

PRACTICAL

ELECTRONICS

JANUARY 1972

20p

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A precision instrument—supplied with standard 3/16" (4.75 mm) diameter, detachable copper chisel-face bit*.
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All fully coded, all from well-known manufacturers and now available, while stocks last, at better than bulk-buyer's prices! Cash with order only.

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| 2N3391 | Si NPN Hi Gain (250-500) low noise transistor. | 3 for 50p |
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| 2N2923 | 25V version of 2N2926. (orange) | 7 for 50p |
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(1N914) | Signal Diode. | 18 for 50p |
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This month's Star Bargain
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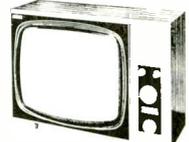
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TEAK HI-FI STEREO CABINETS £14.95



Brand new 44in wide 16in deep 18in high with legs. A superb piece of furniture. Carriage £1. WHILE STOCKS LAST.

HI-FI VALUE

(1) Garrard SP25 Mk. III: £11.50. P.P. 50p.

(2) Teak Plinth and Tinted Cover: £4.95. P.P. 35p.

(3) Sonatone 9TAHC Diamond Cartridge: £2.50.

1, 2, 3 Bargain Package: £17.95. P.P. 85p.



COMPONENTS MUST BE CLEARED

Transistor Radio Cases: 25p each. Size 9in x 6in x 3in. Post 15p. Speakers: 35p. 2 1/2in 8Ω. Brand new. Post 15p.

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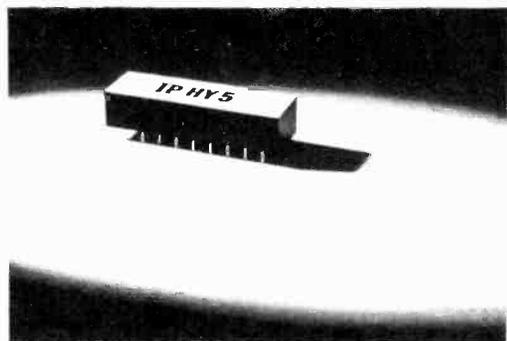
Transistor Gang Condensers: 20p. Miniature AM. Post free. Modern Gang Condensers: 30p. AM/FM or AM only 20p. Post 10p.

Transistors 15p each. Post free. AC126, AC128, AF114, AF117, OC45, OC71, OC81, OC81D.

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Lets face it — an immediate success, the HY40 is here to stay. HY40 means Hybrid Power, power neatly locked away inside an Intregrated Circuit. Power the modern way, simply mount only five additional components on a printed circuit board (all of which are supplied with the HY40). Power not only for Hi-Fi, power for Groups, for public address, for industry, power for all.

HY40 is HI-FI POWER ILP are POWER PROUD

In addition to the P.C. board and manual supplied with the HY40 we now include the five remaining components, at minimal cost, needed to complete the assembly of a High Performance Power Amplifier.

By merely combining two HY40s with a Stereo Preamp (2 x HY5) and simple Power Supply (PSU45), premium quality stereo may be obtained for a very modest outlay.

The free manual supplied with the HY40 gives clear, easy build instructions for Power Supply; volume, bass, treble and balance controls, together with inputs for Ceramic and Magnetic Pick-ups, Tape, Tuner and Auxiliary functions.

Internally the HY40 is based on conventional and proven circuit techniques developed over recent years.



OUTPUT POWER British Rating 40 WATTS PEAK, 20 watts RMS continuous.

LOAD IMPEDANCE 4—16 ohms

INPUT IMPEDANCE 22Kohms at 1KHz.

INPUT SENSITIVITY 300 mV for maximum output.

VOLTAGE GAIN 30db at 1KHz.

FREQUENCY RESPONSE 5Hz-60KHz \pm 1db.

TOTAL DISTORTION less than 1% (typical 0.1%) at all output powers.

SUPPLY VOLTAGE \pm 22.5 volts D.C.

SUPPLY CURRENT 0.8 amps maximum.

PRICE: including comprehensive manual, P.C. Board and FIVE EXTRA COMPONENTS:

MONO £4-40 **STEREO** £8-80 all post free.

A WORLDS FIRST TO JOIN THE WORLDS BEST

The HY5 is a unique and revolutionary concept in High-Fidelity pre-amplifiers. Thanks to the latest techniques, all feedback and equalization networks are, for the first time, combined into an integrated pre-amplifier circuit.

Simply by adding volume, treble, bass potentiometers and only three stabilizing capacitors, which are supplied, your HY5 is complete and ready for use.

The HY5 provides equalization for almost every conceivable input. This years developments in equalization technique enables precise correction for both output voltage and frequency response for any crystal or ceramic cartridge. Yet another feature of the HY5 is its inbuilt stabilization circuit, allowing it to be run off any unregulated power amplifier supply.

The HY5 contains a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo preamplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY40 and PSU45 forms a completely integrated system.

INPUTS

Magnetic Pick-up (within \pm 1db RIAA curve) 2mV.
Tape Replay (external components to suit head). 4mV.
Microphone (flat) 10mV.
Ceramic Pick-up (equalized and compensatable) 20 — 2000mV variable.

Tuner (flat) 250mV.
Auxiliary 1 250mV.
Auxiliary 2 2—20mV.

OUTPUTS

Main Pre-amp output 500mV.
Direct tape output 120mV.

ACTIVE TONE CONTROLS

Treble \pm 12db.
Bass \pm 12db.

INTERNAL STABILIZATION

Enables the HY5 to share an unregulated supply with the Power Amplifier.

SUPPLY VOLTAGE

15—25 volt.

SUPPLY CURRENT

5mA approx.

OVERLOAD CAPABILITY

better than 28db on most sensitive input infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE

0.5mV.

PRICE

Mono £3-60 **Stereo** £7-20

POWER SUPPLY PSU45



The PSU45 is specifically designed to supply, simultaneously, your HY40 (in mono or stereo format) and one or two HY5s.

Spec.

PSU45 \pm 22.5 volts, 2 amps simultaneously.

PRICE: £4-50 including Postage and Packing

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BLACK LIGHT



THE OUT OF SIGHT LIGHT



This kit consists of a high-pressure mercury discharge lamp enclosed in a deep blue-violet outer bulb. This absorbs all visible light given by the discharge but transmits the long-wave ultra-violet rays.

The unit performs in a similar fashion to the fluorescent tube type units in use in some discotheques but instead uses a 3-pin B.C. lamp fitted into a high intensity spot-fitting with fully adjustable swivel bearing. The reflector is also fully adjustable and the unit may be mounted in any position and focused as desired.

White shirts and dresses glow "Whiter than white". Paint scenes on walls, etc., with our special fluorescent paint, focus the black-light from across the room and switch-on. The pictures glow brilliantly as if by magic!

Full kit includes lamp, reflector, control-gear, generous samples of five different colours of fluorescent paint and full instructions. Price £25 carr. paid. S.A.E. with all inquiries.

PRACTICAL ELECTRONICS

"SCORPIO"

ELECTRONIC IGNITION SYSTEM

This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.

Helps to promote easier starting (even under sub-zero conditions), improved acceleration, better high-speed performance, quicker engine warm-up and improved fuel economy. Eliminates excessive contact-breaker point burning and the need to adjust point and spark-plug gaps with precision.

Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour. A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7 1/2 in x 4 in x 2 in approx.

Complete assembly and wiring manual 25p, refundable on purchase of kit. Price: £10.50 plus 50p P. & P. S.A.E. with all enquiries.

PSYCHEDELIC LIGHTING UNIT Mk. 3



This unit represents a natural progression from our phenomenally successful Mk. 1 and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.

The unit is constructed on professional fibre-glass printed-circuit board material and uses latest full-wave triac circuitry. There is a master-level control, together with independent sensitivity controls for each channel. The original minimum ambient light level controls have been redesigned permitting their use as faders; allowing dimming from max. to zero at the turn of a knob. R.F.I. suppression is now incorporated as standard as well as provision for D.J. "Pulse-Flash" controls. The choice of two inputs enables operation from both high and low power amplifiers. Max. power 1.5kW per channel at 240V a.c.

Complete assembly built and tested. Size 9 in x 7 in x 3 in. Price £25 carr. paid. S.A.E. with all inquiries.

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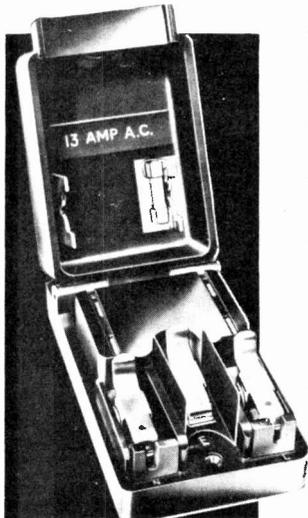
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Type	BV _{gss} (Min.)	I _{gss} (Max.)	V _p (Max.)	ID _{ss} (Max.)	R on (Max.)	Case
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ANY 6 — 60p

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BUDGET HIGH-FIDELITY STEREO SYSTEMS



PREMIER STEREO SYSTEM "ONE" consists of the new Premier 800 all transistor stereo amplifier, Garrard 2025 T/C auto manual record player unit fitted stereo mono ceramic cartridge with diamond stylus and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. 800 amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble, Volume, Balance, Selector, Mono/Stereo switch, Headphone socket, Power on/off. Black leatherette cabinet with aluminium front panel. Size 12 1/2 in x 6 1/2 in x 2 1/2 in. (Amplifier available separately if required **£16-25**, Carr. 40p.)

PREMIER STEREO SYSTEM "TWO", as above but with Garrard SP25 Mk. III and magnetic cartridge—**ONLY £48**, Carr. £1-75.

ONLY £57-75
carr £1 75

PREMIER STEREO SYSTEM "THREE." This consists of KLINGER KC003 stereo amplifier giving 6 watts rms per channel with Bass, Treble, Volume and Balance Controls. Inputs for Magnetic and ceramic pick-up, tuner, tape in and out. Stereo earphone socket. Garrard SP25 Mk. III in teak finish plinth with cover and fitted Sonotone 9TA1ICD diamond stereo cartridge. A pair of HMF Speakers size 16 1/2 in x 10 1/2 in x 9 in fitted EMI units complete the matching system. **ONLY £57-75**, Carr. £1-75.

ONLY £40-95
carr. £1 75

FREE
STEREO HEADPHONES and all leads and plugs supplied with all systems

PREMIER HI-FI OFFERS!

- Philips 580 Stereo Amplifier (List £29-00) **£23-00**
- Rogers Ravensbrook 11 Stereo Amplifier in teak case (List £52-50) **£39-50**
- Rogers Ravensbourne Stereo Amplifier in teak case (List £64) **£49-00**
- Metrosound ST20E Stereo Amplifier in teak case (List £39-50) **£28-50**
- Golding GL75 less cartridge (List £41-61) **£29-00**
- Garrard SP25 111 less cartridge **£11-30**
- Garrard SP25 111 with Goldring G800 cartridge (List £28-35) **£15-50**
- Garrard AP76 less cartridge **£19-50**

Garrard 3500 with Sonotone 9TAHC stereo cartridge (List £15-50) **£9-97**

Garrard 2025 T/C with Sonotone 9TAHC Diamond Cartridge **£9-97**

Garrard 2025 T/C with Sonotone 9TAHC Diamond Cartridge ready wired in teak plinth with cover **£14-00**

Carriage and Insurance 50p extra any item.

TAPE CASSETTES		
C60 (60 min.)	37p	3 for £1-05
C90 (90 min.)	62p	3 for £1-80
C120 (120 min.)	87p	3 for £2-55

FREE Cassette Head Cleaner with every 10 cassettes purchased.
All cassettes can be supplied with library cases at 3p extra each.

SP25 Mk III SPECIAL!



Garrard SP25 Mk. III Single Record Player. Fitted Goldring G800 Magnetic Stereo Cartridge as available. Complete in Teak Plinth with Rigid Perspex Cover.

Total list Price over £34.
PREMIER £18-90
P. & P. 50p



HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2 1/2 in speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft lead and stereo jack plug. **£2-47** P. & P

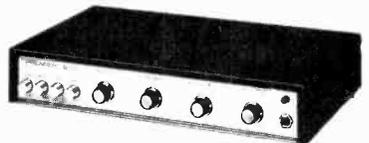
STEREO STETHOSCOPE SET Low imp. **£1-25**, P. & P. 10p
MONO STETHOSCOPE SET Low imp. **52p**, P. & P. 10p

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Fitted two 2 1/2 in tweeters and crossover network. Available with 8 or 16 ohm impedance. Handling capacity 10W. Brand new. **£3-47** P. & P. 40p

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A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000Hz ± 2db. Distortion: 1%. Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Mono/Stereo switch. Stereo Headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12 1/2 in x 6 1/2 in x 2 1/2 in.

ONLY £16-25 Carr. 40p



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Saves time and simplifies soldering in the home and service dept. Two position trigger gives instant dual heat 100/140 watt. 240 volt A.C. **£4-25** P. & P. 30p

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Lightweight, 3/4 in pencil bit, 25 watt. 240 volt A.C. **£1-50** P. & P. 15p

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SP3 5" 600' P.V.C.	42p	SP7 7" 1200' P.V.C.	62p
LP5 5" 900' P.V.C.	50p	LP7 7" 1800' P.V.C.	75p
DT5 5" 1200' POLYESTER	75p	DT7 7" 2400' POLYESTER	£1-25
TAPE SPOOLS 3" 5p, 5", 5 1/2", 7" 9p.		TT7 7" 3600' POLYESTER	£2-50

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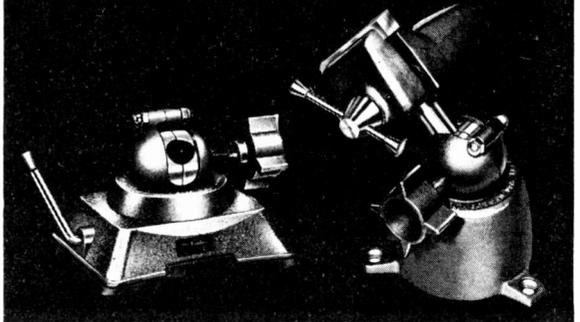
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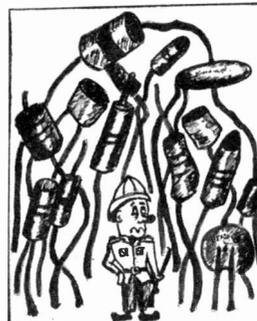
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TYPE SW. 100 100 x 80 mm		TYPE S-80 80 mm square fronts	
500μA	23-85	50μA	23-20
1mA	23-10	50-0-50μA	23-10
20V d.c.	23-10	100μA	23-75
30V d.c.	23-10	100-0-100μA	23-10
300V d.c.	23-10	500μA	23-00
1A d.c.	23-10	1mA	23-60
5A d.c.	23-10	20V d.c.	23-60
300V a.c.	23-10	50V d.c.	23-60
100-0-100μA	23-45	300V a.c.	23-60
		300V d.c.	23-87

"SEW" CLEAR PLASTIC METERS

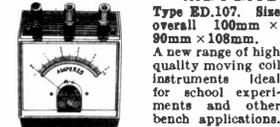
Type MR. 85P. 4 1/4in x 4 1/4in fronts.		Type MR. 38P. 1 21/32in square fronts.	
50μA	23-60	150mA	21-80
50-0-50μA	23-60	200mA	21-80
100μA	23-10	300mA	21-80
100-0-100μA	23-00	500mA	21-80
500μA	23-00	750mA	21-80
500-0-500μA	23-00	1A	21-80
1mA	23-80	2A	21-60
1-0-1mA	23-80	5A	21-60
5mA	23-80	10A	21-60
10mA	23-80	3V d.c.	21-80
		10V d.c.	21-80
		15V d.c.	21-80
		20V d.c.	21-80
		100V d.c.	21-80
		150V d.c.	21-80
		300V d.c.	21-80
		500V d.c.	21-80
		150V d.c.	23-80
		300V a.c.	23-80
		1mA	23-80
		5A a.c.*	23-80
		50-0-500μA	21-80
		1mA	21-80
		1-0-1mA	21-80
		2mA	21-80
		5mA	21-80
		10mA	21-80
		20mA	21-80
		50mA	21-80
		100mA	21-80

Type MR. 52P. 2 1/2in square fronts.		Type MR. 46P. 2in square fronts.	
50μA	23-10	50μA	22-25
50-0-50μA	23-10	50-0-50μA	22-10
100μA	23-60	100μA	22-10
100-0-100μA	23-60	100-0-100μA	21-87
500μA	23-00	500μA	21-75
500-0-500μA	23-00	500-0-500μA	21-70
1mA	23-80	1mA	21-70
1-0-1mA	23-80	5mA	21-70
5mA	23-80	10mA	21-70
10mA	23-80	50mA	21-70
		100mA	21-70
		1A	21-70
		5A	21-70

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50-0-50μA	23-75	1A	21-80
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100-0-100μA	23-65	15A	21-90
200μA	23-65	30A	21-90
500μA	23-40	50A	21-90
500-0-500μA	23-20	5V d.c.	21-80
1mA	23-20	10V d.c.	21-80
5mA	23-20	20V d.c.	21-80
10mA	23-20	50V d.c.	21-80
1A	23-20	150V d.c.	21-90
5A	23-20	300V d.c.	21-90
10A	23-20	30V a.c.*	21-95
50A	23-20	50V a.c.*	21-95
10V d.c.	23-20	150V a.c.*	21-95
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2N3415	2N3416	2N3417	2N3418	2N3419	2N3420	2N3421	2N3422	2N3423	2N3424	2N3425	2N3426	2N3427	2N3428	2N3429	2N3430	2N3431	2N3432	2N3433	2N3434	2N3435	2N3436	2N3437	2N3438	2N3439	2N3440	2N3441	2N3442	2N3443	2N3444	2N3445	2N3446	2N3447	2N3448	2N3449	2N3450	2N3451	2N3452	2N3453	2N3454	2N3455	2N3456	2N3457	2N3458	2N3459	2N3460	2N3461	2N3462	2N3463	2N3464	2N3465	2N3466	2N3467	2N3468	2N3469	2N3470	2N3471	2N3472	2N3473	2N3474	2N3475	2N3476	2N3477	2N3478	2N3479	2N3480	2N3481	2N3482	2N3483	2N3484	2N3485	2N3486	2N3487	2N3488	2N3489	2N3490	2N3491	2N3492	2N3493	2N3494	2N3495	2N3496	2N3497	2N3498	2N3499	2N3500	

Integrated Circuits	FJH101	FJH111	FJH121	FJH131	FJH141	FJH151	FJH161	FJH171	FJH181	FJH191	FJH201	FJH211	FJH221	FJH231	FJH241	FJH251	FJH261	FJH271	FJH281	FJH291	FJH301	FJH311	FJH321	FJH331	FJH341	FJH351	FJH361	FJH371	FJH381	FJH391	FJH401	FJH411	FJH421	FJH431	FJH441	FJH451	FJH461	FJH471	FJH481	FJH491	FJH501	FJH511	FJH521	FJH531	FJH541	FJH551	FJH561	FJH571	FJH581	FJH591	FJH601	FJH611	FJH621	FJH631	FJH641	FJH651	FJH661	FJH671	FJH681	FJH691	FJH701	FJH711	FJH721	FJH731	FJH741	FJH751	FJH761	FJH771	FJH781	FJH791	FJH801	FJH811	FJH821	FJH831	FJH841	FJH851	FJH861	FJH871	FJH881	FJH891	FJH901	FJH911	FJH921	FJH931	FJH941	FJH951	FJH961	FJH971	FJH981	FJH991	FJH1001
FJH101	FJH111	FJH121	FJH131	FJH141	FJH151	FJH161	FJH171	FJH181	FJH191	FJH201	FJH211	FJH221	FJH231	FJH241	FJH251	FJH261	FJH271	FJH281	FJH291	FJH301	FJH311	FJH321	FJH331	FJH341	FJH351	FJH361	FJH371	FJH381	FJH391	FJH401	FJH411	FJH421	FJH431	FJH441	FJH451	FJH461	FJH471	FJH481	FJH491	FJH501	FJH511	FJH521	FJH531	FJH541	FJH551	FJH561	FJH571	FJH581	FJH591	FJH601	FJH611	FJH621	FJH631	FJH641	FJH651	FJH661	FJH671	FJH681	FJH691	FJH701	FJH711	FJH721	FJH731	FJH741	FJH751	FJH761	FJH771	FJH781	FJH791	FJH801	FJH811	FJH821	FJH831	FJH841	FJH851	FJH861	FJH871	FJH881	FJH891	FJH901	FJH911	FJH921	FJH931	FJH941	FJH951	FJH961	FJH971	FJH981	FJH991	FJH1001	

VALVES	6X4	6X5	6X6	6X7	6X8	6X9	6X10	6X11	6X12	6X13	6X14	6X15	6X16	6X17	6X18	6X19	6X20	6X21	6X22	6X23	6X24	6X25	6X26	6X27	6X28	6X29	6X30	6X31	6X32	6X33	6X34	6X35	6X36	6X37	6X38	6X39	6X40	6X41	6X42	6X43	6X44	6X45	6X46	6X47	6X48	6X49	6X50	6X51	6X52	6X53	6X54	6X55	6X56	6X57	6X58	6X59	6X60	6X61	6X62	6X63	6X64	6X65	6X66	6X67	6X68	6X69	6X70	6X71	6X72	6X73	6X74	6X75	6X76	6X77	6X78	6X79	6X80	6X81	6X82	6X83	6X84	6X85	6X86	6X87	6X88	6X89	6X90	6X91	6X92	6X93	6X94	6X95	6X96	6X97	6X98	6X99	6X100
6X4	6X5	6X6	6X7	6X8	6X9	6X10	6X11	6X12	6X13	6X14	6X15	6X16	6X17	6X18	6X19	6X20	6X21	6X22	6X23	6X24	6X25	6X26	6X27	6X28	6X29	6X30	6X31	6X32	6X33	6X34	6X35	6X36	6X37	6X38	6X39	6X40	6X41	6X42	6X43	6X44	6X45	6X46	6X47	6X48	6X49	6X50	6X51	6X52	6X53	6X54	6X55	6X56	6X57	6X58	6X59	6X60	6X61	6X62	6X63	6X64	6X65	6X66	6X67	6X68	6X69	6X70	6X71	6X72	6X73	6X74	6X75	6X76	6X77	6X78	6X79	6X80	6X81	6X82	6X83	6X84	6X85	6X86	6X87	6X88	6X89	6X90	6X91	6X92	6X93	6X94	6X95	6X96	6X97	6X98	6X99	6X100	

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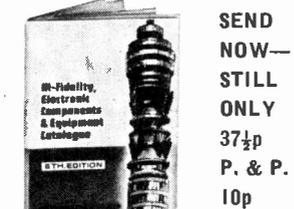
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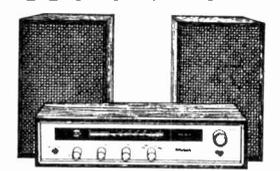


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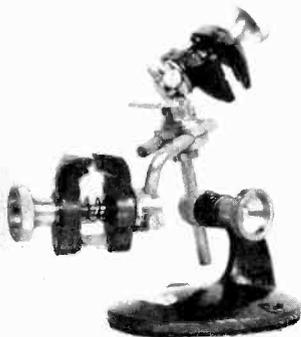
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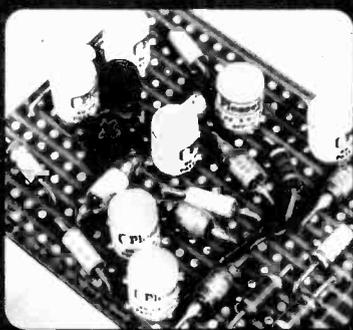
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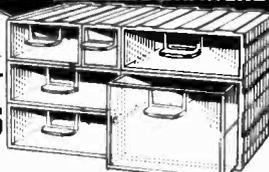


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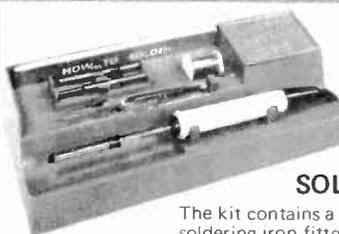
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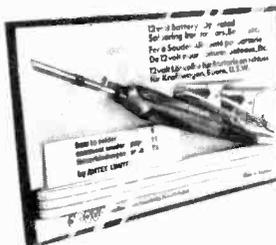
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400	0-06	0-13	0-07	0-20	0-27	0-37	1-25
600	0-07	0-16	0-10	0-23	0-34	0-45	1-85
800	0-10	0-17	0-13	0-25	0-37	0-55	2-00
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U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0-50
U8	50 Sil. planar diodes 250mA, OA/200/202	0-50
U9	20 Mixed volts 1 watt Zener diodes	0-50
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U13	30 PNP-NPN sil. transistors OC200 & 2R104	0-50
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U29	10 1-Amp SCR's TO-5 can up to 600 PIV CR81/25-600	1-00
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PRICE 1-24 25-99 100 up 43p each 40p each 38p each	SILICON 50 WATTS MATCHED NPN/PNP. RIP19 npn TO-3 plastic. BIP20 pnp Brand new. VCB0 10V VCE0 50V IC 10A. HFE type 100ft 3mhz.	SILICON 50 WATTS MATCHED NPN/PNP. RIP19 npn TO-3 plastic. BIP20 pnp Brand new. VCB0 10V VCE0 50V IC 10A. HFE type 100ft 3mhz.
SILICON High Voltage 250V NPN TO-3 case. G.P. Switching and Amplifier Applications. Brand new Coded R2400. VCB0250V/VCE0100V/IC 6A/30W. HFE type 20/FT 5Mhz.	OUR PRICE PER PAIR 1-24 25-99 100 50p 45p 40p	OUR PRICE PER PAIR 1-24 25-99 100 prs. 80p 55p 50p
OUR PRICE 1-24 25-99 100 up 50p 45p 40p	115 WATT SIL. POWER NPN Price 63p each	

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TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each.

FET'S

2N3819	35p	2N5458	50p
2N3820	25p	2N5459	50p
2N3821	35p	2N5460	45p
2N3823	35p	MPF103	40p

PHOTO TRANS.
OCPT1 Type. 43p

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GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8, BSY27/28/95A.

