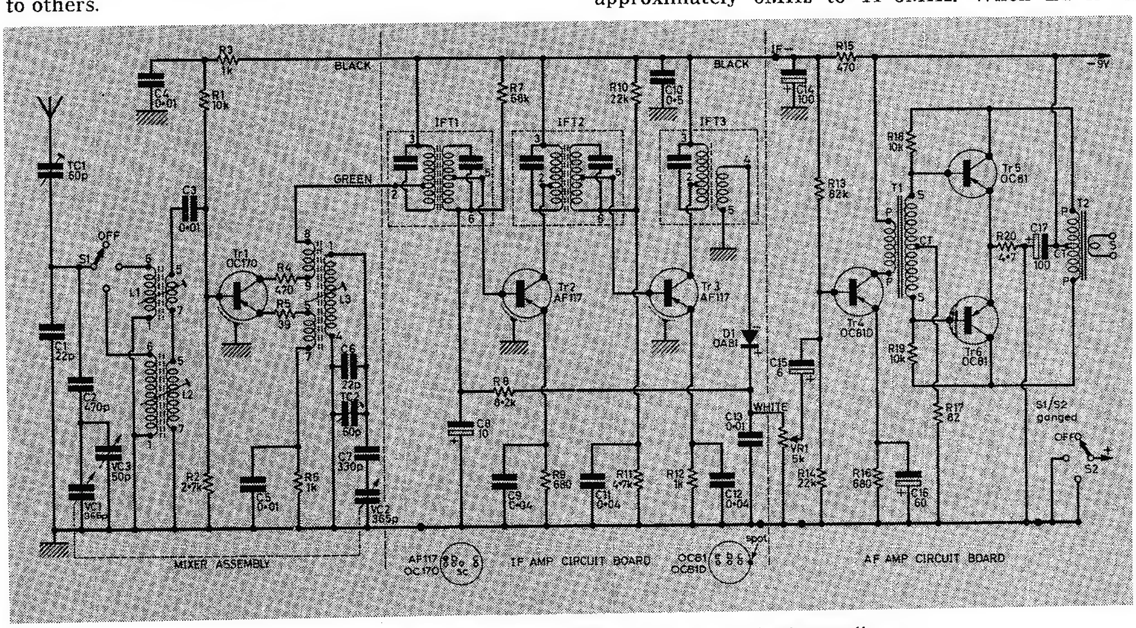

Fig. 1: Circuit diagram of the Harmonic Six with transistor lead-out connections.

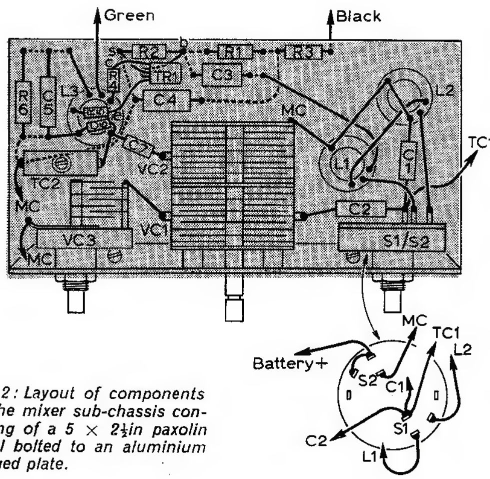

Fig. 2: Layout of components on the mixer sub-chassis consisting of a 5 × 2½in paxolin panel bolted to an aluminium flanged plate.

circuit, VC1, in conjunction with C1 and C2, allows the aerial section to tune from approximately 5·5-11MHz. In terms of actual frequencies, the oscillator is 465kHz h.f. of the aerial circuit, in the usual way.

To reduce oscillator pulling, some transistor receivers have the oscillator working at half frequency, for the highest frequency range. This is purposely done in this receiver, so that no switching, or further coil or trimmer will be needed instead of L3. Instead, the second harmonic of the oscillator frequency is used, and the range of this harmonic is approximately 12-23MHz. L1 is in circuit for this band, and tunes 465kHz lower in frequency than the second harmonic, or about 11·5-22·5MHz. There is actually a little overlap between bands, giving continuous coverage from about 5·5-22MHz.

The receiver can bring in many transmissions with a short indoor aerial, either wire, or self-supporting rod, and the aerial trimmer VC3 is a panel control, so that L1 or L2 can be peaked for maximum results, despite changes to the aerial.

Resistors R4 and R5 are to avoid excess oscillation, which sometimes causes whistles and other troubles on the higher frequencies. In some cases it may be worth while modifying the values of R4 or R5, as mentioned later.

The mixer assembly is secured in the case by the bushes of VC3 and S1, this completing the positive or earth return. Two leads run from the mixer assembly—black for the negative supply circuit, and green for the i.f. amplifier.

IF Circuit. This board carries i.f.t.1, i.f.t.2, i.f.t.3, Tr2, Tr3, and the associated components. It is wired separately, and may be checked or tested alone. Two double-tuned i.f.t.'s with AF117's give very good gain and selectivity. Automatic gain control bias is obtained from the diode D1 in the usual way.

The positive circuit of the i.f. board is completed by its two mounting bolts, through the metal case. Audio output is from D1, the white lead running to the volume control VR1.

VR1 is fixed to the case front and so is not present on either i.f. or a.f. boards.

AF Amplifier. Audio signals are taken to the audio amplifier and driver Tr4, which is followed by the push-pull output pair Tr5/6. This is a straightforward arrangement capable of giving a good output, and it is wired complete on its own circuit board. Positive returns are made through the fixing bolts and metal case, as before.

S2 is the second pole of the switch S1, which is 3-way. The third position interrupts the positive circuit for "OFF." Should an on-off switch be preferred on VR1, it is necessary to fit a compact potentiometer with switch, or there will not be enough space for a PP9 battery in the receiver.

A connecting point is provided at the junction of C14 and R15 for the black lead from the i.f. board.

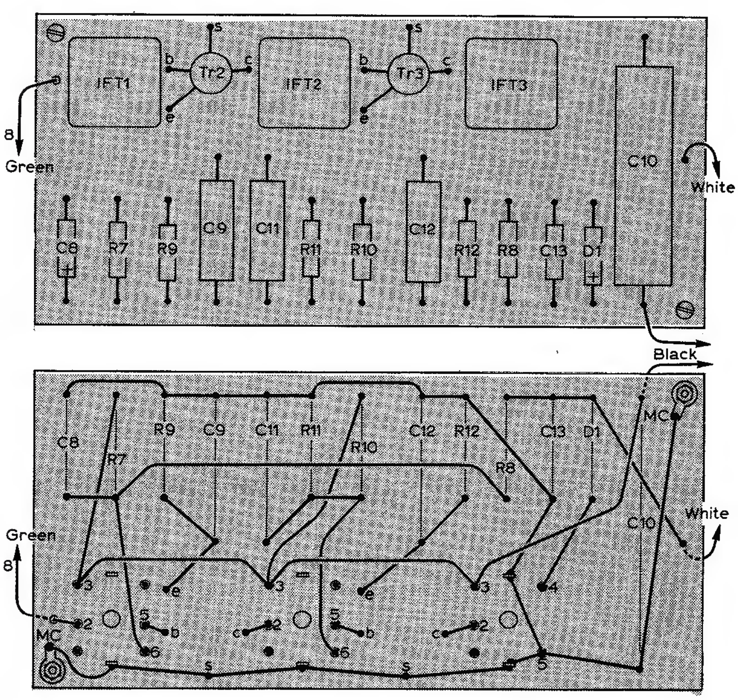

Fig. 3: Component layout and wiring details of the i.f. circuit board 3¾ × 1¾in.

CONSTRUCTION

Mixer Assembly. Components are placed as in Fig. 2. Holes are made in the 5 x 2in. flanged plate for the variable capacitors and switch. Washers or other means of spacing, about ⅜in. thick, are put between the plate and ganged capacitor, on each of the three fixing screws. It is essential that these screws are not too long.

Two bolts hold the insulated board to the flanged plate. Wire

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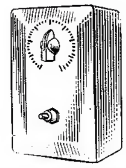

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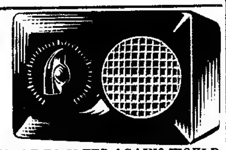

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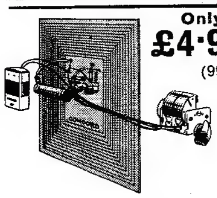

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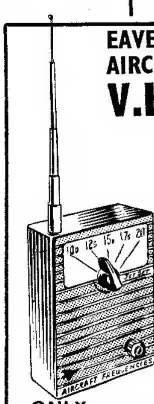

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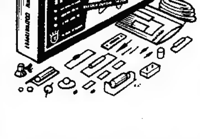

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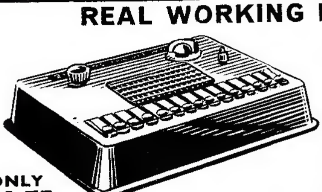

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ACY40	15p
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AD149	50p
AD161	37p
AD162	37p
AF114	25p
AF115	25p
AF116	25p
AF117	25p
AF118	62p
AF124	25p
AF125	20p
AF126	17p
AF127	17p
AF139	30p
AF178	47p
AF179	65p
AF180	52p
AF181	42p
AF186	40p
AF239	40p
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ASY27	32p
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BC116A	30p
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BC119	35p
BC134	25p
BC135	20p
BC136	22p
BC137	25p
BC138	25p
BC147	17p
BC148	12p
BC149	20p
BC154	37p
BC157	20p
BC158	17p
BC159	20p
BC169C	15p
BC177	25p
BC178	25p
BC179	27p
BC182L	12p
BC183L	12p
BC184L	15p
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BCY72	15p
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7474	Dual O type Flip-Flop	43p	40p	37p	33p
7475	Quad latch	47p	45p	43p	40p
7476	Dual J-K with pre-set and clear	47p	45p	43p	40p
7480	Gated Full Adders	87p	77p	67p	60p
7481	16-bit read/write memory	£1·35	£1·25	£1·15	£1·00
7482	2-bit Binary Full Adders	£1·30	£1·20	£1·00	85p
7483	Quad Full Adder	87p	77p	67p	60p
7486	Quad 2 input Exclusive OR Gates	80p	70p	60p	50p
7490	BCD decade counter	87p	77p	67p	60p
7491	8-bit Shift Registers	£1·21	£1·00	87p	75p
7492	Divide-by-Twelve Counters	87p	77p	67p	60p
7493	4-bit Binary Counters	87p	77p	67p	60p
7494	Dual entry 4-bit shift register	87p	77p	67p	60p
7495	4-bit up-down shift register	87p	77p	67p	60p
7496	5-bit Parallel in parallel out Shift Register	87p	77p	67p	60p
74100	8-bit Bistable Latches	£1·75	£1·65	£1·65	£1·35
74118	Hex Set-Reset Latches	£1·30	£1·20	£1·00	85p
74121	Monostable Multivibrators	87p	77p	67p	60p
74141	BCD-to-Decimal Decoder/Driver	87p	77p	67p	60p
74145	BCD-to-Decimal Decoder/Drivers	£1·80	£1·70	£1·60	£1·50
74151	8-bit Data Selectors (with Strobe)	£1·40	£1·30	£1·20	£1·05
74153	Dual 4-Line-to-1-Line Data Selectors/Multiplexers	£1·40	£1·30	£1·20	£1·05
74191	Binary Counter reversible	£3·50	£3·25	£3·00	£2·50

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

SILICON RECTIFIERS

1 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS

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

1.5 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS

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

3 AMP PLASTIC WIRE ENDED RECTIFIERS

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

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

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

INTEGRATED CIRCUITS

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

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BZY 88 Range. All voltages 3·3–33 Volt. **15p** each.
25+ **12p**; 100+ **10p**; 500+ **8p**; 1000+ **6p**. Any one type.

1½ Watt 5% Metal case. Wire Ends.
6·8V. all voltages to 100V. **25p** each.
25+ **22p**; 100+ **19p**; 500+ **17p**; 1000+ **15p**. Any one type.

3 Watt Plastic Wire Ends 5%
All voltages 6·8–100V. **30p** each.
25+ **27p**; 100+ **25p**; 500+ **23p**; 1000+ **21p**. Any one type.

10 Watt Stud Mounting 5%
All voltages 5·1–100V. **40p** each.
25+ **37p**; 100+ **35p**. Any one type.

TRIACS

(All stud mounting)

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

DIAC ST2 20p
Larger quantity prices Extn. 4

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AF114 Mullard **25p**
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100 + 17p
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AF115 Mullard **25p**
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100 + 17p
500 + 15p

AF116 Mullard **25p**
25 + 20p
100 + 17p
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AF117 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p

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

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

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

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

AF139 **30p**
Siemens V.H.F.
25 + 25p
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AF186 **40p**
Mullard V.H.F.
25 + 35p
100 + 30p
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OC170 Mullard **25p**
25 + 21p
100 + 17p
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BYZ13 **25p**
Mullard 6a 200v
25 + 20p
100 + 17p
500 + 15p

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

BC107, BC108, BC109 **12p** each
I.T.T. Planars
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100 + 10p
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BY127 Mullard **20p**
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100 + 15p
500 + 13p

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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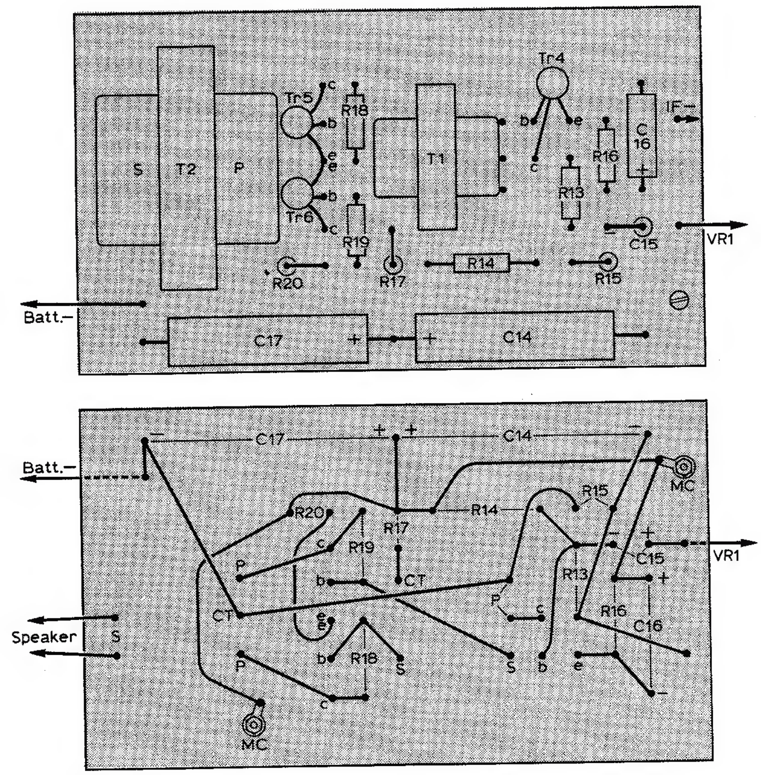
Fig. 4: Wiring and layout of the audio amplifier board, $3\frac{1}{2} \times 2$in.



up as in Fig. 2, keeping all leads in this section short and direct. The metal flanged plate is the positive or chassis return, a tag being put under one fixing nut. Solder a black flexible lead to R3.

Tr1 is suspended by its wire ends about level with the top of L3 while trimmer TC2 is mounted on the paxolin by its tags.

IF Board Wiring. Fig. 3 shows both top and bottom of this panel. Holes are drilled so that the pins and can fixings tags on the i.f.t.'s are placed as shown. A central hole is required under the i.f.t.'s for trimming.

Two $\frac{1}{2}$in. 6BA bolts secure the tags MC. Later, extra nuts are put on these bolts, which pass through the metal case, forming the positive or chassis return.

Guide lines are scribed on the paxolin and holes for resistors and other leads made with a 1/16in. or 5/64in. drill. The i.f.t.'s, resistors and capacitors are then inserted. Note the polarity of C8 and D1. The board is then turned over, and wired as shown. Use insulated sleeving on all leads which cross. Joints are kept against the board so that they will not touch the metal of the case.

Before inserting the transistors, it is helpful to put pieces of 1mm coloured sleeving about $\frac{3}{8}$in. to $\frac{1}{2}$in. long on the leads—blue for emitter, green for base, and orange for collector, leaving the shield wires bare. Then position the leads as shown in Fig. 3, solder them and snip off excess.

For easy identification of external connections, solder on a green lead for pin 2 of i.f.t.1, a black lead for the negative line, and a white lead from D1 positive.

Audio Amplifier Wiring. Fig. 4 shows both sides of the a.f. amplifier. Tags MC are tightly bolted as before, for chassis return points. All the capacitors are electrolytic, so have to be placed as shown.

T1 is the driver transformer but note that various makers place the tags in different positions. In Figs. 1 and 4, P-P are the primary, S-S the secondary, and CT the secondary centre tap. These connections must be correct for the actual transformer used.

T2 is the output transformer, with primary connections P-P and primary centre tap CT. Two thin flexible leads are soldered to the secondary tags S which run to the speaker (or phones) jack.

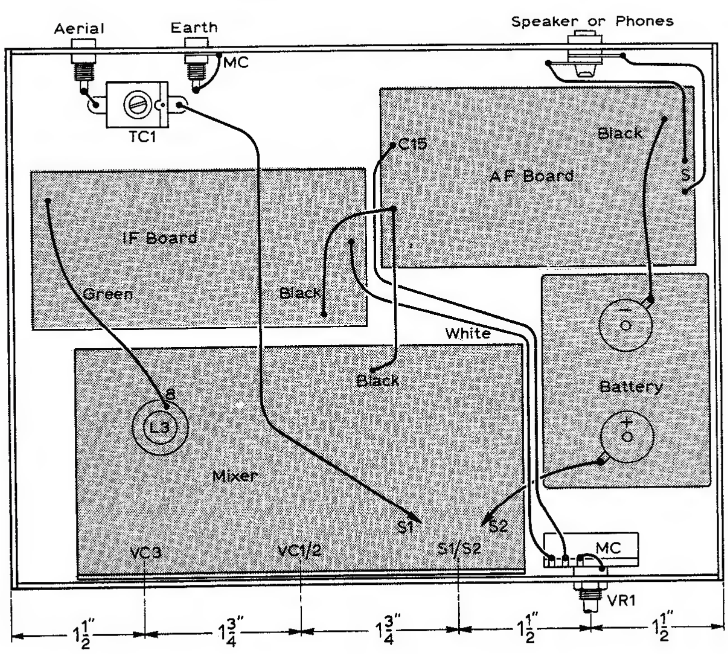


Fig. 5: Disposition of the three boards inside the cabinet.

★ components list

Resistors:

R1	10kΩ	R6	1kΩ	R11	4·7kΩ	R16	680Ω
R2	2·7kΩ	R7	68kΩ	R12	1kΩ	R17	82Ω*
R3	1kΩ	R8	8·2kΩ	R13	82kΩ	R18	10kΩ*
R4	470Ω	R9	680Ω	R14	22kΩ	R19	10kΩ*
R5	39Ω	R10	22kΩ	R15	470Ω	R20	4·7Ω

All ¼W 10% except those marked * 5%
VR1 5kΩ potentiometer, log.

Capacitors:

C1	22pF SM	C7	330pF SM	C13	0·01µF tub.
C2	470pF SM	C8	10µF 6V	C14	100µF 12V
C3	0·01µF tub	C9	0·04µF tub.	C15	6µF 6V
C4	0·01µF tub	C10	0·5µF tub.	C16	60µF 6V
C5	0·01µF tub	C11	0·04µF tub.	C17	100µF 12V
C6	22pF SM	C12	0·04µF tub.		

VC1/2 365 + 365pF 2-gang Type OO slow motion (Jackson)
VC3 50pF miniature airspaced variable (Jackson)
TC1 60pF trimmer TC2 60pF trimmer

Inductors:

L1 Range 5 'Blue'
L2 Range 4 'Blue'
L3 Range 4 'Red'
} Denco miniature type for transistors.

IFT1 Type 18/465
IFT2 Type 18/465
IFT3 Type 14/465
} Denco

Semiconductors:

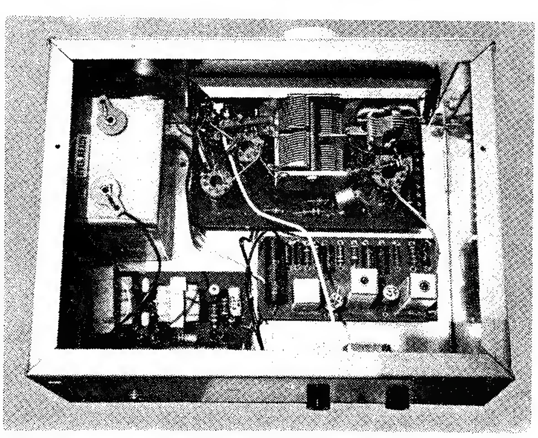
Tr1	OC170	Tr4	OC81D
Tr2	AF117	Tr5	OC81
Tr3	AF117	Tr6	OC81
D1	OA81		

Chassis:

Universal Chassis side 5 × 2in.
Universal Chassis members:—
2 off 8 × 4in. CU56A
2 off 6 × 4in. CU41B
2 off 8 × 6in. plates CU178
All from Home Radio

Miscellaneous:

T1, OC81D/2 × OC81 driver transformer
T2, 2 × OC81/3Ω speaker transformer
S1/2, 2 pole, 3-way, wafer switch.
Paxolin or 'eyelet' boards, 5 × 2½in, 3¼ × 2in, 3¾ × 1¾in. Knobs, 1-off type KN84F and 3-off type KN84D (Home Radio). Feet 4-off type Z146 (Home Radio).



Transistor leads can be identified as mentioned, or sleeving put on the wires to avoid possible short circuits.

Solder on a black flexible lead, fitted with a battery negative clip. Leave a short wire projecting at the point IF negative, and connect an insulated wire from C15 positive.

FINAL ASSEMBLY

If preferred, the mixer, i.f. and a.f. sections can be wired together and tested before fitting them in the case. The positive circuits must then be temporarily joined with wire.

The case front is a 4 x 8in. flanged member and three holes, for VR1, switch and VC3 are made 1½in. from the bottom edge. The hole for VC1/2 is 2in. from this edge.

The fixing nuts of the switch and VC3 are then removed, so that the bushes can pass through the case front. If necessary, put a washer or two on each bush, then fit the mixer assembly to the case front, and lock it in position with the nuts of VC3 and the switch.

The bottom is then fixed. It was placed inside the flanges, but could be outside. Take a piece of paper of the same size, and mark the positions of L1, L2 and L3. Also the fixing bolts of i.f. and a.f. boards, and the central holes under the i.f.t.'s. Drill or punch these holdes, which are to allow alignment when all boards are in position.

The bottom is then bolted to the bottom flange of the front, the sides and back of the case being added later.

The i.f. and a.f. panels are fixed as in Fig. 5 by using extra nuts and lock nuts on the ½in. bolts. There should be plenty of clearance, but if any joints are too near the metal, cut pieces of card to match the panels, and fit these under the i.f. and a.f. boards.

The green lead from i.f.t.1 is then cut and soldered to pin 8 of L3. VR1 is fitted to the front, and connected to positive line, D1 and C15, and other connections are made as shown.

When the case is to be completed, this is done by adding the two sides, then the back. All are bolted together with the flanges provided.

IF ALIGNMENT

The i.f.t.'s listed are supplied pre-aligned. This means that signals should be obtained through the i.f. amplifier at good strength. If no signals are obtained, it is better to look for a wiring error or other fault, rather than move the cores of the i.f.t.'s.

When a signal is present, carefully adjust each core for best results. A screwdriver blade can easily break this type of core, and should not be used. If a proper tool is not available, it is recommended that one be obtained from the i.f.t. maker—the "Denco" TT5 tool is suitable.

Signals for i.f. alignment may be from a signal generator, input being to the base of Tr1, or from a transmission, correctly tuned in. If adjustment is by ear, use a signal which is quite weak even with VR1 near maximum. Alternatively, set a 10kΩ/V or other high-resistance meter at its 10V range, and clip it across VR1, negative to chassis. Alignment is then for maximum voltage reading. Only slight re-adjustment

—continued on page 418

SERVICING

AN INTRODUCTION TO FAULT-FINDING

PART 5

H. W. HELLYER

A KNOWLEDGE OF JUST HOW STEREO SIGNALS ARE GENERATED AT THE TRANSMITTER AND DECODED AT THE RECEIVER IS ESSENTIAL TO AN UNDERSTANDING OF THE STEPS INVOLVED IN THE ALIGNMENT OF STEREO RECEIVERS

WHETHER or not you live in an area of the country served by a stereo transmitter, your interest in this series of articles must also encompass stereo broadcasting. Quite apart from the hideous interference that spoils a.m. radio on the "broadcast" bands, especially during peak hours, the restricted frequency response that results from a necessarily narrow bandwidth takes away any pretension to quality reception. With f.m. broadcasting, we can achieve a wider bandwidth and more nearly approach hi-fi—whatever that may mean.

FM MULTIPLEX—THEORY AND PRACTICE

Nowadays, very few mono tape recorders and hardly any mono record players are to be found in the shops. Stereo is the order of the day, even in a cheap radiogram where the loudspeaker placement quite obliterates any good effect channel separation may have given! Stereo radio is the only way onwards.

Here is where that ugly word "compatibility" takes the stage. So that users of the existing mono system could continue to listen; so that stereo broadcasts could be "slotted in" to the current framework of programmes without robbing some poor listener of his entertainment, a system had to be devised whereby the stereo signals were combined in some way with the mono signals and some form of switched selector devised to differentiate between them.

Fig. 1 shows how this is done in the system employed in this country. Here, we have the encoder at the transmitter which takes the stereo signal, applies it to an electronic adder and subtractor, and produces a left+right and a left−right signal. The difference signal, L−R is the vital stereo information. The L+R signal gives the mono listener all he needs (with, it must be admitted, a slight degradation of the signal-to-noise ratio... but this is seldom mentioned).

The L−R signal modulates a sub carrier, the frequency of which is 38kHz. This is obtained by doubling the 19 kHz pilot tone output of a high stability oscillator. The trick here is to amplitude modulate the 38kHz sub-carrier at the transmitter. The modulator suppresses the sub-carrier so all that comes out, for application to the adder, is the upper and lower sidebands of the signal.

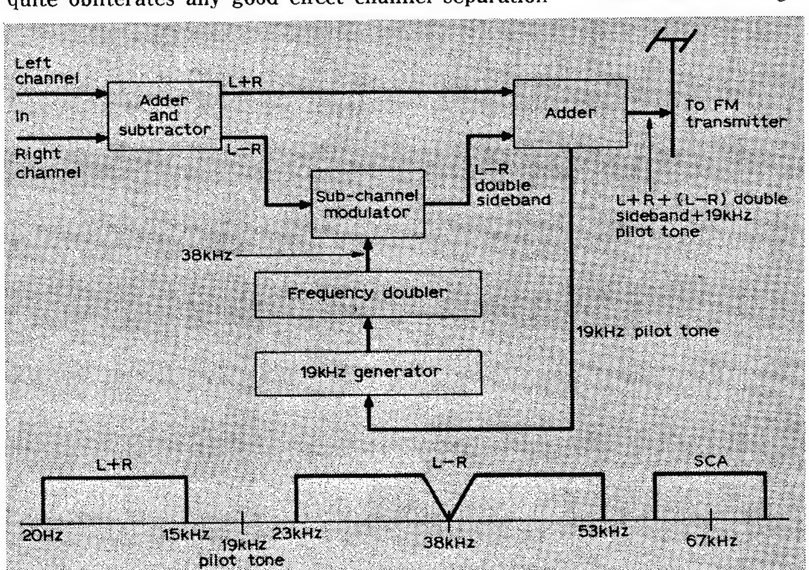


Fig. 1. (top) illustrates the number of stages involved in the formation of a stereo signal at the transmitter while Fig. 2 (below) shows the frequency spectrum of a multiplex signal.

Also applied to the adder is the untreated L+R signal, and a 19kHz pilot tone, which is to be used as a reference at the receiver. The signal spectrum at the transmitter, Fig. 2, helps to make this plain. This is the true multiplex signal. Suppression of the sub-carrier has given the two signals, L+R and L−R, 90% of the 100% modulation, the remaining ten per cent being taken up by the pilot tone.

It should be remembered that when L+R is maximum L−R is minimum and vice versa; in this way, the best use is made of the modulation "space". If the sub-carrier had been left in, the available "space" would have been reduced to 50%.

COMPATABILITY

Fig. 2 shows that the ordinary mono information is still available up to quite a high frequency, around 15kHz. The useful sidebands of the 38kHz sub-carrier extend to well over 50kHz. So a flat frequency response is needed throughout the propagation chain. One aspect not always considered is the need for good phase relationship. As the L+R and L−R signals depend on cancellation (in effect, the +L and −L components must cancel in the right-hand channel and the R components in the lefthand channel) the phase relationships of the various signals must stay correct. One reason, you may argue, for a good aerial, and not just any old piece of wet string that happens to receive a signal. As we shall see, there are other reasons, too.

From the adder, this composite signal is fed to the transmitter and is used to frequency modulate it. It is this f.m. signal we receive, in the 88-97MHz section of the f.m. band.

Without going too deeply into this matter, we can state that there are two completely different ways of achieving this stereo signal and more than two ways of decoding it. Referring again to Fig. 1, we note that an electronic "mixing" system has been used to encode the stereo signal. A "switching" system could have been used as easily. Similarly, the decoder, in the receiver, can be the matrix type or the simpler switching decoder which is more often used.

SERVICING PROBLEMS

Tuners are undergoing some revolutionary changes just at present. Gordon King has said, and will be saying, a few things about varicaps, and tuning devices. From the servicing point of view, the problems that arise are the same as in other tuners: component failures, displaced components, causing changes in inductance/capacity, where leads and supports are significant at the frequencies in use: plus the inevitable bogey of mistuning. Plus—it must be said—aerial mismatching, inadequate aerials and troubles with the feeder and its connections.

Through the i.f. channel, the main consideration is to achieve the necessary bandwidth and broad tuning is the order of the day. Attempts to "peak up" the i.f. channel of an f.m. receiver will inevitably result in an impaired response. IC's are being widely used in modern i.f. strips, giving very high gain. Tuning problems remain much the same, but are practically lessened by there being, in general, less tuned circuits to align. Ceramic filters, too, have made our life a little easier in the service department, refusing to go off tune, except when externally abused.

THE DECODER

So let us get on to the decoder. This can either be the sum-and-difference type of Fig. 3a or the switching type of Fig. 3b. In the first, a mirror image of the encoder at the transmitter, three filters split the signal into its components. The first selects the 19kHz pilot tone, which is passed on to the frequency doubler stage. The second selects the mono L+R signal and presents it to the matrix. The L−R signal is selected by the third filter and passed to the balanced demodulator. To the same point the regenerated 38kHz sub-carrier is also fed. Addition and subtraction in the matrix now produces replicas of the original left and right signals.

The switched type of decoder is more common (less complicated!) and so will concern us more. Fig. 3b shows its block diagram. Multiplexed signals from

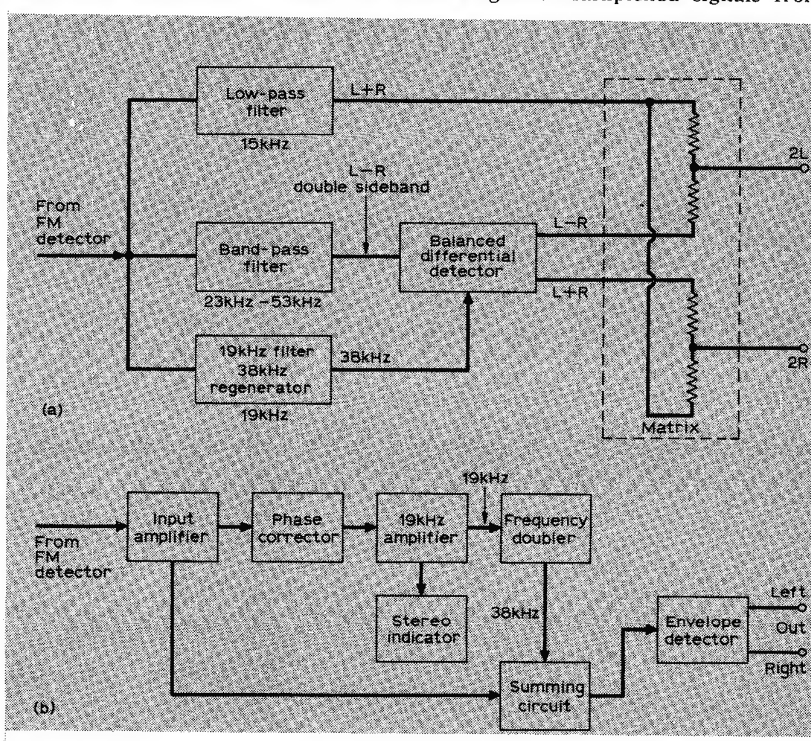


Fig. 3 (a) gives the requirements of a matrix decoder, the more common switching decoder being depicted in Fig. 3 (b).

the f.m. detector are fed to an input amplifier. From the output is selected the 19kHz pilot tone and the stereo information. No filters are necessary at the input to this amplifier, revealing at least one reason why the matrix decoder is out of favour in this country.

From the input amplifier, the pilot tone is phase corrected and amplified, then doubled in frequency to produce the 38kHz sub-carrier. An envelope detector is used, as with this method the left channel information is amplitude modulated on one side of the 38kHz carrier and the right channel information modulated on the other side. Alternate demodulation at a repetition rate of 38kHz gives a resultant audio output to each channel.

After demodulation, de-emphasis is applied. That bald statement is the reason why so many attempts at adding a decoder to a mono f.m. receiver to convert it to stereo failed dismally. Quite apart from the impaired S/N ratio—a factor which makes it vital to first obtain as good a mono signal as possible—the de-emphasis network which is fitted to counteract the high-frequency boost given to the signal at the transmitter has its effect as soon as we attempt to convert. De-emphasis is usually incorporated in the decoder design. The idea of this system is to obtain the best possible audio signal and also to attenuate residual sub-carrier components.

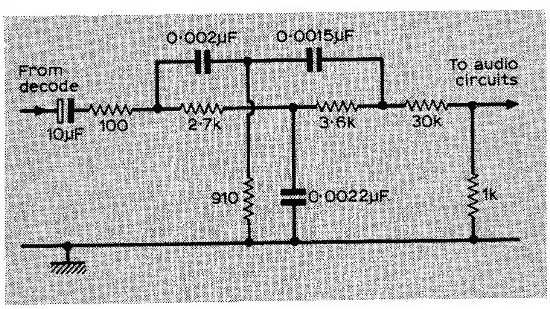


Fig. 4. Practical circuit of a 38kHz notch filter.

Despite this attenuation, some additional filtering may be needed if the stereo broadcast signals are to be applied to a tape recorder. Fig. 4 shows a notch filter suitable for removing all trace of the 38kHz signal from a tape recorder input. Many tape recorder manufacturers, particularly Continental ones, well used to f.m. reception, have already fitted filters, usually LC types in screened compartments near the input sockets. The circuit of Fig. 4 is easily constructed for experimental purposes by the person who adds his own decoder. It can give a fair measure of de-emphasis as well, and should be fitted between the decoder output and the amplifier input.

DECODER CARE

Whenever any work is done at or around the decoder, connecting wires must be kept as short as possible. High frequency attenuation is easily caused by careless wiring, and instability by shoddy component placing. If a stereo socket is to be fitted, it should be mounted for efficiency rather than for convenience. There is always a temptation to cut corners—sometimes with costly results.

An example is the omission or removal of the "cross-diodes" in a decoder circuit. Good stereo separation is still obtained; the signal is received clearly; there is no obvious interference. But more than once damage to output transistors has been caused, and it is possible that tweeters could be impaired in a hi-fi system, simply because the removal or failure of this circuit allows the 38kHz sub-carrier to break through at full strength. We cannot hear it, but we shall certainly hear its effect!

One item noted on the block diagram of our decoder is the stereo beacon light. This is latched to the 19kHz amplifier and should light only when a pilot tone is present. Unfortunately, as any user of stereo receivers will know, it more often lights with every blip of noise.

OTHER FACTORS

Other factors that are special to the f.m. receiver, and to stereo receivers particularly, are the automatic frequency control circuits, the muting circuits, and various devices to aid "capture." Some examples of these can be seen in Fig. 9 of Part 2 by Gordon King. (Page 136, *PW,* June 1971). See also the description of the a.f.c. circuits, on page 153 of the same issue.

Reference must also be made to my last part, where we began by treating the stereo receiver as we would a normal mono receiver, aligning for the correct response and checking the i.f. with a marker. The basic method is to connect the instruments as shown in my Fig. 6 of the last part, for normal f.m. alignment.

For more detailed work, a specially designed stereo generator is employed.

TEST EQUIPMENT

An example of such an instrument is the Heathkit IG-37, costing £47·35 as a kit. This instrument provides a composite stereo signal plus a pilot tone and gives a phase test signal (i.e. channels added) for sub-carrier transformer adjustment. A variable r.f. oscillator signal is available, having an adjustable sweep width around a nominal 100MHz frequency. A mono f.m. signal can be obtained and this is modulated by any one of three modulation frequencies—giving a rapid "spot check facility."

In addition to this, four marker frequencies are supplied for r.f. alignment checks and two s.c.a. (subsidiary communications authorisation) frequencies for adjustment of filters. To the workshop that has to undertake regular checks of f.m. receivers, such an instrument can be invaluable.

MULTIPLEX ALIGNMENT

With the proviso that the service manual for the receiver being aligned should be consulted initially, we now go on to detailed general steps of the alignment procedure of a typical stereo receiver, using the IG-37.

IF alignment: connect output of the generator, "RF Out," to the aerial terminals of the receiver. Connect the input of the last limiter circuit of the receiver to the vertical input of an oscilloscope, using a demodulator probe. Loosely couple the "IF Marker" of the generator to the first i.f. stage of the receiver.

This produces a 10·7MHz marker signal. Adjust the oscilloscope for a 60Hz line sweep. Use the "Mono/FM" facility with audio modulation and tune the generator to approximately 100MHz. Then switch to "RF Sweep" input, with "IF marker." Produce a response curve (Fig. 5a) and adjust the successive i.f. stages for best response.

The next step entails comparison of curves and to do this we first need to view the generator output as applied to the oscilloscope and then beat in the signal from the receiver. To do this, first "kill" the tuner section, remove the vertical input of the oscilloscope from the receiver limiter circuit and connect it to the output of the detector stage.

Disconnect the i.f. marker. Connect the composite signal from the generator to the horizontal input of the oscilloscope, now set for external sweep, i.e. trigger the scope with the generator. With the tuner in action again, a curve as in Fig. 5b should appear. The detector coil can now be adjusted to approach this. Always refer to the maker's manual, if this is available.

Recheck the front end alignment using the r.f. marker signals at 90·95, 96·3, 101·65 and 107MHz adjusting the r.f. and oscillator coils for good response, and accurate tuning.

Stereo alignment: this needs a step-by-step operation, according to the type of circuit in use. In the IG-37 manual, these basic circuits are divided into four types (1) several 19kHz amplifier stages followed by a doubler; (2) a 19kHz oscillator circuit and doubler; (3) 19kHz amplifier, doubler and 38kHz oscillator, and (4) 19kHz amplifier and 38kHz oscillator. It is necessary to identify the circuit before proceeding, but some tests are common to all.

First set "Pilot Level" to minimum and function level fully clockwise, switch frequency to SCA and filter switch to 65 or 67kHz to suit the filter of the receiver, set function switch to "Audio" and "Mono/FM," adjust the r.f. frequency adjustment to get a signal in a clear spot of the tuner band somewhere near 100MHz. Make sure the phase control is central. If a separation control is provided on the generator, centralise this. Switch the a.f.c. off, and also, if available, the squelch circuit. Connect generator to aerial terminals. Switch on both generator and receiver and allow to warm up for 10 minutes.

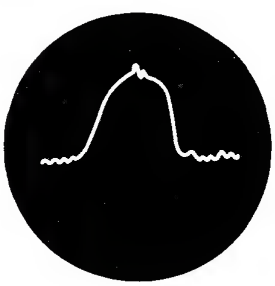


Fig. 5 (a) Response curve of i.f. channel of stereo receiver with superimposed 10·7MHz marker signal.

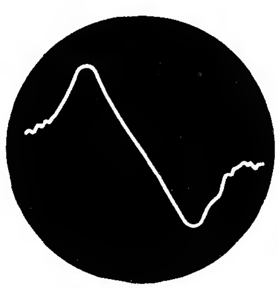


Fig. 5 (b) Response curve required at the output of the detector stage.

If the set has an oscillator type of circuit, this should be "killed" for the SCA filter adjustment. If the filter is a complex or stagger-tuned one, the tuning will have to be done according to the maker's instructions. When feeding in the signal to the receiver keep the level such that the scope gives a clear trace—i.e., do not overdrive.

After this, proceed according to the type of circuit; the differences being the positioning of the oscilloscope, setting of the pilot level control and synchronisation of signals (19kHz and 38kHz) as against peaking.

Taking the example of our Fig 3, i.e., 19kHz amplifier and doubler, we first peak both 19kHz and 38kHz circuits. The oscilloscope is connected to the output of the 38kHz doubler, pilot level turned to maximum (with regard to overloading), function switch set to Left channel, frequency switch to 1000Hz and the relative coils, including any stereo indicator coils, peaked for maximum indication.

Next, an operation common to all types, to adjust the phase of the reinserted carrier to the same phase as the sub-carrier. The oscilloscope is now connected to the left channel output, other settings are the same, and the phase is adjusted for maximum audio output. Normally, this operation requires the alteration of a 19kHz or 38kHz coil, and will be special to the particular circuit. Again, we need to refer to the maker's instructions, or trust our experience. No general guidance can be given without being misleading.

If a separation control is fitted, now is the time to adjust it. With the input to the left channel, we now read off the output from the right channel and adjust the control for minimum. (This operation can be done with the aid of the B.B.C's late night test signals.)

Last step is adjustment of the 19kHz and 38kHz traps. Here, the pilot level control is turned to minimum, the function switch is again set to "Mono" and the generator frequency to the appropriate 19 to 38kHz. The oscilloscope reads off the appropriate channel output and adjustments are made for a minimum. Any automatic switching circuit that is fitted must here be locked according to the maker's instructions.

Now and again we come across circuitry that does not allow for easy adjustment. In these cases, always follow the maker's instructions explicitly. It is unfortunate that this has to be said so often, but circuits vary widely, as Gordon King has shown and which I hope my previous notes may have underlined. Something of the same conditions has to be met with audio equipment generally and with tape recorder circuits in particular, as we shall show in succeeding articles.

END OF PART FIVE.

NEXT MONTH WE RETURN TO CO-AUTHOR GORDON KING WHO WILL DISCUSS THE DESIGN, CHARACTERISTICS AND PROBLEMS OF THE AUDIO SIDE OF EQUIPMENT BOTH VALVED AND SOLID-STATE

IN NEXT MONTH'S PRACTICAL WIRELESS

EXTRA INSIDE

8 PAGE SUPPLEMENT SMALL WORKSHOP TOOLS

We have seen some 'bird's-nests' in our time, purporting to be copies of our various projects! While ingenuity in using a kitchen knife as a screwdriver-cum-wire-stripper might be commendable in an emergency we feel that the serious constructor would prefer to buy the proper tools for the job. This supplement provides plenty of information on all kinds of small tools and accessories thus enabling readers to assess their requirements before spending their money.

plus

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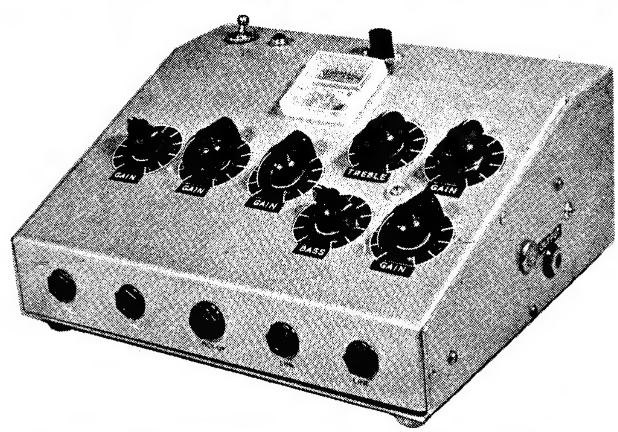

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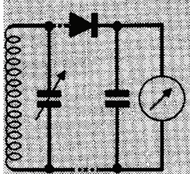
IN the past, as far as the amateur or experimenter was concerned, there have been two main instruments for measuring frequency, the absorption wavemeter and the heterodyne frequency meter.

The absorption wavemeter has the advantage of being simple and responding to the fundamental frequency, but having a measurement accuracy limited to about 1%. It consists of an LC tuned circuit where the variable capacitor has a calibrated dial. It must be coupled to the circuit containing the frequency to be measured and when tuned to this frequency the absorption of power from the circuit may be noticed either by an effect produced in the circuit itself, or by an indicator attached to the wavemeter as shown in Fig. 1.



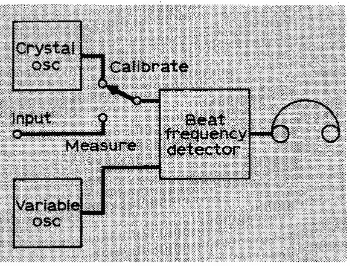


Fig. 1 (above left) Absorption wavemeter.
Fig. 2 : (above right) Heterodyne frequency meter.

The heterodyne frequency meter is a much more sophisticated instrument which is capable of accurate frequency measurement. This is limited mainly by the accuracy of its internal standard oscillator and tuning dial. It consists of an accurate crystal oscillator, a stable variable frequency oscillator, with a finely divided dial and a beat frequency detector feeding headphones, as shown in Fig. 2. The variable oscillator is calibrated against the crystal oscillator by observing the zero-beat points where the fundamental or harmonics of the crystal and variable oscillators coincide. The input signal is measured by zero-beating the variable oscillator with it and then reading off and calculating the frequency from the crystal check points nearest to that of the input signal frequency.

Because the heterodyne frequency meter will also respond to harmonics of the input frequency, reasonable care has to be taken to identify and exclude these and other spurious responses.

Frequency Measurement by Counting

An example of this method is in measuring the frequency of a heart beat. To do this, the doctor feels the patient's pulse and counts the number of pulses that occur in a fixed period of time.

The frequency of the heart beats can be stated in pulses per minute, no matter whether he counts for half a minute, one minute or ten minutes, simply by multiplying by a suitable factor.

Although electronic frequency counters have been in use professionally for many years, their construction has remained outside the range of home constructors, because of their complexity and high cost. However, the present availability of quite complex integrated circuits at extremely low prices has now made the construction of a frequency counter with digital read-out not only within the price range of the home constructor but, in some aspects, its performance and price compares favourably with the cost of a heterodyne frequency meter available on the surplus market, such as the BC221.

Principle of Operation

An electronic frequency counter consists of a switch, to define the counting period, in series with the input to an electronic counter and associated display, as shown in Fig. 3.

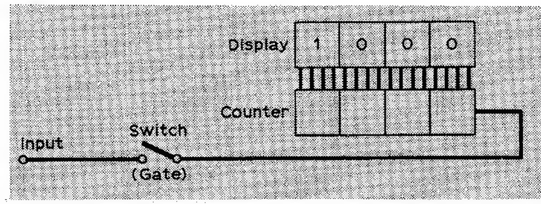


Fig. 3 : Frequency counter and display.

Assume for a moment that the input signal is a square wave of frequency 1000 Hz. If we close the switch for exactly 1 second, then in that time 1000 cycles of the input signal will have passed through the switch to the counter. If the counter has 4 decades, comprising of thousands, hundreds, tens and units, then this will have completed a count of 1000 and as the counter is connected to a numeral display, the number displayed will be 1000.

It follows then that the frequency of any input signal will be indicated directly on the display, in cycles per second (Hz), providing that it is not greater than 9999Hz, which is of course the maximum reading for 4 digits.

DIGITAL FRE

The digital frequency counter/timer offers reliability, stability and read-out convenience, which can not be achieved using alternative techniques.

Wide use is made in this design of integrated circuits. Their use considerably simplifies the design, construction and adjustment. In its present form, this instrument is capable of operating in excess of 15MHz.

JOHN THORNTON-LAWRENCE

Should we wish to make the same sort of measurement at 1MHz (1,000,000Hz) then we must arrange for the switch to be closed for exactly 1mS (1/1000 of a second). In that time 1000 cycles of the input signal will have passed through to the counter and the display will again show 1000, but this now represents 1000kHz, not Hz, (1000kHz = 1MHz).

In a practical frequency counter, the switch is in the form of an electronic switch or "gate" and we call the time the switch is closed, the "gate time."

The accuracy of the frequency measurement made by counting depends mainly on the accuracy of the gate time. For instance when counting an input signal of 1MHz for a gate time of 1mS, an inaccuracy of 1μS will cause an error of one count, which in the displayed answer represents 1kHz. (There is also a counting error of one least significant digit, and this is discussed later.) Below is a list of maximum frequency readings displayed by a 4 decade counter for different gate times.

Gate time	Maximum Reading
100μS	99·99MHz
1mS	9·999MHz
10mS	999·9kHz
100mS	99·99kHz
1 Second	9·999kHz or 9999 Hz.

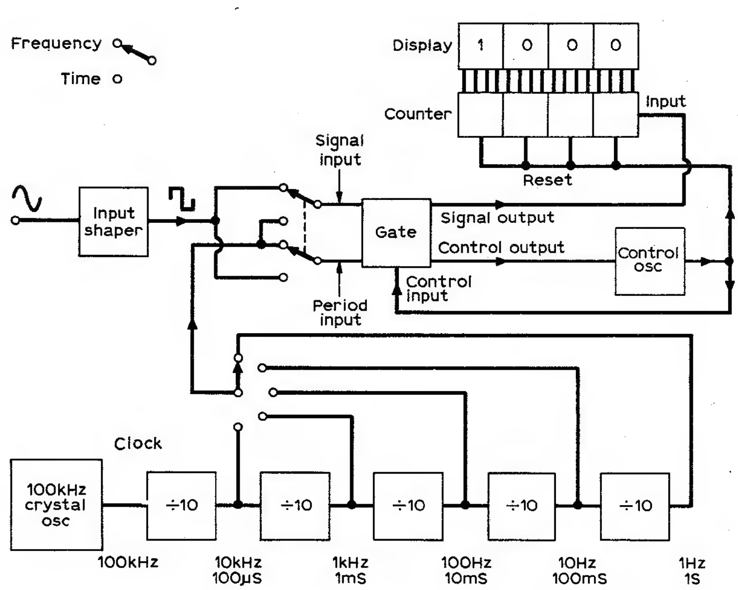
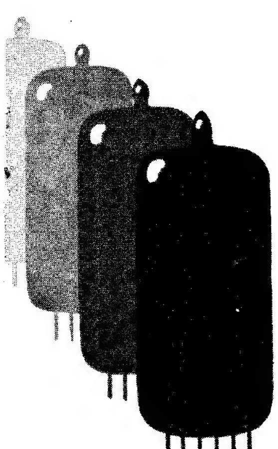
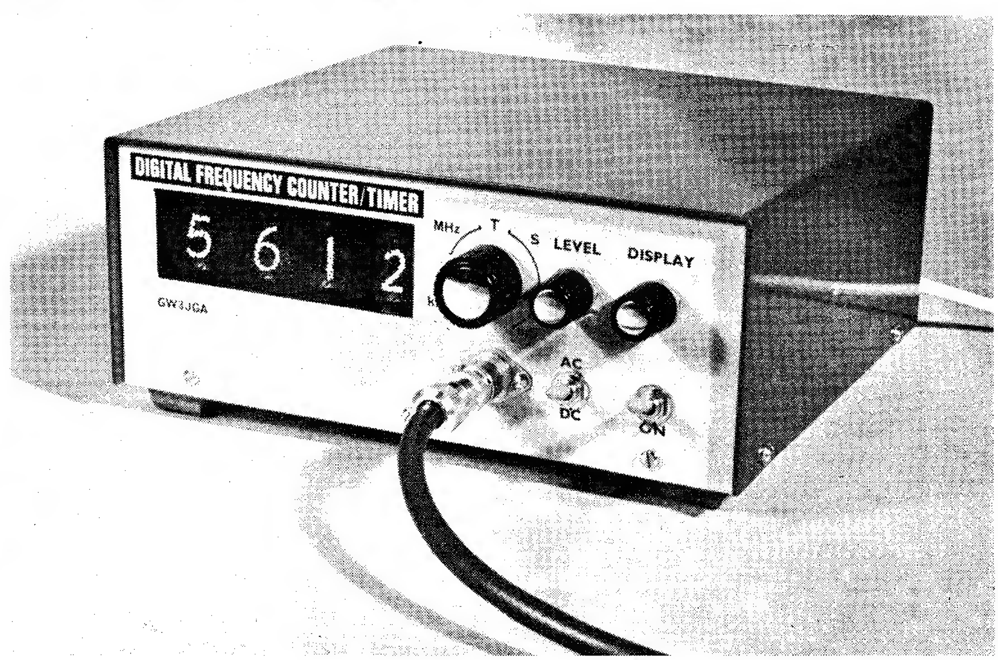


Fig. 4 : Digital frequency counter timer.

To obtain the required order of accuracy it is necessary for the gate time to be derived from a very accurate and stable oscillator. A crystal oscillator operating at 100kHz and at normal room temperature 18°C-22°C, can be expected to have a frequency stability of about 1 part in 100,000, which is equivalent to 0·01% and is more than adequate for a 4 digit read out.

QUENCY COUNTER/TIMER





GW3JGA

The block diagram in Fig. 4 shows how various gate times may be generated and connected to the gate. In this arrangement the crystal oscillator operates at 100kHz and this frequency is divided or counted down in stages of ten giving the frequencies and gate times shown in the diagram. As this section determines the exact gate time we call it the "clock".

For example, with the clock switch in the 1 second position, the start of a 1 second square wave will open the gate (equivalent to closing the switch in Fig. 3) and the start of the next 1 second square wave will close the gate (equivalent to opening the switch), producing a 1 second gate time during which the input signal will pass through to the counter to be counted and displayed. It is assumed that prior to the gate opening, the counter is reading 0000; if this were not so then each successive reading would add to the previous one and defeat the object of the measurement.

The Control Oscillator

To ensure that the counter is set to zero, a control oscillator is used. This oscillator has several functions; first it resets the counter to 0000, then instructs the gate to operate on the next clock signal and after the measurement has been made disables the gate for a few seconds, long enough to allow the displayed reading to be read before resetting to 0000 and repeating the operation. The sequence of operation is shown in Fig. 5 and will be discussed in more detail later.

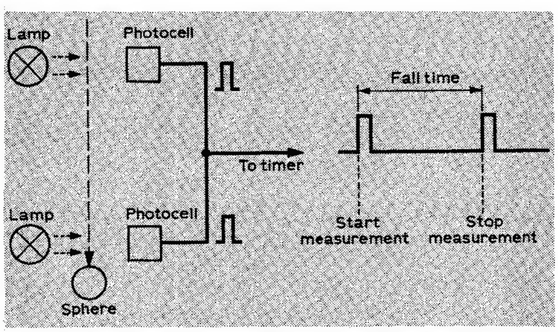
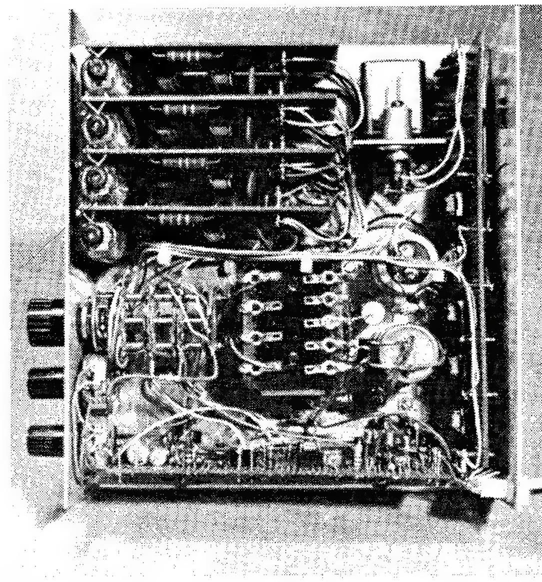


Fig. 5: Measurement of time between two events

Counter and Display

The counter and digital display for a 4 digit readout consists of 4 identical counter and display units. Each digit has a decade counter which counts from 0 to 9, returning to 0 on the tenth count and providing a "carry" signal to the next higher decade. The counters count in binary form and the actual count figure is presented in binary coded decimal at 4 outputs, these having a weighting of 1, 2, 4 and 8 respectively.

The outputs are connected directly to a "decode-driver" which converts the binary coded decimal input to a decimal output. The 10 outputs are connected directly to a numerical indicator tube which displays the figure existing in the counter. A separate input connection to the counter enables it to be reset to zero at any time.



Photograph showing general layout of the digital frequency counter timer.

In the block diagram the input stage is shown connected between the input terminal and the gate. The purpose of this stage is firstly to shape the input signal to provide a square wave output suitable for driving the counter stages and secondly to provide a high input impedance.

Time and Period Measurement

The basic component parts of a frequency counter can be rearranged very simply to provide the measurement of the period of one cycle of a low frequency signal or the time between two events. This is done by crossing over the clock and signal inputs by means of a change-over switch as shown in Fig. 4.

For example, suppose that we need to measure the frequency of a signal of 0·5Hz by the period method, (0·5Hz=2 seconds per cycle). With the change-over switch in the time position, the input signal now controls the gate and the counter counts the clock output.

If the clock output is 1kHz, that is 1 pulse per millisecond, and the period of one cycle of the input signal is exactly 2 seconds, then there will be a total count of 2000. We can convert this reading to frequency.

$$f = \frac{1}{t} = \frac{1}{2000\text{mS}} = 0{\cdot}5000\text{Hz}$$

This means that we can now measure a low frequency with good accuracy.

The period measurement can also be used as an electronic stop watch for measuring the time between two events. For example, to determine the time taken for a sphere to fall a known distance, a set-up as shown in Fig. 5 may be used. Many other applications of this feature come to mind including race timing, camera shutter speed measurement, etc.

★ components list

Resistors:

R1	47kΩ	R18	150kΩ	
R2	1MΩ	R19	1kΩ	
R3	2·2kΩ	R20	150kΩ	
R4	1kΩ	R21	1kΩ	
R5	470Ω	R22	3·3kΩ	
R6	680Ω	R23	2·2kΩ	
R7	2·2kΩ	R24	1kΩ	
R8	2·2kΩ	R25	470kΩ	
R9	680Ω	R26	82Ω	1W
R10	10Ω	R27	82kΩ	1W
R11	220Ω	R28	82kΩ	1W
R12	1kΩ	R29	82kΩ	1W
R13	10kΩ	R30	82kΩ	1W
R14	10kΩ	R31	220kΩ	
R15	4·7kΩ	VR1	50kΩ pot. carbon, linear	
R16	1kΩ	VR2	50kΩ pot carbon, linear.	
R17	1·5kΩ			

all resistors 10% ½ watt unless otherwise specified.