All usable devices no open or short circuits. ALSO AVAILABLE IN PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

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uL914 Dual 2 1/2p
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74 series T.T.L. I.C.'s DOWN AGAIN IN PRICE

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

Order No.	Similar Types to:—Description	Price and qty. prices		
		1-24 \$p	25-99 \$p	100 up \$p
BP00 = 7400	Quad 2-input NAND gate	0-15	0-14	0-12
BP01 = 7401	Quad 2-input pos. NAND gate (with open collector output)	0-15	0-14	0-12
BP02 = 7402	Quad 2-input pos. NOR gates	0-15	0-14	0-12
BP03 = 7403	Quad 2-input pos. NAND gates (with open collector output)	0-15	0-14	0-12
BP04 = 7404	Hex Inverters	0-15	0-14	0-12
BP05 = 7405	Hex Inverter (with open-collector output)	0-15	0-14	0-12
BP10 = 7410	Triple 3-input pos. NAND gates	0-15	0-14	0-12
BP13 = 7413	Dual 4-input Schmitt trigger	0-29	0-26	0-24
BP20 = 7420	Dual 4-input pos. NAND gates	0-15	0-14	0-12
BP23 = 7430	8-input pos. NAND gates	0-15	0-14	0-12
BP40 = 7440	Dual 4-input pos. NAND buffers	0-15	0-14	0-12
BP41 = 7441	BCD to decimal nixie driver	0-67	0-64	0-58
BP42 = 7442	BCD to decimal decoder (4-10 lines, 1 of 10)	0-67	0-64	0-58
BP46 = 7446	BCD-to-seven-segment decoder/driver	2-00	1-75	1-50
BP47 = 7447	BCD-to-seven-segment decoder/drivers (15V outputs)	0-97	0-94	0-88
BP48 = 7448	BCD-to-seven-segment decoder/driver	0-97	0-94	0-88
BP00 = 7450	Expandable dual 2-input and-or-invert	0-15	0-14	0-12
BP01 = 7451	Dual 2-wide 2-input and-or-invert gates	0-15	0-14	0-12
BP03 = 7453	Quad 2-input expandable and-or-invert	0-15	0-14	0-12
BP54 = 7454	4-wide 2-input and-or-invert gates	0-15	0-14	0-12
BP60 = 7460	Dual 4-input expander	0-15	0-14	0-12
BP70 = 7470	Single-phase J-K flip-flop	0-29	0-26	0-24
BP72 = 7472	Master slave J-K flip-flop	0-29	0-26	0-24
BP73 = 7473	Dual Master slave J-K flip-flop	0-37	0-35	0-32
BP74 = 7474	Dual D type flip-flop	0-37	0-35	0-32
BP75 = 7475	Quad latch	0-47	0-45	0-42
BP76 = 7476	Dual J-K with pre-set and clear	0-43	0-40	0-38
BP80 = 7480	Gated full adders	0-67	0-64	0-58
BP81 = 7481	16-bit read/write memory	0-97	0-94	0-88
BP82 = 7482	2-bit binary full adders	0-97	0-94	0-88
BP83 = 7483	Quad full adder	1-10	1-05	0-95
BP86 = 7486	Quad 2-input exclusive NOR gates	0-32	0-30	0-28
BP90 = 7490	BCD decade counter	0-67	0-64	0-58
BP91 = 7491	8-bit shift registers	0-87	0-84	0-78
BP92 = 7492	Divide-by-twelve counters	0-67	0-64	0-58
BP93 = 7493	4-bit binary counters	0-67	0-64	0-58
BP94 = 7494	Dual entry 4-bit shift register	0-77	0-74	0-68
BP95 = 7495	4-bit up-down shift register	0-77	0-74	0-68
BP96 = 7496	3-bit parallel in parallel out shift-register	0-77	0-74	0-68
BP100 = 74100	8-bit bistable latches	1-75	1-65	1-55
BP104 = 74104	Single J-K flip-flop equivalent 9000 series	0-97	0-94	0-88
BP105 = 74105	Single J-K flip flop equivalent 9001 series	0-97	0-94	0-88
BP107 = 74107	Dual Master slave flip-flops	0-40	0-38	0-36
BP110 = 74110	Gates master-slave flip-flops	0-55	0-53	0-50
BP111 = 74111	Dual data lock-out flip-flop	1-25	1-15	1-00
BP118 = 74118	Hex set-reset latches	1-00	0-95	0-90
BP119 = 74119	Hex set-reset latches, 24-pin	1-35	1-25	1-10
BP121 = 74121	Monostable multivibrators	0-67	0-64	0-58
BP141 = 74141	BCD-to-decimal decoder/driver	0-67	0-64	0-58
BP145 = 74145	BCD-to-decimal decoder/driver O/C	1-50	1-40	1-30
BP160 = 74160	16-bit data selector	1-80	1-70	1-60
BP151 = 74151	8-bit data selectors (with strobe)	1-00	0-95	0-90
BP153 = 74153	Dual 4-line-to-1-line data	1-20	1-10	0-95
BP154 = 74154	4- to 16-line decoder	1-80	1-70	1-60
BP155 = 74155	Dual 2- to 4-line decoder	1-40	1-30	1-20
BP156 = 74156	Dual 2- to 4-line decoder O/C	1-40	1-30	1-20
BP160 = 74160	Sync. decade counter	1-80	1-70	1-60
BP161 = 74161	Sync. 4-bit binary counter	1-80	1-70	1-60
BP190 = 74190	Sync. up-down BCD counter	3-50	3-25	3-00
BP191 = 74191	Sync. binary up-down counter (single clock line)	3-50	3-25	3-00
BP192 = 74192	Sync. up-down decade counter	2-10	1-95	1-75
BP193 = 74193	Sync. binary up-down counter (two clock lines)	2-10	1-95	1-75
BP196 = 74196	Pre-settable 50MHz decade counter	1-80	1-70	1-60
BP197 = 74197	Pre-settable 50MHz binary counter	1-80	1-70	1-60
BP198 = 74198	8-bit parallel L-R shift register	5-60	5-00	4-00
BP199 = 74199	8-bit parallel access shift register	5-50	5-00	4-00

Devices may be mixed to qualify for quantity price. Larger quantities—prices on application (TTL 74 Series only).
Data is available for the above series of I.C.'s in booklet form. Price 13p.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock.

BRAND NEW LINEAR I.C.'s—FULL SPEC.

Type No.	Case	Leads	Description	Price		
				1-24	25-99	100 up
BP 201C—8L201C	TO-5	8	G.P. Amp	68p	53p	45p
BP 701C—8L701C	TO-5	8	OP Amp	68p	50p	45p
BP 702C—8L702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709 —72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P— μ A709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 710—72710	D.I.L.	14	Differential comparator	58p	50p	45p
BP 711— μ A711	TO-5	10	Dual comparator	58p	50p	45p
BP 741 —72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
μ A 703C— μ A703C	TO-5	6	R.F.—I.F. Amp	49p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 292—	TO-74	10	G.P. Amp	90p	75p	70p
TAA 330—	TO-5	8	Wide band limiting amplifier	170p	158p	150p

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THE NEW S.G.S. EA 1000 AUDIO AMPLIFIER MODULE

*GUARANTEED NOT LESS THAN 3 WATTS RMS

Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TA/821 providing unlimited applications for the enthusiast in the construction of radios, record players, Audio and Stereo units. Also ideal for intercom systems, monitoring applications and phone answering machines. OTHER USES: portable applications where supply rails as low as 9V are of prime importance.

- Sensitivity 40mV for 1 watt VOLT-AGE GAIN 40dB but can be varied up to 73dB for some applications.
- Signal to Noise Ratio 86dB.
- Frequency response better than 50Hz to 25KHz for -3dB.
- Normal supply Voltage 9-24V.
- Suitable for 8-16 OHM Loads.
- Overall Size 2" x 3" x 1".
- Typical Total Harmonic distortion at 1 watt less than 1%.
- Supply voltage (V_{cc})=24V 150hm load. Module Tested and Guaranteed
- Quantity 1-9 10-25
- Price each £2-63 £2-28
- Larger quantities quoted on request

Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

NOTE THESE PRICES!

Type No.	Function	IC's DTL 930 SERIES LOGIC	
		1-24	25-99 100 up
BP930	Expandable dual 4-input NAND	23p	20p
BP932	Expandable dual 4-input NAND buffer	25p	22p
BP933	Dual 4-input expander	25p	23p
BP935	Expandable Hex Inverter	25p	23p
BP936	Hex Inverter	25p	23p
BP944	Dual 4-input NAND expandable buffer without pull-up	25p	23p
BP945	Master-slave JK or RS	35p	32p
BP946	Quad 2-input NAND	28p	25p
BP948	Master-slave JK or RS	35p	32p
BP951	Monostable	90p	85p
BP962	Triple 3-input NAND	23p	20p
BP963	Dual Master-slave JK with separate clock	80p	75p
BP964	Dual Master-slave JK with separate clock	80p	75p
BP967	Dual Master-slave JK with Common Clock	80p	75p
BP969	Dual Master-slave JK Common Clock	80p	75p

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

DTL AND TTL INTEGRATED CIRCUITS

Manufacturers' "Full class"—out of spec. devices including functional units and part function but failed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C.'s and experimental work.

Pak No.	IC's	Pak No.	IC's
UIC930 = 12 x μ A 930	50p	UIC948 = 8 x μ A 948	50p
UIC932 = 12 x μ A 932	50p	UIC951 = 5 x μ A 951	50p
UIC933 = 12 x μ A 933	50p	UIC961 = 12 x μ A 961	50p
UIC935 = 12 x μ A 935	50p	UIC963 = 5 x μ A 963	50p
UIC936 = 12 x μ A 936	50p	UIC964 = 5 x μ A 964	50p
UIC944 = 12 x μ A 944	50p	UIC967 = 5 x μ A 967	50p
UIC945 = 8 x μ A 945	50p	UIC969 = 5 x μ A 969	50p
UIC946 = 12 x μ A 946	50p	UIC = 925 Assorted 930 Series	£1-50

Packs cannot be split but 25 Assorted Pieces (on mix) is available as PAK UIC9. Data Booklet available for the BP930 Series. PRICE 13p.

UIC00 = 12 x 7400N	50p	UIC46 = 5 x 7446N	50p	UIC81 = 5 x 7481N	50p
UIC01 = 12 x 7401N	50p	UIC47 = 5 x 7447N	50p	UIC82 = 5 x 7482N	50p
UIC02 = 12 x 7402N	50p	UIC48 = 5 x 7448N	50p	UIC83 = 5 x 7483N	50p
UIC03 = 12 x 7303N	50p	UIC50 = 12 x 7450N	50p	UIC86 = 5 x 7486N	50p
UIC04 = 12 x 7404N	50p	UIC51 = 12 x 7451N	50p	UIC90 = 5 x 7490N	50p
UIC05 = 12 x 7405N	50p	UIC53 = 12 x 7453N	50p	UIC91 = 5 x 7491N	50p
UIC10 = 12 x 7410N	50p	UIC54 = 12 x 7454N	50p	UIC92 = 5 x 7492N	50p
UIC13 = 8 x 7413N	50p	UIC60 = 12 x 7460N	50p	UIC93 = 5 x 7493N	50p
UIC20 = 12 x 7420N	50p	UIC70 = 8 x 7470N	50p	UIC94 = 5 x 7494N	50p
UIC40 = 12 x 7440N	50p	UIC72 = 8 x 7472N	50p	UIC95 = 5 x 7495N	50p
UIC41 = 5 x 7441N	50p	UIC73 = 8 x 7473N	50p	UIC96 = 5 x 7496N	50p
UIC42 = 5 x 7442N	50p	UIC74 = 8 x 7474N	50p	UIC121 = 5 x 74121N	50p
UIC43 = 5 x 7443N	50p	UIC76 = 8 x 7476N	50p	UICX1 = 25 x Ass'd	74's £1-50.
UIC44 = 5 x 7444N	50p	UIC77 = 8 x 7477N	50p		
UIC45 = 5 x 7445N	50p	UIC80 = 5 x 7480N	50p		

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CLOCK RADIO 8FC-59WA** **SAVE
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Sony's elegantly designed 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 features Sony's unique sleep button, you fall gently to sleep lulled by the sweet tone of the radio, which switches itself off at a pre-determined time. Available in either black or white. 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 a.c. 50Hz. Dimensions: 12½in 3½in 5½in.

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£28.94 PRICE £16.75** Post 25p

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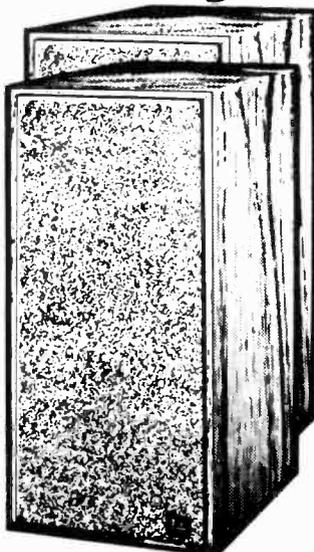


The great new 1972 edition of Lasky's famous Audio-Tronics Catalogue is now available — **FREE** on request. The 44 newspaper size pages—many in full colour—are packed with 1,000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast. Electronics hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio accessories and don't miss **LASKY'S AUDIO-TRONICS CREDIT CARD SCHEME** offering holders one month's interest free credit up to £50 and the fantastic £1,000 plus colour TV competition. Send your name and address and 15p for post and inclusion on our regular mailing list.

NEW From Lasky's

**CRITERION
Mk. X**

Because of the increasing demand for inexpensive, high quality bookshelf speakers, we have seen fit to introduce the Criterion Mk. X bookshelf system. The speaker is a sealed infinite baffle type enclosure using 8in woofer, a 5in mid-range and 2½in tweeter. The compact cabinet is finished in oiled walnut and black woven speaker grille cloth. Frequency response: 40Hz-20KHz. Power handling capacity: Max. 20 watts. Impedance: 8 ohms. The Criterion is fitted with two types of speaker lead connections — screw terminal and phono. Size: 18½in (H) x 9½in (W) x 9½in (D). Operational horizontally or vertically.



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AMAZING
PRICE**

£25

C & P 50p

£13.50 each

a sound future

Lasky's Radio for over 38 years Great Britain's Leading Radio, High Fidelity, Tape Recorder and Electronics Specialists have vacancies in their West End and City Branches for both male and female Sales Assistants. We are seeking intelligent young men and women sales personnel to join our expanding organisation (already the largest in Europe) on a career basis with the finest prospects for early promotion and financial advancement. Working with our energetic sales teams in any of our six West End and City branches will bring you into contact with people from every walk of life including Pop Stars, film and television personalities, royalty and above all enthusiasts in every field of Audio, Hi-Fi and Electronics—people who expect you to share their enthusiasm and interest.

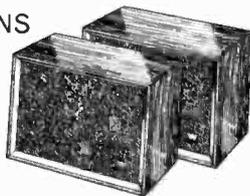
Knowledge of Hi-Fi and electronics is not essential although it will help—all that we require as the basic qualities needed for a successful application are willingness to learn and a common-sense approach to the business of selling. Salary ranges from £850 to £1,850 plus, three weeks' holiday after one year, and Incentive Bonus Schemes are added benefits of working in our progressive organisation. Holiday arrangements will be honoured. If you are interested in a career in Audio and Hi-Fi write at once to: **Kenneth Lasky, Lasky's Radio Limited, 3-15 Cavell Street, London E1 2BN.**

Interviews will be arranged to suit your convenience.

SUPER SPEAKER BARGAINS

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A compact system sold in matched pairs for a perfectly balanced stereo system. Each Denton contains an 8in bass unit with 3in pressure unit, coupled by a Wharfedale crossover network. Rated input: 15 watts maximum. Frequency response: 65-17,000Hz. Impedance: 4/8 ohms. Cabinet 9 1/2in x 14in x 8 1/2in. Available in oiled teak finish and are small enough to fit in with most surroundings.

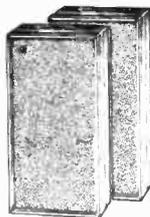


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WHARFEDALE TRITONS

A new and exciting addition to the Wharfedale range, this three-speaker system will satisfy the most ardent Hi-Fi enthusiast. Shelf or floor standing—hand finished in oiled teak. Frequency response: 55-22,000Hz. C.A.B. Dome pressure unit. Bass unit 8in. Mid-range unit 5in. Treble unit 2 1/2in. Impedance: 8 ohms. Size: 2 1/2in x 9 1/2in x 9in.



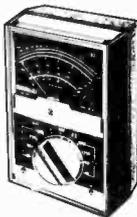
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MODEL TM-1 MINI-TESTER

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Size Only

- DC/V: 0-10-50-250-1,000 at 1k OPV
- AC/V: 0-10-50-250-1,000 at 1k OPV
- DC CURRENT: 0-1mA, 100mA

- Resistance: 0-150k
- Decibels: -10dB to 22dB
- Complete with test leads, battery and instructions

LASKY'S PRICE £1.95 POST 13p

TM-5 5K ohms/V POCKET MULTIMETER

Another new look pocket multimeter from Lasky's providing top quality and value. The "slimline" impact resistant case, size 4 1/2in x 2 1/2in x 1 1/2in, fitted with extra large 2 1/2in square meter. Readability is superior on all low ranges; making this an excellent instrument for servicing transistorised equipment. Recessed click stop selection switch. Ohms zero adjustment. Buff finish with crystal clear meter cover.

- DC/V: 3-15-150-300-1,200 at 5k OPV
- AC/V: 6-30-300-600 at 2.5k/OPV
- DC Current 0-300µA, 0-300mA
- Resistance: 0-10k/ohms, 0-1M/ohm OPV
- Decibels: -10dB to +16dB
- Complete with test leads, battery and instructions.

LASKY'S PRICE £2.95 POST 13p

LASKY'S NEW "LOW NOISE" CASSETTES FROM the U.S.A.

Model	Singles	5	10	20
C. 60	32p	£1.52	£2.96	£5.60
C. 90	50p	£2.37	£4.62	£8.75
C. 120	69p	£3.28	£6.38	£10.85

Post Each 5p. 5-20p. 10-25p. 20-50p.

TRIO KA.2002 PACKAGE DEAL TOP VALUE

- TRIO KA.2002 £39.50
- Pair Wharfedale Dentons .. £39.90
- BSR MP60 £15.20
- LASKY BASE & COVER £4.75
- AD76K CARTRIDGE £4.35

Total list price **£103.70**

PACKAGE PRICE £79.50

Carriage in U.K. £2.00

ADD £9 if Wharfedale TRITONS are preferred to Dentons

TMK MODEL 200 METER KIT

TMK offer the unique opportunity of building a really first-class precision multimeter at a worthwhile saving in cost. The cabinets are supplied with the meter scale and movement mounted in position. The highest quality components and 1% tolerance resistors are used throughout. Supplied complete with full constructional circuit and operating instructions.

Specification

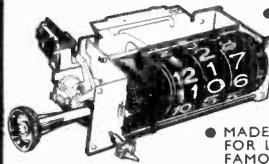
20,000 P.O.V. Multimeter. Features 24 measurement ranges with mirror scale accuracy. DC/V and current: 2% A.C./V: 3%. Resistance 3%. Special 0-6V DC range for transistor circuit measurements.



ONLY

LASKY'S PRICE £4.60 POST 13p

DIGITAL CLOCK SCOOP



- SHOCK AND VIBRATION PROOF
- 12-HOUR ALARM
- AUTO "SLEEP" SWITCH
- HOURS, MINUTES AND SECONDS READ-OFF
- FORWARD AND BACKWARD TIME ADJUSTMENT
- SILENT OPERATION
- SYNCHRONOUS MOTOR
- MADE ESPECIALLY FOR LASKY'S BY FAMOUS MAKER
- MAINS OPERATION

- BUILT-IN ALARM BUZZER

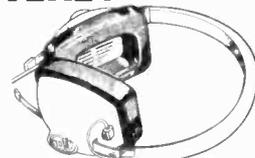
EXCLUSIVELY FROM LASKY'S in chassis form for you to mount in any housing. The clock measures 4 1/2W x 1 1/2H x 3 1/2D (overall from front of drum to back of switch). SPEC.: 210/240V AC, 50Hz operation; switch rating 250V, 3A. Complete with instructions.

HUNDREDS OF APPLICATIONS. COMPLETE WITH KNOBS

LASKY'S PRICE £6.50 POST 18p

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TRIO HS.1 HS.2. STEREO HEADPHONE BARGAINS



Models HS.1 and HS.2. Both these sets by TRIO offer really superb stereo reproduction in a lightweight, fully adjustable headset designed for optimum comfort. Listening fatigue is unknown with TRIO headphones. Brief spec.

both models: Input imp.: 8 nominal (matching 4 to 8); max. input 0.5W; frequency response 20-19kHz; output sensitivity at 1mW input: HS.1 118dB, HS.2 111dB; weight 0.66lbs. Identical in appearance—both models are finished in ivory with contrasting foam-filled ear pads and head band.

HS.1. List Price £8.40.

Lasky's Price £5.00

HS.2. List Price £6.75.

Lasky's Price £4.00 Post 18p

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1N85	0-88	AC128	0-20	BF184	0-20
1N253	0-80	AC187	0-25	BF185	0-20
1N256	0-50	AC188	0-25	BF184	0-17
1N645	0-25	AC177	0-30	BF193	0-15
1N725A	0-20	AC178	0-25	BF196	0-15
1N914	0-07	AC179	0-25	BF197	0-15
1N4007	0-20	AC180	0-20	BF861	0-28
18021	0-20	AC181	0-20	BF898	0-28
18113	0-15	AC182	0-10	BFX12	0-20
18130	0-18	AC183	0-25	BFX13	0-25
18131	0-18	AC184	0-17	BFX29	0-25
18202	0-23	AC185	0-30	BFX30	0-25
2G240	1-97	AC186	0-15	BFX35	0-98
2G301	0-20	AC187	0-15	BFX63	0-60
2G302	0-22	AC188	0-25	BFX84	0-25
2G306	0-80	AD140	0-50	BFX85	0-30
2G371	0-22	AD141	0-50	BFX86	0-25
2G381	0-25	AD161	0-37	BFX87	0-25
2G414	0-30	AD162	0-37	BFX88	0-20
2G417	0-22	AF106	0-30	BFY10	1-00
2N214	0-48	AF114	0-25	BFY11	1-25
2N247	0-25	AF115	0-25	BFY17	0-25
2N250	0-80	AF116	0-25	BFY18	0-25
2N404	0-20	AF117	0-25	BFY19	0-25
2N687	0-25	AF118	0-15	BFY24	0-42
2N698	0-40	AF119	0-20	BFY44	1-00
2N706	0-10	AF124	0-25	BFY50	0-22
2N706A	0-12	AF125	0-20	BFY51	0-20
2N708	0-15	AF126	0-17	BFY52	0-22
2N709	0-63	AF127	0-17	BFY53	0-17
2N711	0-27	AF130	0-30	BFY54	0-42
2N987	0-58	AF178	0-55	BFY90	0-85
2N1090	0-80	AF179	0-65	B8X27	0-60
2N1091	0-88	AF180	0-62	B8X60	0-98
2N1131	0-25	AF181	0-42	B8X76	0-15
2N1132	0-25	AF186	0-40	B8Y26	0-18
2N1302	0-18	AF179	1-17	B8Y27	0-17
2N1303	0-18	AF211	0-60	B8Y51	0-50
2N1304	0-22	AF212	1-00	B8Y95A	0-12
2N1305	0-22	AS226	0-25	B8Y95	0-12
2N1306	0-25	AS227	0-32	BT102/500R	0-47
2N1307	0-25	AS228	0-25	0-75	0-75
2N1308	0-25	AS229	0-30	BTY42	0-92
2N1309	0-25	AS230	0-25	BTY79/100R	0-42
2N1420	0-98	AS231	0-17	0-75	0-75
2N1507	0-28	AS232	0-40	BTY79/400R	0-47
2N1526	0-38	AS233	0-20	1-25	0-81
2N1909	2-25	AS234	0-20	BY100	0-15
2N2147	0-75	AS235	0-25	BY126	0-15
2N2148	0-60	AS236	0-25	BY127	0-17
2N2160	0-60	AS237	0-42	BY182	0-85
2N2218	0-20	AS238	0-75	BY213	0-25
2N2219	0-20	AUY10	0-98	0-25	0-25
2N2287	1-03	AU101	1-50	BYZ10	0-35
2N2297	0-20	BC107	0-10	BYZ11	0-32
2N2369A	0-15	BC108	0-10	BYZ12	0-30
2N2444	0-25	BC109	0-10	BYZ13	0-30
2N2613	0-28	BC113	0-15	BYZ15	1-00
2N2646	0-45	BC115	0-20	BYZ16	0-62
2N2712	0-25	BC116	0-25	BYZ16	0-62
2N2784	0-50	BC116A	0-30	BYZ86/3V3	0-30
2N2846	0-75	BC118	0-25	0-15	0-15
2N2848	0-42	BC121	0-20	CL11	0-85
2N2904	0-25	BC122	0-20	CR81/03	0-25
2N2904A	0-25	BC125	0-68	CR81/40	0-47
2N2906	0-20	BC126	0-65	CS4B	2-50
2N2907	0-23	BC140	0-55	CS10B	3-18
2N2924	0-23	BC147	0-15	DD000	0-15
2N2925	0-15	BC148	0-13	DD003	0-15
2N2926	0-10	BC149	0-15	DD006	0-18
2N3054	0-50	BC157	0-15	DD007	0-49
2N3055	0-75	BC158	0-12	DD008	0-38
2N3702	0-10	BC160	0-63	GD3	0-33
2N3705	0-10	BC169	0-13	GD4	0-05
2N3706	0-23	BCY31	0-85	GD5	0-33
2N3707	0-12	BCY32	0-65	GD8	0-25
2N3709	0-10	BCY33	0-25	GET102	0-05
2N3710	0-10	BCY34	0-30	GET103	0-22
2N3819	0-85	BCY38	0-40	GET113	0-20
2N3820	0-60	BCY39	1-00	GET114	0-15
2N3823	0-75	BCY40	0-50	GET115	0-45
2N8027	0-53	BCY42	0-25	GET116	0-50
2N8088	0-30	BCY43	0-15	GET120	0-25
28005	1-00	BCY71	0-20	GET172	0-30
28178	0-10	BCZ10	0-85	GET175	0-25
28301	0-50	BCZ11	0-50	GET180	0-87
28304	0-75	BD121	0-65	GET181	0-25
28501	0-37	BD123	0-80	GET182	0-25
28703	0-62	BD124	0-75	GET185	0-25
AA129	0-20	BFY11	1-62	GEX44	0-98
AAZ12	0-30	BF115	0-25	GEX45/1	0-10
AAZ13	0-12	BF117	0-50	GEX941	0-15
AC107	0-87	BF167	0-25	GJ3M	0-25
OC43	0-40	GJ4M	0-38	OC43	0-40
OC44	0-17	GJ6M	0-25	OC44	0-17
OC44M	0-17	GJ7M	0-87	OC44M	0-17
OC45	0-12	HG1003	0-50	OC45	0-12
OC45M	0-18	HE1004	0-20	OC45M	0-18
OC46	0-27	MAT100	0-25	OC46	0-27
OC57	0-60	MAT101	0-30	OC57	0-60
OC58	0-60	MAT120	0-25	OC58	0-60
OC59	0-55	MAT121	0-80	OC59	0-55
OC66	0-65	MJ E520	0-87	OC66	0-65
OC70	0-12	MJ E2855	1-37	OC70	0-12
OC71	0-25	MJ E3055	0-87	OC71	0-25
OC72	0-20	NKT128	0-35	OC72	0-20
OC73	0-80	NKT129	0-30	OC73	0-80
OC74	0-80	NKT211	0-25	OC74	0-80
OC75	0-25	NKT213	0-25	OC75	0-25
OC76	0-85	NKT214	0-15	OC76	0-85
OC77	0-40	NKT216	0-37	OC77	0-40
OC78	0-25	NKT217	0-25	OC78	0-25
OC79	0-22	NKT218	1-13	OC79	0-22
OC81	0-20	NKT219	0-38	OC81	0-20
OC81D	0-20	NKT222	0-20	OC81D	0-20
OC81M	0-20	NKT224	0-22	OC81M	0-20
OC81DM	0-18	NKT251	0-84	OC81DM	0-18
OC81Z	0-20	NKT271	0-25	OC81Z	0-20
OC82	0-40	NKT273	0-25	OC82	0-40
OC82D	0-20	NKT273	0-15	OC82D	0-20
OC83	0-25	NKT274	0-20	OC83	0-25
OC84	0-25	NKT275	0-25	OC84	0-25
OC114	0-38	NKT277	0-20	OC114	0-38
OC122	0-60	NKT278	0-25	OC122	0-60
OC123	0-40	NKT301	0-40	OC123	0-40
OC139	0-25	NKT304	0-75	OC139	0-25
OC140	0-35	NKT403	0-75	OC140	0-35
OC141	0-60	NKT404	0-55	OC141	0-60
OC169	0-20	NK T678	0-30	OC169	0-20
OC170	0-25	NKT713	0-25	OC170	0-25
OC171	0-80	NKT773	0-25	OC171	0-80
OC190	0-40	NKT777	0-38	OC190	0-40
OC201	0-70	07R	0-38	OC201	0-70
OC202	0-80	OA5	0-20	OC202	0-80
OC203	0-40	OA6	0-12	OC203	0-40
OC204	0-40	OA47	0-10	OC204	0-40
OC205	0-75	OA70	0-10	OC205	0-75
OC206	0-80	OA71	0-10	OC206	0-80
OC207	0-90	OA72	0-10	OC207	0-90
OC460	0-20	OA74	0-10	OC460	0-20
OC470	0-30	OA79	0-10	OC470	0-30
OC71	0-67	OA81	0-08	OC71	0-67
ORP12	0-50	OA85	0-12	ORP12	0-50
ORP60	0-40	OA86	0-15	ORP60	0-40
ORP91	0-42	OA90	0-08	ORP91	0-42
S18T	0-80	OA91	0-07	S18T	0-80
SAC40	0-25	OA95	0-07	SAC40	0-25
SFT308	0-88	OA200	0-07	SFT308	0-88
ST722	0-88	OA202	0-10	ST722	0-88
ST723	0-83	OA210	0-25	ST723	0-83
SX68	0-20	OA211	0-30	SX68	0-20
SX631	0-30	OA220	0-60	SX631	0-30
SX635	0-40	OA2201	0-60	SX635	0-40
SX640	0-50	OA2202	0-42	SX640	0-50
SX641	0-55	OA2203	0-42	SX641	0-55
SX642	0-60	OA2204	0-30	SX642	0-60
SX644	0-75	OA2205	0-42	SX644	0-75
SX645	0-75	OA2206	0-42	SX645	0-75
V15/30P	0-50	OA2207	0-47	V15/30P	0-50
V30/201P	0-75	OA2208	0-32	V30/201P	0-75
V60/201	0-58	OA2209	0-82	V60/201	0-58
V60/201P	0-75	OA2210	0-32	V60/201P	0-75
XA101	0-10	OA2211	0-32	XA101	0-10
XA102	0-18	OA2222	0-45	XA102	0-18
XA151	0-15	OA2223	0-45	XA151	0-15
XA152	0-15	OA2224	0-45	XA152	0-15
XA161	0-25	OA2241	0-22	XA161	0-25
XA162	0-25	OA2242	0-22	XA162	0-25
XB101	0-48	OA2244	0-22	XB101	0-48
XB102	0-10	OA2290	0-38	XB102	0-10
XB103	0-25	OC16	0-50	XB103	0-25
XB113	0-12	OC16T	0-88	XB113	0-12
XB121	0-48	OC19	0-87	XB121	0-48
ZR24	0-63	OC20	0-85	ZR24	0-63
ZS170	0-10	OC22	0-50	ZS170	0-10
ZS271	0-18	OC23	0-60	ZS271	0-18
ZT21	0-25	OC24	0-80	ZT21	0-25
ZT43	0-25	OC25	0-25	ZT43	0-25
ZTX107	0-15	OC26	0-37	ZTX107	0-15
ZTX108	0-12	OC28	0-80	ZTX108	0-12
ZTX300	0-85	OC29	0-80	ZTX300	0-85
ZTX304	0-12	OC30	0-40	ZTX304	0-12
ZTX500	0-16	OC35	0-50	ZTX500	0-16
ZTX503	0-17	OC36	0-80	ZTX503	0-17
ZTX531	0-25	OC41	0-25	ZTX531	0-25
ZTX531	0-25	OC42	0-30	ZTX531	0-25

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Size 5
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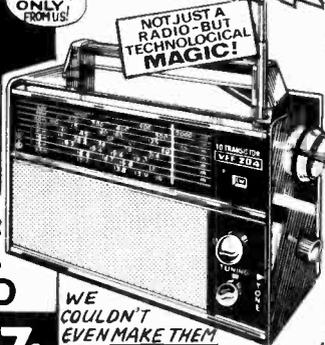
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AND NOW WITH SHIP-TO-SHORE MARINE BAND

BATTERY MODEL £13.97p
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MAINS/BATTERY ELIMINATOR £1.38p extra



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*COMPARE ITS PERFORMANCE WITH £42 RADIOS!

Important! This latest model incorporates all the latest technological improvements and supersedes all earlier models! **Yes! DESIGNED FOR WORLD WIDE RECEPTION**—it'll probably make your present radio seem like a "crystal set"! It even incorporates a special **MARINE WAVEBAND** to receive spoken communications from ship-to-shore! We're almost giving them away at only £13.97—a mere fraction of even today's Russian miracle price! Compare performance with £42 radios! *Refund if not astounded! Purer and sweeter tone than ever! Wider band spread for "pin-point" station selection! The Russians have really surpassed themselves this time proving again their ability in the field of space communications. Yes, 8 separate wavebands, including Standard Long, Medium and Short waves to cover the world, PLUS special "ship-to-shore" **MARINE BAND!** Thousands of different transmissions and stations at your fingertips 24 hours a day, including ships at sea, etc., and messages from all over world—truly nothing is secret! You must hear it to believe it! Superb, sweet tone—controlled from a whisper to a roar! Push-pull output! Separate ON/OFF volume and Treble/Bass tone controls! Press-button dial illumination! Take it anywhere—runs economically on standard batteries or through battery eliminator from 220/240V a.c. mains. Internal ferrite rod plus telescopic aerial. It's also a fabulous **CAR RADIO!** Black and Chrome case 11in x 9in x 3in overall approx. Made to give years of perfect service. Complete with **WRITTEN GUARANTEE**, manual with simple operating instructions and circuit diagram. **ONLY £13.97** (with mains/battery eliminator £1.38 extra). **POST 50p.** Standard batteries 38p extra. Can also be used through extension amplifier, tape recorder or public address system. Send today or call. (SORRY—we cannot change these new radios for any earlier model already purchased!)

fabulous BRAND NEW

SAVE £13.98 NOW!
FIRST CLASS MAKER'S DE LUXE MODEL!

Cassette TAPE RECORDER and PLAYER



RECOMMENDED LIST PRICE £26.97p
OUR PRICE £12.99
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WITH REMOTE CONTROL MICROPHONE
MAKE NO MISTAKE—this is the **EXPENSIVE** model with "PIANO KEYBOARD" CONTROL PANEL and SPECIAL RECORDING LEVEL! **SAVE £13.98!** Due to price we cannot mention famous maker's name—but rest assured you're getting one of the **BEST!** New cassette model—no fiddling with awkward tape and reels, just "slap in" a cassette and off you go! (takes 30-, 60-, and 90-minute standard Philips Cassette tapes obtainable everywhere). Amazing performance ensures perfect tapings and superb reproduction! Remote control microphone. Separate volume control! Rapid rewind! Beautiful tone from a whisper to a roar! Completely self-contained—record anywhere. Separate jacks for remote control microphone, etc. Size 9in x 4in x 2in overall approx. Case design can vary slightly. With carry handle. With **WRITTEN G'TEE** and instructions. **Only £12.99**, post 30p. **ALSO AVAILABLE: SPECIAL BATTERY/MAINS AC/DC MODEL**, ready to plug in £3.50 extra if required. Refund g'tee. **BONUS** one per customer: Cassette tape, set of Standard batteries and microphone stand all for 51p extra if required. Send quickly or call.

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RECOMMENDED RETAIL PRICE £44

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FANTASTIC (even by our standards!) Brand new—the latest sensation in the world of sound! First class makers! Not only a fabulous VHF AM/FM Radio AND Cassette Tape Recorder and Player combined, but it also runs off standard batteries or mains (simply plug in 220/240V a.c. line cord). Now you can record and play back anything, anywhere! You can even tape direct from the Radio as you listen! **RECOMMENDED RETAIL PRICE GENUINELY £44 YET WE OFFER AT ALMOST HALF PRICE!** Just look at these wonderful features:—*Press-button Keyboard Control panel! *New "pop-up" Cassette ejection system! *"MAGIC EYE" Visual Battery check/recording level indicator! *Separate ON/OFF, and HI-LO volume controls! Heavy duty built-in speaker! *Earphone (for personal listening or "monitoring") and extension speaker sockets! *Remote control microphone! *Built-in swivel telescopic extension aerial (24in approx)! Magnificently made case, size 11in x 9in x 3in overall approx., with carry handle (DESIGNS VARY SLIGHTLY). Takes standard 30, 60, 90 or 120 minute Philips Cassette Tapes obtainable everywhere. But wait, the amazing built-in full circuit VHF AM/FM Radio gives you superb clarity of tone and incredible station selection—Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus BBC National VHF. Picks up dozens of foreign stations and short mobile transmissions. Also fabulous in your car! You could pay ££££ more for a Car Radio or Car Cassette Player ALONE! **OUR FANTASTIC PRICE, ONLY £23.75** carr. etc. 35p. Complete with simple instructions, personal listening earphone, remote control microphone with on/off switch and microphone stand. **WITH WRITTEN GUARANTEE. BONUS OFFER**—Standard Batteries and Cassette Tape 25p extra. Refund guaranteed.

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WE COULDN'T EVEN MAKE THEM FOR THIS PRICE!

6 WAVEBAND 10 TRANSISTOR PLUS 3 DIODES PORTABLE RADIO
WORLD WIDE RECEPTION
THOUSANDS OF TRANSMISSIONS AND STATIONS THE WORLD OVER!
£9.97
BOX POST ETC. 43p



NOT JUST A RADIO—BUT TECHNOLOGICAL MAGIC!
THE VERY LATEST MODEL, SUPERSEDING ALL PREVIOUS MODELS—FANTASTIC BRAND NEW RUSSIAN "MERIDIAN" 6-WAVEBAND PORTABLE RADIO. DESIGNED FOR WORLD WIDE RECEPTION. Only put into production after incorporation of every conceivable possible up-to-date technological improvement had been carefully considered and thoroughly examined. So advanced it will probably make your present radio seem like a "crystal set"! It's far better than any 6-wave radio even they have produced! Finest value we've ever offered! We're almost giving them away at £9.97—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with that of £34 radios! *Instant refund if you are not astounded! *Purer and sweeter tone than ever! Much wider band spread than hitherto for "pin-point" station selection. Once again the Russians have proved their fantastic ability in electronics—brilliantly reflecting their advanced micro-circuitry techniques in the field of space and satellite communications. **YOU GET THIS AMAZING SET FROM US AT A PRICE THAT BEARS NO RELATION TO TRUE VALUE!** Yes, 6 separate wavebands, including Standard Long, Medium and Short Waves to cover world! Separate ON/OFF volume and Treble/Bass tone controls! Take it anywhere—runs economically on standard batteries. Internal ferrite rod aerial plus built-in telescopic aerial extending to full 33in length. It's also a fabulous **CAR RADIO**—any speed, requires no additional aerial. **UNIQUE!** Elegant Black, White and Chrome finish case. **SIZE** 10in x 8in x 3in overall approx. Magnificently designed, made to give years of perfect service. With **WRITTEN GUARANTEE**, manual with simple operating instructions and circuit diagram. **ONLY £9.97**, **POST ETC. 43p.** Standard batteries 25p extra. Can also be used through extension amplifier, tape recorder or public address.

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There are two stereo amplifiers—the R100 for ceramic cartridges, the R101 for magnetic and ceramic. Both incorporate FETs (FIELD EFFECT TRANSISTORS), just like top-priced units. FETs give you more of the signal you want, and almost none of the background hiss you don't. Both units have a jack socket to plug in headphones and there's a separate output for tape recorder. Filters (an unusual feature in this price range) and tone controls give a wide range of bass and treble adjustment which compensate for input deficiencies and domestic acoustic conditions.



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Viscount III R101 amplifier	£22+90p	P.&P.
2 Duo Type II speakers	£14+£2	P.&P.
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23+£1.50	P.&P.
Total	£59	

Available complete for only **£52+£3.50**
P.&P.

SYSTEM 2

Viscount III R101 amplifier	£22+90p	P.&P.
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Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23+£1.50	P.&P.
Total	£77	

Available complete for **£69+£4** P.&P.

SYSTEM 3

Viscount III R100 Amplifier	£17+90p	P.&P.
2 Duo Type II speakers	£14+£2	P.&P.
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21+£1.50	P.&P.
Total	£52	

Available complete for only **£49+£3.50**
P.&P.

SPEAKERS Duo Type II

Size approx. 17in \times 10 $\frac{1}{2}$ in \times 6 $\frac{1}{2}$ in. Drive unit 13in \times 8in with parasitic tweeter. Max. power 10W, 3 ohms. Simulated Teak cabinet. **£14 pair + £2 P. & P.**
Duo Type III Size approx. 23 $\frac{1}{2}$ in \times 11 $\frac{1}{2}$ in \times 9 $\frac{1}{2}$ in. Drive unit 13 $\frac{1}{2}$ in \times 8 $\frac{1}{2}$ in with H.F. speaker. Max. power 20W at 3 ohms. Frequency range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair + £3 P. & P.**

SPECIFICATION R100/101

14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0.1%. P.U.1 (for ceramic cartridges) 150mV into 3 Meg. P.U.2 (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within \pm 1dB R.I.A.A. Radio 150mV into 220K. (Sensitivities given at full power.) Tape out facilities; headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to -17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to -12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) R101—P.U.1. and radio—65dB. P.U.2—58dB. R100 same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than -35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13 $\frac{1}{2}$ \times 9in \times 3in.

R+TV

Radio and TV Components (Acton) Ltd. 21D High Street, Acton, London, W3 6NG
323 Edgware Road, London, W.2. Mail orders to Acton. Terms C.W.O. All enquiries S.A.E.

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Practical Electronics January 1972

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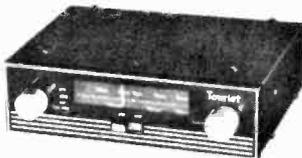
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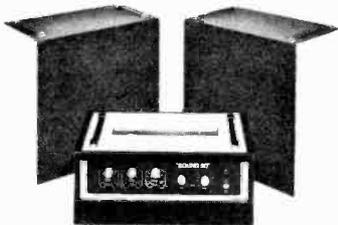
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SOUND 50

50 WATT AMPLIFIER & SPEAKER SYSTEM



Output Power: 45 watts R.M.S. (Sine wave drive).
Frequency response: -3dB points 30Hz at 18KHz. Total distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB.
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SPEAKERS! Size 20in x 20in x 10in incorporating 12in heavy duty 25 watt high flux, quality loudspeaker with cast frame. Cabinets attractively finished in two tone colour scheme—Black and grey.

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POWER OUTPUT: 12 Watts R.M.S. into 3 to 4 ohms speaker.

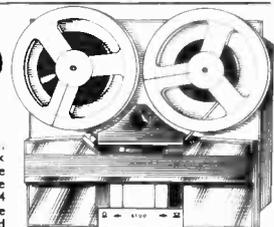
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SUPPLY: 220 to 250V A.C. Mains.
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BC212L	12p	NKT217	50p	OC172	30p	2N3705	10p
BCY30	25p	NKT219	25p	OC200	37p	2N3706	9p
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IN4004	400	100	090
IN4005	600	120	100
IN4006	800	140	130
IN4007	1000	190	150
	p.i.v. 500+ 1000+		
IN4001	50	045	040
IN4002	100	055	045
IN4003	200	060	050
IN4004	400	070	060
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Mfd.		
0.01		3p
0.015		3p
0.022		3p
0.033		3p
0.047		4p
0.068		4p
0.1		4p
0.15		5p
0.22		5p
0.33		7p
0.47		8p
0.68		11p
1.0		14p
1.5		20p
2.2		24p

Mullard Electrolytic C437 series

Mfd.	Volt.	Wkg.	
250	16		9p
400	16		12p
640	16		15p
1,000	16		18p
160	25		9p
250	25		12p
400	25		15p
640	25		18p
100	40		9p
160	40		12p
250	40		15p
400	40		18p

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63 volt working. Range 1.8pf to 220pf (usual pref. values).
Packs of 6 (any values) 15p

CAPACITORS—Mullard Miniature Electrolytic C426 series

Mfd.	Volt	Wkg.	
2.5	16		8p
10	16		6p
20	16		6p
40	16		6p
80	16		6p
1.6	25		8p
6.4	25		6p
12.5	25		6p
50	25		6p
80	25		6p
1	40		8p
4	40		6p
8	40		6p
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32	40		6p
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TRADE WINDS

FOR some time it has been clear that certain sections of the U.K. electronics industry will face a difficult, if not threatening, situation due to overseas competitors, chiefly Japan, in the coming years. For the home producers of television receivers, it seems the danger is quite imminent.

Shut out of the American market by recently imposed tariffs and debarred from Germany and Italy by the terms of the licensing agreement which allows them to manufacture television receivers for the PAL system, the Japanese look now to the large U.K. market as a main outlet for their huge output of colour receivers. And with 20in models likely to retail at £100 against home products costing around £180, it is too much to expect patriotism to win against price. Anyhow precedents have already been provided by the watch and camera trades, and imported radio, audio, and measuring equipments are now taking over sections of the home electronics market.

There is, unfortunately, the possibility of an even more serious threat to the electronics industry in the next decade. The danger of an unimpeded flow of cheap products is not merely the worry of that part of the industry catering for the consumer market. Producers of industrial equipment may well have to face intense overseas competition in the coming years. Japan, for example, is reported to be making phenomenal progress in industrial electronics. She has already taken over the U.S.A. market for desk calculators; and as the largest ship building country in the world, she can be expected to exploit this situation fully, and to offer in time vessels fully equipped with communications, radar, and navigational equipment, as complete going concerns. This kind of development in world trade could be a serious blow to the capital equipment section of the U.K. electronics industry—the very section which has so far been the major exporter, in terms of value, of the whole U.K. electronics industry.

Can any measures be taken to avert the more serious consequences of this "cut price" competition from countries operating under quite different social and economic systems to our own? British industrialists no doubt look with envy to the U.S. and would welcome a similar initiative from our government. But tariffs and trade protection arouse no enthusiasm among customers at large. More likely our industry's chief hope rests in the continuing expansion of world requirements for electronic products of all kinds. But frequent "priming of the pump" by the introduction of technical innovations that lead to further new and commercially valuable applications for electronic techniques seems now, more than ever, an imperative operation for the industry.

F.E.B.

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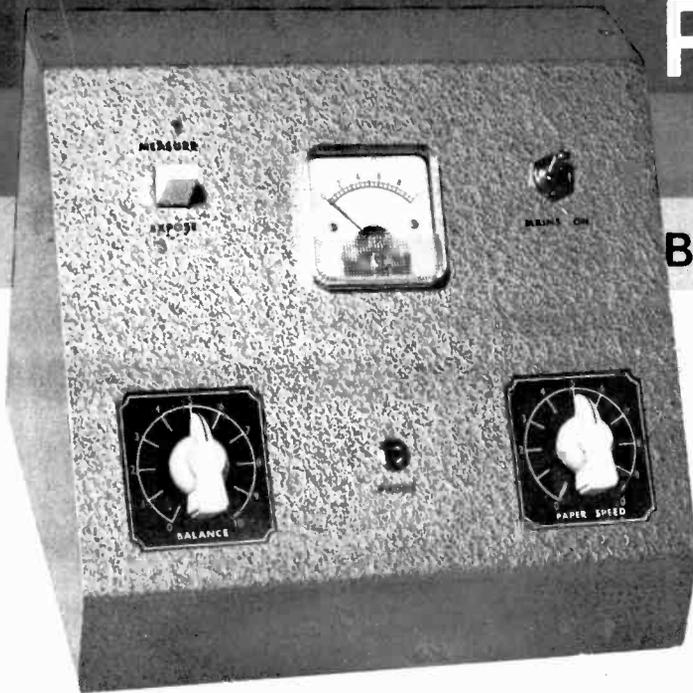
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Our February issue will be published on Friday, January 14.

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Photo-Print Process

By A. WOODROW



MANY amateur photographers like to do their own processing, and an increasing number are attempting colour printing. One of the more tedious tasks of processing is the printing of a roll of negatives. When printing monochrome, each negative requires that a test strip be made to determine the correct exposure needed, the test then being assessed and a final print then made.

When a roll of 36 negatives is being printed, the amount of time and wasted materials involved can be quite considerable. When colour negatives are used, the problem is multiplied by the necessity of obtaining the correct colour balance as well as density. It is possible to waste a complete printing session without obtaining a single satisfactory colour print.

The unit to be described is designed to take most of the trial-and-error out of printing; in fact, prints are made almost automatically in the case of monochrome. The work involved in colour printing is a little greater than for black and white, but it is still possible to make a successful print at the first attempt.

THREE FUNCTIONS

An exposure meter first assesses the negative, and the information obtained is transferred to a timer, which switches the enlarger lamp on for the required time to give a correctly exposed print. The exposure meter is also used for the comparison of a colour negative with a "standard" negative to obtain the correct colour balance.

One of the most important factors in successful photographic processing is consistency of conditions; temperatures, strength of solution, etc. must be constant if good results are to be obtained. One such factor which is often overlooked is mains voltage. If an enlarger lamp is operated at low mains,

its light will be more yellow than at nominal voltage, as well as giving a reduced light output. Conversely, a lamp operated at high voltage gives a bluer light.

The change in light output is serious enough in monochrome printing, but the additional variation in colour can cause chaos in colour printing; a change of two or three volts is sufficient to cause a noticeable shift in colour. With this in mind, the control unit includes a stabiliser unit to hold the lamp voltage constant against variations of mains.

The control unit thus has three parts, intended to be used together, although any one or two sections could be constructed and used independently of the others. The unit will automatically assess and expose negatives over the range one second to one minute, and the stabiliser holds the lamp voltage constant for mains inputs between 220-250V. For nominal mains voltages other than 240V, the stabiliser will operate over a correspondingly lower range.

EXPOSURE METER

If a light source of known brightness is projected through a negative, the amount of light allowed to pass by the negative is a measure of the density of it, and thus of the exposure required to make a print. In this case, the light source is the enlarger lamp, and the amount of light passed by the negative is measured at the enlarger baseboard by a light dependent resistor.

This device, as its name implies, varies its resistance according to the amount of light falling on its sensitive surface. When the device is placed on the baseboard, its resistance depends on the amount of light transmitted by the negative, and thus on the required exposure.

A light dependent resistor, however, has no "memory"; when the illumination is removed, the information gained from the measurement is lost.

Control Unit

As this information is later needed by the timer, a further element must be added to store the reading, ready for transfer to the timer. A bridge is therefore used for the measurement, and the basic circuit is shown in Fig. 1.

BRIDGE CIRCUIT

The main property of this circuit is that when $R_1 \times R_4 = R_2 \times R_3$ no current will pass through the meter. In this condition, the bridge is balanced. When the equation is not satisfied, a current flows in the meter. This current is of a magnitude dependent on the degree of unbalance and the voltage of the supply, but the point at which balance occurs is independent of applied voltage.

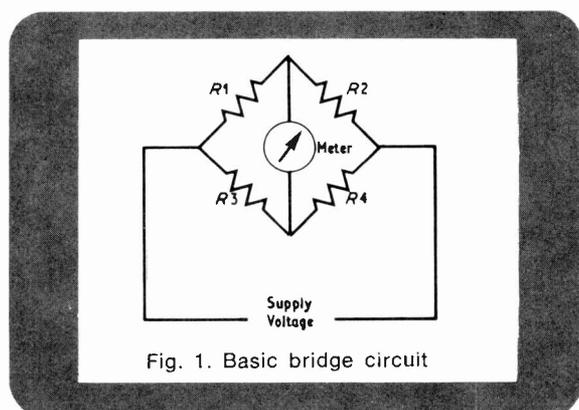


Fig. 1. Basic bridge circuit

Referring now to the main circuit in Fig. 2, the bridge is formed by VR1, VR2 and the light dependent resistor PCC1. Resistors R10, R11 and R15 are also included in the bridge, but serve only to limit the range of the controls, preventing any arm of the bridge from being short-circuited. Potentiometer VR1 forms two arms, either side of its wiper, this control being preset according to the type of printing paper in use.

The supply is 12V a.c., taken from the mains transformer. The output from the bridge is rectified by D3, and then passed to TR4. This transistor is connected as an emitter follower, i.e. a current amplifier, driving ME1, a 1mA meter. Resistor R14 limits the maximum current through the transistor, preventing the meter needle from wrapping itself around the endstop if the unit is switched on with the bridge well out of balance. C3 removes ripple, giving a steady meter reading, and R12 adds a small amount of forward bias to TR4.

The function switch S2 selects either "measure" or "expose" operations. When negative measurement is required, S2c and S2d switch the balance potentiometer into the bridge circuit. Closure of S2b applies voltage to the meter circuit, and also switches on the relay driver transistor TR3 via R8, thus energising the relay RLA and turning on the enlarger lamp for focussing and measurement purposes. The diode D2 prevents voltage surges from damaging TR3 when the relay is de-energised.

TIMER

With the function switch in the "expose" position, S2c and S2d transfer the information regarding the required exposure, contained in VR2, into the timer circuit. As S2b is now open, the relay is de-energised. No supply voltage is yet applied to the timer, as RLA1 and S2e contacts are open-circuit at this stage.

Contacts S2e are now closed to initiate the timing period. Resistors R2, R3 and R4 form a voltage divider, and TR2 has a forward bias derived from the voltage developed across R4. This transistor is thus turned on, its collector volts now being close to the supply of 12V.

The voltage dropped across R5 is applied via R6 to the base of TR3, energising the relay. The enlarger lamp is thus turned on via contacts RLA2, and contacts RLA1 bypass S2e which may now be released, as the supply voltage to the timer is now applied by the relay contacts.

THE NEED FOR AN F.E.T.

The heart of the timer is C1, VR2 and TR1, a field effect transistor. The main property of a field effect transistor in this application is its extremely high input resistance. The highest value of timing resistance which can be used in any timer circuit is determined by the resistance of any circuit connected to it.

If a bipolar transistor were used for TR1, the maximum input resistance obtainable would be only a few megohms. For the timing period to be determined by the timing resistance alone, as is required for accurate performance, the maximum value of timing resistance must be about one tenth of the input resistance of TR1, i.e. a few hundred kilohms.

As the timing period is proportional to $C1 \times VR2$, and the timing resistance is low, C1 must obviously be high. Large values of capacitance give rise to further problems, as they will have a relatively low leakage resistance, and this can also affect the accuracy of the timer. The field effect transistor, with an input resistance of several hundred megohms, allows a low value to be used for C1, with a large value of VR2.