Capacitors:

C1	200pF	S.M.	500V
C2	0·47μF	Polyester	400V
C3	200pF	S.M.	500V
C4	0·01μF	Disc cer	15V
C5	50μF	Elec	15V
C6	10μF	"	"
C7	0·47μF	Polyester	125V
C8	470pF	S.M.	500V
C9	60pF	Concentric trimmer	
C10	50pF	S.M.	500V
C11	1000pF	Polyester	125V
C12	32μF	Elec	450V (or 16+16μF in parallel)
C13	100μF	Elec	25V
C14	2000μF	" can	" 1in. dia.
C15	0·01μF	Disc cer	15V
C16	0·01μF	"	"
C17	0·01μF	"	"
C18	0·01μF	"	"
C19	0·01μF	"	"

Integrated Circuits:

IC1	SN7473N	Texas Instruments
IC2	SN7400N	" "
IC3	SN7490N	" "
IC4	SN7490N	" "
IC5	SN7490N	" "
IC6	SN7490N	" "
IC7	SN7490N	" "
IC8	SN74141N	" "
IC9	SN7490N	" "
IC10	SN74141N	" "
IC11	SN7490N	" "
IC12	SN74141N	" "
IC13	SN7490N	" "
IC14	SN74141N	" "
IC15	SN7490N	" "

I.C. Sockets:

14 pin—dual in-line-11 off
16 pin—dual in-line-4 off
Barnes or Texas Supply Co.

Semiconductors:

Tr1	2N3823	Texas Instruments
Tr2	2N3702	" "
Tr3	BSX20	" "
Tr4	BSX20	" "
Tr5	2N3704	" "
Tr6	2N3704	" "
Tr7	2N3704	" "
Tr8	2N3704	" "
Tr9	2N3704	" "
Tr10	2N3704	" "
Tr11	MJE521	Motorola
D1	1S44	Texas Instruments
D2	1S44	" "
D3	1S44	" "
D4	1S44	" "
D5	1S44	" "
D6	VR525 (CV7172)	A.E.I. (5·25V 1·5W 5% zener)
D7	1N4007	Texas Instruments
D8	BS1 100 p.i.v. 1A bridge rectifier	International Rectifier
D9	1S2051	Texas Instruments

Indicator Tubes:

V1	XN13	Hivac
V2	XN13	" alternatively the XN3
V3	XN13	" may be used
V4	XN13	"
V5	Min. wire end neon. Radiospares	
V6	" " " " "	
V7	" " " " "	

Transformer:

T1 Midget mains trans. Radiospares. sec. 250V 25mA and 6·3V 1·2A

Switches:

S1 SPST miniature toggle
S2 4 pole 11 way, built from:—
1 – miniature 'Maka-Switch' shafting assy.
4 – M-B wafers, 1 pole, 12 way
2 – packets miniature spacers—Radiospares.
S3 DPDT Miniature Toggle

Crystal:

X1 100kHz STC 4044 Type A
Senator Crystals or Henry's Radio Ltd.

Metalwork:

Complete metalwork (undrilled) in plain 16 s.w.g. aluminium is available from H. L. Smith & Co., 289 Edgware Rd., London W.2., at £1.40 (inc. p &p).

Miscellaneous:

Veroboard 17·9 × 4·7in., 0·1 × 0·1in. matrix (part no. VB126) cut to make 4 panels 2·325 × 4·1in., 1 panel 2·325 × 5·5in., 1 panel 2·325 × 7·1in. Crystal socket 10XJ. Brackets 12-LK2331 Lektrokit (Home Radio). Knobs with pointers. Filter, red 1½ × 4½in. Coax. socket, 3-3mm. insulated sockets, wire, nuts, screws, etc., 4 plastic stick-on feet, cable cleat, grommets, capacitor clips.

The instrument to be described operates according to the principles already outlined. Integrated circuits are used as far as is possible and these are of the Texas Transistor-Transistor Logic (TTL) 74 Series, which require a +5 volt supply and are capable of operating at frequencies in excess of 15MHz.

For this type of Logic the 'High' or logic '1' level is a voltage of greater than +2 volts and the low or logic '0' level is a voltage of less than 0·8 volts.

The numeral display employs Hivac neon numeral indicator tubes which operate from a 300 volt supply and give a clear bright display.

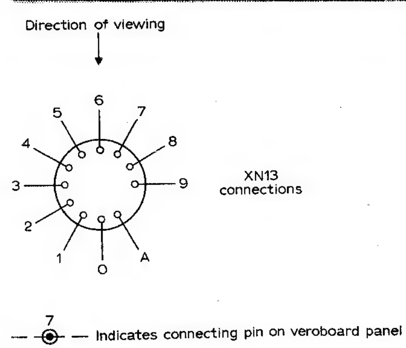
The clock crystal oscillator uses a 100kHz quartz crystal and this frequency and two of the divided frequencies are brought out to sockets for calibrating receivers, etc.

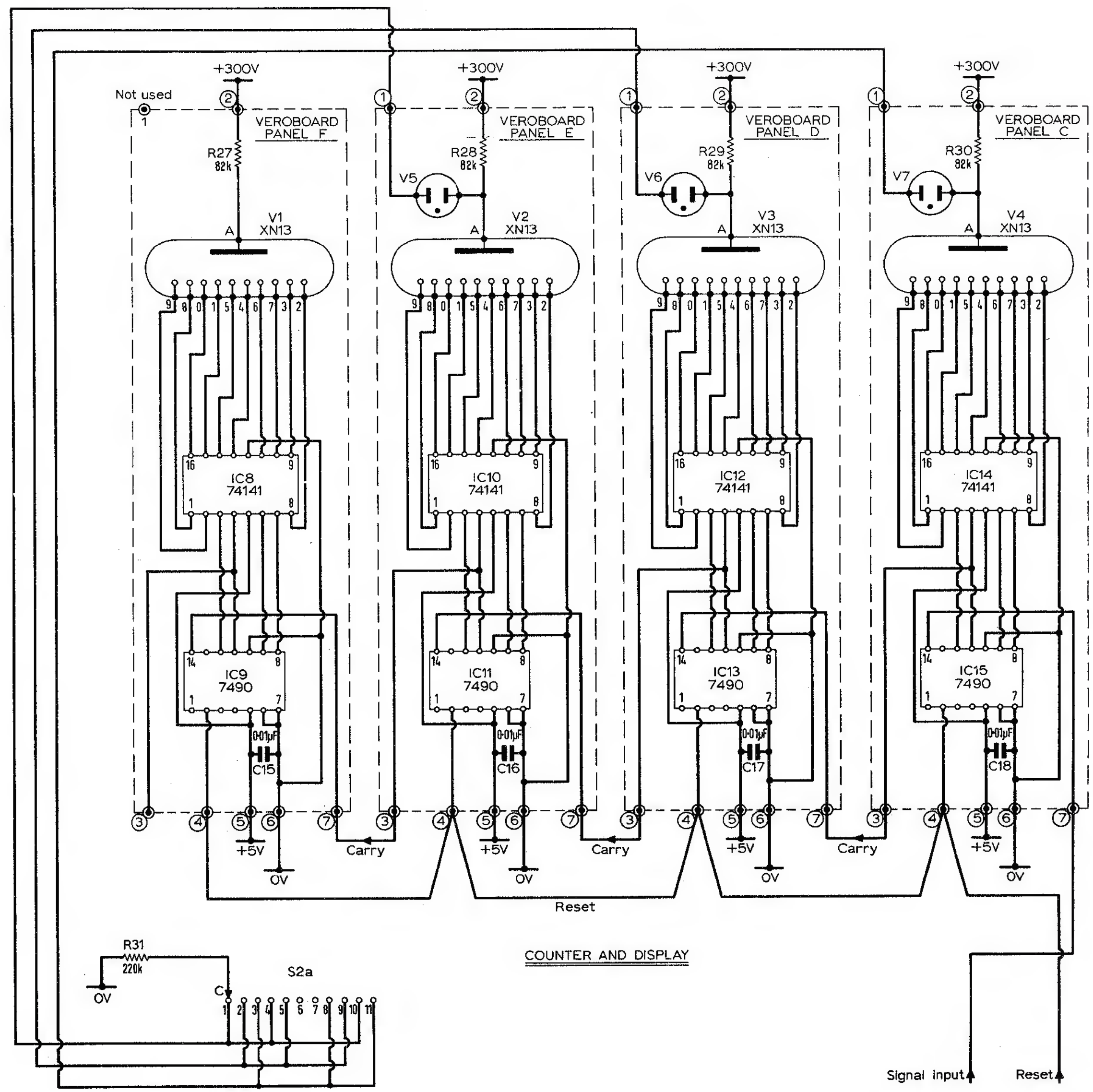
The complete circuit is shown in Fig. 6.

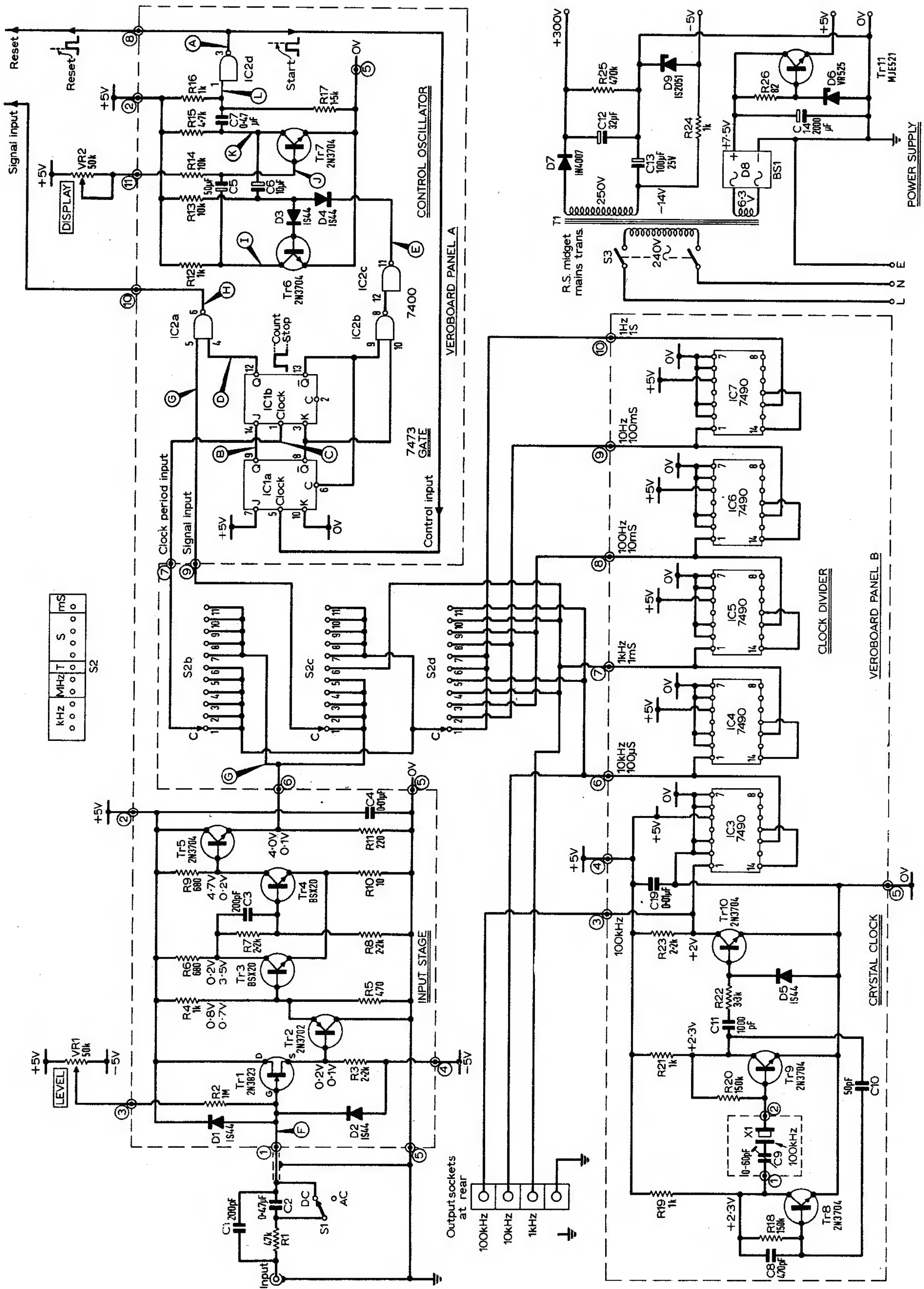
The input stage consists of an f.e.t. source follower directly coupled through a transistor emitter fol-

DIGITAL FREQUENCY COUNTER TIMER

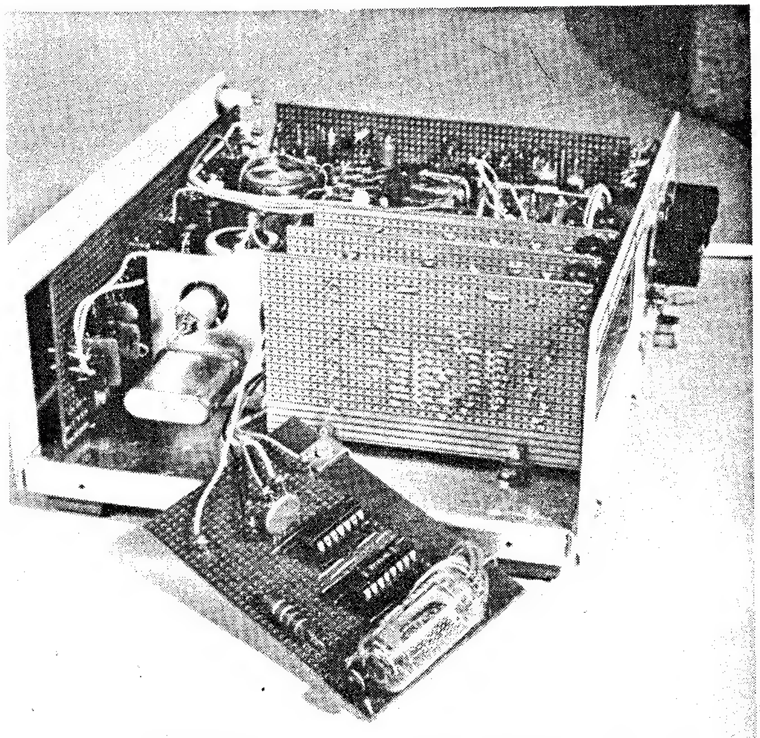
Fig. 6: The complete circuit of the digital frequency counter timer. The diagram shown on the lower page contains the input stage, gate, control oscillator, crystal clock, clock dividers and power supply. The diagram on this page shows the counter and display section.



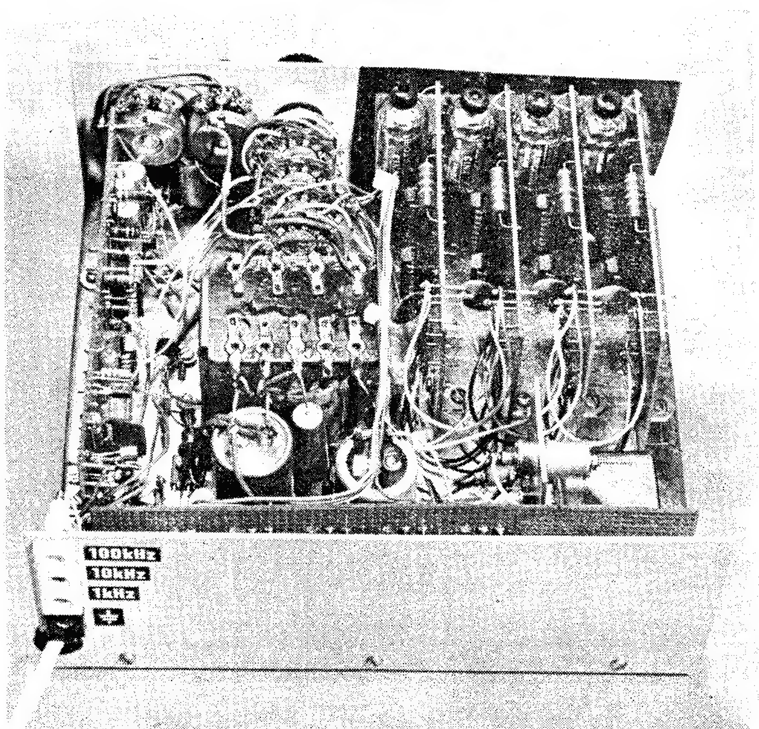




CONTROL OSCILLATOR
VEROBOARD PANEL A
INPUT STAGE
VEROBOARD PANEL B
CLOCK DIVIDER
CRYSTAL CLOCK
POWER SUPPLY
Reset
Signal input
Clock period input
Control input
Count Stop
Start
DISPLAY
LEVEL
Input
Output sockets at rear
100kHz
10kHz
1kHz
1Hz 1S
10Hz 100mS
100Hz 10mS
1kHz 1mS
10kHz 100μS
R.S. midget mains trans.
7473 GATE
7400
7490



Counter and display panel removed, showing the integrated circuits and numeral indicator tube. The position of the oscillator crystal and concentric trimmer can be clearly seen at the rear of the counter and display panels.



Rear view of the instrument. The crystal oscillator and divider outputs can be seen on the rear metal panel.

lower to a Schmitt trigger circuit, which drives the TTL circuits through a further emitter follower.

Working backwards, the output from Tr5 must be sufficient to drive the TTL at frequencies up to about 20 MHz. This means that the output voltage must swing from greater than +2 volts to less than +0·8 volts at this frequency.

An input at the base of Tr3 of greater than +0·8 volts causes Tr3 to conduct, Tr4 to cut off and the output from Tr5 emitter to be +4·0 volts, representing a logic "1". An input to the base of Tr3 of less than 0·7 volts causes Tr3 to cut off, Tr4 to conduct and the output from Tr5 emitter to be +0·1 volts, representing a logic '0'.

For small input signals Tr1 and Tr2 have a gain of less than unity and an input of about 100 mV r.m.s. is sufficient to drive the Schmitt trigger circuit. To ensure that the output voltage at Tr2 emitter is at the correct level for switching Tr3, the gate of Tr1 is connected through R2 to a variable voltage provided by the 'LEVEL' control VR1. The LEVEL control is set at the position which gives reliable operation on small input signals. It will also allow the point of operation to be set to a particular level on a larger input signal.

For an input signal of a few volts peak-to-peak, Tr1 and Tr2 form an input clipping circuit having a high input impedance. At this signal level, Tr1 is cut off during the negative half cycles and Tr2 is cut off during the positive half cycles. This results in a square wave signal at the base of Tr3 having an amplitude which is more than sufficient to drive the Schmitt trigger reliably.

Input Protection

The input to Tr1 gate is protected against excessive voltage by the clamping diodes D1 and D2. These diodes conduct at +5·6 volts and −5·6 volts respectively. R1 is included in the input circuit to limit the current that might be passed through the diodes, and C1 bypasses R1 for the higher frequencies. C2 is a direct voltage blocking capacitor which is in circuit in the 'AC' position of S1 and blocks off any direct voltage which may be present on the input signal.

In the 'DC' position of S1, C2 is shorted out and a direct input is available for very low frequency signals and for use in the timer or period mode of operation.

Clock Crystal Oscillator and Divider

The clock consists of a crystal oscillator running at 100kHz followed by five ÷10 stages giving output frequencies and equivalent gate times as shown below:—

Frequency	*Gate time*
10kHz	100μS
1kHz	1mS
100Hz	10mS
10Hz	100mS
1Hz	1 Second

Crystal Oscillator

The crystal oscillator contains a 100kHz quartz crystal connected in the feedback loop of a two-stage amplifier formed by Tr8 and Tr9. Simple biassing is provided by R16 and R18. C8 is connected between the base and collector of Tr8 to provide the correct gain and frequency response for reliable oscillation of the crystal.
(N.B. A surplus 100kHz crystal was tried in the prototype and due to its lower activity it required C8 to be reduced to 200pF.)

The crystal operates in series resonance and C9 enables a fine adjustment of frequency to be made. The output from the oscillator is coupled by C11 and R22 to the clipping stage Tr 10. The square wave output at Tr10 collector has a suitable voltage swing for driving the first decade divider IC3.

Each decade divider consists of an integrated circuit decade counter connected to give a division of ten and a square wave output of unity mark space ratio. The outputs are fed to S2d and to the output sockets as shown in the circuit diagram.

Control Oscillator and Gate

The gate actually carrying the signal through to the counter is IC2a. This gate is controlled by the Q output of the JK flip-flop IC1b which in turn is controlled by the JK flip-flop IC1a and the control oscillator.

The simplified sequence of events is shown in Fig. 7 and is as follows:—

The leading edge of a positive pulse from IC2d resets the counter to zero and the negative going edge sets IC1a with Q high and $\bar{Q}$ low. This causes the output of IC2b to be high and the output of IC2c to be low, causing the clamping diode D4 to conduct. The control oscillator multivibrator is rendered inoperative by the conduction of D4.

The output condition of IC1a presets IC1b so that at the next negative going edge of the clock period input waveform Q of IC1b will go high. This is the commencement of the gate period.

—*continued on page 430*

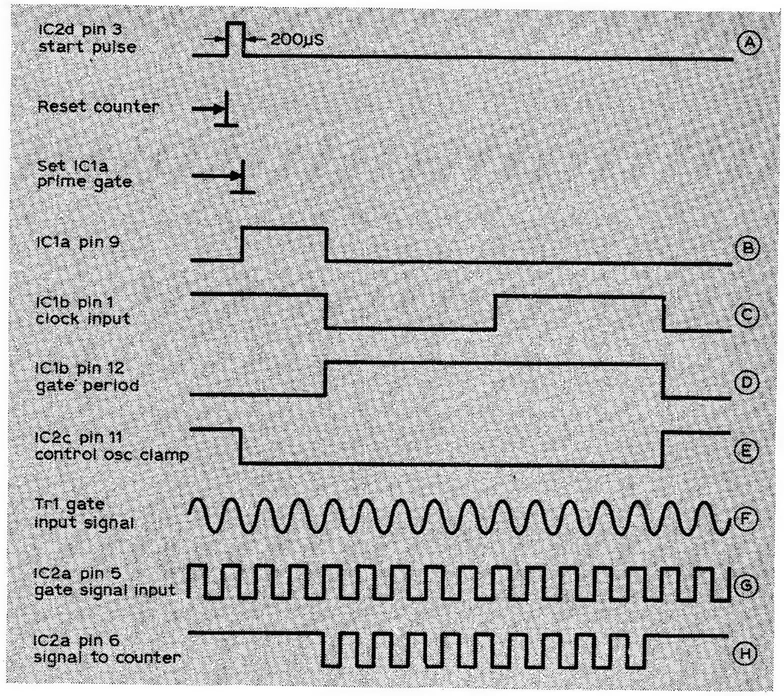


Fig. 7 : Frequency counter gate waveforms

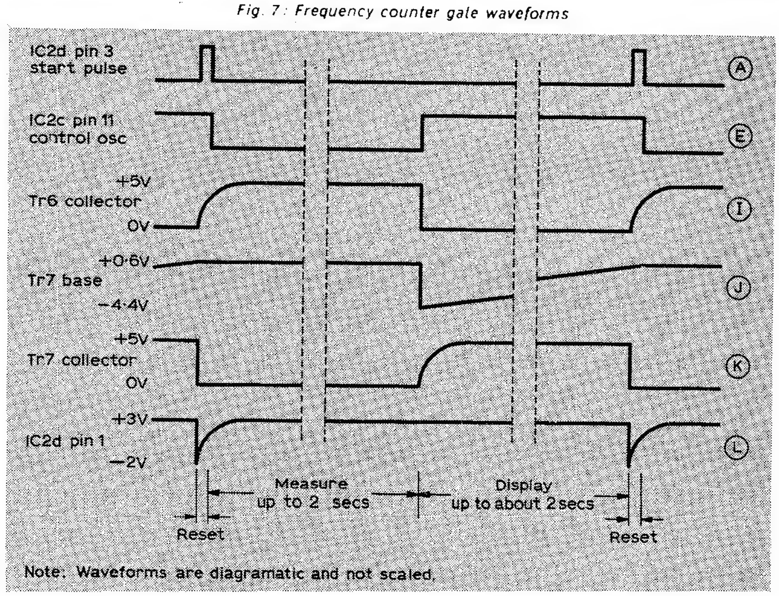
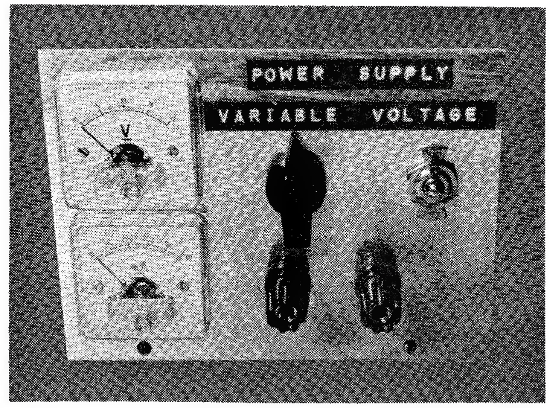


Fig. 8 : Frequency counter control oscillator waveforms

VARIABLE STABILISED power supply

B.T. ENGLISH



A very popular piece of equipment in any experimenters workshop is a variable low voltage d.c. supply. Most transistorised equipment operates from supplies of from 3-30V and the unit described here was designed to give this output with a maximum current rating of 500mA which should satisfy the needs of most experimenters. An added advantage is that the unit is cheap to construct and rugged in use. Virtually any PNP transistors capable of withstanding 30V can be used in the unit and surplus transistors were found to give very satisfactory results. Tr4, of course, must be a power transistor capable of dissipating up to 10W, but no difficulty should be experienced if it is mounted properly on the aluminium chassis.

The theoretical circuit diagram is shown in Fig. 1. Full wave rectification is achieved by the diodes D1-D4 in the form of a silicon bridge rectifier type BY164 giving a d.c. voltage on C1 of about 22V. Two zener diodes in series provide the reference voltage on the base of Tr1. The voltage across these diodes remains constant at 20V over a wide range of current through the diodes. Consequently Tr1 will act as a constant current transistor with the potential developed across VR1 remaining fixed. Voltage control is achieved by varying the current through Tr4 connected in series with the load, this is done by VR1. Tr2 and Tr3 connected in the *super-alpha* configuration offer a high input impedance and prevent loading of VR1.

The prototype was constructed on a small tag board with flying leads to the transformer, power transistor, and output circuit. Details of the mounting and general layout are given in Fig. 2. ■

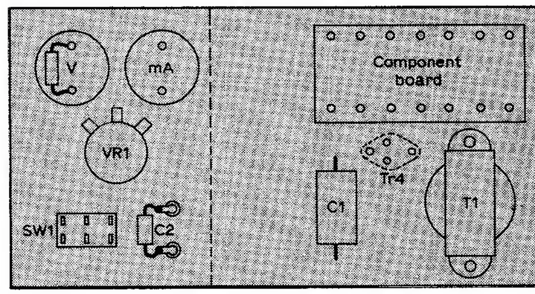
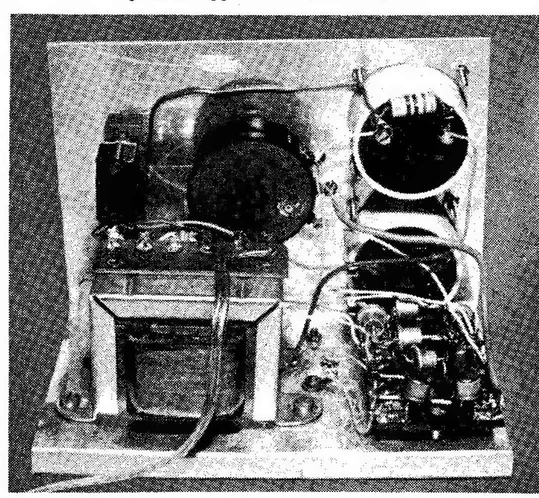


Fig. 2: A suggested component layout.



A rear view of the prototype.

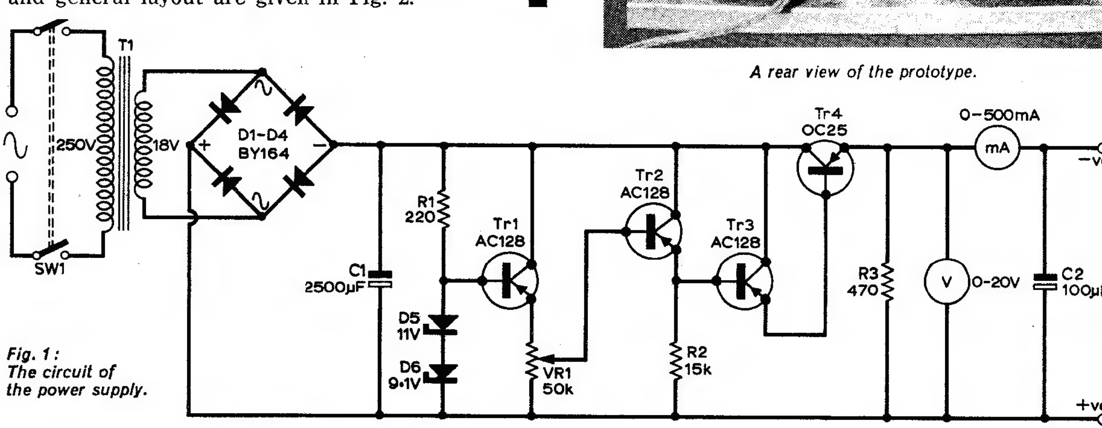


Fig. 1: The circuit of the power supply.

ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

THE BROADCAST BANDS

Malcolm Connah

Frequencies in kHz • Times in GMT

THE recent bad weather has probably been the cause of the large number of reports received this month. The first report this times comes from **Martin Ward** in Portchester. Martin's equipment consists of a Mullard 5-valve domestic receiver and a 75-foot end-fed antenna, his log included:—

7285 *R. Warsaw,* Poland with music at 1200.
9620 *R. Yugoslavia* in English at 1530.
9750 *R. Pakistan,* Karachi in English at 1945.
11920 *R. Kuwait* with music at 2000.
15105 *WIBS,* Grenada with music at 2000.
15250 *R.S.A.,* South Africa in English at 1800.
17845 *R. WNYW,* U.S.A. at 1700.

The next report is from **Alan G. Crookes** of Sheffield who has a Veritone CR-150 and a 200-foot long-wire at 20 feet, these enabled him to hear:—

6115 *R. Berlin Int.* in English at 2035.
6135 *R. Free Europe* in English at 2315.
9600 *R. Baghdad,* Iraq in English at 2030.
11860 *R. Vilnius,* Lithuania at 2335.
15160 *R. Ankara,* Turkey noted in English at 2205.
15345 *R. Kuwait* in English at 1800.
21520 *SBC,* Switzerland from Berne at 1530.
21535 *R.S.A.,* South Africa at 1600.

Stephen John Mathews of Hull has used a Bush 4-valve domestic receiver and a 90-foot wire in his loft. This simple equipment brought in many interesting stations including:—

11672 *Radio Pakistan* in English at 0030.
11730 *Radio Kiev* in English at 0030.
11790 *Radio Australia* in English at 1710.
11760 *R. Havana,* Cuba in English at 0355.
11795 *R. Nacional de Rio de Janeiro* in Portuguese at 0210.
11805 *R. Globo,* Brazil in Portuguese at 0145.
11825 *R. Jornal de Comercio,* Brazil at 0040.
11914 *Radio Nacional* Lima, Peru at 2150.
11935 *R. Clube Paranaense,* Brazil at 2025.
15265 *R. Afghanistan* in English at 1810.
15290 *Damascus Radio,* Syria in English at 2040.
17765 *VOA Tinang* in English at 1700.
17855 *NHK,* Japan in English at 1020.

Hugh Cocks of Mayfield used his Unica UNR-30, 50-foot long-wire and outdoor TV aerial to compile an extremely long log which included:—

6135 *HCJB,* Ecuador at 0845.
6540 *Pyongyang,* N. Korea at 1900.
7235 *R. Australia,* signing off at 1730.
7270 *R.S.A.,* South Africa at 2000.
9525 *R.S.A.,* South Africa at 2100.
9550 *R. Australia* at 1700.
9580 *BBC,* Ascension Island at 0715.
9745 *HCJB,* Ecuador at 0930.
9912 *All India Radio* at 2000.
10040 *Hanoi,* N. Vietnam at 2000.
11675 *Radio Pakistan* at 2000.
11775 *TWR,* Bonaire, signing on at 0730.
11795 *WINB,* U.S.A. at 2100.
11835 *Algeria* in French at 1200.
11860 *BBC,* Ascension Island at 0700.
11910 *ETLF,* Ethiopia with news at 1930.
11955 *BBC,* Malaysia at 1645.
11960 *VOA Thessaloniki,* Greece at 1630.
15018 *Hanoi,* N. Vietnam at 2000.
15110 *WIBS,* Grenada at 2000.
15125 *R. Australia* at 0700.
15155 *ELWA,* Liberia in Arabic at 1615.
15185 *Lagos,* Nigeria at 0700.
15200 *Lagos,* Nigeria with news at 1530.
15295 *TWR,* Bonaire in English at 2145.
15325 *Rwanda* relay of Deutsche Welle at 0630.

Jeffrey Malina, London N.4, has a Skyrover Mk. II receiver and a 110-foot long-wire which enabled him to hear:—

7245 *BBC,* East Med. relay at 2115.
9009 *Israel,* Jerusalem, English at 2115.
9480 *Radio Kiev,* Ukraine in English at 1930.
9545 *BBC,* Ascension Island at 2100.
9625 *Israel,* Jerusalem at 2045.
15250 *R. Bucharest,* Rumania at 1300.
17775 *R. Afghanistan* in English at 1815.
17875 *VOA,* Monrovia, Liberia in Russian at 2115.
21535 *NHK,* Japan in English at 0800.
21545 *R. Accra,* Ghana at 1445.

Colin Beesley of Bristol is another reporter with a Unica UNR-30 receiver which he uses in conjunction with a 75-foot aerial to hear stations which include:—

9725 *R. Sweden* in German at 1200.
9805 *R. Cairo,* Egypt with news at 2340.
11875 *RAI,* Italy in French at 1530.
11930 *Radio Australia* at 2230.
15160 *R. Ankara,* Turkey, news in English, 2300.
21545 *R. Accra,* Ghana, news in English at 1630.
25790 *R.S.A.,* South Africa in English at 1625.

Christopher Gibbs in Camberley has a Trio 9R-59DS receiver, a 20-foot long-wire and a Joystick antenna which enabled him to hear:—

5035 *R. Clube de Cabinda,* Angola with music at 2000.
6025 *R. Portugal* with DX programme at 2100.
6090 *R. Luxembourg* at 2109.
7210 *R. Norway* noted at 1805.
7220 *R. Budapest,* Hungary at 2132.
9525 *R. Warsaw,* Poland with news at 2030.
11755 *R. Finland* with news at 1815.
11940 *R. Bucharest,* Rumania in French at 1900.

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

ON THE SHORT WAVES

THE AMATEUR BANDS

David Gibson, G3JDG

Frequencies in kHz • Times in GMT

THE short skip conditions of the last month seemed to suggest that two metres should be showing some interesting results. However, logs from listeners did not bear this out. The skip was particularly noticeable on twenty where locals and near Europeans were coming in at colossal signal strength despite many of them using verticals, including some ground planes, which are often described in the antenna textbooks as just the thing for cutting down the local signals and picking up the DX.

Conditions have been about average for the time of year with most of the DX packing into 14 and 21MHz. The lower frequency bands have not seemed to be too keen to part with any DX, at least, at this scribe's QTH. Ten metres has been up and down with the "down" being the more dominant of the two. Trouble is with ten, the moment you switch to another band the 28MHz sector can quite easily jump to life and permit the keen listener to log five continents in about the same number of minutes.

Topband has been lively as far as G stations are concerned with the usual crop of mobiles (including G3JDG) putting up quite a bit of r.f. Apart from the odd OK this band appears to have become a G-band unless someone has been hearing things I haven't?

John Moore (Leicester) says that his c.w. is quite good and claims that not only does he now find c.w. DXing as easy as phone, but he has the extra pleasure of knowing that fewer listeners are hearing his best c.w. DX stations. Just goes to show what can be done with a bit of persistence and determination. John bagged a couple of OK's on Topband and even managed to log s.s.b. squeaks from: MP4MBC, UF6FAX (c.w.) ZC4MU, ZS4RO, ZS6AYW, 5H3LV, 9J2RA, 9J2TF on ten metres.

"There's no 'H' in Witney," says **Stefan Kaye** (Witney with no 'H'). A peep at 80 metres with an AR88D and a 250ft. long wire at ground level revealed: CT1UEG, EA4ITU, EP2BQ, PY1AJ, VE1AGH, ZL4JF/A, ZL3LE, ZS1MH, all s.s.b.

T. Wright (High Wycombe) seems to bear out my remarks about 160 by saying that there have been "hoards of G stations about this month". Tim's log for 14MHz received on an R107 and 120ft. end fed includes: JA3EP, JX8IL and KP4GM plus a long list of EU stations. Looks like the short skip was quite prominent for best part of the month.

D. Palmer (Bishopbriggs) observes that I do not appear to receive many logs for forty metres. Receiver is a modified 19 set with a 7MHz dipole and a.t.u. which raised thirteen PY stations plus: CX1AA, CX1BBR, JW7UH, JW9QH, K1GZL, LU8AJG, VP2AA, ZB2A, 4Z4DX.

M. Bradford (Edmonton, N.9.) says that the l.f. bands have failed to produce anything interesting and that ten metres has been disappointing. This was not the case with 14MHz which obliged with s.s.b. from: CN8MC, CT2BB, EA8DJ, K4RON, KG4AL, KG4EQ, LU4ECO, PY4AEB, VK2NN, VK5AZ, VP2BGL, W3UBM/MM, 4X4AE, 4Z4JW, 9K2YG. A listen on 21MHz produced: CE4ME, EA8GZ, JA4JBP, JA7EA, KZ5AA, LU2ECS, VS9MB, VS9MT, 9Q5OA.

Les took his homebrew v.h.f. Rx and it didn't work (hard luck Les), this is only part of the story. Three conspirators pooled their gear to form a combined assault on the amateur bands. The results on 20 were: FG7TD, HK1CDK, HK3AUE, HR1SO, HR5JDC, MP4BIN, TI2AAC, UL7NW, VE1AVM, VE2DVV, VE3DLC, VK3BM, W5DRW, XE1WA, YV5BPG, and on 15 metres: CR6GA, W2AMM, W9IYY, YV1AVU, 4X4AE, 4Z4HF. Will the real **D. Lawley, A. Wade** and **L. Allen** please stand up? Incidentally, D. Lawley also sent in an individual log which included 27 VK stations received on his CR7OA and 64ft. end fed at about 18ft.

S. Lamprey (Cardiff) has a 9R59DE which has had a few unspecified mods done to it. The aerial is 30ft. of wire with a Joystick on the end. Signals received from: EP2SW, HV3SJ, JW5NM, JW7UH, JY1, M1ACH, MP4BJG, OD5FI, ST2SA, DJ3DH/TA, TU2AZ, 5Z4MI, 7Z2OM, 7Z3AB, 9K2AM, 9M2CP, 9Q5IA. No mode mentioned.

DX letter this month comes from **Tony Curtis** (Canberra, Australia). Tony is 17 and has been an s.w.l. for about four months. His s.s.b. log, using domestic receiver (Circa 1950), is fitted with a homebrew b.f.o. which has a bad attack of the drifts. However, the log for 20 metres reads: G6IA, G7LB, JA1EPJ, VK1EP, VK2ACD, VK3AJP, VK4AZ, VK5EB, VK6RU, VK8JS, VK9XI, countless W stations, ZL1ALW, ZL2ON, ZL3FM.

Happiness is JR-500S-shaped to **J. Iredale** (Llandudno). His pet is fed regularly with a dipole or 132ft. end fed (nothing like a varied diet) and in return for this loving care produced 20 metre evidence of: CT2AK, CT2BB, DU1DBT, JA3AAW, JA6AV, JA9YBA, JW5NM, K2LQQ/TF, KV4AM, KZ5JF, LU1FKF, LU8DFB, OX3BD, PY2CSV, PY3BXW, PY7YS, TI2JO, TI2WA, TG9LM, WA1NGK /TF, W6REH, ZB2A, ZL1PY, ZL2ABY, 4Z4HF.

A new CR7OA at the Coulsdon QTH of **J. Iggleden** is fed from a 215ft. network of wire (knit yourself an antenna kit?). Since installation it has produced 21MHz s.s.b. from: EA7DJ, JA8NJO, K5HYB, K6HTM, PY2ERS, TR2AA, W6ATW/M, W6TUQ, ZM6UP, 4X4AE.

Busy month for keen types. August 7-8, WAE c.w.; 8, Woburn mobile rally; 9, 2 metre s.s.b. contest; 15, 70MHz c.w. contest; 15, Derby mobile rally; 15, Torbay mobile rally; 22, Swindon mobile rally; 28-29, All Asia c.w. contest; 29, Stratford-upon-Avon mobile rally. September 4-5, v.h.f. n.f.d.; September 4-5, Region 1 IARU v.h.f./u.h.f. contest.

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

practically wireless commentary by HENRY

No. 83

Odd Audio —again

THE more we get embroiled in that fringe area of wireless —what is now known as the hi-fi world—the less scrupulous salesmen seem to be. Trade Descriptions Act notwithstanding, some purveyors of audio equipment beg a great many questions when they prepare their sales brochures.

We are familiar with the 'what's a Watt?' argument, aware that output power can depend on all sorts of different measuring conditions, from the way you supply your amplifier voltage to the way you cock your head. By judicious juggling, one can make a humble ten-watter sound—on paper—like one of those monstrosities that pump P.A. around the local discotheque.

What we are not always ready, or able, to dispute, even if willing, is the more subtle business of distortion percentage, signal-to-noise ratio and overload. Even where these are stated, the trusting soul can be caught out.

Just lately, our illustrious contributor, Gordon J. King, has been insisting on applying more stringent tests. He would like makers to quote a true 'power bandwidth' and he requires more comprehensive distortion limits than a manufacturer is usually prepared to give. And what Gordon wants, Gordon usually gets.

Don't jump on me, Joe

One of the things he wants is a statement of the output power over the rated frequency range of the equipment relative to the test frequency setting. The frequency limits where output falls by half then become the 'power bandwidth,' much more revealing than a single figure at a single frequency.

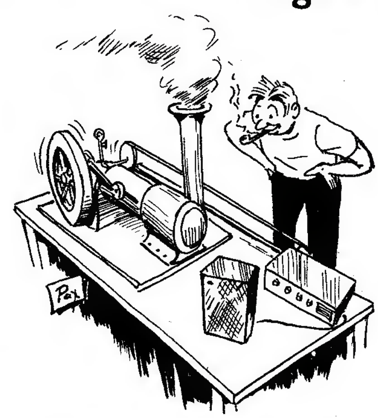
Moreover, he demands rms watts—none of your cheap and nasty Music Power for him. No use the amplifier designer arguing that real-life conditions do not encompass sinewave signals at full whack. Gordon and others argue that unless the rms test can be applied—continuous sinewave power—meaningful measurements cannot be taken and true comparisons can never be made.

Distortion is another matter for argument. A lovely low percentage at full power at 1kHz may make a Class B amplifier seem impressive. Check it again at 'normal' listening level, and see what you have got.

Then do a 'distortion bandwidth' test the way you did the power bandwidth test, i.e., over the specified frequency range. Oh boy! You should see the curves obtained from some quite well-regarded amplifiers when we make them suffer that indignity.

Some of the high-falutin' chatter that is going on about low-noise tape recording and the superiority of cassettes conveniently overlooks the fact that the distortion figure for a run-of-the-mill machine may be a couple of per cent—against the 0·1% we nowadays expect from a good amplifier and the 0·5% we usually get from a mid-price version. All right then—don't jump on me, Joe. I know that you cannot compute percentages like that.

But Henry would also like to see a regular set of standards applied. Even now, there is a committee advising another sub-committee, who are passing on their findings to the British Standards Institution, who may—eventually —stir their sluggish feet and complete BSS 3860; 1968 and 1568 and Part 1 1970.



Driving our amplifiers by steam

Mind you, there is some very odd audio around. Take the Bose system. At 250-quid for a couple of speakers and an equaliser—*you* take it. Henry sticks his neck out in merely mentioning it for Dr. Aram Bose is currently sueing the American Consumer Association for more than they have got because they said his speakers needed tons of power to drive them and were not very effective when you did!

There is a review of the Bose 901 in the July 1971 issue of *Hi-Fi News,* where Ralph West keeps on about the 'smoothness' of the sound. He theorises about violins and Rolls-Royces being 'run-in' and the good sound of paper-cone speakers because the bugs are worn away.

Then the Editor chips in with a dry footnote to the effect that the original 4 inch drive units (Bose has nine of these per speaker) were taken from a Fisher FM table radio. You see? Odd audio or not, we come back to wireless in the end. Just think, if Benjamin Franklin hadn't earthed his key, we would have been driving our amplifiers by steam.

TAKE 20

JULIAN ANDERSON

No. 29
SLAVE FLASH TRIGGER

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

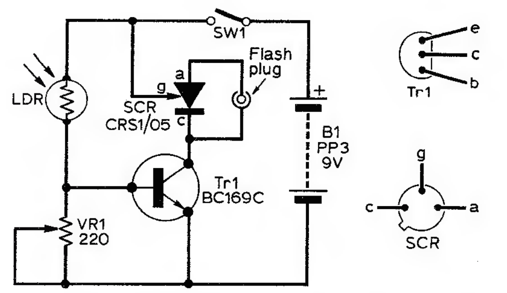


Fig. 1 : The circuit of the slave flash trigger with the semiconductor connections shown on the right.

ELECTRONICS has brought about the introduction of excellent, inexpensive electronic flash guns. They are so cheap in fact that there is little demand for circuits to build one's own (though this is perfectly possible) but a number of ancillaries can be made for use with a flash gun.

One of the disadvantages with flash pictures is that the subjects often look harsh as narrow bands of dark shadow usually outline one edge of the subject. This, of course, is due to the flash point not being at exactly the point of the lens on the camera.

Bounce flash overcomes this but has the serious drawback that it is extremely difficult to calculate the exposure.

Another solution is to use two flash guns, one conventionally but a second one pointing from a very different angle whose job it is to soften the hard shadows and we can call this one a "slave flash". It would be possible to arrange some form of direct switching to trigger both from the shutter contacts but the one described here is completely unconnected electrically and is thus far more versatile.

The light from the master flash is arranged to trigger our little circuit, which in turn makes the contacts for the slave flash.

The reduction of components prices in recent years has made it possible for us to use some components that would not have been possible before in our series as the total cost would have exceeded the £1 limit. In this circuit we are using two such components: a light dependent resistor (LDR) and a thyristor or silicon controlled rectifier (SCR).

Light dependent resistors are exactly what their name implies. In bright light—such as produced by a flash gun—their resisitance is very low. The actual value varies considerably with the actual specimen but ranges between 10Ω and 200Ω. On the other hand in complete darkness a good sample will have a resistance of several megohms and even poorer ones at least 10kΩ.

This LDR is connected between the positive line and the base of Tr1. In the ordinary way, even in complete darkness, this would be sufficient to bias the transistor into conduction, but VR1 is connected between the base and the emitter, forming a potential divider.

Being a silicon transistor, Tr1 will be off (i.e. no current will flow from emitter to collector) until the base is at about 0·6V above that of the emitter. It will thus be seen that, by correct setting of VR1, Tr1 can be arranged to be off in ambient light but as soon as extra light falls on the LDR, the potential at the base rises and the transistor is switched on.

The SCR in the collector circuit of Tr1 operates in much the same way as a relay. In normal conditions there is a very high resistance between anode and cathode but when triggered with a pulse at the gate, the resistance falls to practically nothing. In this circuit, for convenience, the gate is constantly at supply potential and it is arranged for the cathode to be made more negative, but it comes to the same thing as pulsing the gate.

If the electronic flash switch contacts are connected across the SCR, these will thus be shorted out when the light level on the LDR reaches a certain level. This operation takes place at electronic speeds and although there will be a delay between the main flash and the slave flash, it can be measured as a few millionths of a second.

Flash guns are usually fitted with 3mm coax plugs and the corresponding sockets can be obtained from most photographic shops, though the cost of this item takes us outside our £1 limit.

Note that the flash contacts *must* be connected the right way round, positive to anode, negative to cathode, and the potentials at the flash gun's plug should be checked.

As far as the camera aperture is concerned, this will depend on the film used and the direction in which the slave flash is pointed. Black and white film is not so critical as colour as far as exposure is concerned and no adjustment is necessary. ■

★ components list

Tr1	BC169C	11p†
SCR	CRS1/05 Thyristor, 50V, 1A	25p*
LDR	Light dependant resistor	43p‡
VR1	220Ω linear potentiometer	12p†
SW1	On-off toggle switch	7½p‡
		98½p

† Electrovalue Ltd.

* G. W. Smith Ltd. or A. Marshall and Son.

‡ J. Bull (Electrical) Ltd.

Prices are those advertised in Practical Wireless July 1971 and may have changed. No allowance is made for minimum order costs or for postage and packing and these should be checked carefully before ordering.

VARIABLE FREQUENCY AUDIO OSCILLATOR

J. B. WILLMOTT A.I.P.R.E.

MANY constructors will have in their spares box a selection of 1·4V filament battery valves taken from discarded "All Dry Portable" receivers. It occurred to the author that, when only intermittent operation over short periods is required, battery type valves of the B7G based miniature range form an excellent basis for the construction of simple test equipment. The one which forms the subject of this article was a wide range variable frequency audio oscillator, an extremely useful piece of equipment for testing audio amplifiers or the audio section of radio receivers. The majority of the old type battery portable receivers used a standard line up of four "DK" type valves, typically DK96, DF96, DAF96 and DL96. The requirements of the instrument described here are for two general purpose triode valves, and it was found that using the DF96 and DAF96 (or the older 1T4 and 1S5) connected as triodes, gave very satisfactory results.

The completed instrument will give a generous output (somewhere in the range of 2V peak) over a wide range of frequencies, from approximately 40Hz to 20kHz, the latter of course beyond the range of human hearing, but desirable when testing audio equipment. The coverage is given in three switched ranges (a fourth position of the range switch is the "Off" position), each of which slightly overlaps its predecessor. The waveform produced is good, and if an oscilloscope is available, the response of the amplifier under test can be accurately displayed and and tendency to distortion at certain frequencies becomes readily apparent.

Circuit Description

The circuit composes two triode connected valves, linked together by conventional RC coupling by the components R3, C7 and R4. The output from the anode of V2 is applied in the form of negative feedback via the capacitor C9, and the potential divider network provided by VR2 and VR3 to the cathode (filament) of V1. Simultaneously, positive feedback is applied to the grid of V1 through the potential divider network comprising C1, C2 or C3 (as selected by the section "A" of the range switch) and VR1a, together with C4, C5 or C6 (selected by section "B" of the range switch) and VR1b.

Provided that the amount of positive feedback at the grid of V1 exceeds that of the negative feedback applied to its cathode, oscillation will take place and be maintained, the frequency depending on the setting of the range switch and the ganged potentiometer VR1. Both VR2 and VR3 are adjustable, and the circuit can be so "balanced" that steady a.f. oscillation is maintained throughout the range. The values specified for C1 to C6 are such that each "sweep" of VR1 provides the desired range of audio frequencies. It is important that VR1 is a dual ganged potentiometer of the linear type, otherwise a steady increase in frequency as the control is rotated clockwise will not be obtained. The third "pole" ("C") of the range switch is utilised to provide on/off switching, in the maximum anti-clockwise position, the LT supply to the valve filaments is broken, and hence the instrument is "off", as no HT current can flow unless the valve filaments are heated by the passage of the LT supply through them.

The audio output of the intrument is picked off from the anode of V2 via C8, and taken to the coaxial output socket. In order to minimise the effect of connecting external apparatus of widely varying output impedance, a 27kΩ resistor is connected permanently across the output socket (R6).

—continued overleaf

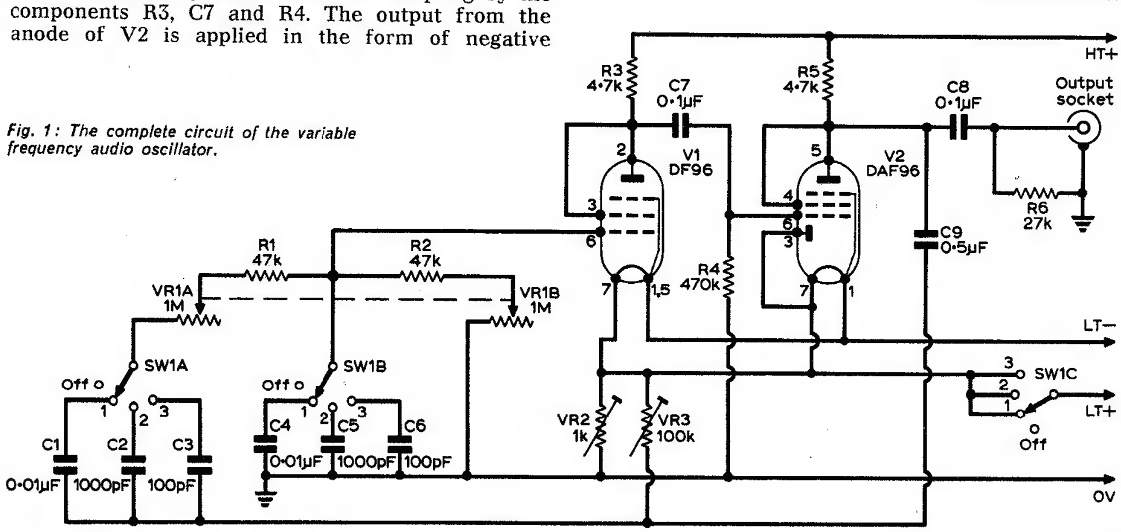


Fig. 1: The complete circuit of the variable frequency audio oscillator.

Testing the Instrument

Connect the output of the instrument to the input sockets of any available audio amplifier (valve or transistor) known to be in good working order, or to the pick-up sockets of a radio receiver. Set the fine frequency control to the mid-point of its range, and also set VR2 and VR3 to approximately midway setting. Switch on the amplifier (or radio receiver) and in the case of valve equipment, allow time to warm up. The volume control should be set approximately at the level required for normal radio (or record) reproduction. Now, having first made sure that the HT and LT batteries have been connected, turn the range switch to position 3, i.e., the middle range of frequencies. A note of approximately 400Hz should be heard in the loudspeaker. Adjust VR2 for maximum output, then reduce the setting of VR3 (by turning it anticlockwise) until oscillation ceases. Now re-advance VR3 until the oscillation just recommences. Next vary the setting of the fine frequency control VR1 and ensure that oscillation is maintained at all settings. VR3 should be set at the "minimum" consistent with maintained oscillation. Now set the switch to Range 1 (lowest), and finally to Range 3 (highest) frequency settings, and make sure that all positions of VR1 oscillation is maintained. Adjust VR3, and VR2 if necessary, to ensure that this is the case. The instrument is now completed and ready for use. ■

TOPIC OF THE MONTH

"Electronic Vandals" continued from page 383.

why not join the society and take part in properly conducted explorations!

How does all this square up with the publication last month of the P.W. *Treasure Tracer?* In the first place let it be said that your editor is not only professionally involved in the making and using of electronic devices but is also an active archaeologist, a foot in both camps as it were. Basically it is felt that there is no reason why people should not enjoy innocent amusement with metal locators. It is generally thought that some site looters are unaware of the irreparable damage they can do so quickly, but a little thought will show that the robbing of archaeological sites is as indefensible as looting the showcases in a local museum. These sites are not only part of *our* heritage but also of future generations. So, don't get carried away with ideas of a vast fortune just waiting to be dug up—try the pools for that! And don't go tramping about on farmland without having first obtained permission from the owner.

W. N. STEVENS—*Editor.*

BACK NUMBERS

We regret that the back numbers department of P.W. has now closed and consequently we are unable to supply these.

Requests for specific back issues can usually be included in our 'CQ' section; there is no charge for this but it is a service between readers and P.W. are unable to meet any of these requests.

HARMONIC SIX—*continued from page 398*

of the cores should be needed.

Once the i.f. amplifier is aligned it should not be touched further as it is pointless to alter these cores again while aligning the mixer stage.

MIXER ALIGNMENT

All the cores are adjusted so that about $^3\!/_8$in. of brass rod projects. Screw TC2 about half down. Switch to the lower frequency range and tune in a signal with VC1/2 nearly fully open. Peak up the signal by rotating VC3. If VC3 is nearly fully open, screw down TC2 a little. With a signal peaked with VC3, tune towards the l.f. end of the band. When signals are tuned in, adjust the core of L2 for best volume. Continue until VC1/2 is nearly fully closed. If much adjustment of L2 core is needed, repeat from the h.f. end of the band. The purpose is to adjust TC2 so that signals peak with VC3 near the h.f. end of the band, with VC3 about half closed, then to set the core of L2 so that the minimum re-adjustment of VC3 is necessary, while tuning to the l.f. end of the band.

When this is done, switch to the h.f. range and repeat, adjusting the core of L1 near the l.f. end of this range.

If necessary, actual band coverage can be altered by moving the core of L3 near the l.f. end of the bands, and adjusting the trimmer TC2 near the h.f. ends of the bands. After any such change to coverage, adjust L1 and L2 to match, as mentioned.

AERIALS

For a short rod or wire aerial, TC1 can be about half closed but for a longer aerial it should be unscrewed somewhat.

The aerial in use will influence the setting of VC3. Provided VC3 can be peaked for best results, at any frequency, and is not fully open or fully closed, there is no loss of efficiency due to wrong alignment. However, when alignment is correct, little or no adjustment of VC3 will be wanted while tuning, except perhaps to peak up very weak signals.

NOTES

Resistors R4 and R5 are to prevent squegging and violent oscillation near the h.f. end of the oscillator range. With the coils and values shown, good results should be obtained without experiment.

In some cases a change in one or both values will be more suitable for the actual transistor fitted for Tr1. It may be found that R5 can be omitted, Tr1 emitter being wired directly to pin 5. With some transistors, R4 could also be omitted, or could be of lower value. R4 and R5 should be of the lowest values which do not result in numerous whistles and oscillation accompanying all signals tuned in near the higher frequency ends of the wavebands.