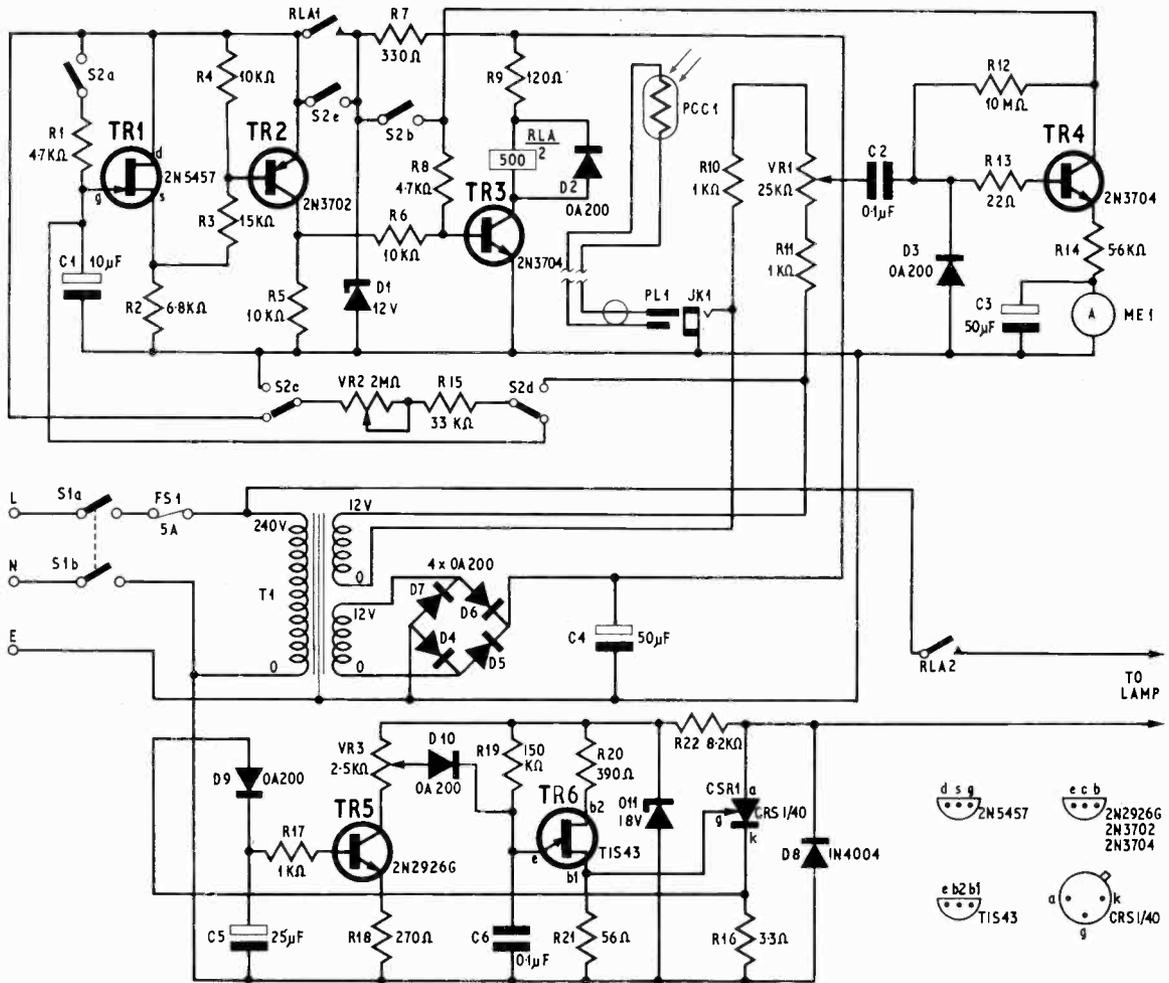


Fig. 2. Complete circuit diagram of the enlarger control unit

THE TIMING OPERATION

Returning to the operation of the complete timer, TR1 has a small bias applied by the voltage drop across R2. Initially C1 is discharged, so the gate of TR1 is at zero volts. When the supply is connected by S2e, C1 begins to charge at a rate determined by the setting of VR2, previously determined by the exposure meter. As the gate voltage approaches the bias voltage of the source, TR1 begins to conduct. The gate voltage thus becomes transferred to the source by the self-biasing action of the source current. Resistor R3 also applies the source voltage to the base of TR2.

When TR1 source voltage, and thus TR2 base voltage, reaches approximately 11V, TR2 switches off, this transistor being a *pn*p type. The collector voltage falls to zero, switching off TR3, and de-energising RLA. The enlarger lamp is turned off, and the supply is removed from the timer by contacts RLA1, S2e having been previously released.

The standing bias, derived from the potential divider R2-R3-R4, is removed from TR1, which now becomes forward biased by the charge remaining on C1. The capacitor is discharged rapidly through the gate-source junction of TR1 and R2, resetting the timer ready for the next timing operation.

THE FUNCTION OF R1

The function of R1 is best explained by considering the circuit without this component. During the measurement operation, VR2 is disconnected from the gate of TR1, leaving C1 in a discharged condition, but voltage is applied to the timer via the contacts of RLA1 which is energised.

When the function switch is changed to "expose", the timer begins a complete timing sequence, as C1 is now charged via the now-connected VR2. The enlarger lamp will thus remain on until a complete timing sequence has elapsed, which is obviously inconvenient if the timer is set for more than a few seconds.

During measurement, R1 is switched in, maintaining C1 in a fully charged condition. When the function switch is changed to the "expose" position, the timer is in the same state as at the end of a timing period, and the lamp is switched off.

The power supply for the exposure meter and timer is conventional. A full-wave bridge rectifier, D4 to D7, is fed from the mains transformer T1, the resulting pulsed d.c. being smoothed by C4. The relay is then supplied via R9, and the remainder of the circuits are fed from a 12V rail stabilised by R7 and the Zener diode D1.

LAMP STABILISER

The basic principle of the stabilised supply to the enlarger lamp is illustrated in Fig. 3a, which shows two cycles of the voltage across the lamp. Only part of each positive half-cycle is applied to the bulb, although the whole of each negative half-cycle is applied.

If the supply is fed to the lamp at point A, the result will be a higher r.m.s. voltage for the complete cycle than if the supply were not allowed to reach the lamp until point B.

Thus, a rise in mains voltage can be counteracted by delaying the point in the positive half-cycle at which the bulb is switched on. Conversely, a drop in mains voltage can be corrected by an earlier switch-on, allowing more of the half-cycle to reach the bulb.

Referring to Fig. 2, each negative half-cycle is fed to the lamp via D8. The positive half-cycles are controlled by the silicon controlled rectifier CSR1.

The silicon controlled rectifier, or thyristor, is an extension of the normal silicon diode. It will under no circumstances conduct when the cathode is positive with respect to the anode, and will also block when forward biased, until a third electrode, the gate, is made positive with respect to the cathode. The thyristor will then conduct until the forward voltage is reduced to zero, even though the gate voltage is removed.

Once the thyristor turns off, it will revert to its blocking state until it is again forward biased and a gate voltage is applied. Thus CSR1 can be switched on at any point during the positive half-cycle as desired, by applying a gate voltage when required. The gate voltage is derived from TR6, a unijunction transistor.

THE UNIUNCTION TRANSISTOR

The unijunction is a semiconductor device with two bases and an emitter. It acts as a pure resistance of 5 to 10 kilohms with zero emitter voltage. This condition is maintained as the emitter voltage is increased, with only a few microamps of emitter current, until a critical (peak point) level is reached.

At this point, the emitter-base one junction breaks down, allowing a large emitter current to flow. If the emitter voltage is now removed, the device reverts to its original state, with very small emitter current, and once more acts as a resistance between base one and base two.

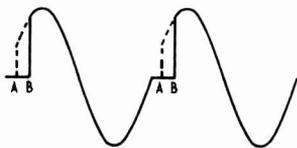


Fig. 3a. Waveform of voltage applied to enlarger lamp

TRIGGER CIRCUIT

Referring again to Fig. 2, the diode D10, TR5 and the associated circuitry will initially be ignored.

At the beginning of the positive half-cycle, CSR1 is not conducting. D8 is reverse biased, and is also blocking. Thus, the full mains voltage is developed across CSR1, and is applied via R22 to the trigger circuit formed by TR6.

Initially, D11 does not conduct, until the mains voltage reaches 18V, when the Zener will clamp at this voltage. Thereafter, the supply to the trigger circuit will remain at 18V, the surplus voltage being dropped across R22.

As soon as the supply begins to rise, C6 starts to charge via R19. As the supply voltage is stabilised by D11, the capacitor will always charge at the same rate. When the charge on C6 reaches the peak point voltage of the unijunction TR6, the emitter conducts, and C6 discharges through the emitter-base one junction. This current gives a positive voltage across R21, and this voltage is applied to the gate of CSR1, switching it on.

Once the trigger circuit has supplied the gate pulse, it is no longer required until the next positive half-cycle begins. As CSR1 is in parallel with the supply to the trigger circuit, and as this component has a very small voltage drop when conducting, it is apparent that the trigger circuit will be inactive once it has turned on the thyristor, and will remain so during the negative half-cycle, when D8 is conducting.

Resistor R20 is included to stabilise the working conditions of TR6 against temperature variations.

CORRECTION OF FIRING POINT

Transistor TR5 and the associated circuitry gives the correction of thyristor firing point necessary for stabilisation against mains variations. The mains voltage is monitored by R16, in series with the lamp and CSR1.

This resistor develops a voltage across it while CSR1 is conducting, i.e. during the positive half-cycle. As this half-cycle is incomplete, being chopped to provide the correction in the lamp supply, it is obvious that the r.m.s. and average voltages across R16 will not provide a suitable reference. The peak voltage is thus used.

The waveform across R16 is applied via D9 to C5. This capacitor is charged to the peak of the waveform, and will remain at that level unless

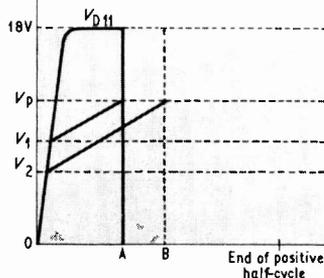


Fig. 3b. Waveforms of lamp stabiliser

allowed to discharge. Three discharge paths are available. C5 cannot discharge back into the supply as it is prevented from doing so by D9.

The second path is into the base of TR5. By the use of a high gain transistor in this position, a relatively high input resistance is achieved, and C5 loses little of its charge this way.

The third possible path is through its own leakage resistance, but the loss this way is also small enough to be ignored. Thus, the voltage across C5 is proportional to the peak voltage of the mains supply. This voltage is amplified by TR5, and a portion of the amplified voltage is tapped off from VR3, being passed by D10 to give a standing charge on C6.

STABILISER OPERATION

Taking the action of the stabiliser unit in its entirety, and referring to Fig. 3b, a voltage proportional to the peak of the mains supply appears across C5. This voltage is amplified by TR5, and tapped off from the slider of VR3, then applied to C6. This gives a voltage on C6 of V_1 . C6 is also charged via R19, and its voltage increases until it reaches the peak point voltage of TR6, V_p . The thyristor is then turned on by the pulse across R21, and the remainder of the half-cycle is applied to the enlarger lamp.

If the mains voltage now rises, a larger voltage is developed by C5. This results in a reduced voltage at the collector of TR5, and a lower initial voltage on C6— V_2 in Fig. 2b. Then C6 begins to charge via R19 at the same rate as before; as the starting voltage is lower than previously, C6 takes longer to achieve V_p . The thyristor is thus turned on later in the half-cycle, compensating for the rise of mains voltage.

The peak point voltage of unijunctions varies from sample to sample, and an adjustment is necessary to compensate for this. VR3 is therefore used to adjust the d.c. level fed to C6, this being the only control necessary to set up the stabiliser.

ALTERNATIVE SEMICONDUCTORS

Many of the components are uncritical, and alternatives can be used. This applies particularly to the semiconductors.

TR1 must be an *n*-channel field effect transistor. The 2N5457 (also available under the number MPF103) has been selected because it has a lower range of characteristics compared with other types. Other f.e.t.s will work satisfactorily, but may not give the same range of times—this is not too important, as the only result will be a different setting of the paper speed control when the unit is calibrated.

TR2 is required to be a *pn*p silicon transistor, and any such component will work satisfactorily. Similarly, TR3 and TR4 are merely required to be *n*p*n* silicon types, the only limitation being that TR3 must be able to handle the relay current—100mA at most. TR5 is a high gain *n*p*n* silicon transistor—BC109 or 2N3711 are two suitable alternatives. TR6 is a unijunction—2N2646, 2N2160 or BEN3000 will work quite happily here. If alternatives are employed, the lead-outs must be checked, as the various types may differ from those specified.

Any Zener diodes of the required ratings are suitable, and D8 may be any silicon diode with a 1A 400V rating, or better. Similarly, CSR1 can be

COMPONENTS . . .

Resistors

R1	4.7k Ω	R13	22 Ω
R2	6.8k Ω	R14	5.6k Ω
R3	15k Ω	R15	33k Ω
R4	10k Ω	R16	3.3 Ω 2.5W (for 150W lamp) 6.8 Ω 2.5W (for 75W lamp)
R5	10k Ω		
R6	10k Ω	R17	1k Ω
R7	330 Ω	R18	270 Ω
R8	4.7k Ω	R19	150k Ω
R9	120 Ω	R20	390 Ω
R10	1k Ω	R21	56 Ω
R11	1k Ω	R22	8.2k Ω 5W
R12	10M Ω		

All resistors $\pm 10\%$, $\frac{1}{4}$ W unless otherwise specified

Potentiometers

VR1	25k Ω lin
VR2	2M Ω log
VR3	2.5k Ω subminiature skeleton preset

Capacitors

C1	10 μ F 15V tantalum
C2	0.1 μ F 250V foil
C3	50 μ F 6V electrolytic
C4	50 μ F 25V electrolytic
C5	25 μ F 6V electrolytic
C6	0.1 μ F 250V foil

Semiconductors

TR1	2N5457 (or MPF103)
TR2	2N3702
TR3	2N3704
TR4	2N3704
TR5	2N2696G
TR6	TIS43
CSR1	CRS1/40

Diodes

D1	12V 400mW Zener
D2-7	OA200 (6 off)
D8	1N4004
D9, 10	OA200 (2 off)
D11	18V 1W Zener

Switches

S1	2-pole on-off, toggle
S2	P.O. type lever switch 4CL/4CN (see text)

Relay

RLA	500 ohm coil, 2 make contacts (one heavy duty)
-----	--

Transformer

T1	Miniature mains transformer, 2 \times 12V secondaries (R.S. Components)
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Miscellaneous

PCC1	ORP12
ME1	1mA meter, type MR38P
	Veroboard, 5in \times 3 $\frac{1}{2}$ in, 0.15in pitch, copper clad
	Case, 8in \times 6in \times 6in sloping front
FS1	Fuse 5A and fuseholder
	2 pointer knobs
	3.5mm jack plug and socket
	4 rubber feet
	Heat sink, TO5
	Small plastic box
	Audio screened lead

any type of adequate rating, 1A 400V. The rest of the silicon diodes, specified as OA200, may be any small signal types, such as OA202, 1N914, 1N916, SD19.

RELAY AND FUNCTION SWITCH

The specification of the relay and function switch gives the minimum requirements of these components. It may prove difficult to obtain exactly the contacts required.

The relay may have a different coil resistance from the 500 ohm type specified. Any resistance down to 200 ohms can be used in the circuit as it stands; relays down to 150 ohms may be accommodated by reducing R9 to 82 ohms. Two make contacts are needed; most relays will have two or more sets of changeovers, but the unwanted contacts can, of course, be ignored. One set of the contacts at least must be capable of handling 1A at 240V.

The function switch is a P.O. type lever keyswitch. This has three positions; when the lever is pushed in one direction from the centre, the switch locks in this position; this section requires two changeovers and two make contacts. When the lever is pushed in the other direction from centre, the switch is spring-loaded, i.e. it will return to centre when released; this section requires one make contact. As with the relay, any spare contacts can be ignored.

A suitable switch, with four changeovers in each direction, is available from several suppliers, for example Home Radio. The older type of lever keyswitch, with a cylindrical knob is also suitable. As a last resort, the function switch may be separated into two parts; a four changeover wafer switch is used for the "measure" part, and a separate push-button of the press-to-make, release-to-break type initiates the timer.

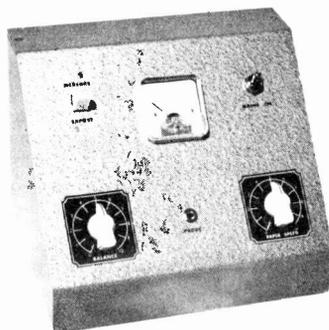
OTHER COMPONENTS

Alternatives to the specified components must not be used in two positions. C1 must be a low leakage capacitor, tantalum being the most suitable type. Paper capacitors are available, but tend to be bulky and expensive. The more familiar aluminium electrolytic should not be used; in fact, the timer will fail to operate with such a component.

This unit requires a transformer with two separate secondaries. Most of the small mains transformers available have a single centre-tapped winding, i.e. 12V-0-12V, but these should not be used. The transformer specified has the necessary secondaries.

The value of R16 must be changed according to the size of the enlarger lamp. A 150W bulb requires 3.3 ohms in this position; 6.8 ohms is used with a 75W lamp.

NEXT MONTH:
Full constructional details and how to use the Photo-Print Process Control Unit



...Off to a good start...



Ignition Booster

Cold, damp weather usually means difficult starting particularly with an ageing battery. You can remove this nagging uncertainty with this ignition booster.

Oscilloscope beam splitter

This valuable aid to those experimenting with digital i.c. systems converts a single beam oscilloscope for viewing four digital waveforms simultaneously.

Fibre optic light guides

The transmission of optical information from one place to another, without having to rely on line-of-sight means, gives rise to some interesting applications that do not require electrical coupling to a sensor.

**PRACTICAL
ELECTRONICS**

FEBRUARY ISSUE ON SALE JANUARY 14

METALS

IN ELECTRONIC ENGINEERING

By A. Freeman, B.Sc., A.R.I.C. (The Marconi Company Ltd)

ALTHOUGH, during the last two decades, the development of transistors and printed circuitry has led to considerable economy of space per equivalent circuit function, the requirement for more sophisticated apparatus has meant that electronic capital equipment now in use may occupy about the same volume as did the simpler systems of 20 years ago. Thus, the reduction in the consumption of metal by the electronic capital goods industry, that would have been expected as a result of the economy of space, has not taken place.

There has, however, been an increase in the use of aluminium alloy because of its lightness, workability, and better corrosion resistance than steel. For the chassis or cases in which circuits are built, cadmium plated steel is often used because of the difficulty of making solder joints in aluminium.

RADIO TELESCOPES

Radio astronomy and communication satellites have led to the erection of large steerable reflector "dishes." Such "dishes" are made from aluminium alloy or stainless steel and must be supported so that their profile is accurately maintained, even in gale-force winds.

Cable and Wireless satellite-communication earth terminal at Bahrain with 90ft diameter dish antenna

Thus, there has grown up a heavy constructional industry, ancillary to the electronics side of the business, using the techniques and materials of ship and bridge-building, but with the accuracy of light engineering.

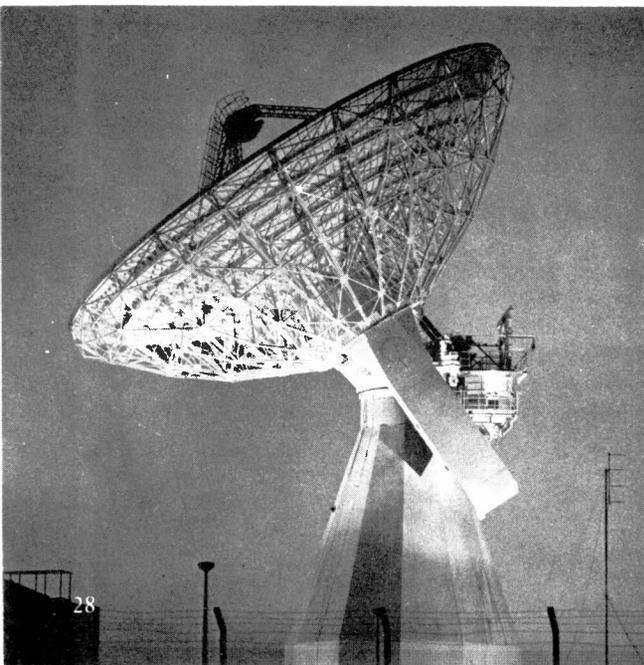
When these devices are erected in climates where winter temperatures are appreciably below freezing point, girders made from ordinary mild steel cannot be used, because at these temperatures they become brittle; comparatively light mechanical shocks can result in fracture. Therefore special steels are used which retain their toughness in very cold conditions.

PRINTED CIRCUITS

Copper is still the most used electrical conductor, not only in the form of wire, but in increasing quantities on printed circuits, where the connections are made by etched foil on an insulating baseboard.

The copper foil for the manufacture of the clad laminates is made by electro-plating polished stainless steel strip and parting the two metals mechanically, which is not difficult because the electro-deposit has only poor adhesion to the polished surface. This method produces foil that is polished on one side and dull on the other.

Erection of the aerial for satellite communications on Ascension Island



The dull side is coated with resin and applied to the surface of the insulating laminate at the same time as fabricating the laminate. The roughness of the dull surface of the copper foil acts as an adhesion key.

Connections are made to the printed circuit either by soldering or, more generally, by sockets containing spring contacts which mate with circuit terminations on the edge of printed-circuit boards. The contacts and the circuit terminations are often gold-plated to prevent tarnishing, which would otherwise lead to poor contact and "noise" in the circuit.

THIN-FILM CIRCUITS

Thin-film devices are similar to printed circuits in that all interconnections are laid down, but they also contain resistors and capacitors as integral parts of the circuit. These devices are made by evaporation techniques. The substrates are glass or ceramic; the metal to be used is evaporated in a vacuum with the metallic vapours passing through a mask to condense in the required pattern on the substrate. The substrate must be kept perfectly clean.

The materials used in this process include gold for the circuit nichrome for resistors, and silicon monoxide as insulation. Capacitors are built up by successive layers of metal and silicon monoxide. As in the case of printed circuits, the manufacture of thin-film devices readily lends itself to automation.

WAVEGUIDES

Brass is used in the manufacture of waveguides, particularly those of large aperture, which are made from sheet as opposed to the smaller drawn tube. In areas where ferrous metals cannot be used because of electro-magnetic fields, brass screws are employed and springs are made in either phosphor-bronze or, for more severe duty, copper-beryllium.

Light alloys are widely used for waveguides, waveguide components and television camera bodies, especially the magnesium alloys N4 and N6 which have good corrosion resistance and good mechanical

Development stage of thin-film production



properties. They are very suitable for machining by methods such as routing, and N4 alloy can be welded without much difficulty.

Satisfactory brazing is really only possible with unalloyed aluminium but this has poor mechanical properties. As there is no perfectly satisfactory solder for use directly on aluminium or its alloys, the problem of the low temperature joining of aluminium alloys is generally overcome by copper-plating the alloy, tinning the areas to be soldered, removing the exposed copper chemically and finally sweating the tinned surfaces together.

When weight conservation is important, as in television camera bodies, magnesium-rich alloys are very attractive, having a density of 1.87 compared with 2.87 for the engineering alloys of aluminium. Unfortunately, these alloys readily corrode if left in an unpainted condition even in mild environments, so they are not suitable for the manufacture of items containing moving parts that cannot be painted.

STAINLESS STEELS

There are two main types of stainless steel, austenitic and martensitic. Austenitic stainless steel is relatively soft, non-magnetic and very resistant to corrosion. This type is often used for domestic items.

Martensitic stainless steel can be hardened, is magnetic and though much more resistant to corrosion than ordinary hard steel is not as resistant to staining as the austenitic type. Table knives are made of martensitic stainless steel.

Both of these types are widely used in the electronics industry but in small quantities. The austenitic steels are particularly useful because of their non-magnetic properties, especially in the fully annealed, or mildly cold-worked condition, when they have the mechanical properties of mild steel.

Some of the special austenitic stainless steels have found use in unusually arduous conditions, e.g. type EN58J is used for equipment that is to be immersed at such a depth in the sea that oxygenation is only very slight. (Oxygenation is necessary for the prevention of corrosion in most stainless steels.)

The assembly of an r.f. module for Skynet II on the left. A completed module, with the cross-welds necessary for weight-saving, on the right



WAVEGUIDE COMPONENTS

Waveguide components are often difficult or even impossible to make from the normal rectangular tube. In such cases, recourse is made to electroforming techniques, using stainless steel formers.

When the shape is such that a steel former could not be withdrawn at the end of the electroplating operation, a thermoplastic former of the desired shape is made. After electroforming, it is removed either by melting or by dissolving out with a suitable solvent. Electroforming methods are slow and a single component may take several days to build up to the required thickness for adequate rigidity.

A recent innovation is the production of simple waveguide components, for example, tapers, by metal spraying techniques, zinc or silver-tin being the metals most often used. A thin deposit about 0.010in thick is applied to the mandrel that has previously been treated with a suitable release agent. Before removing the mandrel, the coating is strengthened with resin-glass cloth laminates wet-laid on to the sprayed metal.

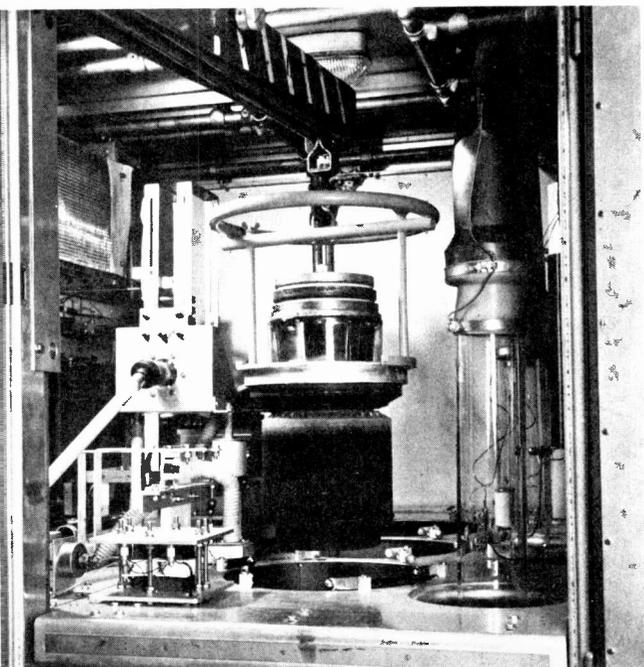
In an increasing number of cases it is essential that the dimensions of waveguide components remain constant in spite of varying temperature. This requirement is achieved by the use of alloys having a low coefficient of expansion, such as invar and nilo. The poor electrical conductivity of these alloys is overcome by electroplating with silver of sufficient thickness that all the radio frequency current is confined to the electro-deposit.

SOLDERABILITY

Alloys similar to invar are used for the leads of transistors and miniature valves in order to obtain the satisfactory glass-to-metal seals required by these components. This application gives rise to soldering problems, because these alloys are not solderable using non-corrosive resin-based fluxes.

In most cases the leads are gold-plated in the course of the transistor manufacturing process but, because the gold is readily soluble in soft solder, the joint is in fact made to the low expansion alloy.

Removing a high-power valve, weighing about 90lb, from a broadcast transmitter



The solderability of component leads was once a serious problem. The leads used to be made of copper wire electroplated with tin but, if the time between electroplating and soldering was more than a month, soldering became increasingly difficult, eventually reaching the stage when it was impossible. This trouble has been overcome in recent years by electroplating the copper wire with 70:30 tin/lead alloy which remains solderable for years, even under adverse conditions of storage.

The use of this alloy also overcomes another difficulty experienced when pure tin is used, namely that of the growth of tin whiskers. These are single crystals in the form of fine whiskers that grow out from the tin surface sometimes reaching lengths of 1in. Such whiskers can cause short circuits in equipment. The growth of whiskers is inhibited by the presence of metals that alloy readily with tin, of which lead is the most convenient. A lead content of three per cent or more gives complete immunity.

PRECIOUS METALS

Among the precious metals, silver is used because of its high conductivity, both as an electro-deposit and on contacts as the block metal or in composites such as graphite-silver, sintered from powder.

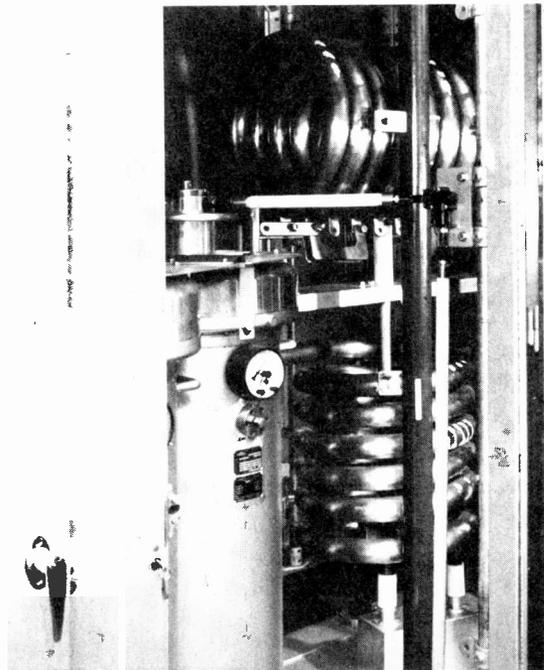
Gold is used as a non-tarnishing finish on copper and silver and in the form of modern "hard" golds, which may contain up to two per cent nickel or cobalt, as wear-resisting finishes for light to medium pressure applications.

Rhodium is used for surfaces subjected to severe wear or as the opposing surface to gold in such bearing surfaces as slip-ring brush combinations, the slip-ring being gold plated whilst the brush is rhodium plated.

HIGH POWER VALVES

Whilst transistor devices have gone a long way in replacing small valves, the manufacture of large transmitting valves is expanding. The electrodes in these valves are made of high conductivity oxygen-

Gas-filled anode tuning capacitors with anode and output coils of 750kW broadcast transmitter



NEWS BRIEFS

MICRO-COMPUTER DEVELOPMENT

THE US space agency NASA, has selected RCA to develop a test model of a space computer that would be 100 times smaller and lighter than equivalent commercial systems.

The microprocessor could be the forerunner of a system for future manned and unmanned space vehicles such as the Space Shuttle and the Earth Orbiting Space Station.

The shuttle is a reusable craft that will take off like a rocket and land like an aeroplane. The space station would be a permanent orbiting laboratory able to accommodate a contingent of scientists.

Heart of the computer under development by RCA will be 15 large-scale integrated (LSI) arrays—one-eighth-inch square chips each containing up to 600 electronic elements. Although the computer will weigh just 10 pounds, occupy one-half cubic foot and require only 15 watts of power, it will be capable of processing functions equivalent to room-size commercial computers.

CHANNEL SURVEILLANCE SYSTEM

THE first radar station to be ordered for the purpose of monitoring shipping movements in the Channel has been installed for the Department of Trade and Industry at H.M. Coastguard station at St Margaret's Bay, near Dover. A Decca 48 mile HR 729 system with two 16in displays, a 9ft scanner and 25kW transceiver, it will range from Boulogne to Dunkirk and over a similar arc of the Eastern approaches to the Dover Straits.

This is the direct outcome of the Government's concern for the accident rate in the Channel, which led to the National Physical Laboratory with the assistance of Decca, carrying out two major traffic surveys based at Dungeness and St Margaret's Bay, for the Department of Trade and Industry.

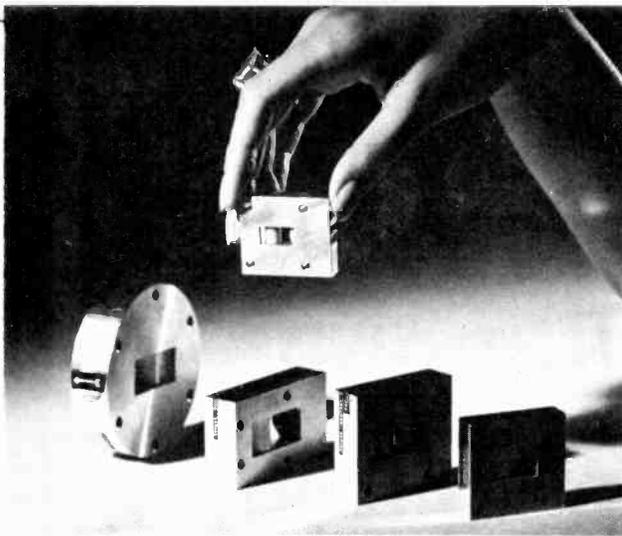
The new radar is the first ever sold to H.M. Coastguard and will also be used for search and rescue of vessels in distress when occasions arise. Its choice follows successful trials at Deal of a smaller Decca radar, which first caught the headlines when, in conditions of thick fog, the Deal Coastguard homed the Ramsgate lifeboat onto a yacht in distress and subsequently conned both back to Ramsgate Harbour.

EVENING LECTURES

A SHORT course of six evening lectures will be held at North Staffordshire Polytechnic, Stoke-on-Trent. Time: 6.30 to 9.0 p.m. All enrolment enquiries should be made to the Polytechnic.

January 12	M. Hughes	General Introduction to D.I.Y. Electronics
January 19	A. Douglas	Electronic Music Synthesis (including ref: to the P.E. Organ)
January 26	F. Hyde	Radio Astronomy (building a simple radio telescope)
February 2	A. J. Dunn	Radio Control of Models
February 9	A. J. Dunn	Electronics for Automobiles
February 16	M. Hughes	Logic Demonstration

All the above are regular contributors to PRACTICAL ELECTRONICS



A series of isolators for use in waveguides

free copper and nickel whilst their supports are of refractory metals such as molybdenum, tantalum or tungsten sheathed in platinum.

All the metals must be of a high purity, in particular being free from gaseous impurities. Valve manufacturers experience great difficulty in obtaining refractory metals of sufficiently high purity.

NEW APPLICATIONS

Investigation into the behaviour of metals and other substances at temperatures well removed from ambience has disclosed properties not normally encountered, some of which are useful for specialised applications. Typical examples are the electrical super-conductivity of certain metals at temperatures near to absolute zero (-273°C). It is possible that continuing research on these lines may have repercussions on the types of metal used throughout the electronics industry.

ACKNOWLEDGEMENT

The author wishes to thank the Technical Director of The Marconi Company Limited for permission to publish this article. ★

Marconi Mark VII colour television camera at the Leeds studios of Yorkshire Television





BY FRANK W. HYDE

WATER ON THE MOON

Till now, the examination of the rocks and dust brought back from the Moon by America and Russia, has indicated that the moon is entirely without water. Doubt is now thrown on these conclusions by Dr J. W. Freeman (chief *Apollo* programme investigator for the instruments) of Rice University, and a statement has been made about his reasons for deciding that there is water in pockets on the Moon.

The effect that this will have on the future of moon stations is very considerable for it would mean that the crew would not have to bring water with them from earth, or manufacture it from chemicals or re-cycling processes.

Dr Freeman and his associate Dr Kent Hills base their statement on the fact that the instruments left on the moon by *Apollo* 12 and 14 detected a water cloud that was like a geyser in eruption. The vapour was very diffused and probably amounted to about a quart of water. The eruption was from a crack in the moon's surface and the event was recorded on instruments which are called suprathermal ion detectors.

The largest event that was detected covered an area of 10 square miles, and was in the region of the Sea of Storms. The accuracy of the exact position is not as good as could be hoped since there are only two instruments operating. However, the precise location can be established later.

One other point that supports the contention by Dr Freeman is that the geyser coincided with small moon quakes recorded by the seismographs left on the moon. The advent of cracks is therefore well supported.

Planetary scientists have always held that in the solar system planets all contain carbon dioxide and

water in their interiors; with the geyser like eruptions on the moon is the proof of the fact. It will of course require further supporting evidence before acceptance but no doubt this will be dealt with on the remaining two missions.

ROCK HARVEST

The geophysical harvest of the *Apollo 15* mission has been excitedly acclaimed by scientists. It will take a great deal of time to examine fully and analyse the rock and dust samples amounting to about 170lbs. They have a much wider variety of types and some 60 large pieces. The rocks which have been called Genesis are not as hoped the primeval lunar material.

One of the reasons for the choice of the Fra Mauro site on the *Apollo 15* mission was the hope that primitive finds would be made. However, the amount of information that will be obtained from the samples is very important.

HOT MOON

The moon is a hot body with the heat concentrated in the interior or alternatively in pockets of radio-active material. These pockets are perhaps around a hundred miles down from the surface.

This evidence of the heat gradient was obtained from the two probes which were put down to a depth of 6ft into the moon by the *Apollo 15* astronauts. The heat flow measurements showed that the increase in temperature amounted to about one degree fahrenheit for each increase of one foot in depth.

Compared with the earth this is about one fifth of the escape flow. This would indicate that there are radio-active minerals inside the moon. If the abundance is evenly distributed in the body of the moon then there must be a molten core. Melting temperatures would appear at about 300 miles below the surface. If this is not the case then the radio-active materials must be in pockets at about 100 miles depth.

MOONQUAKES

There are now on the moon three seismic stations which were set up by the crews of *Apollo* 12, 14 and 15. The network has brought an immense amount of new knowledge of day to day happenings on and in the moon which were not even suspected. The happenings were disguised from previous observations because of the rigidity of the shell.

The power of some of the tremors would undoubtedly have made cracks in the earth's surface which is much less rigid than the moon. The major effects take place when the earth and the moon are near to each other each month. The forces that are set up due to the increased tidal pull and the effect

of the changing barycentre cause the tremors which are transmitted back to earth. One such record showed that the disturbance originated some 500 miles below the surface which may be even greater than those occurring on earth.

The moon then is a body that is convulsed internally without visible signs on the surface.

CORE SAMPLES

A 8½ft core sample was taken from the moon and this was found to contain some 57 layers of soil. This illustrates about 2,400 million years of the history of the moon. The layers are of varying thickness and range from half an inch to five inches. It is possible that each layer represents a different meteorite impact.

At the bottom of the sample core a 3¼in section was of much coarser material containing some chips up to ¼in diameter. This could be basic rock which was overlaid by the rest of the material.

MYSTERIOUS MINIQUAKE

One of the mysteries of the seismic recordings of the moon are the swarms of minor disturbances quite unrelated to tidal effects.

The majority of the activity on the moon lies in a small area below the Ocean of Storms and this is where the deep tremors are recorded. These may be due to heat from the depths of the moon. The mini swarms however, cannot come from this source.

One suggestion is that they are triggered off by the mascons. These are areas on the moon where there is a specially dense region. These cause an out of balance effect and it may be that this is the answer. Nothing definite can be said about this at the moment. If this should not prove to be the answer then there must be some other activity that has not yet been detected.

The swarms of mini-quakes over a period of two and a half days showed four swarms and thirty events.

SATELLITE TROUBLE

There has been some trouble with the ATS-3 satellite, whose full title is Applications Technology Satellite-3. It is in a synchronous orbit at 70 degrees West longitude 22,300 miles above Colombia.

Fitted on this vehicle is an aerial which should rotate at 100 rev/min. This is necessary to keep it pointed at the earth while the satellite spins. About the middle of July 1971 the aerial began to slow up and fell to 80 rev/min and sometimes stopped altogether and sometimes revolved at other speeds.

It would appear that this is due to the sun which when it is north of the equator heats up the satellite and causes the aerial to seize up. When the sun moves south of the equator all should be well again.

LIE DETECTOR

By O. COCKERELL

Though not to be taken too seriously, this highly sensitive circuit provides a fascinating tool for psychological experimentation. Without any modifications it can be used as an audible pulse monitor.

THE psychogalvanic reflex has long been used by experimental psychologists, policemen, and others, as a "window on the mind". Indeed a whole cult of fringe medicine has sprung up around it: self-styled "scientologists" spend hours questioning each other while holding the electrodes of a resistance meter. Now, thanks to the availability of integrated circuits, the enterprising constructor can make an instrument of much greater sensitivity than was possible until a year or so ago.

WHAT IS MEASURED?

If someone tells a lie they usually blush. This reflex, whose biological origin is not entirely explained, is associated with a number of small but detectable metabolic changes—respiration, heart rate and perspiration being the most easily measured.

Changes in perspiration can be detected almost instantaneously by the simple expedient of measuring the resistance between two electrodes placed on the skin. While one can observe some changes with something no more elaborate than an Avometer, one would be limited to subjects whose skin resistance was within the range of the meter, and one would certainly not be able to observe small changes such as occur with a passing thought in the mind of the subject.

In general a lie detector must register resistance changes as small as one per cent over a period of up to five seconds, the average value of resistance being anything between 10 kilohms and 10 megohms. As one is limited to a few volts at the electrodes (more would cause an unpleasant tingle), it turns out that a versatile instrument must detect current changes of a few nanoamps (amps $\times 10^{-9}$) per second. The instrument should also respond with equal sensitivity when the percentage change is the same, but when the actual current is a thousand times as great.

The block diagram, Fig. 1, shows how the huge range is encompassed in a single instrument without need for adjustment. The skin current is passed through a silicon diode which produces a voltage proportional to the logarithm of the current through it. Thus equal percentage changes of current will produce equal increments of voltage, about 2 millivolts for a 10 per cent change. The amplifier is in fact a differentiator below a few hertz so that an output appears only for a change of input.

HUM AND NOISE

Anyone who has put his finger on the input of a high gain amplifier will tell you that all you get out will be an almighty hum, and possibly some Radio 1 as well! For this reason components are included to provide 12dB per octave roll-off above a few hertz.

THE READOUT

Various readouts are possible, perhaps the simplest being a voltmeter. The present instrument, however, uses a voltage controlled oscillator and a crystal microphone as a speaker, so that a lie registers as a note of rising pitch. This serves two purposes: most people can hear a small percentage change of pitch over a very wide range, so that greater sensitivity than with a meter is possible; and secondly a sort of positive feedback occurs—as the subject hears the accusing little squeak he responds by making it even worse. It is also possible to use an earpiece if the subject is to be kept unaware of his responses.



Fig. 1. Basic lie detector block diagram

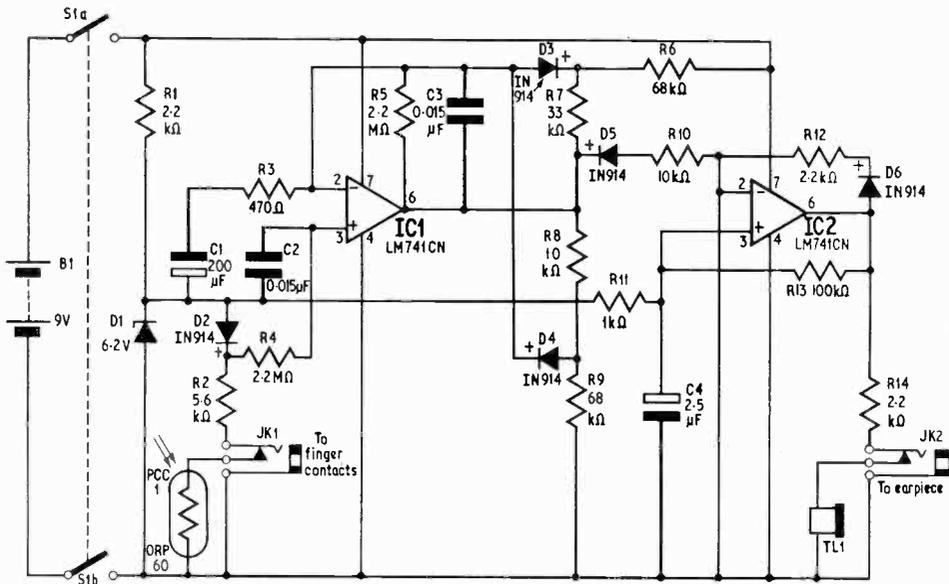


Fig. 2. Circuit diagram of lie detector

PULSE MONITOR

A bonus offered by the circuit comes in the form of a pulse monitor. If a photoconductive cell is used in place of the finger electrodes, and the subject's fingertip placed over it, his heartbeat can be heard in the form of frequency modulation of the output tone. The way it works is that the light passing through the finger is modulated in intensity by the blood pulsing through it.

THE 741 OPERATIONAL AMPLIFIER

If you have never used an operational amplifier before, or if you have fiddled for hours trying to get an earlier type to behave, only to find that it has succumbed to your ministrations and given up the ghost—take heart! The 741 is virtually indestructible. You can short the outputs to ground or to either supply and it doesn't mind. Even if you connect the battery the wrong way round the battery

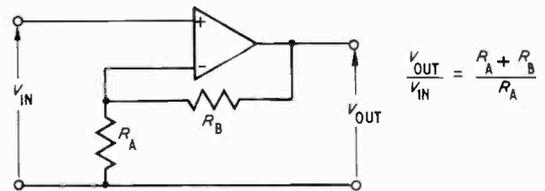


Fig. 3. Non-inverting operational amplifier configuration

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_A + R_B}{R_A}$$

will be the first casualty (but don't try this with anything bigger than a PP3).

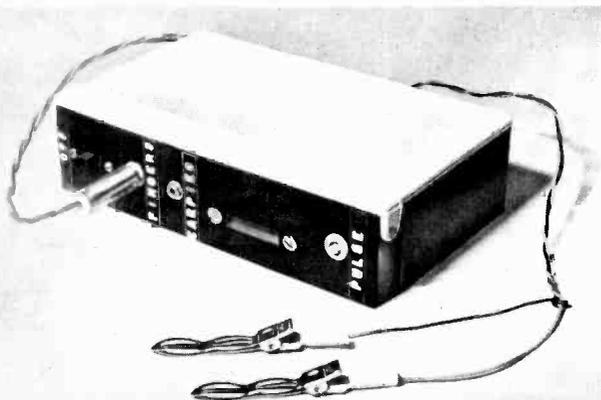
If you are not quite sure what an "op.amp." does it is simply this: the output goes positive if the "+" input is positive of the "-" input, and goes negative if the opposite is true. The input currents are tiny, usually less than a tenth of a microamp, and the output resistance is low, a few hundred ohms. The open loop gain—that is without feedback—is tens of thousands as long as the inputs are not allowed to get a sniff of the output in high impedance circuits.

CIRCUIT DETAILS

Fig. 2 shows the complete circuit diagram. An integrated circuit, IC1, is used as an amplifier in the standard non-inverting configuration. Fig. 3 shows this in simplified form. The gain is simply

$$\frac{R_A + R_B}{R_A} \text{ or if } R_B \gg R_A, \text{ simply } \frac{R_B}{R_A}$$

In the actual circuit R_B is 2.2 megohms and R_A is 470 ohms so the gain is about 4,000 at around 1Hz. The capacitor C1 starts reducing the gain below 1Hz, and C2 and C3 reduce it above 3-4Hz.



COMPONENTS . . .

Resistors

R1	2.2k Ω
R2	5.6k Ω
R3	470 Ω
R4	2.2M Ω
R5	2.2M Ω
R6	68k Ω
R7	33k Ω
R8	10k Ω
R9	68k Ω
R10	10k Ω
R11	1k Ω
R12	2.2k Ω
R13	100k Ω
R14	2.2k Ω
All $\pm 5\%$, $\frac{1}{4}$ W carbon	

Light Dependent Resistor

PCC1 ORP60 or U1100 Miniature CdS photocell

Capacitors

C1	200 μ F elect. 4V
C2	0.015 μ F
C3	0.015 μ F
C4	2.5 μ F elect. 64V

Integrated Circuits

IC1, IC2 LM741CN, SN72741 or 741-OPA (8-lead D.I.P.) (2 off)

Diodes

D1 6.2V 400mW Zener
D2 to D6 IN914 or any small silicon signal diode (5 off)

Speaker

TL1 Crystal mic. insert

Switch

S1 Double pole changeover slide switch

Jack plugs and sockets

JK1 3.5mm Jack socket with break contact, and plug
JK2 2.5mm Jack socket with break contact, and plug

Miscellaneous

Crystal earpiece (optional)
Plastic box 6in \times 4in
B1 9V Battery PP3
Sprung hair clips
Veroboard 0.1in matrix, 5.7in \times 2.8in with copper strips
Battery connector
Capacitor clip (for mounting TL1)

The diodes D3 and D4 together with R6 to R9 reduce the gain as the output swings above zero and below -2 volts. These voltages are with reference to the positive end of the Zener. Their purpose is to reduce the time taken to recover from a very large input swing.

VOLTAGE CONTROLLED OSCILLATOR

Fig. 4 shows the essential components of the voltage controlled oscillator. The 100 kilohm and 1 kilohm resistors apply positive feedback so that small voltages at the input cause the output to swing to its limits (about $+2$ and -4 volts, with respect to the positive end of the Zener). One hundredth of the output appears at the "+" input by potential divider action.

Assuming the output has just switched to its upper ($+2$ V) limit, diode D_F will be forward biased and the "+" input will be at $+20$ millivolts. Capacitor C_T will charge up through D_F and R_F until its voltage reaches the 20 millivolts on the "+" input when the output swings rapidly to -4 volts, taking the "+" input to -40 millivolts. Diode D_F is now reverse biased and C_T can only discharge through R_T at a rate dependent on the input voltage V_C , which is assumed to be at a negative potential. As soon as the "-" input reaches -40 millivolts, the output switches to $+2$ volts and the cycle starts again.

Thus the output is a series of pulses of almost constant width but of repetition frequency determined by V_C .

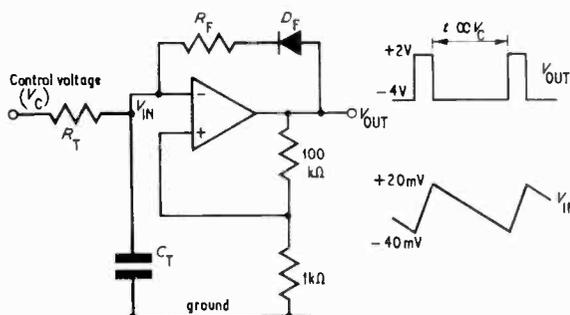


Fig. 4. Voltage controlled oscillator circuit

THE SKIN ELECTRODES

The finger clips or skin electrodes are the only items unlikely to be found in the average constructor's inventory—they are in fact sprung hair curlers. Get the nickel-plated type rather than the aluminium ones which are difficult to solder. I got mine from Woolworths.

MANHATTEN LAYOUT

Layout of components and cuts in the copper strips are shown in Fig. 5. The form of Veroboard layout used will probably seem wasteful at first

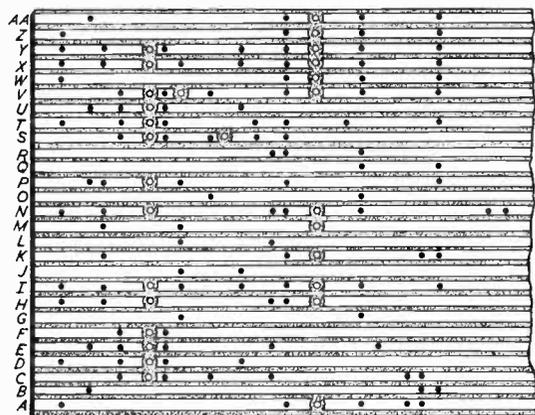
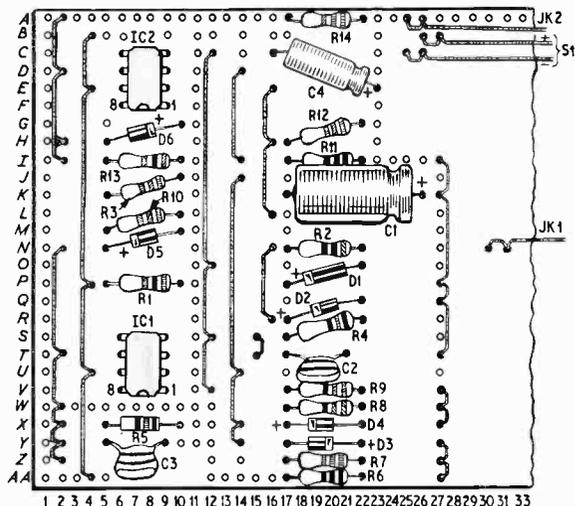


Fig. 5. Component assembly and wiring details of Veroboard panel (Note that the copper strip should be cut at 19T)

glance, but it has the advantage of being easy to implement and to check. All components are more or less parallel to the copper strips, while component side links run at right angles (like the streets of Manhattan). The battery slides into three 20 s.w.g. straps on the board which prevent it from moving about, but allow it to be replaced (see Fig. 6).

Apart from the battery clips only four wires connect to the board—input, output and positive and negative supplies. The negative supply is the common rail for input and output.

The miniature jacks used for input and output are of the type which break a connection when the plug is inserted.

WARMING UP TIME

When you first turn the machine on, the large electrolytic, C1, may take a minute or so to polarise—that is, as well as taking a few seconds to charge up, and it can take considerably longer for the leakage current to reduce to its proper value. The pitch of the oscillations should fall to a very low value,

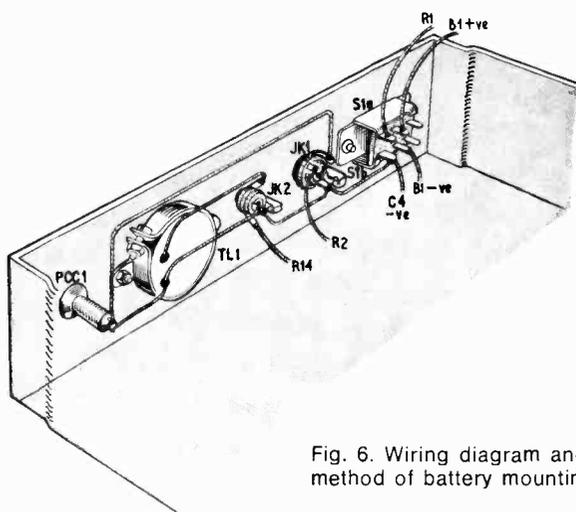
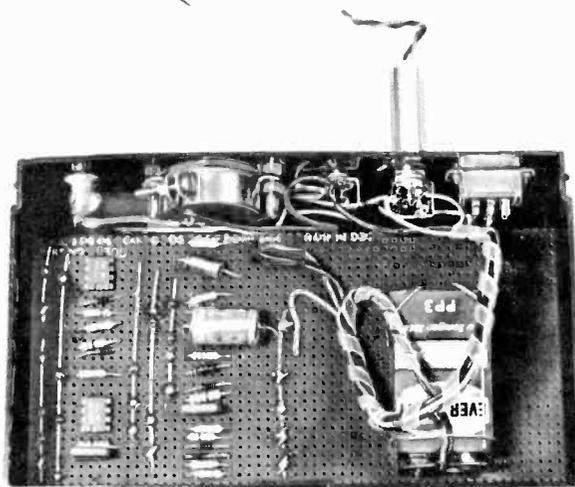


Fig. 6. Wiring diagram and method of battery mounting



certainly less than a hundred hertz, before asking questions. A simple test to establish that the device is "in range" is to get the subject to take several deep breaths, this should elicit a full scale response.

OPERATION

Put the finger clips on the subject with soothing reassurances that he won't get electric shocks. Then proceed to shock him by proving that the gadget works. A simple demonstration is to ask him to think of a number, say between one and five, and then ask him about each number in turn. He must of course say no to each number so that he must lie once. Present the numbers in random order otherwise the reaction as his number approaches might be confused with the previous one.

WARNING

Don't try to operate the gadget from a mains supply, or battery eliminator, even small leakage currents can be felt, and larger ones could be dangerous.



VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/140V a.c. 50/60 OUTPUT VARIABLE 0.260V

All Types (and Spares) from 1/2 to 50 amp from stock.

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1 amp, £7.00 2.5 amp, £8.05
5 amp, £11.75
10 amp, £22.50 20 amp, £49.00
15 amp, £25.00 25 amp, £58.00
37.5 amp, £82.00 50 amp, £98.00



2.5 amp

All plus £1 carr. where not specified. **OPEN TYPE** (Panel Mounting) 1/2 amp, £4.75. 1 amp, £7.00. 2 1/2 amp, £8.05. Carr. 40p on open type.

L.T. TRANSFORMERS

All primaries 220-240V	Type No.	Sec. Taps	Price	Carr.
1	12V at 5A		£1.88	28p
2	30, 32, 34, 36V at 5A		£4.68	45p
3	30, 40, 50V at 5A		£6.88	45p
4	10, 17, 18V at 10A		£4.95	45p
5	6, 12V at 20A		£6.43	45p
6	17, 18, 20V at 20A		£7.28	55p
7	6, 12, 20V at 20A		£6.88	55p
8	24V at 10A		£5.23	35p
9	4, 6, 24, 32V at 12A		£7.15	45p



ELECTRONIC ORGAN KIT

Easy to build. Solid State. Two full octaves (less sharps and flats). Fitted hardwood case. Powered by two penlite. 1.5V batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. Price £3.00. P. & P. 22p.

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(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, 0.38 amp. Type 2) 28 r.p.m. Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, 0.28 amp. "As new" condition. Input voltage of motor 115V a.c. Supplied complete with transformer for 230/240V a.c. input. Price, either type £3.15 plus 35p. P. & P. or less transformer £2.13 plus 27p P. & P.

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Powerful 1 amp. REVERSIBLE motor. Speed 3,750 r.p.m. complete with external gear train (removable) giving final speed of 125 r.p.m. Size: 4 1/2 in dia. Price 95p inc. post.

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Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox.

1 R.P.M.	1 R.P.H.	10 R.P.H.
30 R.P.M.	2 R.P.H.	15 R.P.H.
60 R.P.M.	3 R.P.H.	20 R.P.H.
	6 R.P.H.	30 R.P.H.

Fraction of makers' price. All at 75p incl. P. & P.

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MICRO SWITCH

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700	16-24	4M 2B	63p*
700	16-24	4 c/o	78p*
700	12-24	2 c/o	63p*
700	15-35	2 c/o HD	73p*
700	16-24	6M	65p*
1,250	24-36	4 c/o	63p*
2,500	36-45	6M	63p*
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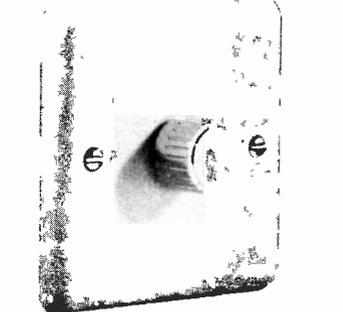
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STATE OF THE INDUSTRY

Official statistics necessarily trail events. It takes time for companies to make their returns to the Department of Trade and Industry and more time to analyse and collate them. So we had to wait until November 3 before getting the 1971 first half results on how the capital equipment sector is making out in these troubled times.

The figures were not as bad as some had feared. Compared with the first half of 1970 total output was up 5 per cent at £336.6 million. Radar was a bright feature, up 28 per cent, but slumps in broadcast equipment (-20 per cent), navigational aids (-11 per cent), and radio communications equipment (-10 per cent) eliminated the gains. Control equipment put on 22 per cent and nucleonic instruments a cracking 25 per cent, although the latter is such a small segment of the industry that the gain had little effect on the overall totals. Exports were down from 40 per cent to 36 per cent. Surprisingly, employment remained constant, this year being 150,000 people at the end of both the first and second quarters.

The red light is seen in the forward order book. The figure at June 30, 1970, was £648 million. On the same date in 1971 the figure had slumped to £572 million. The conclusion must be that the great days of 15 per cent growth every year are all but over.

LEANER AND TOUGHER

Squaring up to the commercial facts of life is no easy matter. Some people throw in the sponge as did RCA with computers. Since then the U.S. General Electric has pulled out of microcircuits. After

an investment of £20 million and four years of struggle.

Others persist by seeking economies and building better management structures. Plessey recently underwent a complete reorganisation converting a cumbersome operation into "businesses", each accountable directly to the main Plessey board.

Some details of how Mullard tackled their problem have been revealed by commercial director Jack Akerman. Mullard now has four divisions each responsible for a market sector. They are Consumer, Computer, Communications, and Instrumentation and Control. The general manager of each division looks after his market sector not only from the sales point of view but also the Mullard manufacturing plant producing goods for his market area. Each is charged with making a profitable return on the capital employed which totals some £90 million right across the board.

Everyone is expected to work for the benefit of the whole company—not just for his own division. Akerman regards the organisational change as a platform for growth in the '70s. Results after 6 months showed a reduction in stocks of over 10 per cent while providing a better service to the customer, reduction in the commercial staff and better morale.

SLIMMING DOWN

Another example of slimming down to better meet the future as well as today's problems is to be seen in SGS whose U.K. operations are based on a marketing unit at Aylesbury and a substantial manufacturing plant at Falkirk. Fears that the Falkirk plant would be closed entirely were recently allayed by a lightning visit from Milan by Giancarlo Maimone, newly appointed managing director, who had discussions with local MP Harry Ewing and union representatives. The outcome was that Falkirk appears to be saved, for the time being at least, but with a labour force pruned from a peak of 1,100 down to some 500-600.

The marketing team at Aylesbury has also been streamlined and it is possible that a joint marketing team with ATEs (a company associated with SGS through the Italian holding company IRI) will be set up. Other SGS plants in Italy, France, Germany and Singapore are all reported to be working well under capacity. Mr Maimone has some tough decisions ahead in relation to cut-backs elsewhere but, for the moment, SGS men in the U.K. are optimistic. "At least we now have a clean situation on which to build", was the opinion of marketing manager Roy Hood.

TELECOMMUNICATIONS BOOM

One sector of the industry which is flourishing is telecommunications which, with the introduction of PCM and electronic exchanges, is getting more and more electronic in character. The TXE 2 electronic exchange is now firmly established. Since the first was commissioned in Ambergate, Derbyshire, in 1966, some 150 have been installed and they are now coming into service at a rate of more than two every week.

The big TXE 4 with up to 40,000 lines (TXE 2 has only 2,000 lines) has now been finally ordered by the Post Office from Standard Telephones and Cables. The development of TXE 4 has not been without problems but these have now been resolved. First contract is worth £15 million and the first installation will be made in London at the beginning of 1975. Soon afterwards, TXE 4's will be in service in Manchester and Birmingham.

The TXE 2 has been a big success for Plessey who have supplied the bulk of them to the Post Office and have also been successful in selling them overseas.

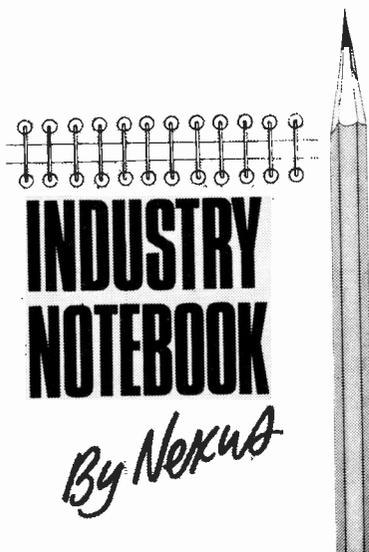
But the biggest telecommunications boom area of all is data communications. Fifteen countries in Europe have now come together in sponsoring a year's study by PA International Management Consultants in London on the data communications requirements of Europe for the next 15 years. The study is planned to show future customer requirements, anticipated data traffic flow with Europe, and between Europe and other continents, and future developments in data processing systems.

BRITAIN IN SPACE

The biggest rocket to get airborne (but only just) on Guy Fawkes day was *Europa 11* launched from Kourou in Equatorial French Guiana. Regrettably, it was the biggest flop of the year.

A few days earlier the British technology satellite *Prospero* (formerly X3) was successfully launched in orbit by a *Black Arrow* from Woomera and has been functioning well.

Prospero's success, however, will not compensate us in prestige for the loss of *Europa 11*. We pulled out of the European Launcher Development Organisation (ELDO) in 1968. It was a controversial move which did not endear us to our continental partners. The *Blue Streak* rocket used on November 5 was sold to ELDO. One crumb of comfort was that Marconi's navigational guidance system was not at fault.





BOOK REVIEWS

THE ARLINGTON DICTIONARY OF ELECTRONICS

Published by Arlington Books
171 pages, 8½in × 7½in. Price £3

THIS new book of American origin is well produced and attractively presented. The range of material covered is enormous, ranging from simple circuit theory to microwave engineering and quantum physics. Also included is some advanced maths including vector calculus. Digital computer fundamentals are also dealt with. Diagrams, though not profuse, are clear and well explained and the definitions are succinct and, wherever possible, assume only elementary knowledge.

My main criticism is not of this book itself but of the whole philosophy of presenting technical information in dictionary format. It is difficult to imagine when this type of book would be of use. In text books obscure terms are usually given lengthy explanations whilst a lay reader encountering technical terms would be unlikely to learn much from this type of book.

However, if this type of book appeals to you I can recommend it as an addition to library or personal book collection.

S.R.L.

110 INTEGRATED CIRCUIT PROJECTS FOR THE HOME CONSTRUCTOR

By R. M. Marston
Published by Iliffe
128 pages, 8½in × 5½in. Price £1.20

IN cramming 110 circuits into as many pages Mr. Marston has undoubtedly achieved quite a feat. The integrated circuits described range from the CA3018, which is simply four transistors on one chip, to the PA246 five watt amplifier. There is also a section describing 35 RTL digital i.c. projects.

The general procedure used is that a description of the internal circuit of the i.c. is presented, then several projects are described so that the reader becomes familiar with the function of the unit. Many of the projects are useful and interesting and it is almost certain that everyone will find something of use in this book.

The presentation of the information is, however, not all that good. Each new project does not have a heading so one has to resort to the index to find a particular circuit. All the i.c.s, apart from the digital, are represented with the operational amplifier symbol of a triangle. For i.c.s such as the CA3018 this makes it very difficult to read circuit diagrams, and on some diagrams output signals seem to come out of inputs.

At one new penny per circuit the book is certainly good value: but a little more care in presentation would have helped.

R.S.

QUESTIONS AND ANSWERS ON RADIO AND TELEVISION (3rd edition)

By H. W. Hellyer
Published by Newnes-Butterworth
172 pages, 6½in × 4½in. Price 60p

THIS book is clearly aimed at people who would like to know how television and radio systems operate, but whose knowledge of electronics is slight. It takes the reader through the main principles of electronics and then goes on to explain, in simple terms, the basic features of electronic devices, including the valve and the transistor. Some of the important circuits in radio and television are then described with many circuit diagrams to illustrate practical considerations. The final chapters deal with the functions of the television receiver, including tuning, synchronising and picture linearity control. Colour reception is not dealt with in any detail.

The sections on basic electronics are lengthy and, on the whole, they provide a useful introduction to the subject for a beginner. However, in a book with this title, I think that some of the questions and answers on semiconductor manufacture would have been better replaced by explanation of some practical points, such as the methods of correct biasing for transistors. The description of the field effect transistor, which is anyway complicated by the use of the term "depletion layer" without definition, seems superfluous to this kind of book.

Apart from these criticisms the book provides a lot of useful information on radio and television and would give the interested beginner plenty of food for thought.

S.R.L.

RADIO AND TELEVISION YEAR BOOK 1971/72

Edited by Eric Ickinger
Published by IPC Electrical-Electronic Year Books Ltd

224 pages, 8½in × 5½in. Price £1

A COMPLETE guide to radio and television broadcast stations, transmitting at v.h.f. and u.h.f. in the U.K., precedes the up-dated cataloguing of commercial equipment under classifications: monochrome television, colour television, radiograms, record players, table radios, portable radios, car radios, tape recorders, unit audio.

The format follows the usual style as a buyer's guide giving descriptions, brief specifications, and prices (November 1971). Some illustrations are also included.

HI FI YEAR BOOK 1972

Edited by Colin Sproxtton
Published by IPC Electrical-Electronic Year Books Ltd

376 pages, 8½in × 6in. Price £1.25

AMONG the preceding articles in this latest Hi Fi Year Book is an interesting outline of the Dolby noise reduction system that is now being increasingly incorporated in commercial equipment. Also included are: Hi Fi from FM radio; a short review of eighteen of the best recordings over the past year or so; the meaning and importance of pick-up parameters; a glossary of terms associated with microphones; a list of common abbreviations and meanings.

The equipment descriptions and prices are up-dated but do not include all new items that took their bow at the 1971 Audio Fair (see our Audio Fair report in this issue). A complete list is given in the centre of this book of September 1971 list prices and new purchase tax rates.

Build yourself a TRANSISTOR RADIO

NEW! ROAMER 10 WITH VHF INCLUDING AIRCRAFT

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

Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. Switched earpiece socket complete with earpiece. 10 transistors plus 3 diodes. 7in x 4in speaker. Air spaced ganged tuning condenser with VHF section. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in x 7in x 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts).

TOTAL BUILDING COSTS

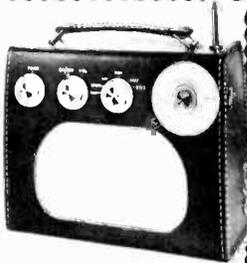
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P.P. & INS. 50p
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NOW WITH VARIABLE TONE CONTROL



7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. Switched earpiece socket complete with earpiece. 8 transistors plus 3 diodes. 7in x 4in speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts).

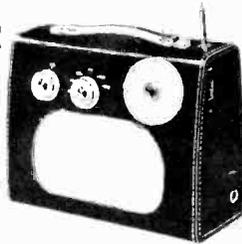
TOTAL BUILDING COSTS **£6.98** P.P. & INS. 41p
(OVERSEAS P. & P. £1)

ROAMER SEVEN Mk. IV

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND.

Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. 7in x 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening, 30p extra.

TOTAL BUILDING COSTS **£5.98** P.P. & INS. 41p
(OVERSEAS P. & P. £1)

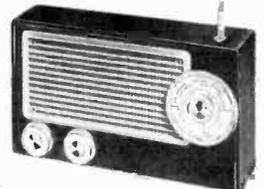


ROAMER SIX

6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC.

Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£3.98** P.P. & INS. 26p
(OVERSEAS P. & P. £1)



POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 6 1/2in x 1 1/2in x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£2.23** P.P. & INS. 21p
(OVERSEAS P. & P. 63p)

TRANSONA FIVE

NOW WITH 3in SPEAKER

3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone 3in moving coil speaker. Attractive case with red speaker grille. Size 6 1/2in x 4 1/2in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£2.50** P.P. & INS. 22p
(OVERSEAS P. & P. 63p)



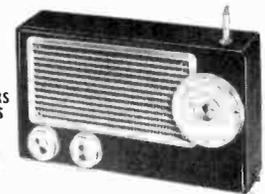
TRANS EIGHT

8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, SW3 AND TRAWLER BAND.

Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£4.48** P.P. & INS. 31p
(OVERSEAS P. & P. £1)



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BUILD RADIOS, AMPLIFIERS, ETC., FROM EASY STAGE DIAGRAM. FIVE UNITS INCLUDING MASTER UNIT TO CONSTRUCT. Components include: Tuning Condenser; 2 Volume Controls; 2 Slider Switches; 4" x 2 1/2" Speaker; Terminal Strip; Ferrite Rod Aerial; 3 Plugs and Sockets; Battery Clips; 4 Tag Boards Balanced Armature Unit; 10 Transistors; 4 Diodes; Resistors; Capacitors; Three 1/2in Knobs.

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ROAMER EIGHT	<input type="checkbox"/>	TRANS EIGHT	<input type="checkbox"/>
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POCKET FIVE	<input type="checkbox"/>	EDU-KIT	<input type="checkbox"/>

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AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p	2N1131	20p	2N2905	25p	2N3707	13p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	T1543	40p	2N1302	17p	2N2905A	30p	2N3708	8p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p	2N1303	17p	2N2906	27p	2N3709	8p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p	2N1304	20p	2N2907	25p	2N3710	10p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p	2N1305	20p	2N2907A	30p	2N3711	10p
AC142K	17p	AF129	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p	2N1306	22p	2N2923	13p	2N3819	40p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p	2N1307	22p	2N2924	13p	2N3820	£1
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G302	19p	2N1308	27p	2N2925	13p	2N3903	25p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G302	19p	2N1309	27p	2N2926	12p	2N3905	25p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p	2N1613	17p	(G)	12p	2N3906	27p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p	2N1711	20p	2N2926(Y)	11p	2N4058	15p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p	2N1889	35p	2N2926	12p	2N4059	10p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p	2N1890	45p	(O)	10p	2N4060	12p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p	2N1893	37p	2N3010	80p	2N4061	12p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p	2N2160	60p	2N3011	20p	2N4062	12p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p	2N2147	75p	2N3053	20p	2N4063	12p
AC176	23p	AS526	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p	2N2148	60p	2N3054	50p	2N4064	12p
AC177	20p	AS527	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p	2N2192	30p	2N3055	63p	2N4065	12p
AC187	30p	AS528	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p	2N2193	30p	2N3056	63p	2N4066	12p
AC188	30p	AS529	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p	2N2194	27p	2N3057	63p	2N4067	12p
AC197	25p	AS550	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p	2N2217	20p	2N3058	63p	2N4068	12p
AC198	30p	AS551	25p	BC175	22p	BF160	30p	BSY38	9p	OC71	9p	2G382	15p	2N2218	20p	2N3059	63p	2N4069	12p
AC199	30p	AS552	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p	2N2219	27p	2N3060	63p	2N4070	12p
AC200	20p	AS554	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G41+	30p	2N2220	22p	2N3061	63p	2N4071	12p
AC201	20p	AS555	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p	2N2221	22p	2N3062	63p	2N4072	12p
AC222	19p	AS556	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388	30p	2N2222	27p	2N3063	63p	2N4073	12p
AC227	18p	AS557	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p	2N2223	27p	2N3064	63p	2N4074	12p
AC228	19p	AS558	25p	BC182	10p	BF173	35p	BU105	£3.90	OC81	15p	2N404A	22p	2N2224	27p	2N3065	63p	2N4075	12p
AC229	30p	AS559	25p	BC183	10p	BF176	35p	CI11E	60p	OC81D	15p	2N404A	30p	2N2225	27p	2N3066	63p	2N4076	12p
AC230	25p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p	2N2226	27p	2N3067	63p	2N4077	12p
AC231	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p	2N2227	27p	2N3068	63p	2N4078	12p
AC234	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p	2N2228	27p	2N3069	63p	2N4079	12p
AC235	18p	BC109	11p	BC184L	13p	BF180	50p	C425	40p	OC84	20p	2N697	15p	2N2229	27p	2N3070	63p	2N4080	12p
AC236	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p	2N2230	27p	2N3071	63p	2N4081	12p
AC240	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p	2N2231	27p	2N3072	63p	2N4082	12p
AC241	18p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p	2N2232	27p	2N3073	63p	2N4083	12p
AC244	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p	2N2233	27p	2N3074	63p	2N4084	12p
AD140	40p	BC118	25p	BC212L	11p	BF188	30p	C444	37p	OC200	25p	2N708	12p	2N2234	27p	2N3075	63p	2N4085	12p
AD149	43p	BC119	45p	BC213L	11p	BF194	30p	C450	17p	OC201	27p	2N709	45p	2N2235	27p	2N3076	63p	2N4086	12p
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C720	12p	OC202	27p	2N71	40p	2N2236	27p	2N3077	63p	2N4087	12p
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C742	25p	OC203	25p	2N717	42p	2N2237	27p	2N3078	63p	2N4088	12p
AD161/162(MP)	63p	BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	24p	2N2238	27p	2N3079	63p	2N4089	12p
AD170	60p	BC134	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p	2N2239	27p	2N3080	63p	2N4090	12p
ADZ11	£2	BC136	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p	2N2240	27p	2N3081	63p	2N4091	12p
ADZ12	£2	BC137	35p	BC318	12p	BF257	35p	C762	17p	P397	45p	2N743	17p	2N2241	27p	2N3082	63p	2N4092	12p
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	C764	60p	OC271	43p	2N744	17p	2N2242	27p	2N3083	63p	2N4093	12p
								EC401	15p	ORP12	43p	2N914	17p	2N2243	27p	2N3084	63p	2N4094	12p

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BA126	22p	BYZ16	35p	OA91	7p
BY100	15p	BYZ17	35p	OA95	7p
BY101	12p	BYZ18	30p	OA200	6p
BY105	15p	BYZ19	25p	OA202	7p
BY114	12p	OA5	17p	SO10	4p
BY126	15p	OA10	22p	SO19	4p
BY127	17p	OA47	7p	IN914	6p
BY130	15p	OA70	7p	IN916	6p
BYZ10	35p	OA79	8p	IN4148	6p

500,000

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Price: 500 £9; 1,000 £15

TYPE STP18. Silicon Planar Transistors npn TO-18 Metal Can. Types similar to: BCY70-72, 2N2906-7, 2N2411 and BC186-7. Also used as complementary to the above npn type device type STN18.
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TYPE STN5. Silicon Planar Transistors npn TO-5 Metal Can. Types similar to: BFY50-51-52 and 2N2192-92.
Price: 500 £9.50; 1,000 £16

TYPE STPL. As above but in npn and similar to types 2N5354-56, 2N4058-2N4061 and 2N3702-3. Also used as complementary to the above npn devices type STNL.
Price: 500 £7.50; 1,000 £13

TYPE STNK. Silicon Planar Plastic Transistor npn with TO-18 pin circular lead configuration, I.C. 200mA, 300mW and similar to BC107-8-9, BC170, BC173, BC182-184, BC237-8-9 and BC337-8.
Price: 500 £9.50; 1,000 £16

When ordering, please state type required, i.e., STNK or STN18, etc.

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Clearance of npn Silicon Transistors from the 2S300 (TO-5) and 2S320 (SO-2) range and similar to the GC200-205 and BCY30-34 series. Ideal for Amateur Electronics, Radio Hams and for experimental use in Schools, Colleges and Industry.

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1,000 off—£4 (plus p. & p. 25p)
10,000 off—£35 (plus p. & p. 55p)

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10 MILLION DIODES

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1,000	£2.00	50,000	£30.00
5,000	£7.00	100,000	£50.00

2,000,000 SILICON PLANAR TRANSISTORS TO18 P.N.P. & N.P.N. TYPES

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500	£6.00	50,000	£400.00
1,000	£10.00	100,000	£625.00

i.c. audio mixer

Combines Mic or Tuner inputs into a single channel

By M. J. Bunce

THIS article describes a simple three channel, audio mixer using an integrated circuit pre-amplifier. It has a substantially flat frequency response in the audio range, and is designed for use with both domestic and semi-professional tape recorders, particularly with regard to cine soundtrack recording.

The mixer can also be used by pop groups, using impedance matching transformers if low output impedance transducers are used, such as dynamic or ribbon microphones.

CIRCUIT DESCRIPTION

The circuit of the mixer itself is given in Fig. 1. The input lines to the pre-amplifier are blocked to d.c. by capacitors C1, C2 and C3. This is necessary to prevent crackling and hiss caused by current flowing through the potentiometer wiper circuits.

The pre-amplifier is an integrated circuit operational amplifier contained in a standard eight-lead TO5 package. Such amplifiers are beginning to appear quite cheaply on the surplus market.

The circuit described was designed around an S.G.S. $\mu A709$, which has an open loop gain in the order of 50,000 at frequencies up to around 1MHz.

The gain of the amplifier for a single channel is given by:

$$G = \frac{R_F}{R_I}$$

where R_F is the value of feedback resistance R5 in ohms and R_I is the value of input resistance. In this case:

$$\text{Gain } G = \frac{1,000,000}{100,000} = 10$$

Thus the amplifier has an overall gain of ten.

CAPACITOR ROLES

To prevent the amplifier from amplifying stray radiation, picked up by the external connecting leads, the input is shunted by a resistor/capacitor network, consisting of R6 and C4. Similarly, generation of radio frequency parasitic oscillations within

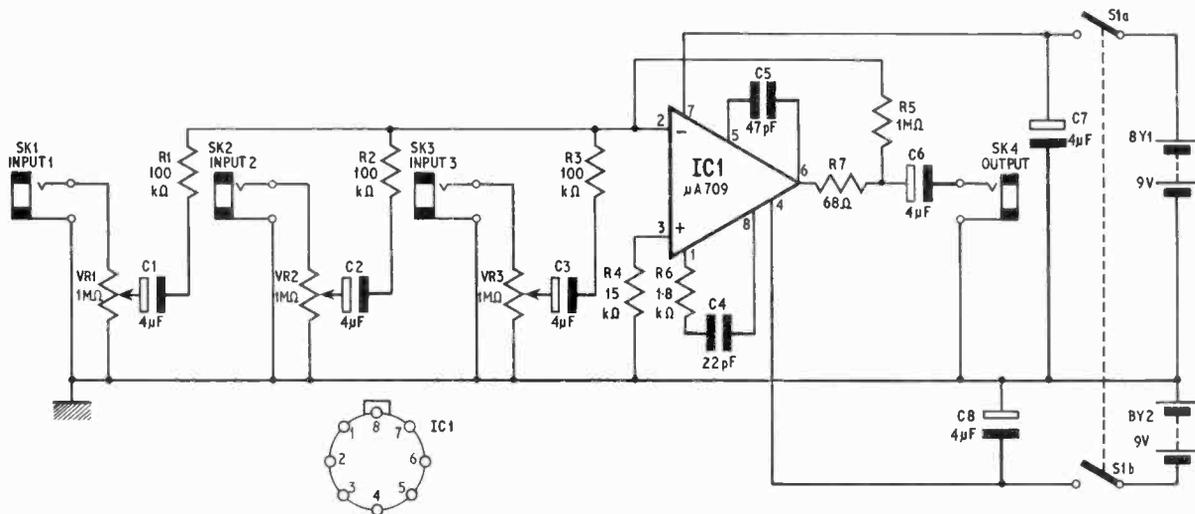


Fig. 1. Circuit diagram of audio mixer

I.C. AUDIO MIXER

COMPONENTS . . .

Resistors

- R1 100k Ω
- R2 100k Ω
- R3 100k Ω
- R4 15k Ω
- R5 1M Ω
- R6 1.8k Ω
- R7 68 Ω
- All $\pm 10\%$, $\frac{1}{4}$ W carbon

Potentiometers

- VR1 1M Ω carbon log.
- VR2 1M Ω carbon log.
- VR3 1M Ω carbon log.