A 3-ohm speaker is suitable and should be in a cabinet, or fixed to a baffle board. A headset with headband is more convenient than a miniature or single earpiece for this type of reception. Medium or low impedance phones will generally be satisfactory.

The tuning dial may consist of a numbered dial, or two scales can be drawn on thin card, and marked with frequencies. The card can extend over the whole panel, and may be covered with thin transparent material. ■

EXPERIMENTERS CORNER

NOVEL DOOR ALARM

DAVID CROSS

As the author's doorbell needed replacing, it was decided that an electronic replacement would be a good idea. It would be simple, but rather dull, to replace this by a simple audio oscillator feeding an amplifier and for this reason a two-tone version was designed, that is one that would provide two notes in rapid succession. Readily available components were used in the construction and on the prototype many of the components were found on discarded computer board panels.

The sound produced by this circuit has many uses other than for a door alarm and works equally well as a burglar alarm. This is especially useful as the sound produced can be made to sound almost exactly like that of a police siren—enough to worry any potential burglar!

When Tr1 is switched on, diode D1 conducts, this provides an additional conducting path for C2, thus shortening the time taken for the capacitor to discharge and trigger Tr2, which does exactly the same for C3 in the next half cycle. As it can be seen, if the resistance is high in VR2, VR3, the frequency is hardly altered, but as the resistance is decreased, C2, C3 alternately discharge through it, shortening their discharge times and therefore the frequency. The two pots used were actually salvaged from ex-equipment computer circuit boards, as were the transistors and some of the resistors.

The output from this multivibrator is picked up from the collector of Tr1 and is fed via C1 to the volume control of the amplifier.

The amplifier used by the author was taken from an old battery tape recorder but any of the commercial amplifiers are suitable such as the Eagle EG 2004 250mW model. Many simple audio amplifier circuits have been published in Practical Wireless and these are also suitable.

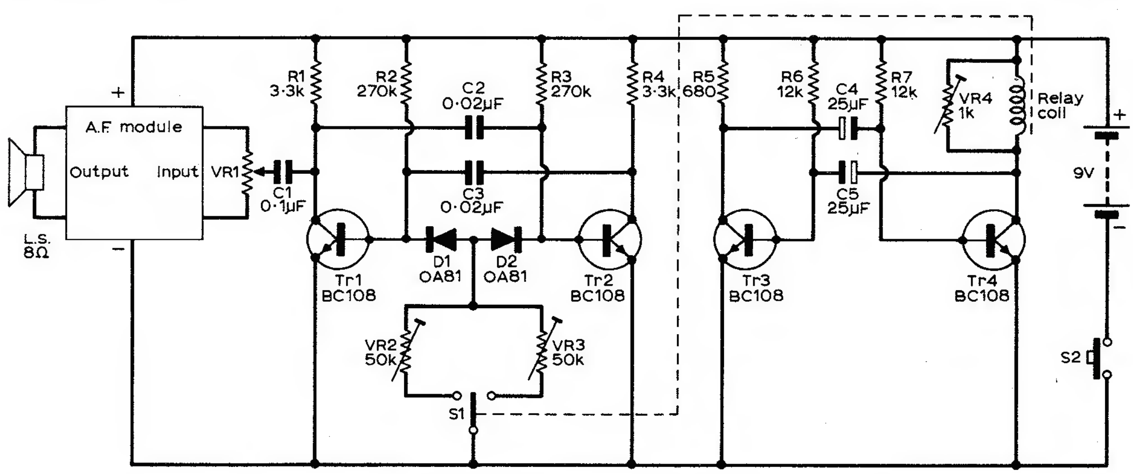


Fig. 1: The circuit of the two tone door alarm.

THE CIRCUIT

The circuit comprises three main parts; two multivibrators and an audio amplifier. One of the multivibrators controls the rate of switching of the two notes, Tr3 and Tr4 provide this function and C4 and C5 control the rate of change. Tr4 has a reed switching coil in the collector circuit and a 1kΩ preset potentiometer is wired across this. VR4 controls the division between the two notes; it can be set for equal division or for any other spacing.

The second multivibrator is designed to operate at audio frequencies, the actual notes generated depend on the settings of VR2 and VR3.

Construction is a matter of personal choice but all the components can be mounted on plain Veroboard, the main wiring being provided using Cir-Kit strip. The existing bell wiring can be used and the bell push is represented by S2.

Once completed VR2 and VR3 can be adjusted for a pleasant couple of notes and VR4 adjusted for the balance between them. ■

CHARLES MOLLOY

THE Medium Wave Column

THE new station at Kinshasa in the Congo has been widely heard in the U.K. with African style music and announcements in French. Listen before 0300hrs GMT while the channel is clear of QRM. On weekdays Deutschlandsender is off the air from 0130 to 0300hrs but on Sunday there is only a 15 minute break from 0245hrs. The north/south path is usually good during the summer. Gerry Wood from a QTH near Cape Town reports regular reception of the more powerful Europeans using a modified car radio.

Medium Wave stations in Newfoundland are often conspicuous in summer from 0200hrs GMT until sunrise. The strongest signal is from CBN 640kHz in St. John's which is the outlet of the Canadian Broadcasting Corporation. Satellites CBNA 610kHz in St. Anthony and CBNM 740kHz in Marystown usually carry the same programme which is announced as the CBC Radio Network. VOCM 590kHz in St. John's is the key station of a commercial network which is also represented by CKCM 620kHz in Grand Falls and CHCM 560kHz in Marystown. All three carry the same programme and have a common identification. CJOX 710kHz in Grand Bank and CJCN 680kHz Grand Falls relay the CJON Radio Service which has its chief station CJON 930kHz in St John's. Newfoundlanders are logged regularly in this country and are often noted before sunrise as a cluster at the bottom of the band.

Broadcasting Stations of the World Part 2 is published at intervals of approximately 18 months by the Foreign Broadcasting Information Service of the United States Government. All known broadcasting stations in the long, medium and shortwave bands in the range 150kHz to 26MHz, in order of frequency, with some data on location, power and station identification, are listed except for MW stations in the U.S.A. The latest edition of the FBIS list, correct to January 1971, is now available. It can be obtained from the Superintendent of Documents, Government Printing Office, Washington DC20402, U.S.A., by quoting catalogue number PX EX 7.9.971 part 2, and sending a money order for $2 in U.S. currency.

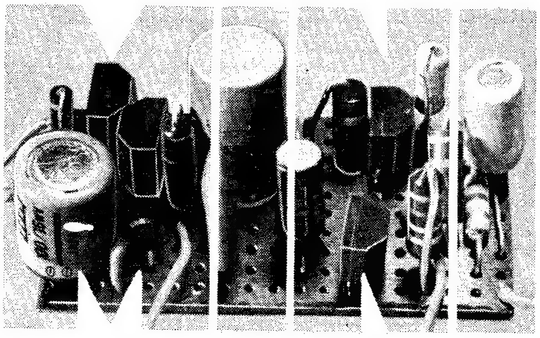
Leslie Smith of Witham, Essex, R. T. Johnston of Christchurch, Hants, and Frank Jeniker of Spur Tree Jamaica have written asking for information on MW loops. Anyone who would like to see an illustration of a loop should write to Radio Nederland and ask for the Frame Aerial Data Sheet. It can be obtained free of charge from Postbus 222, Hilversum, Holland.

Arthur Cushen of Invercargill, New Zealand, has recently verified his 2000th medium wave station. He sends the following details which will surprise many DXers. His QSLs are from stations in 132 different countries and 114 of them are from Europe and include every country. Arthur, who is blind, was awarded the MBE for his services to broadcasting. DXers, including the writer, who met him during his visit to this country in 1969 will be happy to congratulate him on his latest achievement.

All reports and information concerning Medium Wave DXing may be sent to me at the following address:

Practical Wireless Editorial Department, IPC Magazines Ltd., Fleetway House, Farringdon Street, London, EC4A 4AD.

Charles Molloy



amplifier

R.A.PENFOLD

ALTHOUGH integrated circuits have largely taken over in the field of miniature electronics, it is still possible to construct a miniature audio amplifier which is economically competitive with an i.c. and which will give far more satisfaction to build.

The amplifier which is the subject of this article measures approximately 2 x 1 x 1 inches, and will deliver about 250mW to a 25Ω impedance loudspeaker. Its most obvious use is in the role of the audio stages of a small transistor radio, but it may be used for many other purposes. It is possible to buy all the components (excluding the various miscellaneous items) for under £1.

THE CIRCUIT

The circuit is given in Fig. 1. Four transistors are used, and these are all silicon types. Tr1 is an NPN, low noise type, which is used as the input stage. The input signal is coupled to the base of this transistor by C1, after having first passed the volume control. It is biased by the potential divider formed by R1 and R2, R3 being the load resistor.

C2 is a frequency correcting capacitor which is used to give negative feedback at high frequencies, where it has a lower reactance, and thus attenuating the higher frequencies.

Tr2 is a PNP type, and is used as the driver transistor. Biasing is performed by R4 and R5. As R5 is connected to the junction of the emitters of the two output transistors, as the voltage at this junction goes positive and negative with the input signal, the biasing of Tr2 will alter, and thus negative feedback is applied. R6 and R7 allow a small current to flow through the output transistors under quiescent conditions. This prevents crossover distortion which would otherwise occur as the input pulses change from one polarity to another. R6 and R7 also form the load for the driver stage.

OUTPUT STAGE OPERATION

A complementary output pair are used, the BC159 being a PNP transistor, and the BC147 being the NPN type. These transistors are used as emitter followers and so have a very low output impedance, and thus require no output transformer. The bases of these transistors are directly coupled to the driver transistor.

When a negative pulse is applied at the bases, the NPN transistor will shut off, and the PNP one will amplify, and its resistance will fall accordingly. This will cause the voltage at the junction of the two emitters to swing down to a very low level.

If a positive pulse is applied to the transistors, the PNP one will shut off, and the resistance of the

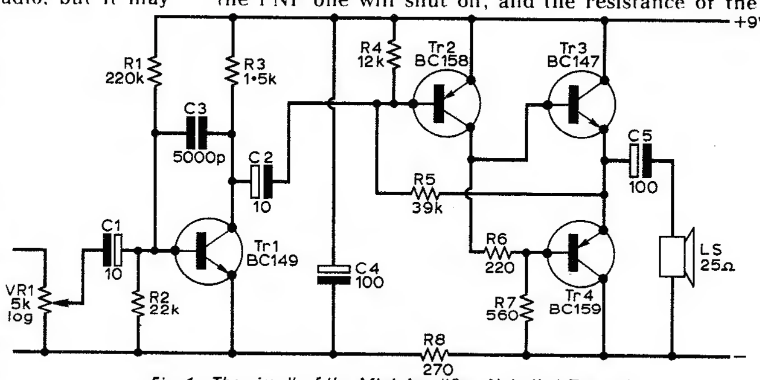


Fig. 1: The circuit of the Mini Amplifier. Note that Tr3 and Tr4 should preferably be matched transistors.

★ components list

Resistors

R1	220kΩ	R5	39kΩ
R2	22kΩ	R6	220Ω
R3	1·5kΩ	R7	560Ω
R4	12kΩ	R8	270Ω

All resistors ¼W, 10% types.
VR1 5kΩ log. pot. with switch

Capacitors

C1	10μF 6V	C4	100μF 10V
C2	10μF 6V	C5	100μF 10V
C3	5000pF		

Semiconductors

Tr1	BC149	Tr3	BC147
Tr2	BC158	Tr4	BC159

Miscellaneous

Veroboard, 2 x 1", 0·1" matrix.
15–30Ω impedance loudspeaker.
9V battery with battery clips.

—continued on page 426

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AC ranges: 1·5-3-7·5-15-30-60-150-300-600V. 600µA-3-15-60-300mA-1·5A.
Resistance: 0·5-5-50-500kΩ.
Capacity and Transmission level scales.
Accuracy: 1·5% DC; 2% AC.
PRICE, with carrying case and leads, **£10·50.**
Both instruments have knife-edge pointers and mirror scales.

TYPE 4312—Low sensitivity (667 o.p.v.) extremely sturdy instrument for general electrical use.
DC ranges: 0·3-1·5-7·5-30-60-150-300-600-900V and 75mV; 300µA-1·5-6-15-60-150-600mA 1·5-6A.
AC ranges: 0·3-1·5-7·5-30-60-150-300-600-900V. 1·5-6-15-60-150-600mA. 1·5-6A.
Resistance: 0·2-3-30kΩ.
Accuracy: DC 1%; AC 1·5%.
PRICE, with carrying case and leads, **£9·75.**

BEST QUALITY CAPACITORS
WIMA DUROLIT

Capacitance	Working Voltage	Tolerance ±20% Net
1000 pF	630	**25p** pack of 5
1500 pF	630	**25p** pack of 5
2200 pF	630	**25p** pack of 5
3300 pF	630	**25p** pack of 5
4700 pF	630	**25p** pack of 5
6800 pF	630	**25p** pack of 5
0·01 µF	630	**27p** pack of 5
0·015 µF	630	**29p** pack of 5
0·022 µF	630	**29p** pack of 5
0·033 µF	630	**33p** pack of 5
0·047 µF	630	**40p** pack of 5
0·068 µF	630	**42p** pack of 5
0·1 µF	630	**50p** pack of 5
0·15 µF	630	**56p** pack of 5
0·22 µF	630	**67p** pack of 5
470 pF	1000	**29p** pack of 5
680 pF	1000	**29p** pack of 5
1000 pF	1000	**25p** pack of 5
1500 pF	1000	**25p** pack of 5
2200 pF	1000	**27p** pack of 5

WIMA TROPYFOL

Capacitance	Working Voltage	Tolerance ±20% Net
47 pF	400	**21p** pack of 5
68 pF	400	**21p** pack of 5
100 pF	400	**21p** pack of 5
150 pF	400	**21p** pack of 5
220 pF	400	**21p** pack of 5
330 pF	400	**21p** pack of 5
470 pF	400	**21p** pack of 5
680 pF	400	**21p** pack of 5
1000 pF	400	**17p** pack of 5
1500 pF	400	**17p** pack of 5
2200 pF	400	**17p** pack of 5
3300 pF	400	**19p** pack of 5
4700 pF	400	**19p** pack of 5
6800 pF	400	**19p** pack of 5
0·01 µF	400	**19p** pack of 5
0·015 µF	400	**21p** pack of 5
0·022 µF	400	**23p** pack of 5
0·033 µF	400	**23p** pack of 5
0·047 µF	400	**25p** pack of 5
0·068 µF	400	**27p** pack of 5
0·1 µF	400	**33p** pack of 5
0·15 µF	400	**44p** pack of 5
0·22 µF	400	**46p** pack of 5
1500 pF	630	**21p** pack of 5
2200 pF	630	**21p** pack of 5
3300 pF	630	**21p** pack of 5
4700 pF	630	**21p** pack of 5
6800 pF	630	**23p** pack of 5
0·01 µF	630	**25p** pack of 5
0·015 µF	630	**25p** pack of 5
0·022 µF	630	**27p** pack of 5
0·033 µF	630	**31p** pack of 5
0·047 µF	630	**36p** pack of 5
1000 pF	1000	**21p** pack of 5
1500 pF	1000	**21p** pack of 5
2200 pF	1000	**23p** pack of 5
3300 pF	1000	**23p** pack of 5
4700 pF	1000	**25p** pack of 5
6800 pF	1000	**27p** pack of 5
0·01 µF	1000	**27p** pack of 5
0·015 µF	1000	**31p** pack of 5
0·022 µF	1000	**36p** pack of 5

ADD 5p PER ITEM POST AND PACKING

WIMA MKS

Capacitance	Working Voltage	Tolerance ±20% Net
0·01 µF	100	**27p** pack of 5
0·015 µF	100	**27p** pack of 5
0·022 µF	100	**27p** pack of 5
0·033 µF	100	**27p** pack of 5
0·047 µF	100	**27p** pack of 5
0·068 µF	100	**29p** pack of 5
0·1 µF	100	**33p** pack of 5
0·15 µF	100	**38p** pack of 5
0·22 µF	100	**40p** pack of 5
0·33 µF	100	**44p** pack of 5
0·47 µF	100	**52p** pack of 5
0·68 µF	100	**69p** pack of 5
1·0 µF	100	**83p** pack of 5
1·5 µF	100	**£1·23p** pack of 5
2·2 µF	100	**31p** pack of 5
3·3 µF	100	**41p** pack of 5
4·7 µF	100	**47p** pack of 5
6·8 µF	100	**63p** pack of 5
0·022 µF	250	**27p** pack of 5
0·033 µF	250	**29p** pack of 5
0·047 µF	250	**29p** pack of 5
0·068 µF	250	**33p** pack of 5
0·1 µF	250	**33p** pack of 5
0·15 µF	250	**42p** pack of 5
0·22 µF	250	**42p** pack of 5
0·33 µF	250	**50p** pack of 5
0·47 µF	250	**56p** pack of 5
0·68 µF	250	**73p** pack of 5
1·0 µF	250	**88p** pack of 5
1·5 µF	250	**£1·25p** pack of 5
2·2 µF	250	**30p** pack of 5
0·01 µF	400	**27p** pack of 5
0·015 µF	400	**29p** pack of 5
0·022 µF	400	**29p** pack of 5
0·033 µF	400	**31p** pack of 5
0·047 µF	400	**33p** pack of 5
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0·1 µF	400	**40p** pack of 5
0·15 µF	400	**44p** pack of 5
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0·022 µF	630	**33p** pack of 5
0·033 µF	630	**33p** pack of 5
0·047 µF	630	**38p** pack of 5
0·068 µF	630	**44p** pack of 5
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I.C. OF THE MONTH

L.A.J. IRELAND

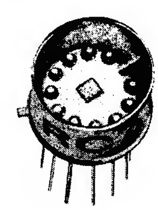
Number 23 — RCA CA3062 Photo-detector/amplifier

AT the outset of the present series of articles it was pointed out that full constructional details could not be given in each article due both to the flood of new devices released on the market and the complexity of some of the i.c.'s reviewed. As a result some inexperienced constructors may have found themselves uncatered for as it would be too much to expect of them to draw up their own printed circuit and layout designs. This month, however, a very useful i.c. is reviewed and a layout pattern illustrated so that a relatively inexperienced constructor may approach it with confidence. Few external components are needed so that success is virtually guaranteed.

Circuit

Photocell devices have always fascinated constructors as their uses are so varied and diverse from such things as counters and position sensors to the more familiar burglar alarm units. Considered in this month's article is the RCA type CA3062, described as a photo-detector and power amplifier and which is particularly suited for operations from either visible light sources or the newer infra-red Gallium Arsenide emitters.

Simple light dependent resistor control circuits suffer from two major drawbacks. First of all their response time is slow and secondly small variations in light intensity are not registered unless amplification follows. The photo-transistor is a much more sensitive device especially when a pair of them are connected in a super-alpha configuration as in the present design. In fact the photo transistors themselves give a variation in current from a mere 4 microamps in the absence of light to 2 mA with a light intensity of 100 lumens per sq. ft. This current variation is usually used to develop a corresponding variable voltage across a 22kΩ load resistor which in turn controls the biasing on either Tr2 or Tr3.



This photograph of the CA3062 is 2½ times its actual size. The i.c. itself can be seen in the centre of the package which is a modified 12-lead TO-5 style.

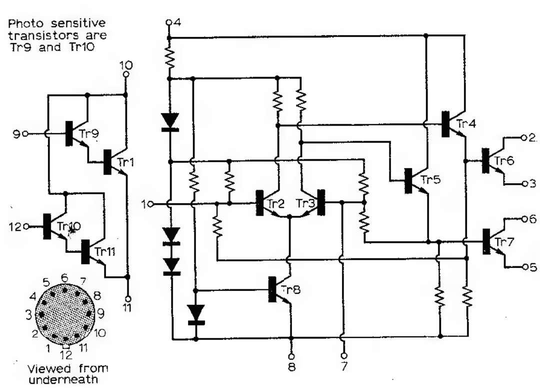


Fig. 1. Circuit of the photo-detector amplifier.

In Fig. 1 a complete circuit diagram of the unit is shown and it can be seen that Tr2 and Tr3 form a differential pair with Tr8 acting as a constant current source. From this configuration it follows that phase inversion occurs between the collectors of Tr2 and Tr3 which in turn control the current in the output pair Tr6 and Tr7 via Tr4 and Tr5 which prevent loading of the differential pair. Some constructors may notice the great similarity in circuit design between this i.c. and an earlier one manufactured by the same company, type CA3020, and featured in the May 1968 issue of P.W. The main amplifier in both are almost identical except for the inclusion of a constant current sink Tr8 in the CA3062 replacing a simple resistor in the earlier i.c. to provide better stability and greater amplification. The same type of specially fabricated output transistors are used in each to enable them to carry the higher currents they draw as output transistors. In fact, up to 100 mA can be taken from the output stage and this is more than adequate to directly drive a relay or thyristor.

Operation

For proper on-off operation the voltage on either pin 1 or pin 7 (either may be connected to the photo transistors) should not exceed 3 volts. This can be achieved by limiting the current through the photo transistors or on the other hand by inserting a clamping diode between whichever pin is used and earth.

It should also be noted that the device can also respond linearly to light variations by connecting a potential divider network between pin 6 and earth with the tap joined to pins 9 and 12 (two 20MΩ). However, in this mode of operation the output current is limited considerably as greater heat dissipation takes place in the silicon chip.

Practical Circuit

A suitable layout pattern for the photo-detector is shown in Fig. 2 and use could profitably be made of a TO-5 12 lead i.c. holder to prevent damaging the i.c. during the soldering process.

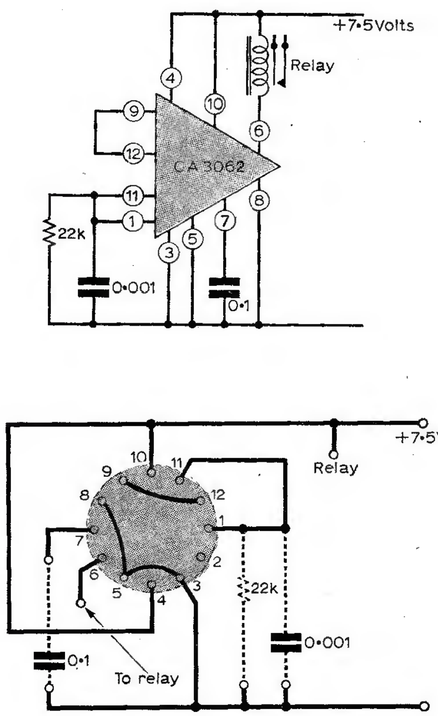


Fig. 2. The top circuit shows the two capacitors, one resistor and the relay needed to provide a practical circuit around the CA3062. The bottom diagram is a suggested layout for a circuit board using a TO5 12-lead i.c. holder.

In conclusion it may be pointed out that this device can provide light beam detection of up to 100 yards when used in conjunction with the new Helium-Neon lasers and which in the past year or so have appeared on the American market and no doubt will eventually filter over to this side of the Atlantic. The prohibitive prices of these devices severely limited their uses to industry and research centres but now one of these laser tubes sells for £20 and a suitable power supply to operate it can be built for under £5. No doubt this offers intriguing possibilities especially in the field of intrusion alarms and we can continue to expect in the future further developments along these lines.

MINI-AMP—*continued from page 422*

NPN one will fall. This will cause the voltage at the junction of the two emitters to swing to a very high level.

In this way the emitter voltage will swing up and down with the input signal. This voltage swing is coupled to the speaker via C5.

Under quiescent conditions the voltage at the emitter junction should be approximately half the supply voltage. This voltage is set by the values of resistors R4 and R5.

If the amplifier is to work properly, the output transistors should be fairly evenly matched. These transistors are not generally available in matched pairs, but some semiconductor suppliers will match transistors, although there may be a small surcharge for this.

Current limiting resistors are often connected between the emitters of the output transistors and the output capacitor, to prevent thermal runaway. Silicon transistors, however, do not suffer from run-away to anything like the extent that germanium types more usually found in this type of circuit do, and these resistors were found to be completely unnecessary.

Although the amplifier will operate using speaker impedances outside the range 15Ω to 30Ω, this is not recommended as it will mean either a loss in available output power, or an increase in the level of distortion.

CONSTRUCTION

The amplifier is built on a 2 x 1 inch piece of 0·1 inch matrix Veroboard, with the copper strip running lengthwise. This has to be cut from a larger piece of Veroboard using a small hacksaw. A wiring diagram of the panel is given in Fig. 2.

Great care will have to be taken with the connections to the Veroboard, and this project should not be attempted by the complete beginner. A soldering iron with a very fine bit is required, and some sort of stand to hold the board steady will be found to be extremely helpful.

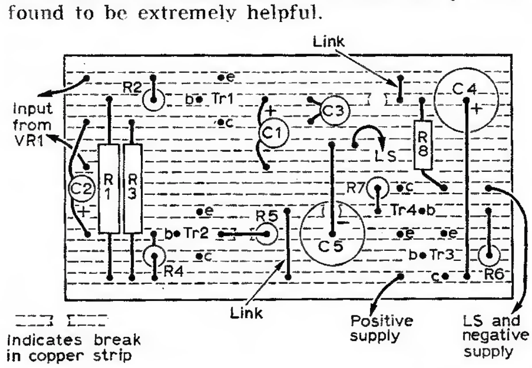


Fig. 2: The component layout on Veroboard.

All transistors are fitted with special leadouts which plug into the Veroboard. These leadouts are very short, and although silicon transistors are very hardy, these should be soldered quickly into place, and should be left until last.

The capacitors will have to be subminiature types, and like many of the components may have to be mounted vertically so as to fit into the available space. ■

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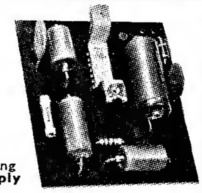

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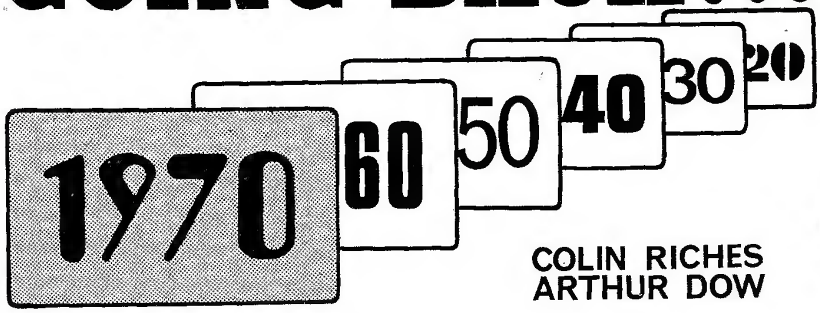
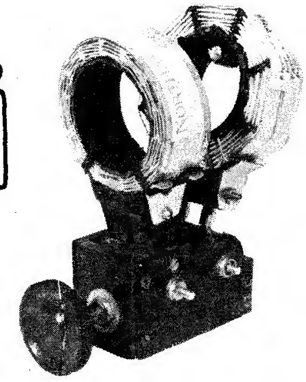
GOING BACK...





COLIN RICHES
ARTHUR DOW

FOLLOWING our brief mention of the type LS3 valve in 'Going Back' for June we were pleased to hear from George Jessop, G6JP, who has been with one of the leading valve manufacturers of this country for many years. George points out that the LS family of valves was introduced to make available larger output powers than were currently available with the 'R' type valve which had first appeared around 1915 (see 'Going Back' July 1971).

'LS' indicated a loudspeaker valve and applied to the earlier series LS1-6 and to several later types such as the LS7, 8, 8A and 9 although these had little in common with the earlier series, having oxide coated filaments and being specially manufactured for the Post Office.

The most famous valve of the early range was undoubtedly the LS5 which was for general purposes while the LS5A was meant for use as an output valve. The higher impedance LS5B completed the range and was intended for use in resistance-capacity coupled stages.

Both the Post Office and the BBC used these valves in their high quality audio amplifiers while, with the radio amateurs, the LS5B reigned supreme in frequency multiplier stages and the LS5 did duty in the power amplifier output stage. G6JP mentions that in 1936 his first 10-metre transmitter used these valves and that a very early 2-metre oscillator, illustrated in "Short Wave Communication" by Ladnor and Stoner (1932), used two 'de-based' LS5's. Since the circular base of the standard LS5 was of metal a considerable reduction in self-capacity was possible by removing the base thus enabling an output of some 5 watts to be obtained from this particular oscillator.

Readers may like to know that this famous range of valves has been graced with CV numbers:

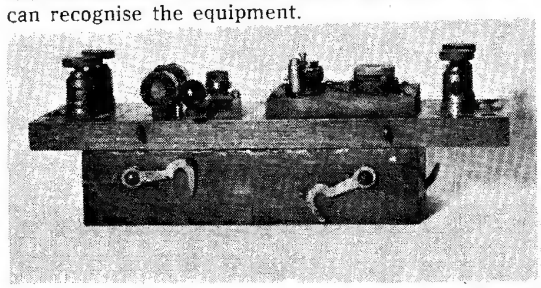
LS5	Metal 4-pin UX base	VT24—CV1636
LS5	Standard British base	VT25—CV1637
LS5A	,, ,, ,,	VT66—CV1650
LS5B	,, ,, ,,	VT40—CV1647

All these valves had an anode dissipation of 10 watts but the later LS6A had this figure increased to 25 watts.

Our thanks to George Jessop for all this interesting information and we are sure that if he cared to put his reminiscences on paper they would prove very absorbing reading.

Vintage Equipment

One of our correspondents has sent this photograph of an ancient piece of gear and asked us to assist in identifying it. Unfortunately we can't help so we are passing the buck to our older but nevertheless revered readers in the hope that someone can recognise the equipment.



Two of the terminals are marked 'aerial' and 'earth' and the other two 'cell'. A couple of coils, a buzzer and a knifeswitch complete the 'thing'. The switch looks rather like a Morse key and no doubt could be used as such with a bit of ingenuity.

Our correspondent did connect a 1·5 volt 'cell' as instructed and reports "it did no good to our TV set". We can imagine! We think it is a crude transmitter for test purposes which could be left running while a receiver was adjusted. Any other ideas?

Devices

Assuming that one or two readers of 'Going Back' have been coerced into using solid state devices, they have probably endeavoured to follow the advice of their betters by using a heat-sink when soldering the leads of transistors and keeping the metal clips on certain FET's until they are safely tucked in. (The FET's, not the readers!)

However the early users of valves also suffered a barrage of injuctions on how to handle their new toys. The following directions, taken from the wireless press of 50 years ago, should raise a smile or two!

BREVITIES FOR VALVE USERS

1. Remember that your receiving apparatus is not a crude collection of switches, but that the operation of every switch should receive due consideration.

2. Turn on your valves slowly.
3. Do not burn them too brightly.
4. Signals are not necessarily stronger the brighter the valves are lighted.
5. Do not let your valves 'howl'. Your neighbour may report you and you risk having your licence cancelled.
6. Having roughly tuned in on your inductance and accomplished finer tuning with your variable condenser, bear in mind para. 5.
7. Remember there is a proper arrangement for the valves. Interchange them from left to right, having tuned in a station, such as FL, until you find the best position for each.

We are sure that reading these 'instructions' will bring back many memories to those who fiddled about in those pioneering days. At least one could see when a valve had failed which is more than one can do with today's 'devices'!

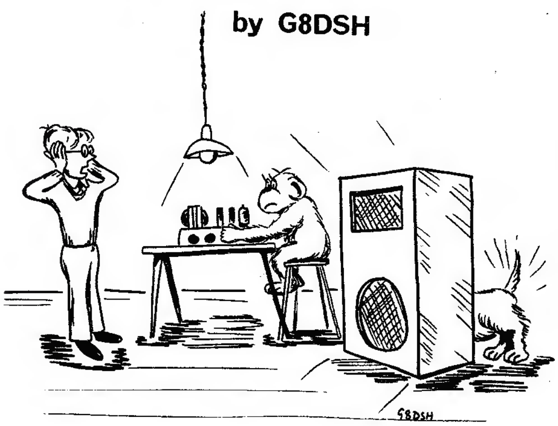
'PROJECT Autumn' 1971

This year we are sponsoring another Project Autumn competition. The rules have been amended so that the PW "Designer's Trophy 1971" will be awarded to the author of the best constructional article published in PW issues dated July 71 to March 72 inc. This allows submitted articles to be published as soon as possible and for authors to be paid without delay.

SUBMIT YOUR ARTICLES NOW

MAXWELL

by G8DSH



"Your bass response is dreadful . . . whatever are you using for a Woofer?"

CQ!CQ!CQ!CQ!

Items in this section are carried free of charge as a service to readers. We only ask that those making use of the service answer all correspondence resulting and reimburse postage and all reasonable expenses. We cannot guarantee inclusion and requests for inclusion will not be acknowledged. Material for inclusion should be sent to Practical Wireless Editorial. Fleetway House, Farringdon Street, London, E.C.4.

INFORMATION WANTED

...circuit diagram for the BCC 715. All costs refunded.—Eskil Persson, Frotunagrand 1, 19400 Upplands Vasby Sweden.

...handbook for Admiralty B40 (Murphy) receiver.—M. Johnson, 5 Barons Court, Haverhill, Suffolk.

...Eagle RX-60N circuit diagram and handbook—buy or borrow.—Lloyd, 70 Heath Drive, Ware, Herts.

...information on the fitting of a magic eye tuning indicator or S-meter to a mains operated superhet 5-valve domestic receiver and any information on issues of P.W. which contain gen on this subject.—J. Towers, 107 Hatfield Galleries, 1068 Burnett Street, Hatfield, Pretoria, Transvaal, South Africa.

...any mods. to the B40C receiver...—B. Eames, 58 Fairway Crescent, Allestree, Derby, DE3, 2PE.

...circuit or info. required for Tx/Rx type CR1—43044 (TBY8)—borrow or buy —D. Byrne, Kylemore, Endsleigh, Douglas Road, Cork, Eire.

...titles of books on electronics for beginners. All correspondence to C. S. Powell, 30 St. Michaels Way, Brundall, Norwich, Norfolk, NOR.86Z.

...instructions or valve line-up for U.S. war surplus Valve Tester I-177.—Roger Decamps, P.O. Box 24, 2800 Malines, Belgium.

...manual or information on Eagle RX80 receiver....R. Williams, 204 Dysart Road, Grantham, Lincs.

...address of place where I may get ferrite rod aerial for Bush mains radio AM62 or any gen on how to make same.—S. C. Moodley, 5 Dale Close, Addlestone, Surrey.

...information on adding a second manual to the Polyphonic Organ published by P.W. some years ago.—R. Wendrick, 22 Longcliffe Gardens, Nanpanton, Loughborough, Lincs.

...instruction manual or any gen on Cossor 1039M oscilloscope.—G. J. Banner, Johnson's Radio, St.Martins Gate, Worcester.

...technical information required regarding ex-Army (Mazda) AT20, CV1361 transmitting valve.—P.A.G. Price, 56/57 The Mall, Meerut, Cantonment, U.P., India.

...any information at all on the surplus W/S 31 especially the valve line-up, supply connections and handbook.—J. H. McGee, 6 Ripon Road, Newton Hall, Durham, Co. Durham.

...any info. on converting the 19 set Rx/Tx.—T. Izard, 41 Clumber Drive, Radcliffe-on-Trent, Notts.

...a fault-finding chart No. 2 which was issued with the May 1968 issue of P.W.—Norman Quinn, E.B.E. Limited, Postbus 6275, Rotterdam, Holland.

ISSUES WANTED

...issues of P.W. (about 1955) dealing with mods to the R1155.—D. Sager, 92 Marnham Crescent, Greenford, Middx.

...P.W. for Jan. and Feb. 1971 and P.E. for Jan. to Oct. 1970 inclusive and P.E. for Jan. and Feb. 1969.—J. R. Rourke, 12 Daisy Grove, Edge Hill, Liverpool, L7.IQR.

...buy or loan the June 1965 issue of P.W. containing the article on PCR Mods.—T. Roche, Arno, Florence Road, Bray, Co. Wicklow, Ireland.

DIGITAL FREQUENCY COUNTER TIMER

continued from page 411

With Q of IC1b high, the signal gate IC2a allows the input signal to produce an output which passes to the counter.

The $\bar{Q}$ output from IC1b is now low and this clears or resets IC1a directly so that the Q output of IC1a now becomes low and the $\bar{Q}$ becomes high.

As the $\bar{Q}$ of IC1b is low, IC2b and IC2c maintain the clamping action of D4.

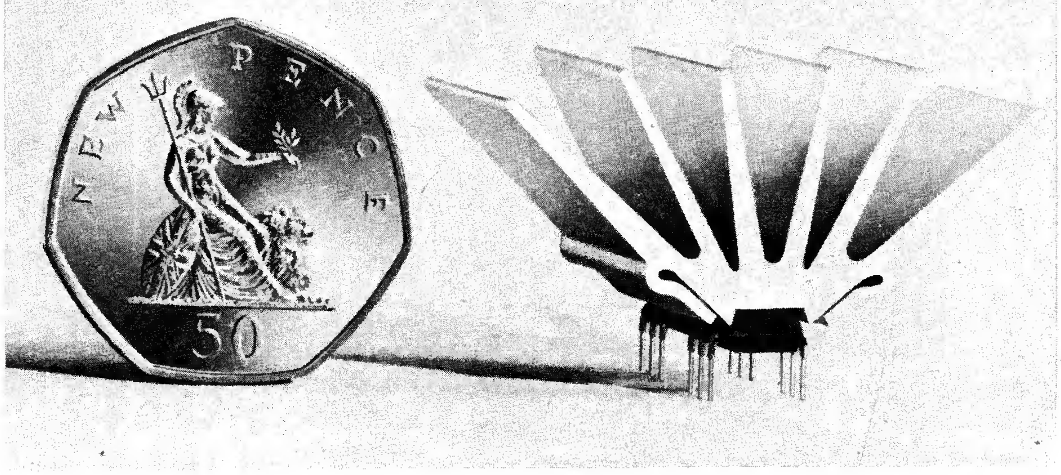
The condition of IC1a with Q low presets IC1b so that on the next negative going edge of the clock period signal, IC1b will set to Q low, thus producing a continuous high output from the signal gate IC2a and terminating the gate period by isolating the input signal from the counter.

The $\bar{Q}$ of IC1a and the $\bar{Q}$ of IC1b are now both high causing IC2b output to be low and IC2c output to be high and rendering the clamping diode D4 non-conducting. The waveforms of the control oscillator are shown in Fig. 8. The state of the control oscillator whilst in the clamped condition is with Tr6 non-conducting and Tr7 conducting. When D4 is made non-conducting, the current through R13 and D3 causes Tr6 to conduct producing a negative-going step at Tr6 collector from +5V to 0V.

TO BE CONTINUED

new

Super IC-12



High fidelity Monolithic Integrated Circuit Amplifier

Two years ago Sinclair Radionics announced the World's first monolithic integrated circuit Hi-Fi amplifier, the IC.10. Now we are delighted to be able to introduce its successor, the Super IC.12. This 22 transistor unit has all the virtues of the original IC.10 plus the following advantages:

1. Higher power.
2. Fewer external components.
3. Lower quiescent consumption.
4. Compatible with Project 60 modules.
5. Specially designed built-in heat sink. No other heat sink needed.
6. Full output into 3, 4, 5 or 8 ohms.
7. Works on any voltage from 6 to 28 volts without adjustment.
8. NEW 22 transistor circuit.

Output power 6 watts RMS continuous (12 watts peak).

Frequency Response 5 Hz to 100KHz ± 1 dB.

Total Harmonic Distortion Less than 1%. (Typical 0.1%) at all output powers and all frequencies in the audio band.

Load Impedance 3 to 15 ohms.

Power Gain 90dB (1,000,000,000 times) after feedback.

Supply Voltage 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

Size 22 x 45 x 28 mm including pins and heat sink.

Input Impedance 250 Kohms nominal.

Quiescent current 8mA at 28 volts.

With the addition of only a very few external resistors and capacitors the Super IC.12 makes a complete high fidelity audio amplifier suitable for use with pick-up, F.M. tuner etc. Alternatively, for more elaborate systems, modules in the Project-60 range such as the Stereo 60 and A.F.U. may be added. The comprehensive manual supplied with each unit gives full circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include car radios, oscillators etc. The very low quiescent consumption makes the Super IC.12 ideal for battery operation.

Price, inc. **FREE** printed circuit board for mounting.

£2.98 Post free

SINCLAIR GENERAL GUARANTEE

Should you not be completely satisfield with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

Sinclair Radionics Ltd, London Rd, St. Ives
Huntingdonshire PE17 4HJ
Telephone St Ives (048 06) 4311

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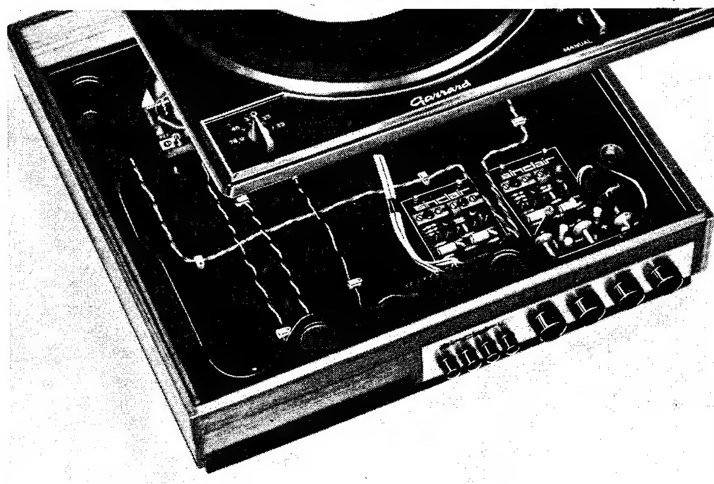
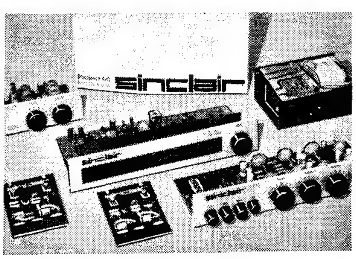
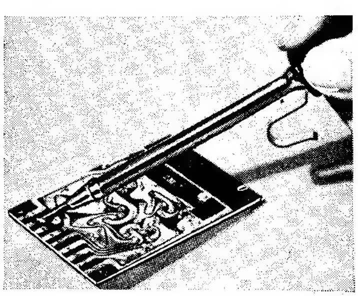
Sinclair Project 60

The World's leading range of high fidelity modules







Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.
Performance characteristics are so good they hold their own with any other available system irrespective of price or size.
Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

Typical Project 60 applications

System	The Units to use	together with	Cost of Units
Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**£4.48**
Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
20+20 W. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	**£23.90**
20+20 W. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.90**
40+40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As above	**£34.88**
Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£19.43**

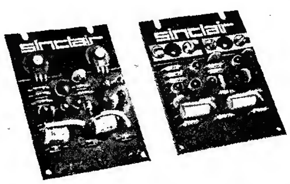
F.M. Stereo Tuner **(£25)** & A.F.U. Filter Unit **(£5.98)** may be added as required.

Sinclair Radionics Limited, London Road,
St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (048 06) 4311

sinclair

from a simple amplifier to a complete stereo tuner amplifier with Project 60 modules

Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz ±1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size: 14 x 80 x 57 mm.

Z.30
Built, tested and guaranteed with circuits and instructions manual. **£4.48**

Z.50
Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Project 60 Stereo F.M. Tuner

First in the world to use the phase lock loop principle

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Good reception is possible in difficult areas, and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 2μV for 30dB quieting: 7μV for full limiting. **Squelch level:** 20μV. **A.F.C. range:** ±200 KHz. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10 Hz – 15 KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC. **Indicators:** Mains on; Stereo on; tuning. **Size:** 93 x 40 x 207 mm.

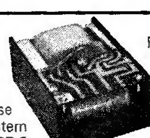
Built and tested. Post free. **£25**

Stereo 60 Pre-amp/control unit

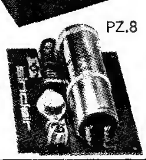
Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A curve ±1dB: 20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 15 to —15dB at 10 KHz: BASS + 15 to —15dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.
Built tested and guaranteed. **£9.98**

Power Supply Units



PZ.5



PZ.8

Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

PZ.5 *30 volts unstabilised* **£4.98**
PZ.6 *35 volts stabilised* **£7.98**
PZ.8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ.8 *mains transformer* **£5.98**

A.F.U. High & Low Pass Filter Unit

For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28KHz to 5KHz. L.F. cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply (0.02% at rated output. **Size:** 66 x 40 x 90 mm. *Built tested and guaranteed.* **£5.98**

The Sinclair Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

Please send	Name
	Address
I enclose cash/cheque/money order.	**PW.971**

Fully guaranteed Individually packed VALVES

B12H	£1·75p	ECH200	62p	OA2	85p
CY31	35p	ECL80	45p	OB2	35p
DAF96	38p	ECL82	32p	PABC80	37p
DF96	37p	ECL83	65p	PC97	40p
DK96	41p	ECL86	42p	PC900	47p
DL92	32p	EF36	45p	PCC84	37p
DL94	40p	EF37A	45p	PCC89	45p
DL96	41p	EF39	40p	PCC189	55p
DM70	30p	EF40	50p	PCE800	75p
DY86	45p	EF41	62p	PCF80	30p
DY87	55p	EF80	25p	PCF82	33p
DY802	48p	EF83	55p	PCF84	46p
E88CC/01		EF85	32p	PCF86	57p
	£1·80p	EF86	31p	PCF200	77p
E180CC	42p	EF89	26p	PCF201	77p
E181CC	90p	EF91	15p	PCF801	48p
E182CC		EF92	37p	PCF802	48p
	£1·05	EF95	30p	PCF805	72p
EABC80	32p	EF183	32p	PCF806	65p
EAF42	50p	EF184	35p	PCF808	72p
EB91	15p	EFL200	75p	PCH200	70p
EBC33	50p	EL34	52p	PCL81	47p
EBC41	52p	EL41	57p	PCL82	37p
ECC81	30p	EL42	53p	PCL83	65p
EBF80	42p	EL84	23p	PCL84	42p
EBF83	42p	EL85	40p	PCL85	42p
EBF89	30p	EL86	40p	PCL86	42p
ECC81	30p	EL90	35p	PFL200	57p
ECC82	28p	EL95	35p	PL36	53p
ECC83	30p	EL500	85p	PL81	50p
ECC84	20p	EM31	25p	PL82	40p
ECC85	40p	EM80	40p	PL83	42p
ECC86	50p	EM84	35p	PL84	35p
ECC88	37p	EM87	55p	PL500	73p
ECC189	52p	EY51	40p	PL504	75p
ECF80	35p	EY86	35p	PY33	60p
ECF82	35p	EY81	35p	PY80	35p
ECF83	75p	EY88	40p	PY81	27p
ECF801	62p	EZ41	42p	PY82	27p
ECF802	62p	EZ80	25p	PY83	35p
ECH35	60p	EZ81	27p	PY88	37p
ECH42	65p	GZ34	52p	PY800	52p
ECH81	28p	KT66	£1·60p	PY801	52p
ECH83	42p	KT88	£2·15p	QQVO3-10	
ECH84	45p	N78	£1·25p		£1·25p

TRANSISTORS, ZENER DIODES etc.

SPECIAL OFFER		OC25	37p	OC200	40p	2N3055	75p	AD149	50p	BYZ13	25p
O9J tube		OC26	25p	OC201	60p	2N3730	50p	AD161	37p	BYZ16	63p
	£1·75	OC28	62p	OC206	90p	2N3731	£2·75p	AD162	37p	CR81/10	25p
		OC29	62p	IN21	17p	2N5109	£2·05p	AF118	62p	CR81/20	38p
OA5	20p	OC35	50p	IN21B	25p	40362	60p	AF127	17p	CR81/30	40p
OA10	25p	OC38	42p	IN25	60p	82303	50p	AF139	30p	CR81/35	48p
OA70	10p	OC44	17p	IN43	10p	3F100	67p	AF178	48p	CR81/40	48p
OA71	10p	OC45	15p	IN70	7p	3FR5	32p	AF180	40p	CR83/05	30p
OA73	10p	OC70	12p	IN702-725	36p	3N128	37p	AFY19	£1·18p	CR83/20	38p
OA74	10p	OC71	15p	IN823A	£1·30	3N139	£1·75p	ASY26	25p	CR83/30	43p
OA79	10p	OC72	25p	IZMT5	35p	3N140	95p	ASY28	25p	CR825/025	
OA81	10p	OC73	30p	IZMT10	38p	3N154	90p	ASY67	48p		75p
OA91	7p	OC75	25p	IZT5	67p	3N159	£1·45p	BAW10	28p	CR83/40	50p
OA200	7p	OC76	25p	IZT10	65p	6FR5	45p	BC107	12p	GET103	28p
OA202	10p	OC81	25p	2G385	51p	12FR60	78p	BC108	12p	GET115	45p
OA210	25p	OC81D	20p	2G403	15p	10D1	16p	BC113	25p	GET116	50p
OA211	37p	OC81DM	20p	IN4785	50p	40594	£1·87p	BC118	38p	GEX66	£1·00
OAZ200	55p	OC82	25p	2N277	52p	40595	£1·87p	BCY72	15p	NKT222	20p
OAZ201	50p	OC82DM	30p	2N918	37p	40636	£1·45p	BF115	25p	NKT304	50p
OAZ202 to		OC83	25p	2N1304	25p	40668	£1·35p	BF173	30p	SD918	26p
OAZ206	42p	OC83R	15p	2N1306	25p	40669	£1·45p	BFY51	20p	SD028	31p
OAZ207	47p	OC84	25p	2N1307	25p	AC126	25p	BFY52	23p	SD938	32p
OAZ208 to		OC122	50p	2N2147	75p	AC127	25p	BSO5	38p	SD94	21p
OAZ213	32p	OC139	25p	2N2904A	32p	AC128	25p	BS	45p	SD088	46p
OAZ223 to		OC140	37p	2N3053	25p	AC176	25p	BS2	47p	V405A	40p
OAZ225	50p	OC170	25p	2N3054	50p	ACY17	30p	BSY29	25p		
OC16	50p	OC171	30p			ACY28	17p	BU100	£1·80p		
OC22	50p	OC172	37p								

QQVO6-40A		UBC41	47p	UY85	30p	3Q4	37p	6AK5	50p	6BA6	25p
	£5·25p	UBF80	35p	VR105/30	35	3S4	35p	6AK8	32p	6BE6	30p
R17	45p	UBF89	35p	VR150/30	35p	3V4	45p	6AL5	15p	6BG6G	55p
R19	87p	UCC85	40p	Z759	£1·65p	5B254M	£2·20	6AL5W	40p	6BJ6	45p
STV280/40		UCF80	55p	Z801U	£15·0p	5B/255M		6AM6	30p	6BQ7A	35p
	£3·00p	UCH42	70p	Z803A	£1·25p		£1·75	6AN8	50p	6BR7	80p
STV280/80		UCH81	35p	Z900T	75p	5R4GY	60p	6AQ5	35p	6BW6	80p
	£9·00p	UCL82	35p	IL4	15p	5U4G	32p	6AQ5W	50p	6BW7	70p
TT21	£2·75p	UCL83	60p	IR5	35p	5V4G	40p	6AS6	37p	6C4	30p
U25	75p	UF41	50p	1S4	25p	5Y4G	40p	6AS7G	80p	6C6	25p
U26	75p	UF80	36p	1S5	24p	5Y3GT	35p	6AT6	30p	6CH6	55p
U27	50p	UF89	35p	IT4	22p	5Z4	75p	6AU6	25p	6CL6	48p
U191	70p	UL41	60p	1X2A	40p	5Z4GT	40p	6AX4GT	40p	6D6	20p
U801	£1·00	UL84	30p	1X2B	40p	6AB7	30p	6AX5GT	65p	6EA8	55p
UABC80	35p	UU5	55p	3A4	30p	6AC7	15p	6B7	40p	6F23	75p
UAF42	55p	UY41	45p	3D6	15p	6AH6	50p	6BK7	40p	6F33	£1·50

MANY OTHERS IN STOCK include Cathode Ray Tubes and Special Valves. U.K. P. & P. Up to £1 12p, £1–£2 17p, £2–£3 22p. Over £3 post free. C.O.D. 20p extra.

COLOMOR brand — ALL valves guaranteed

6H6	20p	12K5	55p	957	30p
6J4WA	75p	12K7GT	40p	991	40p
6J5	40p	12K8GT	45p	1622	£1·00p
6J5GT	25p	12Q7GT	30p	2051	55p
6J6	20p	12SG7	35p	5933	£1·12p
6J7G	35p	14S7	75p	6057	50p
6J7M	40p	19AQ5	40p	6060	50p
6K6GT	50p	19G3	£4·25p	6064	45p
6K7	32p	19G6	£1·50p	6065	65p
6K7G	20p	19H4	£5·00p	6080	£1·37p
6K8GT	45p	20P4	£1·00p	6146	£1·50p
6K25	70p	25L6GT	40p	8020	£2·25p
6SA7	40p	30C15	75p	9001	20p
6SA7GT	32p	30C17	80p	9002	25p
6SC7GT	35p	30C18	75p	9003	50p
6SG7	35p	30F5	64p	9004	15p
6SJ7	37p	30FL1	70p	9006	15p
6SJ7GT	32p	30FL12	92p	**C.R. Tubes**	
6SK7	35p	30FL13	50p	VCR97	
6SL7GT	32p	30FL14	75p		£4·50p
6SN7GT	35p	30L15	85p	VCR517B	
6SQ7	39p	30L17	80p		£3·50p
6SQ7GT	35p	30P12	80p	VCR517C	
6V6G	17p	30P19	80p		£7·50p
6V6GT	38p	30PL1	70p	5FP7	£1·32p
6X4	27p	30PL13	92p	88D	£9·00p
6X5G	25p	30PL14	85p	88J	£9·00p
6X5GT	32p	35L6GT	50p	88L	£9·00p
6Y6G	60p	35W4	80p	**Photo Tubes**	
6-30L2	70p	35Z4GT	45p	UM025	
6Z4	32p	42	45p		£2·75p
7B7	45p	50C5	40p	931A	£3·50p
7C5	35p	50CD6G30		6097C	
7C6	40p		£1·60p		£17·50p
7H7	32p	50EH5	60p	**Special Vlvs**	
7Y4	60p	75	40p	CV1031	
9D6	37p	76	40p		£7·00p
11E2	£2·50p	78	40p	CV2339	
12AT6	30p	80	45p		£20·00p
12AT7	30p	803	£3·25p	JP9/7D	
12AU7	29p	805	£8·00p		£37·50p
12AV6	30p	807	50p	K301	£5·00p
12AX7	30p	813	£3·75p	K305	£12·00p
12BA6	35p	832A	£3·00p	K308	£16·00p
12BE6	35p	866A	75p	K337	£16·00p
12BH7	27p	954	40p	5C22	£18·00p
12C8	32p	955	40p	725A	£16·00p
12E1	£1·25p	956	20p		

29/41ft. AERIALS each consisting of ten 3ft. ⅞in. dia. tubular screw-in sections. 11ft. (6-section) whip aerial with adaptor to fit the 7in. rod, insulated base, stay plate and stay assemblies, pegs, reamer, hammer, etc. Absolutely brand new and complete ready to erect. In canvas bag £4. P. & P. 50p.

METERS Full List of our very large stock of meters on request.

INTERGRATED CIRCUITS— MANY OTHERS IN STOCK

RCA. CA 3005 wide band R.F. Ampl. 300mW diss £1·20
CA 3012 wide band ampl. 150m W diss .. .. £0·90
CA 3020 Audio power ampl. .. .. .. £1·37
CA 3036 Audio pre-ampl. .. .. £0·90
General Electric PA 230 £1·40; PA 234 £1; PA 237 £2·10
Mullard TAA 300 £1·75; TAA 320 73p

Colomor (Electronics) Ltd.
170 GOLDHAWK ROAD, LONDON W12.
Tel: 01-743 0899
Open 9–12.30, 1.30–5.30 p.m. Thursday 9–1 p.m.

ERSIN Multicore 5 CORE SOLDER

for fast, easy, reliable soldering

Contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux required.

SAVBIT ALLOY ALSO REDUCES COPPER BIT WEAR.
Ecomically packed for general electrical and electronic soldering. 75ft. 18 gauge on plastic reel. Recommended retail price **75p**

Size 12

THIN GAUGE SOLDER, ESSENTIAL FOR soldering small components and thin wires. High tin content, low melting point, 60/40 alloy, 170ft. 22 gauge on plastic reel. Recommended retail price **75p**

Size 10

A RANGE OF SOLDERS IN HANDY DISPENSERS.

REF.	ALLOY	SWG	
19A	60/40	18	18p*
Size 5 (Illustrated)	Savbit	18	18p*
15	60/40	22	22p*

*Recommended Price

INVALUABLE FOR STRIPPING FLEX, THE NEW AUTOMATIC OPENING BIB WIRE STRIPPER AND CUTTER, easily adjustable for all standard diameters. Plastic covered handles can also be used as wire cutter. Recommended retail price **50p**

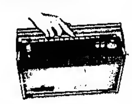
From Electrical and Hardware shops. If unobtainable, write to: Multicore Solders Ltd., Hemel Hempstead, Herts.

UNBEATABLE RUSSIAN VALUE

PERFORMANCE CAN BE COMPARED WITH £65 RADIOS!

Sockets for tape recorder, record player, extension speaker, earphone, external power supply (12v DC), external line and dipole aerials. Battery life approx. 300 hours.

At last, the Astrad Solar Radio combining quality with value and a specification not before available from Russia. Designed for the man who appreciates the extras necessary for quality performance. This 6 waveband Radio has twin speakers for quality. Fully independent Treble and Bass tone controls for ultimate performance and twin separate tuning controls for AM & FM broadcasts. 12 push buttons for waveband selection including automatic frequency control on VHF. This is the big set from Russia, overall dimensions—14" x 9½" x 4½". Included in this incredible specification is an inbuilt tuning meter to ensure that you are spot-on the station you select. Telescopic aerial on universal joint and a push-button dial light. All presented in a luxurious padded case with carrying handle. **This fabulous Radio is fully guaranteed for 1 year.** Only limited supplies available at a never to be repeated price. Immediate delivery.



TECHNICAL DATA: Waveband (frequency)
LW 2000—735·5m.
MW 571·4—186·9m
SW3 53·1—40·54m
SW2 31·91—24·79m
SW1 19·87—16·76m
VHF 3·43—288m
(5—104 mc/s)
17 transistors, 8 diodes

£23·97 Earphones 25p. P. & P. 75p

SEBA ELECTRONICS, Dept. M/O, 104 Uxbridge Road, Hanwell, London, W7. Phone: 01-579 5644

FREE FLOG LIST No.6

Scores Special Bargains

SEND S.A.E. OR CALL AT ANY BRANCH FOR YOURS

HUGE RANGE OF SPECIAL SNIPS—STEREOS, DECKS, TAPE RECORDERS, AMPLIFIERS, SPEAKERS, TRANSISTORS, VALVES, COMPONENTS—AT ALL BRANCHES.