Capacitors

- C1 4 μ F elect. 15V
- C2 4 μ F elect. 15V
- C3 4 μ F elect. 15V
- C4 22pF polystyrene
- C5 47pF polystyrene
- C6 4 μ F elect. 15V
- C7 4 μ F elect. 25V
- C8 4 μ F elect. 25V

Integrated Circuit

- IC1 μ A 709 (S.G.S.) or equivalent

Sockets

- SK1-SK4 Standard type jack sockets (4 off)

Switch

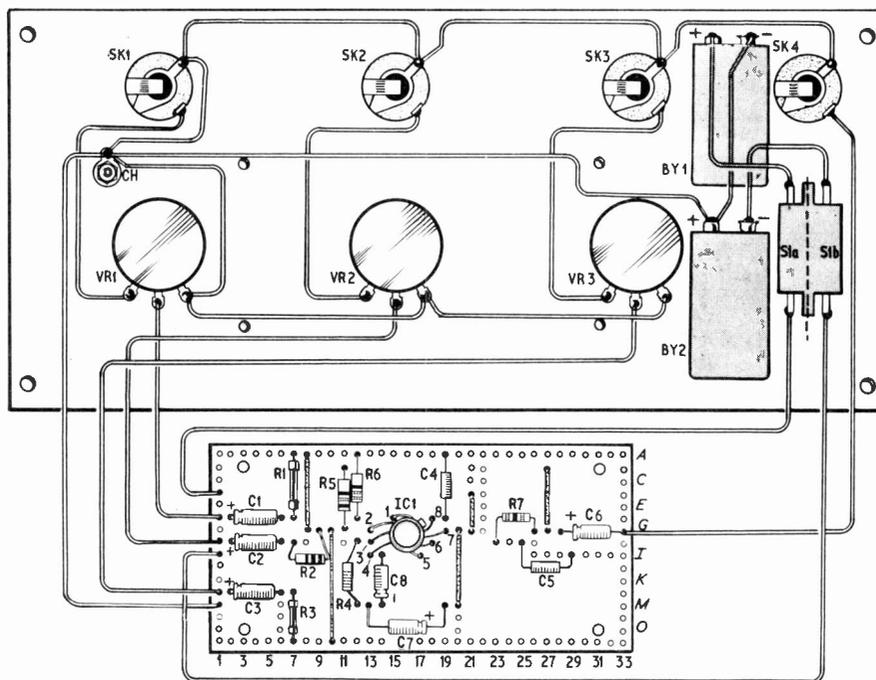
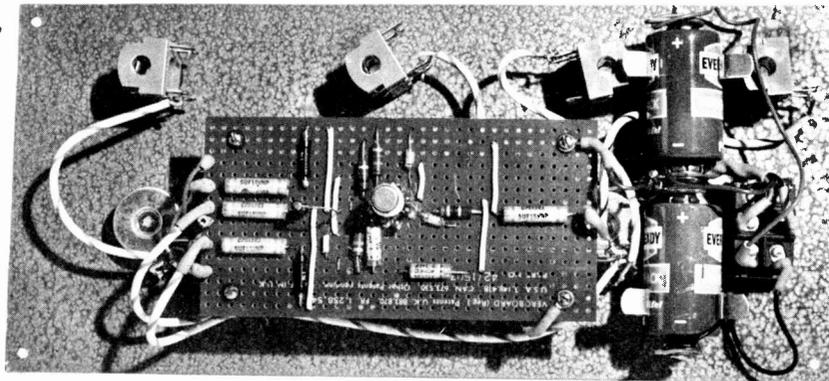
- S1 Double pole on/off switch

Batteries

- BY1, BY2 9 volts type PP9 (2 off)

Miscellaneous

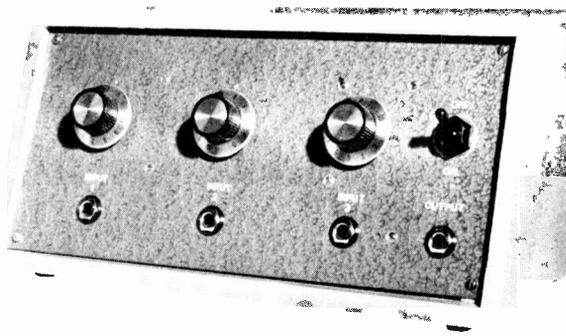
- Aluminium panel 16 s.w.g. 11in \times 5in
- Skirted control knobs numbered 0-10 over 300 degrees
- Veroboard 5in \times 2 $\frac{1}{2}$ in 0.15in matrix
- Hardboard and wood as required



MAKE BREAKS TO COPPER AT:

4A	4P	9F	17F	30C
4B	5F	11H	18M	30N
4C	5H	14G	22G	30O
4N	5L	14H	30A	30P
4O	8H	16I	30B	32G

Fig. 2. Component layout and interwiring of mixer



the amplifier is suppressed by capacitor C5 at the amplifier output.

The values of these components determines the upper frequency response limit of the amplifier; its lower limit is determined by the values of the input capacitors C1, C2 and C3, and also the output capacitor C6. For this mixer application, a fairly sharp roll-off is required above 25kHz.

Any d.c. component in the amplifier output (e.g. that due to offset or drift within the i.c.) is blocked by capacitor C6, which also protects the amplifier against short-circuit fault conditions at the input stages of the equipment to which it is connected. It may seem at first that using the component values specified voltage offsets might easily occur. In practice, however, although offsets of up to $\pm 1V$ can occur at the output of the amplifier, this is of no consequence since the output is d.c. blocked, and the output voltage swing never exceeds $\pm 0.5V$.

INPUT INTERACTION

It would also appear that the inputs might interact (i.e. turning one input to minimum would cause a drop in gain of the remaining inputs). This is also not true, since the input of the i.c. is a virtual earth, and the inputs do not therefore have any effect whatsoever on each other.

As the power requirements of the amplifier are small, it was decided to use two 9V batteries, particularly as the amplifier requires a centre-tapped

supply. The design of a suitable power unit for such a circuit could be disproportionately costly and complex. Besides, for the particular application of this mixer, portability is useful.

Earthing is not critical, although the fewer the number of separate earths, the better.

CONSTRUCTION

The unit is built around the front panel, thus avoiding numerous trailing wires, so that it may be fitted into the case as a complete module. Component assembly details on the front panel are shown in Fig. 2.

The electronic components are all mounted on a piece of Veroboard which is spaced from the panel by four 6BA spacers. The integrated circuit package is mounted on an i.c. socket to obviate the risk of damage when soldering the leads.

The layout of the components on the panel is not critical, however all unused whole copper strips should be electrically bonded to earth to avoid pick-up of extraneous signals.

When laying out the front panel (see photograph), consideration was given to the ergonomic aspects of the design, particularly as the cine sound track operator could well be working outdoors in cold weather. As he could be wearing gloves under such conditions, plenty of room was left between the control knobs, which are of skirted type.

The case is of thin plywood, angled to provide a comfortable degree of rake to the front panel. Since each individual constructor may wish to design his own case to suit his requirements, only a simple perspective view of the prototype case is included (Fig. 3).

HUM SUPPRESSION

The inside of the case is lined with aluminium foil to prevent pick-up of external interference such as mains hum. The foil is earthed to the front panel at the chassis solder tag CH (Fig. 2).

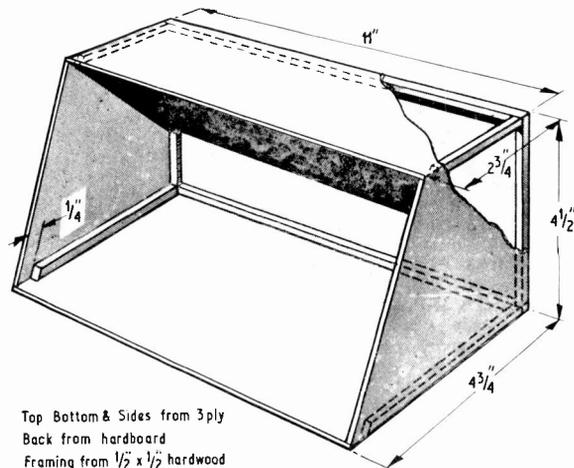
The screws fitted to the front panel are all counter-sunk, with the exception of the four case securing screws, as this improves neatness and avoids any risk of fouling the skirt of at least one of the potentiometer knobs.

USING THE MIXER

In setting up the mixer each number on the control knobs represents a gain increase or decrease of approximately 1dB with the input and feedback resistance values given in Fig. 1.

For amplifier gain variations the input resistors R1, R2 and R3 can be changed either singly or totally to suit individual requirements. Thus, with the 1 Megohm feedback resistance given and input resistors in channels 1, 2 and 3 having values of 1 Megohm, 100 kilohms and 10 kilohms respectively, these will provide suitable gains for an f.m. tuner, crystal microphone and dynamic or ribbon microphone providing the latter two are fitted with impedance matching transformers.

No master gain control is fitted since for its particular design application the tape-recorder input gain control is satisfactory. Monitoring is carried out in the normal way using the recorder facility. ★



Top Bottom & Sides from 3ply
Back from hardboard
Framing from 1/2 x 1/2 hardwood

Fig. 3. Case assembly details

ELECTRONORAMA

Mowing by Moonlight

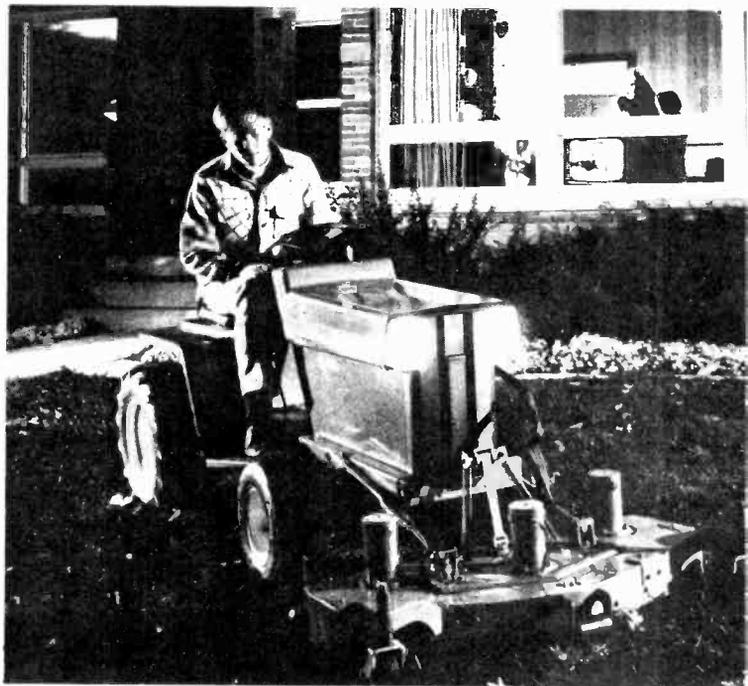
RICH, insomniac Americans can now while away the midnight hours by mowing their lawn, without fear of disturbing their neighbors.

The Elec-Trac is a quiet and compact electric tractor developed by General Electric for use in the garden. It can mow, till, blow away snow, or provide a mobile power source for electrical equipment.

A programmed starting system prevents the operator from applying too much speed too soon and when the controls are set to "full forward" a built-in safety circuit automatically accelerates the vehicle smoothly to the desired speed.

Six long-life batteries will provide eight to ten years of life under normal conditions.

The company predicts a great future for after dark lawn care. They say, "We know that from three years of testing at night that quiet mowing in the cool of the evening or early morning is a real pleasure."



Electronic Cash Register

TO MEET the need for faster check-out in supermarkets and stores, a new electronic system has been designed to replace the slow and cumbersome cash register. Pitney-Bowes call the new system "SPICE" (Sales Point Information Computing Equipment), and the unit which the customer sees is closer to a computer terminal than a cash register.

By connecting all the units to a central in-store controller, all information concerning sales can be recorded on magnetic tape. This can later be processed by a computer and any facts and figures which are needed can be extracted for use by the store manager. As well as accurately recording sales, the terminals may be used to get immediate notification of a customer's credit standing. The terminals can also be used as calculators to work out quantity prices or discounts.

An optional extra to SPICE is "PEPPER" (Photo-Electric Portable Probe/Reader) which eliminates the need for the sales clerk to ring up the prices. All sales items are individually marked with special tickets, on which the price is coded into a row of bars. The electronic "pen" is quickly passed over the ticket, instantly displaying price, item number, and department number on the terminal register. Speed and elimination of human error make this very attractive to both customer and seller.

For small stores or places where access to a central computer is not feasible, a self-contained system known as "SALT" (Stand Alone Terminal) is available which can be programmed to provide on-the-spot point-of-sale information.



A ELECTRONIC

A Sight for Sore Ears

WHEN noise exceeds a certain level it is not only annoying, it can be positively dangerous! In an attempt to lessen the risk to hearing for people who live or work in noisy environments, the Noise Abatement Society is now marketing two new pieces of equipment: a survey meter which lights a lamp if sound exceeds the danger level and ear defenders for protection when it does.

Eye Movements Control Wheelchair

FOR patients who have lost the use of both arms and legs, this wheelchair offers new hope. The only actions needed to start, steer or stop the wheelchair are movements of the eyes. The sight-guide steering mechanism used in the chair was developed originally for NASA, the U.S. space agency, which is seeking ways of freeing the hands of pilots and astronauts for other in-flight duties.

A prototype wheelchair controlled by eye movements is at present being tested at the Institute of Rehabilitation Medicine in New York. If it is eventually put into production, an estimated 100,000 quadriplegics (those with no use of arms or legs) could be made mobile.

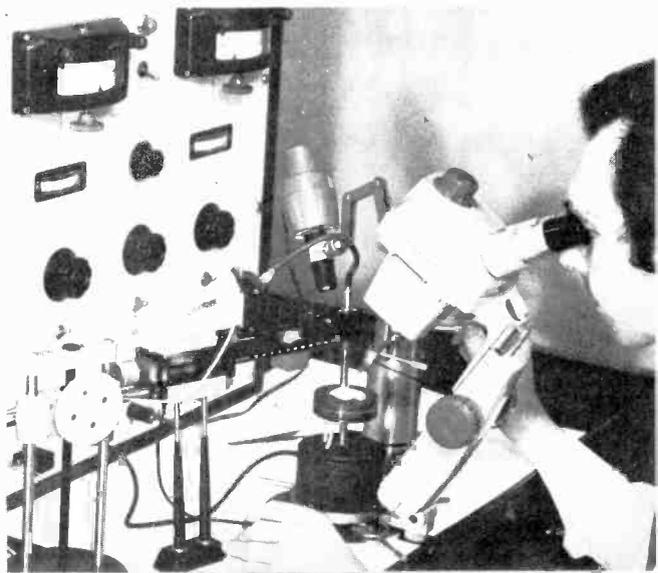


Microstrip Production

WITH the increasing use of microwave communications, EMI's activities in microstrip circuits—miniature microwave devices—have rapidly expanded in the last year. Their range has grown to include doppler generators, Gunn effect power sources, aerials, amplifiers and switches.

These new microwave techniques are being applied in many areas including the development of an experimental digital radio link for the Post Office. This will be designed to transmit and receive digital signals at 120 million bits per second.

The photo shows part of the assembly process using a vacuum probe micro-manipulator.



Use integrated circuits to simplify control functions

LOGICAL

RADIO CONTROL

By A.J. Dunn

PART TWO

CODER 2 is described in this article in two variants. Although more expensive to make than Coder 1 described last month, they are easier to assemble. Both variants use the same basic printed circuit pattern apart from a minor change to the circuitry involving IC7.

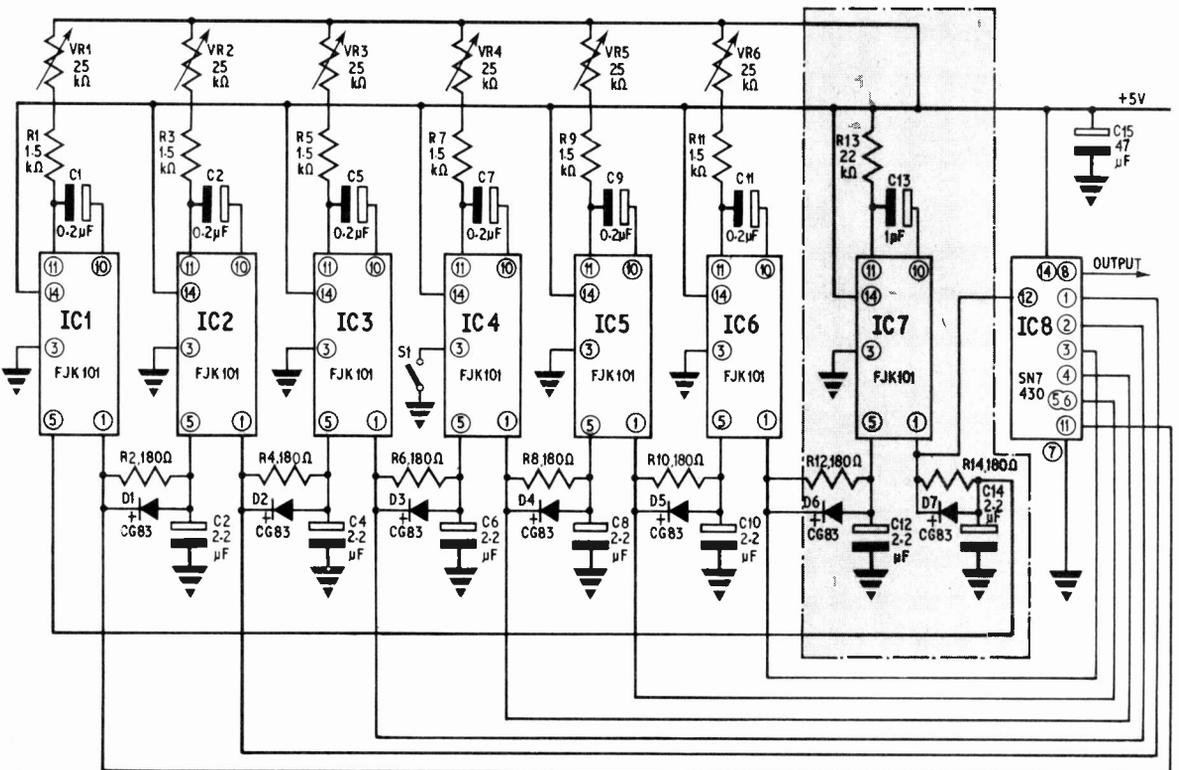
CODER 2A

Fig. 10 shows the circuit of Coder 2A. The grey panel area is the part which is altered to make Coder 2B. More about this later.

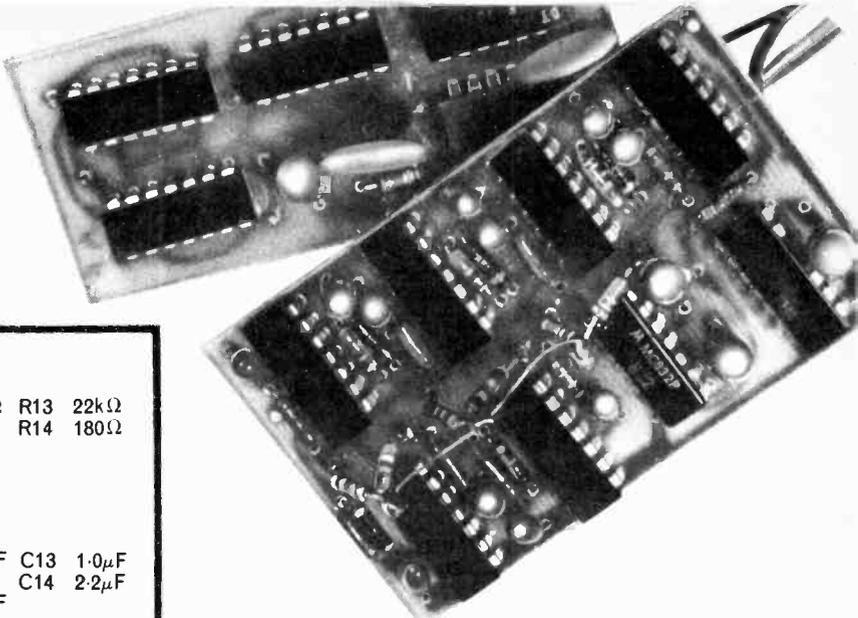
The particular advantage of Coder 2 is the flexibility of timing since the timing resistance combination of R1-VR1 can vary between 1.5 kilohms and about 40 kilohms (R1 is fixed at 1.5 kilohms) with any value for C1. There is no critical lower value for the minimum signal pulse length.

The integrated circuits IC1 to IC7 (Type FJK101 or 74121) are monostable multivibrators, each triggering the next in turn via the R-D-C network from pin 1 (\bar{Q} output), providing the interval period of about 0.32ms. The resistors in these networks (R2, R4, etc.) should not exceed 200 ohms. The sync pulse

CODER 2A



COMPONENTS . . .



CODER 2A

Resistors

R1 1.5k Ω	R5 1.5k Ω	R9 1.5k Ω	R13 22k Ω
R2 180 Ω	R6 180 Ω	R10 180 Ω	R14 180 Ω
R3 1.5k Ω	R7 1.5k Ω	R11 1.5k Ω	
R4 180 Ω	R8 180 Ω	R12 180 Ω	

All $\pm 10\%$, $\frac{1}{8}$ watt carbon

Capacitors

C1 0.22 μ F	C5 0.22 μ F	C9 0.22 μ F	C13 1.0 μ F
C2 2.2 μ F	C6 2.2 μ F	C10 2.2 μ F	C14 2.2 μ F
C3 0.22 μ F	C7 0.22 μ F	C11 0.22 μ F	
C4 2.2 μ F	C8 2.2 μ F	C12 2.2 μ F	

All tantalum bead type

Potentiometers

VR1 to VR6 25k Ω linear carbon (6 off)

Integrated Circuits

IC1 to IC7* FJK101 or SN74121N (7 off)
 IC8 FJH101 or SN7430N

D1 to D7 CG83 or OA10 (7 off)

Miscellaneous

Fibreglass base printed circuit board and etching kit

is taken from the \bar{Q} output of IC7, the pulse length being 0.7CR or approximately 14ms.

For timing capacitors (C1, C3, etc.) of 0.2 μ F and control resistance of 25 kilohms in series with 1.5 kilohms, the corresponding maximum signal pulse length is approximately 5ms.

One of the NAND gated inputs (pin 3) is connected to the common "earth" line except in the case of IC4 where an initiating switch is inserted to start the cycle of operation.

The output from the Coder is taken from IC8, a single eight-input positive logic NAND gate.

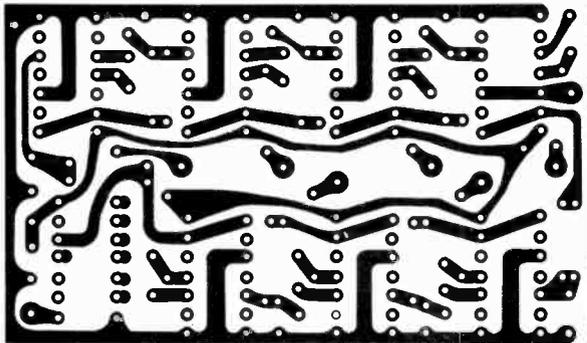
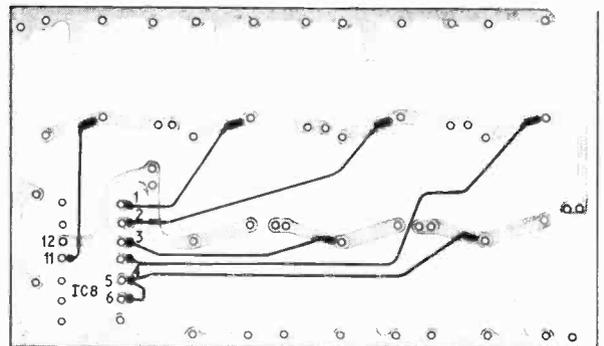
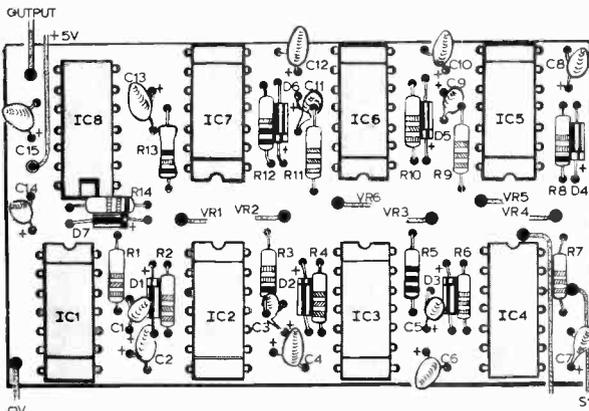


Fig. 10 (far left). Circuit diagram of Coder 2A. The area for modification to convert to Coder 2B is indicated by the grey area

Fig. 11 (left). The printed circuit pattern (full size) for Coder 2A

Fig. 12. Component layout of Coder 2A. The area where modification is required to convert to Coder 2B is shown in Fig. 16

Fig. 13 (below). Wire link connections on the copper side of the board



CODER 2A P.C. BOARD

The pattern for the printed circuit, which should be of fibreglass base, is shown full size in Fig. 11. As with Coder 1 described last month, it is worth providing an extra blank area of board at one end for mounting; this would add about $\frac{1}{2}$ in to the length of the working pattern.

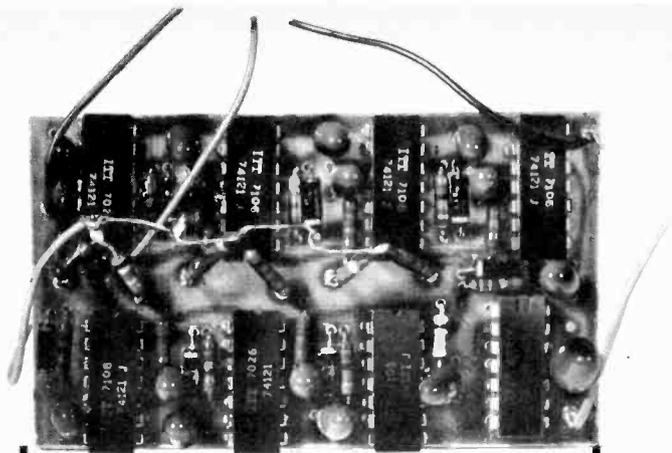
Component layout is shown in Fig. 12, while details of wire link connections are in Fig. 13.

Orientation of the integrated circuits is important; if an error is made after soldering *in situ* it can prove a messy job to remove the i.c. unless a special desoldering tool is available.

CODER 2B

Coder 2B is similar to Coder 2A except it has a fixed cycle time. The integrated circuit IC7 is replaced by a dual four-input NAND gate (DTL type MC832 or 932) equipped with "node" inputs. The outputs from IC7 are capacitor coupled to the opposite "node" inputs, so forming a multivibrator, Fig. 14.

The output from pin 6 initiates the cycle for each period τ_1 (see last month). This period can be adjusted by altering the values of the coupling capacitors C16 and C17. For small variations a series resistor-potentiometer arrangement, as in the other stages, can be connected from pin 3 to the positive line and also from pin 11 to the positive line.