TECHNICAL TRADING

★ Portsmouth–350 Fratton Rd. Tel. 22034
★ Southampton–72 East St. Tel:25851
★ Southampton–77 East St. Tel. 31276
★ Brighton–6 Queens Rd. Tel: 23975
★★ All Mail Order Tel: 0903 882299 15-17 QUEEN ST. ARUNDEL

ENORMOUS PURCHASE, GUARANTEED. APPROX. HALF PRICE.

WORLD FAMOUS ★ TAPE ★

Standard Play			Double Play		
3in.	150ft.	12p	3in.	300ft.	20p
4in.	300ft.	23p	4in.	600ft.	40p
5in.	600ft.	38p	5in.	1,200ft.	75p
5¾in.	900ft.	52p	5¾in.	1,800ft.	95p
7in.	1,200ft.	68p	7in.	2,400ft.	£1·85
Long Play			**Triple Play**		
3in.	225ft.	14p	4in.	900ft.	65p
4in.	450ft.	28p	5in.	1,800ft.	£1·25
5in.	900ft.	53p	5¾in.	2,400ft.	£1·70
5¾in.	1,200ft.	65p	7in.	3,600ft.	£2·20
7in.	1,800ft.	93p			
			Quadruple Play		
Postage	5p	*reel.*	3in.	600ft.	43p

Post Free less 5% on three reels. Quantity and Trade enquiries invited

THIS MONTH'S NEW BARGAINS

TO 3 Heat Sink. Suitable for most power transistors OC 26 etc. This is aluminium, anodised black for maximum heat dissipation. Supplied complete with mica disc and insulation bushes. Price **10p** each or 10 for **90p.** Size approx. 2¾" × 2¾".

12 Volt 500 M.A. Mains Transformers. Miniature type now available, price **55p** each or 10 for **£5.**

3 Core Flex, New Colours. (Brown for live, blue for neutral, yellow/green for earth). This is completely P.V.C. covered and ribbed, virtually non-kinkable. Suitable for washing machines (without heaters) and all portable tools, lawn mowers etc. Conductor size 23/36. **£1** per dozen yards or **£10** per 100 yards coil.

Valve Holders at remarkably low prices—moulded construction—made by most famous company.

Price per each

		1–9	10–99	100–999	1,000 up
B7G	Flanged	2p	1·5p	1·25p	1p
B7G	Skirted	3p	2p	1·75p	1·5p
B7G	Printed Circuit	2p	1·8p	1·4p	1·2p
B9A	Flanged	2p	1·6p	1·3p	1·1p
B9A	Skirted	3p	2·5p	2·25p	2p
B9A	Printed Circuit	2p	1·9p	1·6p	1·3p

MOTOR by A.E.I. 1/20 hp, 1275 rpm Self starting for normal A.C. Mains, a well made enclosed motor with standard $\frac{5}{16}$" dia. shaft 1" long. Suitable for light power operation. Continuous rating. **£1·50** plus 20p post.

Instrument Motor by Evershed Hysteresis motor —makers type No. FEX25-CG30 this is a capacitor start motor for 110v AC working double ended shaft—**£3·50** plus 20p post and insurance.

Cut and Prepared 3 Core Leads. 2 yds. long, P.V.C. covered and ribbed virtually non-kinkable 23/36 conductors. Old colour scheme. **8p** each, 10 for **70p.** New colour scheme **15p** each or 10 for **£1·35.**

Hearing Aid Amplifiers. (Ex behind ear deaf aids). 3 transistors on tiny P.C. board with volume control—whole thing only about half as big as Oxo cube. **£1·75** or with sub-miniature microphone and L.S. attached **£3·50.**

Totally Enclosed Mains Transformers with Primary for normal 230/240 50 Hz mains and secondary rated at 4 amp 80v tapped at 75v and 70v. This is a very well made transformer totally enclosed in metal case. Size 4½" × 5½" × 6¼" high. Made to be mounted above chassis with terminations all on bottom. **£3·50** each plus 65p post.

8 AMP Variacs. –0–260v—panel mounting type—ex unused equipment, fully guaranteed. **£10** each. Carriage—England £1: Wales and Scotland, £1·50.

Wafer Switches. Standard Size (1½ wafer) built to Post Office spec. good contacts and generally very reliable. 9 pole 3 way on 3 wafers **45p**—10 for **£4.** Ditto 2 pole 3 way. **20p**—10 for **£1·80.**

P.C. Edge Connector. 18 contact switch with 2 mounting/earthing lugs—**30p** each 10 for **£2·70.**

Pointer Knobs. Bulgin brass insert type, ref. no. K.357. Black with white line down pointer, grub screw fixing. **5p** each—10 for **45p.**

Jack-Socket Bulgin. Catalogue no. J14. This is a standard size panel mounting jack, with two leaf contact switches incorporated. Makers recommended price 41p. Our price **30p** or 10 for **£2·70.**

Miniature Wafer Switch, 1 Pole 8 Way. This has a short spindle and is therefore suitable only for mounting through a metal panel. Price **12p** or 10 for **£1·08.**

24-Way Rotary Switch—Single pole **£1·25**—double pole **£1·95.**

Double Pole, Double Throw Toggle Switch. Suitable for mains voltage and up to 10 amps. **15p** or 10 for **£1·35.**

BREAK GLASS FIRE ALARM PUSH

Made by AFA. As used all over the country. Made from heavy cast steel. Drop front. Open with Allen key for test. Switch normally closed, opens when glass is broken. Diameter approx. 5" **£1·25** or with cast steel mounting box **£1·75.** Post 20p.

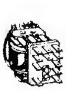
CAR ELECTRIC PLUG

Fits in place of cigarette lighter. Useful method for making a quick connection into the car electrical system. **38p** each or 10 for **£3·42.**

ROCKER SWITCH

13 amp self-fixing into an oblong hole, size approximately 1" × ⅜" **6p** each, 10 for **54p.**

MAINS RELAY BARGAIN

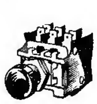


Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V A.C. Good British Make. Unused. Size approx. 1½" × 1".

Open construction

Single pole	**25p** each	10 for **£2·25**
Double pole	**32p** each	10 for **£2·90**
Treble pole	**40p** each	10 for **£3·60**

PUSH BUTTON CHANGE OVER SWITCHES

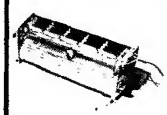


This is a Honeywell micro switch mounted on a metal frame with spring loaded plunger to operate. Panel fixing by single ⅜" hole. Single Changeover switch **25p** each or ten for **£2·25.** 2-changeover switch operated by single plunger **35p** each or ten for **£3·15.** 3-changeover switches **45p** each or ten for **£4·05.**

HORSTMANN "TIME AND SET" SWITCH

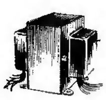
(A 15 amp Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **£1·50,** p. & ins. 23p.

OUT OF SEASON BARGAIN TANGENTIAL HEATERS



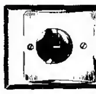
Once again we are able to make a special bargain offer of these very popular heating units. Tangential heaters although brought out a few years ago are still the latest and best type as nothing has yet been made which could be called an improvement on them. The Tangential unit is still the only one used in good quality heaters made by Hoover, G.E.C. and all the famous names. The unit comprises quiet running AC induction mtor with special bearings, the tangential impeller and a 2 section heater element which allows switching half and full heat in the case of the 2 k.w. and one third—two thirds and full heat in the case of the 3 k.w. These heaters are also fitted with a safety cutout to cut the heaters should the impeller stop or the air flow be impeded. They are free standing and need only the simplest of cases, even a wooden cabinet is suitable or the plinth of the kitchen cabinet. Lots of customers missed our special Summer offer of these heaters last year so order early. 200/240 2 k.w. model **£2·50.** 200/240 3 k.w. model **£3·50.** Control switch heaters only **25p** or two-heat, cold-blow and off **35p.** Postage and insurance 33p on heaters.

AMPLIFIER MAINS TRANSFORMERS



50v 1½ amp. Upright mounting with fixing brackets and metal shrouds to contain magnetic field, 50 c/s primary, tapped 110v, 117v, 210v, 230v and 250v. 2 secondaries, one 50v 1½ amp. other 6v 1 amp for pilot light etc. **£1·95,** postage 30p.

THIS MONTH'S SNIP LIGHT DIMMER



For any lamp up to 200 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price **£1·99** plus 20p post & insurance.

CAPACITOR DISCHARGE CAR IGNITION

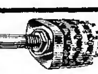
This system which has proved to be amazingly efficient and reliable was first described in the Wireless World about a year ago. We can supply kit of parts for improved and even more efficient version, price **£4·95.** Wnen ordering please state whether for positive or negative systems. Plus 30p post.

STANDARD WAFER SWITCHES

Standard size 1½ wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

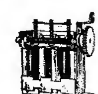
No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles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

INSTRUMENT SWITCHES



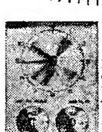
Precision made with dicast indexing mechanism. Full length ¼" spindle 5 amp and silver plated contacts. Range except for 9 way is as standard wafer switches. Prices obviously higher. For 40p read 60p, for 70p read £1, for 95p read £1·40, for £1·20 read £1·80, for £1·45 read £2·20. Note also 2 way types available up to 36 pole, 3 way 30 pole, 4 way 24 pole, 5 way 19 pole, but 10 and 12 way only available up to 6 pole.

3 STAGE PERMEABILITY TUNER



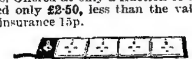
This Tuner is a precision instrument made for the famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available as an extra (if required) with a frequency coverage 1620 Kc/s-525 Kc/s and intended to operate with an I.F. value of 470 Kc/s. Extremely compact (size only 2¾ × 2 × ½ ins. thick) with reduction gear for fine tuning. **65p,** with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier.

ELECTRIC CLOCK WITH 25 AMP SWITCH



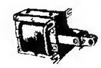
Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **£2·50,** less than the value of the clock alone—post and insurance 15p.

DISTRIBUTION PANELS



Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Suppled complete with 7 feet of heavy cable. Wired up ready to work, **£2** less plug **£2·25** with fitted 13 amp plug; **£2·40** with fitted 15 amp plug, plus **23p** P. & I.

MAINS OPERATED SOLENOIDS



Model 772—small but powerful 1" pull—approx size 1½" x 1¼" x 1½" **60p.**

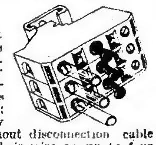
Model 400/1 ⅜" pull. Size 2½" x 2" x 1¾" **75p.**

Model TT10 1½" pull Size 3" x 2½" x 2½"—**£1·80** plus 20p post and insurance.

TREASURE TRACER

Complete Kit (except wood battens) to make the metal detector as described in last month's issue. **£2·50** plus 20p

Mains Connector



A quick way to connect equipment to the mains safely and firmly—L, N. and E. coded to new colour scheme; disconnection by plugs prevents accidental switching on; has sockets which allow insertion of meter without disconnection cable inlets firmly hold one hair wire on up to four 7.029 cables. **85p each**

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **18p** each, **£1·80** dozen, your assortment.

WATERPROOF HEATING ELEMENT

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

COMPUTER TAPES

2,400' of the Best Magnetic Tape money can buy—users claim good result with Video and sound. 1" wide **£1·45** plus 33p post and insurance, with cassette. ¾" wide **£1·25** plus 30p post and insurance with cassette. ½" wide **£1** plus 25p post and insurance with cassette. Spare spools and cassettes—1" **£1.** ¾" **85p.** ½" **75p** each plus 20p post and insurance.

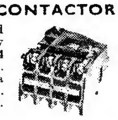
BALANCED ARMATURE UNITS

These Capsules are 1⅜" in diameter and ½" thick. They will operate as a microphone or loud speaker so can be used in intercom and similar circuits. **33p** ten for **£3.**

MULTI-SPEED MOTOR

Replacement in many well-known food mixers. Six speeds are available 500, 850 and 1,100 r.p.m. from either or both of the nylon sockets (where the beaters of the food mixers normally go) and 8,000, 12,000 & 15,500 r.p.m. (ideal polishing speeds) from the main drive shaft. This drive shaft is ¼ in. diameter and approximately 1 in. long. A further point about this motor is that being 230/240v. AC-DC series wound its speed may be further controlled with the use of our Thyrister controller. This is a very powerful and useful motor size approx. 2 in. dia. × 5 in. long, mains 230/240v. Price **88p** plus 23p postage and insurance. 12 or more post free.

MAINS OPERATED CONTACTOR



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

QUICK CUPPA

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

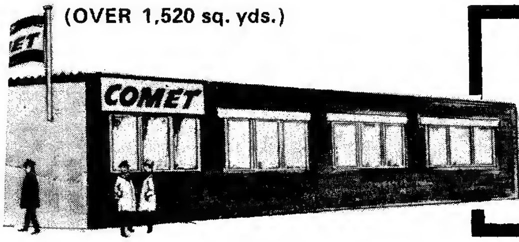
DIGITAL COUNTER TIMER

as described in this issue. Send today for price list of parts.

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

J. BULL (ELECTRICAL) LTD.

Dept. P.W. 7, Park Street, Croydon CRO 1YD



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ALL FULLY GUARANTEED – WITH AFTER-SALES SERVICE

All items offered are brand new, latest models in manufacturers' sealed cartons

	Rec. Retail Price	Comet Price
GOODMANS Audiom 18P	34·00	26·97
GOODMANS Twin Axiom 10	10·23	8·25
GOODMANS ARU172	4·50	3·50
GOODMANS Trebax 100	8·60	6·00
GOODMANS Trebax 5K/20XL	9·70	7·50
GOODMANS Midax	12·95	9·00
GOODMANS Attenuator	3·55	2·50
GOODMANS Crossover Networks XO/950/5000	9·75	7·25
GOODMANS Crossover Networks XO/950	7·40	5·75
GOODMANS Crossover Networks XO/5000	2·65	2·00
WHARFEDALE 8in.Bronze/RS/DD	5·00	4·00
WHARFEDALE Super 8/RS/DD	8·50	7·00
WHARFEDALE Super 10/RS/DD	14·00	11·50
WHARFEDALE WMT 1 Matching Transformer	0·84	0·75

HI-FI STEREO SYSTEMS (complete)

	Rec. Retail Price	Comet Price
ARENA MR15	145·00	115·95
ALBA UA552	47·50	35·95
ALBA UA662	62·97	47·95
DECCA Sound 603	72·50	58·95
DECCA Sound 604	72·50	60·95
DECCA Sound 1204	97·50	78·95
DECCALIAN 5, complete with stand.	65·50	52·95
DECCA Compact 3	135·00	112·95
EKCO SRG 609	88·50	69·95
EKCO ZU5	165·00	135·00
FERGUSON 3422	87·85	69·95
FERGUSON 3423	118·25	94·95
FERGUSON 3424	123·15	99·95
FERGUSON 3425	145·10	111·95
FERGUSON 3450 with radio	75·00	62·95
FIDELITY Music Master UA2	46·00	33·95
FIDELITY Music Master UA1	98·00	82·95
H.M.V. 2416	129·70	103·00
H.M.V. 204/5/6	202·85	165·00
H.M.V. 2452	68·00	56·95
H.M.V. 2450 with Stereo radio	139·00	115·00
K.B. KA1250, complete with two 653 speakers	72·00	59·50
K.B. KA1250, complete with two 651 speakers	83·00	65·95
K.B. 2010 with Stereo radio	76·00	62·95
LEAK30/GOLDRING/WHARFEDALE	182·65	142·95
LEAK 70/THORENS/WHARFEDALE	226·87	175·00
MARCONI Unit 4	77·45	66·95
MARCONI Unit 3	86·00	69·95
METROSOUND Stereo 1010	82·30	65·95
PHILIPS 580/481/105	71·00	55·95
PHILIPS GF823	51·50	41·50
PHILIPS GF824	69·50	56·95
PHILIPS GF833	67·50	55·95
PHILIPS GF834	88·00	73·95
PHILIPS 882 (less L/S)	99·00	78·50
PHILIPS GF417	99·50	82·75
TELETON 2S60F, with Radio	75·00	55·95
TELETON 8TK stereo system	54·75	48·00
TOSHIBA SP8507	248·00	175·00
ULTRA 6405	79·95	66·95

TAPE RECORDERS AND TAPE DECKS

	Rec. Retail Price	Comet Price
AKAI M10L	245·05	185·95
AKAI X200D	190·00	125·00
AKAI X5000 W/L	177·98	135·95
AKAI X330	342·57	265·95
AKAI X-330D	312·56	243·95
AKAI X-360	380·08	279·95
AKAI X-360 D-deck	318·92	243·00
AKAI 1800SD	199·42	129·00
AKAI 1710L 4-track stereo	89·85	65·95
AKAI 1720L	97·21	77·50
AKAI CR80 8-track stereo recorder	115·03	99·95
AKAI CR80D 8-track stereo tape deck	95·00	79·95
AKAI 4000 4-track Stereo	124·90	97·95
AKAI 4000 D 4-track Stereo deck	89·95	69·50
BUSH TP 60 Cassette Tape Rec.	29·40	24·95
BUSH TP 70 Cassette Battery/Mains Tape Recorder	29·95	23·95
BUSH Discassette DC70	21·95	16·95
FERGUSON 3252 4-track	104·30	83·95
FERGUSON 3245 Twin track	38·00	29·95
FERGUSON 3246 4-track	44·10	34·95
FERGUSON 3247 4-track	49·65	39·95
FERGUSON 3248 4-track	55·65	43·95
FERROGRAPH 722	266·41	198·00
FERROGRAPH 724	266·41	198·00
FERROGRAPH 702 2 track tape deck	228·71	193·00
FERROGRAPH 704/W 4 track tape deck	228·71	193·00
GRUNDIG C200 deluxe Cassette	39·90	29·95
GRUNDIG TK 141 (4-track)	61·85	49·95
GRUNDIG TK 121 (Twin-track)	56·85	43·95
GRUNDIG TK 146 (4-track Auto)	68·14	53·95
GRUNDIG TK 149 (4-track)	57·63	47·95
GRUNDIG 222 stereo cassette	59·85	48·95
GRUNDIG TK 147 (4-track Auto.)	96·85	79·95
MIDLAND TC 144 cassette	18·00	11·95
PHILIPS 2202 Cassette	29·90	21·95
PHILIPS 2204 Cassette bat./main.	33·50	25·95
PHILIPS 2205 Cassette Tape Rec.	43·15	34·95
PHILIPS 3302 Cassette	23·90	18·25
PHILIPS 4307 4-track	49·50	38·95
PHILIPS 4404 2-track stereo recorder	95·00	73·95
PHILIPS 4407 4-track stereo recorder	110·00	89·95
PHILIPS 4303 new release	42 00	34·95
PHILIPS 4302 Twin Track Auto	39·00	32·00
PHILIPS 4500 4-Track Stereo Tape Deck	126·00	98·95
PHILIPS 4408 4-Track Stereo	139·00	109·00
PHILIPS 4308 4-Track	60·50	44·95
PHILIPS Cassette Stereo Tape Deck	54·00	44·95
PHILIPS 2400 Stereo Cassette (less L/S)	68·00	59·95
PYE Cassette Recorder/Radio (Batt./Mains)	45·50	36·95
TANDBERG 1841 4-track Stereo Tape Deck	69·75	59·95
TANDBERG 3021X twin track stereo	109·90	93·00
TANDBERG 3041X 4-track stereo	109·90	93·00
TANDBERG 4021X twin track stereo	180·00	150·00
TANDBERG 4041X 4-track stereo	180·00	150·00
TANDBERG 6021X twin track stereo	195·00	165·00
TANDBERG 6041X 4-track stereo	195·00	165·00
TELETON 511 Batt./mains cassette	29·50	17·50
TELETON 8110 cassette	22·00	14·95
TELETON FXB 510 D 4-track Stereo	67·50	47·50
TELETON TRC 130 cassette, with VHF/AM radio. Battery/mains, twin motors	41·75	31·90
TELETON TC110 cassette, bat/mains	27·75	20·00
TOSHIBA GT 840 S	110·00	55·95
TOSHIBA GT 601v Twin Track	45·15	29·95
TOSHIBA 850 SA	94·00	59·95
WHARFEDALE Dolby DC9 Cassette Stereo Tape Deck	115·00	97·00

BASES AND COVERS

	Rec. Retail Price	Comet Price
GARRARD WB1 Base	3·86	3·25
GARRARD WB4 Base	5·69	4·75
GARRARD SPC 1 Cover	3·74	3·00
GARRARD SPC 4 Cover	4·44	3·75
Special offer of Base and Cover to fit GARRARD SP25, SL55, SL65B and 3500	Special Price	4·00
GOLDRING Plinth 75	8·52	7·00
GOLDRING Plinth 69	8·52	7·00
GOLDRING Covers for 69P and 75P	4·21	3·50
THORENS TX25 (for TD125AB)	8·22	6·50
THORENS TX11 Cover	4·11	3·75
Base and Cover for TD 125	15·18	12·50
SME Plinth System 2000	39·20	31·25
MOTORBOARDS only	4·95	3·00

COMPLETE HI-FI SYSTEMS

Completely wired, mounted and ready for use.

	Rec. Retail Price	Comet Price
GOODMANS AUDIO SUITE, Goodmans Maxamp stereo amplifier, Goodmans stereomax AM/FM Tuner with decoder. Pair of Goodmans Magnum K2 speakers, Garrard AP76 turntable in base, complete with cover and Goldring G800 Cartridge. Beautifully finished in walnut	257·13	169·95
GOLDRING 705P turntable complete with G850 Cartridge, Midland Tuner/Amp., pair of Metrosound 103 Speakers	99·56	69·95
GOODMANS Module 80 Tuner/Amplifier, Garrard AP76 Turntable with Goldring G800 Cartridge and 2 Goodmans Minister Speakers	199·00	139·00
METROSOUND 448 8-track stereo play-back unit complete with 2 HFS 10 Speakers	83·56	70·95
GOLDRING 705P turntable complete with G850 Cartridge, Teleton 206 Amplifier, pair of Keletron KN500 Speakers	77·00	49·95
TELETON Stereo 8 track tape Audio system complete with speakers	54·75	48·00
GARRARD SP 25, Mk. III mounted in base, plinth and cover with GOLDRING G800 Cartridge. Teleton 206 Stereo Amplifier 12 watts RMS, and 2 KELETRON KN500 Speakers, each speaker is a 4 speaker system	88·33	58·95
PIONEER PL 12 turntable, Goodmans Maxamp, Shure M55E Cartridge, 2 Keletron KN 700 speakers (each speaker cabinet contains 4 speakers)	144.38	105·00
GARRARD AP76 turntable complete with Goldring G800 Cartridge, base and cover, Rogers Ravensbrook Amplifier in teak case and 2 Goodmans Minister Speakers	142·51	108·50
LEAK 30/THORENS/WHARFEDALE	182·65	142·95
GOLDRING GL 75P mounted in teak base with hinged perspex cover complete with GOLDRING G800E Cartridge. Leak Stereo 30 Plus Amplifier in Teak case. 2 GOODMANS Mezzo 3 Speakers	200·50	154·20
THORENS TD 150AB Mk. II with TX11 dust cover, SHURE M55E Cartridge, LEAK Stereo 70 Amplifier in Teak case. 2 Wharfedale Dovedale 3 Speakers	226·87	175·00
THORENS TD 125AB Electronic Turntable complete with cover. SHURE V15-11 Cartridge, GOODMANS Maxamp, GOODMANS Stereomax AM/FM Tuner. 2 GOODMANS Magister Speakers	422·48	309·00

Complete Price List FREE on request!

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2N697	18p	2N2925	23p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	12p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	11p	BSX20	16p
2N1131	29p	2N3055	60p	AC153K	23p	BC159	12p	C407	17p
2N1132	29p	2N3702	13p	AC176	16p	BC167	11p	MC140	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	10p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	11p	MPS6534	30p
2N1304	26p	2N3705	13p	AD140	63p	BC177	14p	NKT211	25p
2N1305	26p	2N3706	13p	AD142	50p	BC178	13p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	53p	BC179	14p	NKT214	23p
2N1307	33p	2N3708	10p	AD161	33p	BC182L	11p	NKT274	18p
2N1308	36p	2N3709	11p	AD162	36p	BC183L	10p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	24p	BC184L	11p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	24p	BC212L	16p	OC71	33p
2N1711	26p	2N3819	23p	AF117	22p	BC213L	16p	OC81	25p
2N1893	54p	2N3904	35p	AF124	24p	BC214L	16p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	22p	BCY70	18p	ZTX300	14p
2N2218	34p	2N4058	13p	AF139	33p	BCY71	33p	ZTX301	16p
2N2218A	44p	2N4059	10p	AF239	36p	BCY72	15p	ZTX302	22p
2N2219	38p	2N4060	11p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4061	11p	ASY28	27p	BF167	18p	ZTX304	27p
2N2270	62p	2N4062	12p	BC107	12p	BF173	19p	ZTX500	13p
2N2369A	19p	2N4124	13p	BC108	11p	BF194	14p	ZTX501	21p
2N2483	35p	2N4126	27p	BC109	12p	BF195	15p	ZTX502	25p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	22p
2N2646	47p	2N4286	15p	BC126	23p	BFX84	25p	ZTX504	52p
2N2904A	42p	2N4289	15p	BC147	10p	BFX85	32p		

RESISTORS 10% — 5% — 2%

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

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

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

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

MULLARD polyester C280 series

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

ZENER DIODES

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

MULLARD SUB-MIN ELECTROLYTIC

C426 range axial lead — 6p each

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

CARBON TRACK POTENTIOMETERS, long spindles

Double wiper ensures minimum noise level.

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

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

LARGE CAPACITORS

High ripple current types: 1000/25 **28p**; 1000/50 **41p**; 1000/100 **82p**; 2000/25 **37p**; 2000/50 **57p**; 2000/100 **£1·44**; 2500/64 **77p**; 2500/70 **98p**; 5000/25 **62p**; 5000/50 **£1·10**; 5000/100 **£2·91**; 10000/50 **£2·40**.

COMPONENT DISCOUNTS

10% on orders for components for £5 or more. 15% on orders for components for £15 or more (No discount on nett items).

CARBON SKELETON PRE-SETS

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

POSTAGE AND PACKING

Free on orders over £2. Please add 10p if orders under £2. Overseas orders welcome: carriage and insurance charged at cost.

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This latest Peak Sound high fidelity amplifier incorporates many strikingly original features including facility for adding in stereo FM tuner. Superb performance characteristics and luxurious styling Electrovalue choice of simulated soft leather covering in black, blue, red or dark green. As advertised at £45. Our price . . . .

£38·75 nett

MAINLINE AMPLIFIER KITS

70W. **£12·60** nett. (main amplifier module).

30 WATT BAILEY AMPLIFIER PARTS

Transistors and PCB for one channel **£6·46**
Capacitors, resistors (metal oxide), and transistors, one channel. **£6·41.**
Complete unregulated power supply pack, **£4·75.**
Suitable heatsink 10DN 400C. **55p.**

INTEGRATED CIRCUITS SIEMENS' TTL INTEGRATED

CIRCUITS. Full range of all types in stock for very wide range of applications. For full details, see our latest components list. Please send S.A.E.
PLESSEY SL403A 7·5 ohms. **£2·10** nett. Applications data 10p.

S-DeCs put an end to birds nesting

Components just plug in—saves time—allows re-use of components. S-Dec (70 points), **£1·00**
T-Dec. may be temperature-cycled (208 points), **£2·50.**
Also μ-Decs and IC carriers.

INDICATOR LAMPS

NEON chrome bezel, round red NR/R, **24p**; chrome bezel, round amber NR/A, **24p**; chrome bezel, round clear NR/C, **24p**. Neon, square red type LS5C/P, **18p**; amber type LS5C/A, **18p**; clear type LS5C/C, **18p**. All above are for 240V mains operation. **Filament types:** 6V, 0·04A square red type LS5C/R-6V, **30p**, 6V 0·04A amber type LS5C/A-6V, **30p**; 6V 0·04A clear type LS5C/C-6V, **30p**; 6V 0·04A green type LS5C/G-6V, **30p**; 12V 0·04A LS5C/R-12V, **34p**; 34V 0·04A LS5C/R-28V, **45p**.

SIEMENS' POLYCARBONATE CAPACITORS

5% tolerance
250V up to 0·1mF. 100V 0·1mF and above.
0·01, 0·012, 0·015, 0·018, 0·022, 0·027 .. .. **5p**
0·033, 0·039, 0·047, 0·056, 0·068, 0·082, 0·1, 0·12, 0.15, 0.18, 0·22 .. .. **6p**
0·27 .. .. .. **7p** 0·33 .. .. **8p**

DIN CONNECTORS

		plug	*socket*
Loudspeaker	2-pole	12p	10p
Audio	3-pole	13p	10p
Audio	4-pole	14p	12p
Audio	5-pole 180 deg.	15p	12p
Audio	5-pole 240 deg.	15p	12p
Audio	6-pole	15p	13p

CORED SOLDER—64/40 alloy, 20 s.w.g. 8oz reel, **65p**, 1 lb reel, **£1·20**.

Handbook of transistor equivalent and substitutes, 40p. (Postage 3p if ordered alone).

ELECTROVALUE

(Dept. PW.971) 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY
Hours: 9—5.30: Sat. 1 p.m. Tel.: Egham 5533 & 4757 (STD 0784-3) Telex 264475

DISCOTHEQUE EQUIPMENT PACKAGE OFFERS

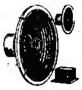
F.A.L. PHASE 50 MK.II AMPLIFIER £33.50
PR. FANE POP 25/2 25W L/SPEAKERS £13.50
Terms: Deposit £5.50 and 9 monthly payments of £4.72 (Total £47.98) £47.00
PACKAGE PRICE **£44** carr. £1

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

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

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

AUDIOTRINE HI-FI SPEAKER SYSTEMS



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

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

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

HF801D	8"	8W	£2.71	HF120D	12"	15W	£4.75
HF102D	10"	10W	£3.40	HF126	12"	15W	£5.50
HF120	12"	15W	£4.25	HF126D	12"	15W	£5.90

FANE 807 HIGH FIDELITY LOUDSPEAKER

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

HI-FI SPEAKER ENCLOSURES

Modern design. Teak veneer finish. Acoustically lined.
All sizes approx. Carr. 30p. per enclosure
JE8 Size 16 x 11 x 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi 'speaker. **£5·35**
SE8 For optimum performance with any 8in. Hi-Fi 'speaker. Size 22 x 15 x 9in. Ported **£6·47**
SE10 For outstanding results with 10in. Hi-Fi 'spkr Size 24x15x10in. P'td. **£6·74**
SE12 For exclnt prfmnce with 12in Hi-Fi speaker and Tweeter. Size 25 x 16 x 10½in. **£7·87**

R.S.C. PLINTHS

Superior Solid Natural Wood Construction for Record Playing units, cut for Garrard 1025, 2025, 3000, AT60, SP25 etc.

£3·15
WITH TRANSPARENT PLASTIC COVER **£6·30**

LEADING MAKES HI-FI EQUIPMENT AT CLEARANCE PRICES AVAILABLE AT BRANCHES ONLY

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1
An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1·5v. and 90v. where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram £3 or assembled ready for use £3.50

SPECIAL HI-FI OFFERS

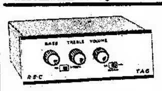
All carriage paid. Mail orders only.

WHARFEDALE/F.A.L. 1 pr Wharfedale Super Linton Speakers, 1 F.A.L. Phase 32 15+15 watt stereo amplifier. Total Rec. Retail Price £87·70, Package Price £66·50.

Above brand new goods. Following have been unpacked for display purposes only.

LEAK MINI SANDWICH (Teak finish) £18, ROGERS RAVENSBROOK STEREO AMP. £39. TANDBERG 62 Tape Recorder (stereo) £88, GOLDRING GL68 Transcription Turntable and P.U. £14·50, GOODMANS AUDIO M91 £19·95.

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



200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9¼ × 2¾ × 5½in. Attractive brushed silver finish facia plate 10½ × 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£7·50** Carr. 40p
OR FACTORY BUILT WITH 12 MONTHS' GUARANTEE **£9·75**

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

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

R.S.C. COLUMN SPEAKERS

R·S·C HI-FI CENTRES LTD.

IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

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

TYPE C48S 25-30 WATTS
Fitted four 8" high flux 8 watt speakers. Overall size approx 48 x 10 x 5 in. Carr 50p
Terms: Dep £3 and 9 monthly payments £2 (Total £21) **£17·75**

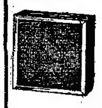
TYPE C412S 50 WATTS
Fitted four 12" 11,000 line 15 watt speakers: Overall size approx 56 x 14 x 9 in. Carr 75p
Terms: Dep. £4 and 9 monthly payments £3 (Total £31) **£27·50**

TYPE C4100 100 WATTS inc. four 12" 50 watt speakers for conservative rating. Extra heavy construction. Size approx 58 × 16 × 10" Acoustically filled and pressurised. Terms: Dep. £7·50 and 9 mthly. pyts. £5·45 (Total £56·55). Carr. £1 **£50·50**

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

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

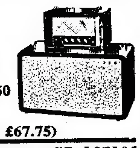
HIGH QUALITY LOUDSPEAKER UNITS



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

L125 50 WATT
Two tone Rexine and vynair finish. Fitted pair of 12" 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Or deposit £4 and 9 monthly payments of £3·35. Total £34·15 **£31** Carr. 75p

R.S.C. BASS REGENT 50 WATT AMPLIFIER



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

FAL PHASE 50 MkII AMPLIFIER 50W

Solid state 4 Separately controlled inputs. Plus master vol. control. Ind. Bass and Treble Controls. Protective circuit to guard against damage from accidental shorts. Output for Speaker/s 3·30 ohms. Size 17" × 7" × 7¼" 200-250v. A.C. mains. Output 60 watts music rating
Or deposit £6 & 9 monthly payments £3·50. Total £37·50. **£33·50** Carr. 65p

FAL PHASE 100 AMPLIFIER 100W

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

FANE ULTRA HIGH POWER LOUDSPEAKERS

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

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

'POP' 60
15" 60 Watt
14,000 gauss
8/15Ω
£12·90
Dep. £3.30 and 9 monthly payments. £1.30 (Total £15).

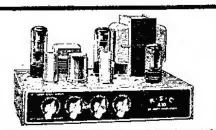
'POP' 50
12" 50 Watt
13,000 gauss
15Ω **£10·50**
Dep £2 and 9 monthly payments £1.15 (Total £12.35) Pair suitable all purposes

FOR BASS GUITAR, ELECT. ORGAN, ETC.

FANE LOUDSPEAKERS 'POP' 25/2

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

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



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

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Primaries 200-250v. 50c/s. Screened
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250v., 60mA, 6.3v. 2a 90p
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250-0-250v. 60mA, 6.3v. 2a., 0-5-6.3v. 2a. £1.25
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300-0-300v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. £1.99
300-0-300v. 130mA, 6.3v. 4a., c.t., 6.3v. 1a.
For Mullard 510 Amplifier £2.40
350-0-350v. 100mA, 6.3v. 4a., 0.5-6.3v. 3a. £1.99
350-0-350v. 150mA, 6.3v. 4a., 0-5-6.3v. 3a. £2.40
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425-0-425v. 200mA, 6.3v. 4a., 6.3v. 3a., 5v. 3a £4.69
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250-0-250v. 70mA, 6.3v. 2a., 0-5-6.3v. 2a. £1.20
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300-0-300v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. £1.99
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Suitable for Mullard 510 Amplifier £2.35
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Types 6.3v. 1.5a. 45p; 6.3v. 2a. 49p; 6.3v. 3a. 69p; 6.3v. 6a. £1.15; 12v. 1a. 50p; 12v. 3a. or 24v. 1.5a £1.20; 0.9-18v. 1½a. 99p; 0-12-25-42v. 2a. £1.60
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Standard Pentode 5,000 Ω or 7,000 Ω to 3 Ω 45p
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SMOOTHING CHOKES 150mA, 7-10H. 250 Ω 65p; 100mA, 10H, 200 Ω 55p; 80mA, 10H, 350 Ω 45p; 60mA, 10H, 400 Ω 25p.

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

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1L4	.13	6F6	.63	10C2	.50	30C1	.29	DF33	.37	ECC85	.27
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1S4	.24	6F14	.44	10LD11	.53	30C18	.63	DF97	.63	ECC189	.48
1S5	.20	6F18	.45	10P13	.54	30F5	.70	DH63	.30	ECC804	.57
1U4	.29	6F23	.70	10P14	1.10	30FL1	.62	DH76	.28	ECC807	1.70
1U5	.48	6F24	.68	10P18	.32	30FL2	.75	DH77	.20	ECF80	.28
2D21	.35	6F25	.60	12A6	.63	30FL12	.71	DK40	.55	ECF82	.28
3D6	.19	6F28	.70	12AC6	.40	30FL14	.70	DK92	.41	ECF86	.65
3Q4	.38	6H6GT	.15	12AD6	.40	30L1	.31	DK96	.36	ECF804	2.10
3Q5GT	.35	6J5G	.19	12AE6	.48	30L15	.60	DL96	.36	ECH21	.63
3S4	.27	6J5GT	.29	12AT6	.23	30L17	.71	DM70	.30	ECH42	.62
3V4	.32	6J6	.18	12AT7	.17	30P4MR	.98	DM71	.38	ECH81	.28
5V4G	.36	6J7G	.24	12AU6	.22	30P12	.69	DW4/350	.38	ECH83	.40
5Y3GT	.28	6J7GT	.38	12AU7	.20	30P19/30P4	.60	DW4/500	.38	ECH84	.36
5Z4G	.35	6K7G	.10	12AV6	.28	30PL1	.61	DY87/6	.26	ECL80	.32
6/30L2	.57	6K7GT	.23	12AX7	.23	30PL12	.33	DY802	.48	ECL82	.31
6A8G	.33	6K8G	.16	12BA6	.30	30PL13	.78	E80F	1.20	ECL83	.52
6AC7	.15	6LI	.98	12BE6	.30	30PL14	.67	E83F	1.20	ECL84	.55
6AG5	.25	6L6GT	.39	12BH7	.27	30PL15	.89	E88CC	.60	ECL85	.55
6AK5	.25	6L7GT	.63	12E1	.85	35L6GT	.42	E92CC	.40	ECL86	.37
6AL5	.11	6L18	.45	12J7GT	.33	35W4	.23	E180F	.95	EF22	.63
6AN8	.49	6L19	1.38	12K5	.50	35Z4GT	.24	E182CC	1.13	EF36	.33
6AQ5	.22	6LD20	.48	12K7GT	.34	35Z5GT	.30	E1148	.53	EF37A	.45
6AT6	.20	6N7GT	.40	12Q7GT	.28	50L6GT	.45	EA50	.18	EF39	.40
6AU6	.21	6Q7	.43	12SA7GT	.40	85A2	.43	EA76	.88	EF40	.50
6AV6	.30	6Q7G	.30	12SC7	.35	90C1	.59	EABC80	.31	EF41	.58
6B8G	.13	6R7	.55	12SG7	.23	807	.59	EAC91	.38	EF42	.33
6BA6	.21	6R7G	.35	12SH7	.15	5763	.50	EAF42	.49	EF54	.98
6BC8	.50	6SA7GT	.35	12SJ7	.23	AC2/PEN	.98	EB34	.20	EF80	.23
6BE6	.22	6SA7M	.35	12SK7	.24	AC2/PEN/DD	.98	EB91	.11	EF83	.48
6BH6	.43	6SG7GT	.33	12SQ7GT	.50	AC6PEN	.38	EBC41	.48	EF85	.28
6BJ6	.39	6SC7GT	.33	14S7	1.15	AC/PEN(7)	.98	EBC81	.33	EF86	.31
6BQ7A	.38	6SH7	.53	19AQ5	.24	AC/TH1	.50	EBC91	.30	EF89	.24
6BR7	.79	6SJ7	.35	19G6	1.45	AC/TP	.98	EBF80	.31	EF91	.17
6BR8	.63	6SK7GT	.23	20F2	.66	AL60	.78	EBF83	.38	EF92	.35
6BW6	.72	6SQ7GT	.38	20L1	.98	ATP4	.12	EBF89	.30	EF97	.55
6BW7	.57	6V6G	.17	20P1	.88	AZ1	.40	EBL21	.60	EF98	.65
6BZ6	.31	6V6GT	.31	20P3	.84	AZ31	.46	EC86	.63	EF183	.27
6CB6A	.26	6X4	.22	20P4	.91	AZ41	.53	EC88	.60	EF184	.30
6C9	.73	6X5GT	.25	20P5	1.00	CL33	.91	EC92	.35	EH90	.38
6CD6G	1.09	7A7	.88	25A6G	.29	CY1C	.53	ECC32	1.58	EL32	.18
6CG8A	.50	7B6	.58	25L6G	.22			ECC33	1.58	EL34	.46
6CH6	.38	7B7	.35	25Y5	.38			ECC40	.60	EL35	1.00
6CL6	.43	7C6	·30							EL37	.87
6CU5	.50	7H7	.28							EL41	.54

EL42	.53	N339	.44	PL84	.31	UCL83	.49	AC107	.15	BCZ11	.38	OA70	.15
EL81	.50	P61	.49	PL302	.60	UF41	.50	AC113	.25	BD119	.45	OA73	.15
EL83	.38	PABC80	.34	PL504/500	·34	UF42	.60	AC127	.17	BF158	.29	OA79	.09
EL84	.23	PC86	.49	PL505	1.30	UF80	.35	AC128	.20	BF159	.25	OA81	.09
EL85	.40	PC88	.49	PL508	.90	UF85	.34	AC156	.20	BF163	.20	OA85	.08
EL86	.40	PC95	.53	PL509	1.30	UF86	.63	AC157	.25	BF173	.38	OA90	.13
EL91	.23	PC97	.38	PL802	.75	UF89	.29	AC166	.25	BF180	.30	OA91	.09
EL95	.34	PC900	.35	PM84	.36	UL41	.59	AC168	.38	BF181	.40	OA95	.09
EM34	.90	PCC84	.31	PX4	1.16	UL84	.32	AC176	.55	BF185	.40	OA200	.09
EM80	.38	PCC85	.29	PX25	1.16	UM80	.33	AC177	.28	BF194	.15	OA202	.10
EM81	.40	PCC88	.44	PY33/2	.50	UY1N	.50	ACY17	.25	BFY50	.23	OC22	.38
EM84	.32	PCC89	.46	PY80	.33	UY21	.55	ACY18	.20	BFY51	.19	OC23	.38
EM87	.36	PCC189	.49	PY81	.25	UY41	.38	ACY19	.19	BFY52	.20	OC24	.38
EY51	.34	PCC805	.60	PY82	.25	UY85	.26	ACY20	.18	BY100	.18	OC25	.38
EY81	.35	PCF80	.29	PY83	.27	U10	.45	ACY21	.19	BY105	.18	OC26	.24
EY83	.55	PCF82	.31	PY88	.33	U12/14	.38	ACY22	.15	BY114	.18	OC28	.60
EY84	.50	PCF84	.40	PY500	.95	U18/20	.75	ACY28	.18	BY126	.15	OC29	.63
EY87/6	.31	PCF86	.45	PY800	.35	U19	1.73	AD140	.36	BY127	.18	OC35	.32
EY88	.43	PCF200	.67	PY801	.34	U22	.39	AD149	.50	BYY23	1.00	OC36	.43
EY91	.53	PCF801	.32	PZ30	.48	U25	.65	AD161	.45	BYZ10	.25	OC42	.63
EZ40	.40	PCF802	.40	QQV03/10	1.20	U26	.59	AD162	.45	BYZ11	.25	OC43	1.18
EZ41	.43	PCF805	.63	QV04/7	.63	U45	.78	ADT140	.63	BYZ12	.25	OC44	.10
EZ80	.22	PCF806	.59	RG1-240A	1·98	U191	.60	AF102	.90	BYZ13	.25	OC45	.11
EZ81	.23	PCF808	.70	R10	.75	U251	.70	AF106	.50	CG12E	.20	OC46	.15
EZ90	.22	PCH200	.62	R11	.98	U281	.40	AF114	.25	FSY11A	.23	OC70	.13
FW4/500	.75	PCL82	.33	R16	1.75	U282	.40	AF115	.15	GD9	.20	OC71	.11
FW4/800	.75	PCL83	.60	R17	.88	U301	.40	AF117	.19	GET113	.20	OC72	.11
GZ30	.35	PCL84	.35	R19	.31	U403	.33	AF121	.30	GET116	.40	OC74	.23
GZ32	.42	PCL805/85	.42	SP42	.75	U404	.38	AF124	.25	GET118	.20	OC75	.11
GZ33	.70	PCL86	.40	SP61	.33	U801	.95	AF126	.18	GET119	.20	OC76	.15
GZ34	.53	PCL88	.67	TH4B	.50	U4020	.38	AF139	.65	GET573	.38	OC77	.27
GZ37	.75	PD500	1.44	TH233	.98	VP23	.40	AF178	.68	GET587	.43	OC78	.15
HABC80	.45	PEN4DD	1.38	TP2620	.98	VP41	.38	AF180	.48	GET873	.15	OC78D	.15
HL23DD	.40	PEN36C	.75	UABC80	.30	VR105	.33	AF186	.55	GET887	.23	OC81	.11
HL41DD	.98	PEN45	.35	UAF42	.50	VT61A	.35	AF239	.38	GET897	.23	OC81D	.11
HL42DD	.50	PEN45DD	.75	UBC41	.45	VU111	.44	BA102	.45	GET898	.23	OC82	.11
HN309	1·40	PEN46	.20	UBC81	.40	VU120	.60	BA115	.14	M1	.15	OC82D	.11
HVR2	.53	PEN453DD	.98	UBF80	.29	VU120A	.60	BA116	.25	M3	.15	OC83	.20
HVR2A	.53	PENDD-4020	.88	UBF89	.31	VU133	.35	BA129	.13	MAT100	.39	OC84	.24
KT2	.25	PFL200	.54	UBL21	.55	W76	.34	BA130	.10	MAT101	.43	OC123	.23
KT8	1.75	PL36	.47	UC92	.35	W107	.50	BA153	.15	MAT120	.39	OC139	.23
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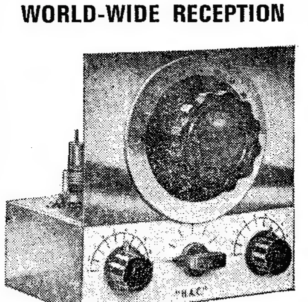

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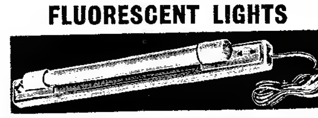

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2D21	0.35	6BQ5	0.25	6K25	0.75	12AV6	0.33
3A4	0.35	6BR8	0.65	6L6GT	0.45	12AV7	0.50
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3Q4	0.40	6BW7	0.70	6LD20	0.40	12B4A	0.55
3S4	0.35	6BX6	0.25	6N7GT	0.40	12BA6	0.35
3V4	0.45	6BZ6	0.35	6P1	0.60	12BA7	0.35
5R4GY	0.60	6C4	0.33	6P25	1.25	12BE6	0.35
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5V4G	0.42	6CB6	0.30	6Q7	0.40	12BY7	0.55
5Y3GT	0.32	6CD6GA	1.15	6SA7	0.40	12K5	0.55
5Z3	0.50	6CG7	0.50	6SG7	0.35	12K7GT	0.35
5Z4G	0.40	6CH6	0.55	6SK7	0.35	12Q7G	0.30
6/30L2	0.75	6CL6	0.50	6SL7GT	0.35	12SR7	0.35
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6AF4A	0.50	6CY5	0.43	6SQ7	0.40	20D1	0.45
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6AJ8	0.30	6DC6	0.75	6U4GT	0.60	20P4	1.10
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6AL3	0.43	6DS4	0.75	6X4	0.30	25L6GT	0.45
6AL5	0.20	6EA8	0.58	6X5GT	0.35	25Z4G	0.30
6AM5	0.32	6EH7	0.30	6X8	0.55	25Z6GT	0.65
6AM6	0.33	6EJ7	0.35	6Y6G	0.65	30A5	0.45
6AQ5	0.35	6EW6	0.65	7Y4	0.60	30AE3	0.40
6AQ6	0.55	6F1	0.70	9BW6	0.50	30C1	0.30

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30F5	0.85	90C1	0.60	DM160	0.65	ECC89	0.50
30FL1	0.70	90CV	1.25	DY86	0.33	ECC91	0.20
30FL12	0.93	807	0.50	DY87	0.35	ECC189	0.60
30FL14	0.75	813	3.75	DY802	0.50	ECF80	0.35
30L1	0.40	866A	0.75	E88CC	0.65	ECF82	0.35
30L15	0.85	5642	0.65	E180F	0.95	ECF86	0.65
30L17	0.80	6080	1.50	E810F	2.90	ECF804	1.50
30P12	0.80	6146	1.50	EABC80	0.35	ECH42	0.70
30P19	0.80	6146A	2.00	EAF42	0.55	ECH81	0.30
30PL1	0.70	6146B	2.50	EBC33	0.50	ECH83	0.40
30PL13	0.93	6360	1.25	EBC41	0.55	ECH84	0.45
30PL14	0.90	6870	2.50	EBC81	0.30	ECL80	0.40
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35D5	0.70	7895	1.25	EC86	0.60	ECL85	0.55
35L6GT	0.50	9002	0.35	EC88	0.60	ECL86	0.40
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35Z3	0.60	AZ1	0.48	EC91	0.50		1.50
35Z4G	0.30	AZ31	0.55	EC92	0.35	EF37A	0.60
35Z5GT	0.40	CBL1	0.80	EC93	0.50	EF39	0.40
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50C5	0.40	DAF96	0.42	ECC81	0.33	EF42	0.70
50CD6G	1.65	DF96	0.42	ECC82	0.30	EF80	0.25
50L6GT	0.50	DK40	0.55	ECC83	0.30	EF83	0.55

EF85	0.35	EZ40	0.45	PCL800	0.93	U78	0.30
EF86	0.30	EZ41	0.45	PCL801	0.70	U191	0.75
EF89	0.28	EZ80	0.25	PD500	1.50	U201	0.35
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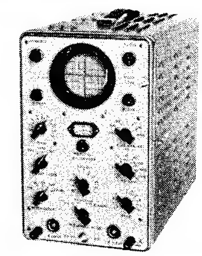
EF92	0.40	GY501	0.80	PF818	0.85	U282	0.40
EF95	0.30	GZ30	0.40	PFL200	0.70	U301	0.40
EF97	0.65	GZ31	0.33	PL33	0.35	U403	0.50
EF98	0.65	GZ32	0.48	PL36	0.55	U404	0.40
EF183	0.30	GZ33	0.70	PL81	0.50	U801	1.00
EF184	0.35	GZ34	0.60	PL82	0.45	UABC80	0.35
EF800	1.00	HABC80	0.40	PL83	0.45	UAF41	0.50
EF804	1.25	HK90	0.35	PL84	0.40	UAF42	0.55
EK90	0.30	KT66	2.05	PL302	0.80	UBC41	0.50
EL33	1.25	KT88	2.00	PL504	0.80	UBC81	0.40
EL34	0.50	N78	1.45	PL508	0.90	UBF80	0.40
EL36	0.50	PABC80	0.40	PL509	1.30	UBF89	0.35
EL37	1.25	PC86	0.60	PL801	0.80	UBL1	0.50
EL41	0.55	PC88	0.60	PM84	0.50	UBL21	0.60
EL42	0.58	PC97	0.50	PY31	0.30	UC92	0.35
EL81	0.55	PC900	0.48	PY33	0.63	UCC85	0.40
EL83	0.42	PCC84	0.40	PY80	0.35	UCF80	0.55
EL84	0.25	PCC85	0.40	PY81	0.30	UCH21	0.60
EL85	0.43	PCC88	0.55	PY82	0.30	UCH42	0.70
EL86	0.40	PCC89	0.50	PY83	0.38	UCH43	0.75
EL90	0.35	PCC189	0.55	PY88	0.40	UCH81	0.35
EL95	0.35	PCC805	0.85	PY500	1.00	UCL81	0.60
EL803	1.00	PCC806	0.80	PY800	0.50	UCL82	0.35
EL821	0.55	PCF80	0.30	PY801	0.50	UCL83	0.60
EL822	0.90	PCF82	0.35	PZ30	0.35	UF41	0.60
ELL80	0.75	PCF84	0.50	QQV2-6	2.15	UF42	0.60
EM34	0.90	PCF86	0.60	QQVO3-10	1.25	UF43	0.60
EM71	0.75	PCF87	0.85	QQV03-20A	5.25	UF80	0.35
EM80	0.40	PCF801	0.50	QQV06-4A	5.50	UF85	0.40
EM81	0.60	PCF802	0.50	TT21	2.65	UF89	0.35
EM84	0.35	PCF805	0.75	TT22	2.80	UL41	0.65
EM85	1.00	PCF806	0.70	U18/20	0.75	UL84	0.30
EM87	0.55	PCF808	0.75	U25	0.75	UM84	0.20
EN91	0.35	PCH200	0.70	U26	0.75	UY1N	0.50
EY51	0.40	PCL81	0.50	U31	0.45	UY11	0.65
EY80	0.45	PCL82	0.35	U37	1.50	UY41	0.45
EY81	0.40	PCL83	0.65	U52	0.33	UY82	0.50
EY83	0.55	PCL84	0.45	U76	0.30	UY85	0.30
EY86	0.40	PCL85	0.40			W729	0.60
EY87	0.43	PCL86	0.45			Z759	1.85
EY88	0.43	PCL88	0.90				

TRANSISTORS

2N404	0.17	2S104	0.50	BC152	0.15
2N444A	0.25	2S701	0.50	BC175	0.25
2N696	0.20	2S702	0.50	BCY30	0.35
2N697	0.23	2S746	0.30	BCY33	0.25
2N698	0.40	AC113	0.15	BCY34	0.30
2N705	0.70	AC125	0.30	BCY72	0.20
2N706	0.15	AC126	0.25	BCZ11	0.40
2N708	0.20	AC127	0.20	BD121	0.80
2N753	0.25	AC128	0.20	BD123	0.95
2N929	0.30	AC132	0.35	BF115	0.20
2N930	0.35	AC153	0.25	BF167	0.25
2N987	0.35	AC154	0.15	BF173	0.30
2N1131	0.40	AC156	0.23	BF181	0.25
2N1132	0.45	AC157	0.20	BF184	0.25
2N1184	1.25	AC169	0.10	BF185	0.20
2N1301	0.40	AC176	0.25	BF194	0.20
2N1302	0.25	AC187	0.30	BF195	0.15
2N1304	0.25	AC188	0.30	BF196	0.20
2N1305	0.25	ACY17	0.30	BF197	0.20
2N1306	0.25	ACY18	0.20	BFW87	0.30
2N1307	0.30	ACY19	0.25	BFW88	0.25
2N1308	0.40	ACY20	0.20	BFW89	0.23
2N1309	0.35	ACY21	0.20	BFW91	0.20
2N1613	0.25	ACY22	0.15	BFX88	0.25
2N1711	0.30	AD140	0.80	BFY17	0.40
2N1756	0.75	AD149	0.50	BFY19	0.60
2N2147	0.75	AD161	0.35	BFY50	0.25
2N2160	1.25	AD162	0.35	BFY51	0.20
2N2217	0.30	ADZ11	1.25	BFY52	0.25
2N2218	0.40	ADZ12	1.25	BSY26	0.25
2N2219	0.45	AF114	0.25	BSY27	0.30
2N2369A	0.25	AF115	0.30	BSY28	0.30
2N2477	0.65	AF116	0.25	BSY65	0.20
2N2646	0.60	AF117	0.20	BSY95A	0.20
2N2905	0.50	AF118	0.45	OC16	0.75
2N2923	0.15	AF125	0.25	OC22	0.65
2N2924	0.15	AF127	0.25	OC23	0.60
2N2926	0.15	AF178	0.40	OC24	0.60
2N3053	0.30	AF180	0.35	OC25	0.40
2N3055	0.75	AF181	0.35	OC26	0.30
2N3133	0.35	AF186	0.50	OC28	0.60
2N3134	0.50	AF239	0.40	OC29	0.65
2N3391	0.20	AFZ11	0.45	OC30	0.75
2N3392	0.15	ASY26	0.25	OC35	0.50
2N3393	0.15	ASY27	0.30	OC36	0.60
2N3394	0.15	ASY28	0.30	OC42	0.30
2N3395	0.20	ASY29	0.30	OC44	0.20
2N3402	0.15	ASY54	0.25	OC45	0.20
2N3403	0.15	ASY74	0.50	OC70	0.20
2N3404	0.35	ASY77	0.35	OC71	0.15
2N3414	0.20	ASY82	0.20	OC72	0.25
2N3415	0.15	ASY86	0.20	OC73	0.40
2N3416	0.25	ASZ15	0.70	OC75	0.25
2N3417	0.25	ASZ16	0.70	OC76	0.25
2N3702	0.15	ASZ17	0.75	OC78	0.25
2N3703	0.15	ASZ18	0.75	OC78D	0.20
2N3704	0.20	ASZ21	0.50	OC81	0.25
2N3707	0.20	BC107	0.15	OC81D	0.15
2N3709	0.15	BC108	0.15	OC83	0.20
2N3710	0.15	BC109	0.20	OC139	0.35
2N3819	0.35	BC113	0.40	OC140	0.40
2N3906	0.30	BC118	0.30	OC141	0.60
2S002	1.00	BC134	0.30	OC170	0.25
2S004	1.00	BC147	0.20	OC171	0.25
2S034	1.00	BC148	0.15	OC200	0.30
2S102	0.40	BC149	0.15	OC202	0.65

SYNCHROSCOPE TYPE C1-5



3-in tube fitted with telescopic viewing hood, giving bright display in full daylight.
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	200 p.i.v.	KD202E	0·20
	300 p.i.v.	KD202I	0·20
3 AMP:	50 p.i.v.	KD202A	0·25
	100 p.i.v.	KD202V	0·25
	200 p.i.v.	KD202D	0·30

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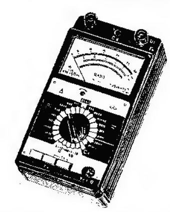

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U4313
with AC current ranges

Type U4312—Low sensitivity instrument (667 o.p.v.) 1% accuracy on DC and 1·5% on AC. 9 current ranges on DC (300μA to 6A) and 8 current ranges on AC (1·5mA to 6A). 9 voltage ranges 0·3 to 900V AC/DC. Resistance 0·2 to 30k Ω. Mirror scale.

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5% tolerance 22–27–33–39–47–56–68–82–100–120–150–180–220–270–330–390–470–560–680–820–1000pF
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MINIMUM QUANTITY (ASSORTED)—20
FOR ORDERS OF 100 PER TYPE PRICE **£3·50** PER 100
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