* MODIFICATIONS TO MAKE CODER 2B

Integrated Circuit

IC7 Change to MC832 or 932. DTL range

Diodes

D6 and D7 not required

Add Resistor

R15 180Ω $\frac{1}{8}$ watt carbon

Capacitors

C15, C16 10μF tantalum or electrolytic (2 off)

CODER 2B

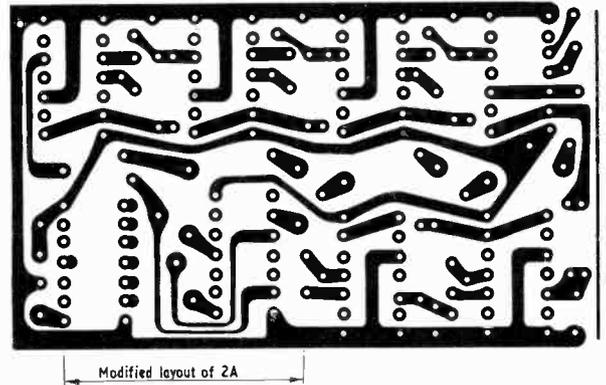
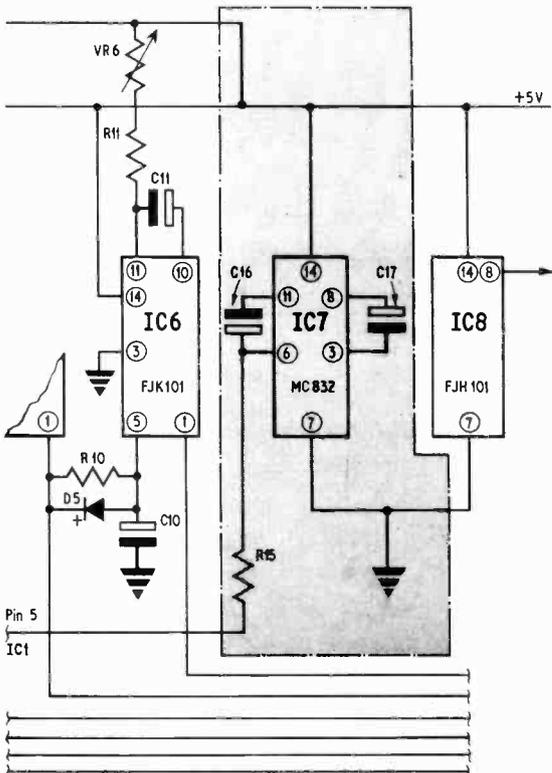
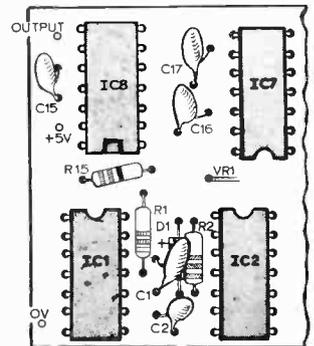


Fig. 14 (left). Modification of Coder 2A circuit from part of Fig. 10 to convert to Coder 2B

Fig. 15 (above). Printed circuit pattern (full size) for Coder 2B

Fig. 16 (right). Modified area of layout for Coder 2B



The modified printed circuit pattern is shown full size in Fig. 15, while the modified part of the component layout is shown in Fig. 16.

DECODER

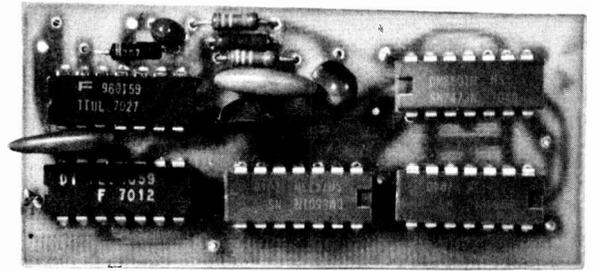
A decoder is essentially a means of translating the information transmitted in pulse code to some form of sequential mode analogous to the operation of model functions.

In the decoder described here, three dual JK flip-flops make up a shift register (Fig. 17) driven by a negative going pulse, derived by feeding the input signal through two paralleled NAND gates. A retriggerable monostable is also used to detect the signal period.

The circuit shown in Fig. 17b is used to produce the negative going pulses required by the shift register inputs to 'clock' and 'clear': this should be considered in connection with the waveform diagram Fig. 18.

The input signal (Fig. 18a) is applied to two parallel NAND gates, each with a "fan-out" of eight, producing the requisite negative going signal (Fig. 18b) adequate to drive the 6×2 clock input loads.

The $0.1\mu\text{F}$ capacitor is used to slow the fast edges slightly and prevent spurious ringing effects. This signal is applied to the input of the retriggerable monostable whose output (Q) is maintained high (Fig. 18c) till after the last trigger (pulse No. 6)



Finished decoder board

dependent upon C_1 and R_1 ($2.2\mu\text{F}$ and $20\text{k}\Omega$) as pulse width $\tau \approx 0.36 R_1 C_1 \left(1 + \frac{0.7}{R}\right)$ R being in kilohms; C in pF; and τ in nanoseconds.

CLEAR PULSE

The positive going edge is differentiated by C_2 and R_2 (Fig. 18c), the negative going spike turning off TR1 whose output is a positive pulse situated in the middle of the sync period (Fig. 18d). This pulse

DECODER

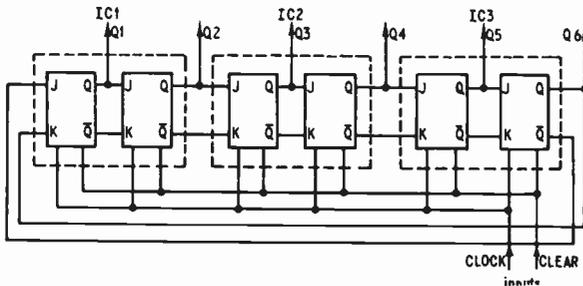


Fig. 17a. Interconnection of six JK flip-flops to form a shift register for decoding

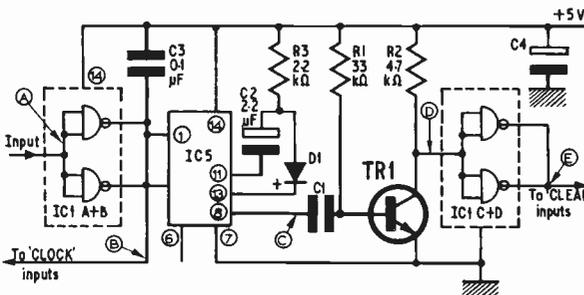


Fig. 17b. Circuit of the "clock" and "clear" pulse generator on the decoder board

COMPONENTS . . .

DECODER

Resistors

- R1 $4.7\text{k}\Omega$
- R2 $33\text{k}\Omega$
- R3 $22\text{k}\Omega$
- All $\pm 10\%$, $\frac{1}{8}\text{W}$ carbon

Capacitors

- C1 $0.1\mu\text{F}$ ceramic disc
- C2 $2.2\mu\text{F}$ tantalum
- C3 $0.1\mu\text{F}$ ceramic disc
- C4 $47\mu\text{F}$ elect.

Integrated Circuits

- IC1 MC846 or 946 quad 2-input gate (DTL)
- IC2, IC3, IC4 FJ121 or 7473N Dual JK (TTL) (3 off)
- IC5 F9601 retriggerable monostable

Transistor and Diode

- TR1 2N3704
- D1 OA202

Miscellaneous

- Fibreglass printed circuit board and etching kit

is applied to two parallel NAND gates whose negative going output (Fig. 18e) drives the "clear" inputs of the register.

The action of the "clear" pulse is to set the outputs (Q) of all six flip-flops to "0" awaiting the arrival of the first signal pulse which causes the output of the first flip-flop to go high (1) (since it takes an input from an inverted output (Q) for the period of the pulse and the interval period. The second signal pulse causes the second output to change to "1" and the first output to revert to "0".

Subsequent pulses appear individually as positive output pulses at the five flip-flop outputs.

The output from Q1 is shown at "B" in Fig. 19b.

SIXTH CHANNEL

The sixth channel output is obtained, if required, by the use of a further quadruple NAND gate wired as shown in Fig. 19a and if desired, associated with a servo unit. The positive going input signal at "A" is gated with the output of the flip-flop output Q1 to produce the signal shown in "C". This is again gated with the input to produce a negative going pulse as at "D", which is inverted, using another gate to produce the sixth positive going signal output at "E".

The shift register is formed by connecting the dual flip-flops in cascade as shown in Fig. 17a, it being noted that one interconnection pair is reversed to store the necessary "1".

Fig. 20 shows the printed circuit layout, the components being assembled as shown in Fig. 21. Note again the orientation of the integrated circuits and polarity of the capacitors and diode.

When carefully soldered, thin insulated wire should be used to wire up the signal connection pads, the positive supply connections and the earth connections (Fig. 22).

DECODER VARIATIONS

The shift register can be extended for as many outputs (channels) as required provided that the "fan out" performance of parallel gates exceeds the number of loads—two per "clock" and "clear" input.

The present cost of SN7473N i.c.s invites the use of a cheaper gate to obtain the last output (Fig. 19) but a single flip-flop (FJJ111) could be used to store the "1".

If Coder 2B (with positive sync pulse) is used the circuit in Fig. 17b is modified and the inverted (Q) output from pin 6 of IC5 is applied to the base of TR1 and an output is taken from its collector (collector load 5.1kΩ) direct to the "clear" inputs.

The "clear" input signal (which overrides the action of "clock" pulses) is maintained to the end of the cycle.

A 1,000pF capacitor should be connected between the clock inputs and ground (0V) to prevent spurious ringing and the "extra" flip-flop method should be employed.

CONSTRUCTION NOTES

It cannot be over-emphasised that care should be taken with construction, particularly the soldering; if sound components are used and the circuit wired correctly, no difficulty may be expected; however, a simple solder bridge between copper pads can cause

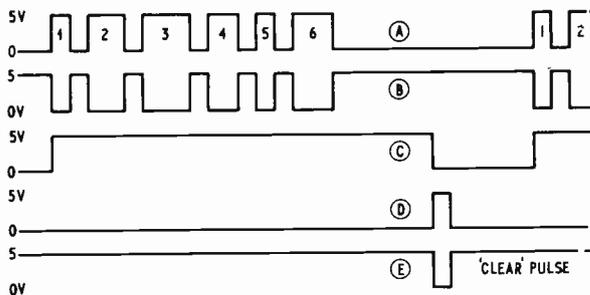


Fig. 18a. A typical input to first two NAND gates in IC1

Fig. 18b. Output of first two NAND gates fed into the clock line and into the signal period detector multivibrator IC5

Fig. 18c. Output Q from the resettable monostable multivibrator IC5

Fig. 18d. Output waveform from TR1 indicating the positive pulse in the middle of the sync period

Fig. 18e. The pulse in Fig. 18d is inverted by two more paralleled NAND gates to produce a sharp "clear" pulse

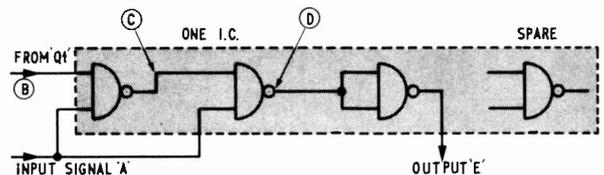


Fig. 19a. Quad 2-input NAND gate is used to obtain the sixth channel from the Q1 output. Waveforms are given below

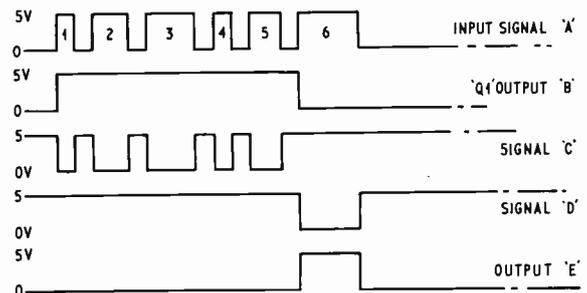


Fig. 19b. Waveforms at input and outputs of the gates

complete malfunction, necessitating the use of an oscilloscope to locate the fault.

The following notes may be of value:

1. The i.c.s should be obtained from a reliable source and properly identified. It is difficult to remove a "dud" and the copper printing may be stripped with excess heat.
2. The capacitors should be inspected for leaking and loose ends and then should be polarised before assembly. A "working" voltage should be applied from a battery via a current meter noting that the leakage current falls to a low value: the absence of an initial charging current indicates an open circuit capacitor and an un-polarised or short circuit capacitor will cause excess current causing i.c. failure. Tantalum capacitors or long life electrolytics are preferred.
3. The wire ends of the diodes should be carefully bent with wiring pliers to avoid fracture of the glass seals.
4. Soldering should not be attempted without a clean small bit.
5. The recommended technique for insulating wire connections is to bare the ends of an excess length of multi-stranded wire, twist up and solder the ends, causing the insulation to creep back beyond the point where baring took place. The ends are then cropped till $\frac{1}{16}$ in of clean soldered wire is exposed: the iron is applied to the tinned copper pad until it runs freely; then the wire is applied.

TESTING

The components should be inserted on the board and wired up as indicated, noting and checking the

polarity of each component as fitted. Before any interconnecting wires are fitted the board should be held to the light and the component connections checked against the theoretical circuit. The variable resistors (coders) may be replaced by a selection of fixed resistors (as shown in photograph) within the VR range and the current supply voltage applied, noting the current to be less than 150mA. If an oscilloscope is available the waveform can now be examined at the output, otherwise an audio test may be applied (capacitor and headphones) noting the output of the multivibrator, each stage and at final output. The coder can now be connected to the decoder as in Fig. 1 noting that the supply current to the decoder is less than 50mA.

An oscilloscope triggered from the coder output should show the pulse train input and individual decoder output pulses.

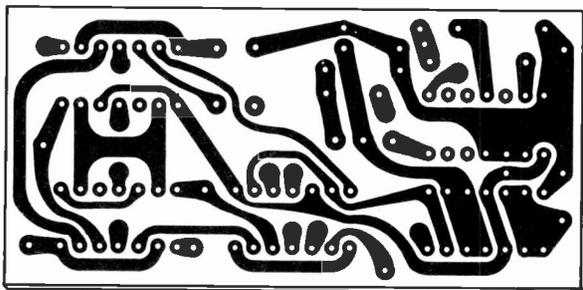
A d.c. meter (of 20 k Ω per volt resistance or better) should indicate different voltages of the order of $\frac{1}{2}$ to $\frac{3}{4}$ V at each decoder output in accordance with the values of coder resistance used. The meter performing an integrating action on the 5V pulses, being present, say, for 4 milliseconds every 30 or $4/30 \times 5V$. The variable resistors may now be fitted and their action noted in changing the decoded pulse length or d.c. output. ★

Note: In Part 1 last month the following corrections are necessary:

Fig. 5. Capacitor C15 should be reversed

Fig. 7. The blob of ink at bottom centre is not part of the printed circuit pattern

Table 1. The quad 2-input NAND gate by STC-ITT should be MIC9465D

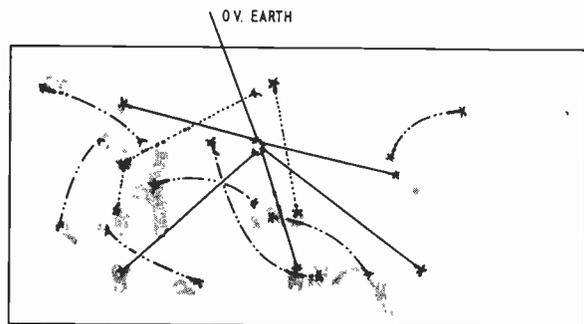
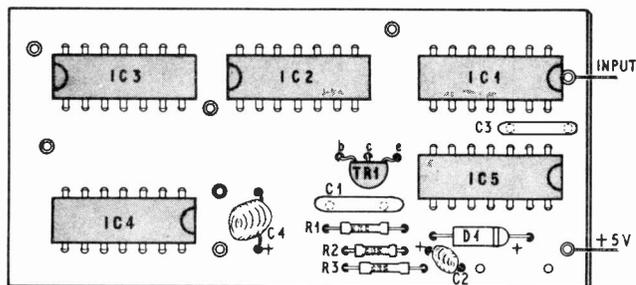


LOOK FOR THE FOLLOW-UP ARTICLE MODEL SERVO CONTROL IN NEXT MONTH'S ISSUE

Fig. 20 (left). Printed circuit pattern for the decoder

Fig. 21. Component layout of the decoder board

Fig. 22 (below). Link wires are soldered on to the copper side for power supplies and signal lines





A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merits.

STABILISED SUPPLY WITH OVERLOAD PROTECTION

The circuit diagram Fig. 1 was designed to power a 12 watt stereo amplifier. It was found to be desirable to have a constant voltage regardless of power being delivered by the amplifier. The circuit in Fig. 1 was evolved to achieve these requirements.

The potential at point A is always a fixed fraction of V_o and is determined by R2 and R3. As R_L is lowered V_o will lower causing the potential at A to decrease. As the base potential of TR1 is fixed by the Zener and VR1 so TR1's base-emitter diode D4 becomes more forward biased. Hence more current flows into the Darlington pair TR2 and TR3 which supplies R_L with a greater current, restoring the original output voltage.

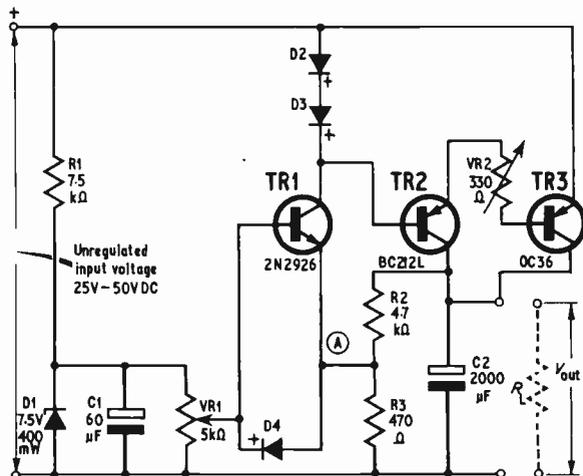


Fig. 1. Circuit diagram of the stabilised supply overload protection

Components VR2, D2 and D3 provide a current limit which is set by adjustment of VR2. Diodes D2 and D3 should be silicon types and have turn-on voltages of 0.6V each. Transistor TR3 is a germanium transistor and so V_{be} will be about 0.2V while V_{be} for TR2 will be about 0.6V.

When a small current is being supplied to the load the voltage drop across D2 and D3 is not large enough to affect the circuit, but if R_L becomes very small the voltage drop across VR2 is arranged to bring D2 and D3 into conduction, preventing an excessive current through TR3. A sharper limiting action could be achieved by replacing D2 and D3 with a zener and increasing the value of VR2.

The output voltage is set to the required value by VR1. To obtain low voltages, say 10V, a bleeder resistor should be inserted across the output as TR3 has a leakage current of about 4mA. Capacitor C1 is included so that the output voltage rises slowly when the circuit is switched on. Diode D1 is included to protect TR1 when the circuit is switched off.

The output resistance of the circuit has been calculated and is given by:

$$R_o = \frac{R2 + R3}{h_{FE}(TR2) \times h_{FE}(TR3)}$$

This is 3Ω at the worst and about 0.5Ω at the best.

J. Welch,
Northampton.

RESETTABLE COUNTER

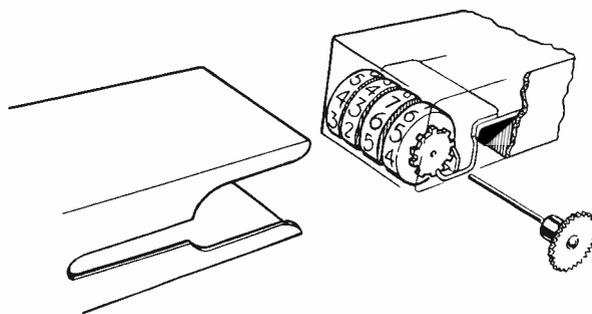


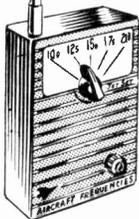
Fig. 1. Exploded view of the counter

I HAVE converted an ordinary electromagnetic counter into a resettable counter by removing the spindle that supports the number wheels, and replacing it by one about $\frac{1}{2}$ in longer. On the protruding end I fixed a small knob. A slot was cut in the metal cover to enable it to be slid over the protruding spindle, see Fig. 1. The counter may now be reset by turning the knob.

With some counters a second ratchet under the number wheels prevents them being reversed. A small lever may be fixed to the second ratchet to enable it to be disengaged when reversing the counter.

A. Hartley,
Bolton,
Lancs.

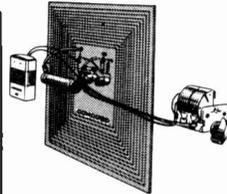
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NOW IT'S HERE AT LAST, after experimenting for four and a half months with a multitude of different circuits and carrying out actual field tests with prototypes, our design team have come up with this real winner. This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. FINDS GOLD, SILVER, LOST COINS, JEWELLERY, KEYS, WAX SOUVENIRS, ARCHAEOLOGICAL PIECES, METALLIC ORE, NUGGETS, ETC., ETC. Outdoors or indoors. Extremely sensitive, will signal presence of certain objects buried several feet below ground! No knowledge of radio or electronics required. Can be built with ease in one short evening by anybody from nine years of age upwards, with the wonderfully clear, easy to follow, step-by-step, fully illustrated instructions—it really is easy as ABC. Transistorised—no valves. Uses standard PP3 battery. No soldering necessary. Size of detector head 13 1/2" x 10" x 2 1/4". Great demand expected at this remarkably low price—ORDER WHILE PRESENT STOCKS LAST. All parts including detector head case, nuts, screws, wire, simple instructions, etc., etc. ONLY £2-37 (47/6) + 27p (5/6) p. & p. (Sectional handle as illustrated 75p (15/-) extra). Parts available separately. Made up looks worth £15!

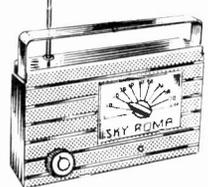


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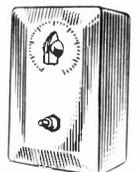
ONLY £2-25 (45/-)



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only £2-25 (45/-)



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SME Model 3009 Series II short arm pick-up

Audio Fair

A brief look at some recent developments in the hi fi industry

By M. A. COLWELL

AUDIO by definition means pertaining to sounds. So perhaps one could be forgiven for expecting noises resembling several kinds of phenomena. And since the Audio Fair has been described as an exhibition of home entertainment, perhaps we could likewise expect to see an assortment of musical instruments, television and radio, or—dare we suggest—electronic games. However, television was strictly banned by the organisers on the day of opening, so how far should we define “home entertainment” in terms of electronics?

Today's Audio Festival and Fair is a far cry from that high fidelity social function erstwhile held in luxury carpeted surroundings at the Hotel Russel and previously at the Waldorf.

LONDON OR BRIGHTON?

Because of overcrowding, the Audio Fair organisers were probably right in finding an alternative venue. Consequently in 1969 we heard some convincing arguments that Olympia was suitable; that acoustically treated demonstration rooms could be successful.

Give them their due, Rex Hassan and company tried hard amid tremendous criticism, but a great deal can be learned by closer examination of the Fair as a whole and its venue, and it is quite obvious that some more hard thinking must be done to rate this exhibition as near a success as can be achieved.

Now is the right time to take stock of such irritating discomforts as would not be tolerated in any hotel premises. Among these, I place catering at the head of the list, litter strewn gangways second, and poor ventilation third. And oh! that dreadful train service!

In the previous week I sampled the exhibition at Brighton called Inter/Nepcon and subsequently conclude that these premises must supersede Olympia by decades. Apart from the sweet ozone and spotless terraced houses nearby, the Metropole has every reason to be proud of its conference and exhibition centre and I recommend it wholeheartedly to organisers of such as the size of the Audio Fair.

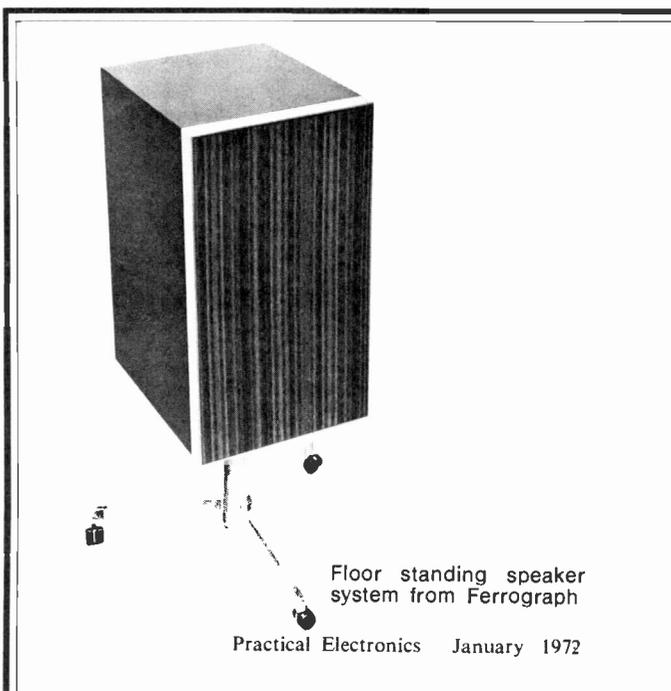
BROAD RANGE

The range of exhibits at this year's Fair has broadened to include medium fi, low fi, and even (if it is possible) no fi at all. The extension of range to include electro-musical gimmicks, record and tape shops, nameplates, and the not-so-high-as-it-used-to-be-fi inevitably lowers the general image that we have become so accustomed to in the past.

The overall technical standard of equipment and products shown was generally interfered with by infiltration of medium fi, but well established high quality products were still to be found.

RANK INFLUENCE

One interesting point to emerge is the influence of big business on the market through an established small company name. I am referring in particular



Floor standing speaker system from Ferrograph

to the Rank Organisation whose acquisition of Wharfedale and Leak has already been geared towards mass marketing.

Although Harold Leak (now retired) did produce most of the parts that make up a complete hi fi system, he did not market a transcription unit. Logical first step then for Rank was to fill this gap, but not from their own stable. They have contracted with the Lenco Company of Switzerland to sell transcription units that they call the "Delta". Believe it or not, these are identical to the established Goldring Lenco GL75.

At least Rank recognises quality when it comes to such deals but it is a smack in the eye for the reputation of the former all-British Leak company. A Shure M75 magnetic cartridge is fitted to the Lenco pick-up arm, which has the usual cueing.

NEW SPEAKER SYSTEMS

Another first timer from Ferrograph, who previously preferred to specialise mainly in the high quality tape recording field, is a loudspeaker system. It is a three-unit assembly designed in collaboration with a university acoustics team, and uses two Goodmans treble units and one KEF B139 woofer.

Ferrograph state that their sophisticated crossover network eliminates what little coloration exists outside the pass bands. From this we can deduce that bandpass cut-off is very sharp so that interaction between speaker units is minimal. They quote a "sensibly flat" response from 30Hz to 15kHz.

Metrosound Audio Products Ltd. also announces a new speaker, the Duplex 25, to match their new ST60 amplifier (or any other make). With one conventional cone type unit for the low frequency end, they have incorporated a new electrostatic unit based on a new patent specification. High frequency dispersion is said to be improved by mounting this behind a lenticular grille.

The Duplex 25 is 27½in high and can handle 25 watts. Nominal impedance is 8 ohms and frequency range is quoted without reference level as 40Hz to 18kHz. Price at time of going to press £52.

HI FI IN KIT FORM

Looking for further outlets for their existing speaker kits, EMI Sound Products Ltd. are now marketing a range of enclosures in kit form from £5.80 for a compact bookshelf model to £29.50 for a large floor standing model. A hammer and screwdriver are the only tools needed to assemble these; the baffle-boards are already cut to suit the appropriate kits.

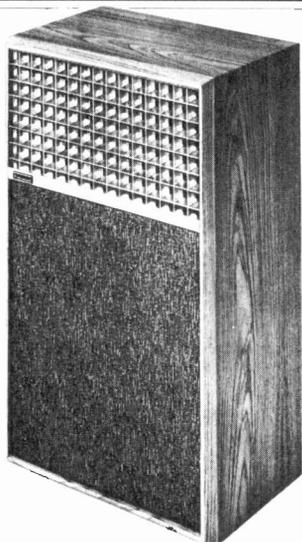
Heath (Gloucester) Ltd., who sell the famous Heathkits, announce a new tuner-amplifier kit, the AR-2000. The tuner processes a.m. (L.W., M.W., and S.W.) and f.m. mono and stereo broadcast signals, using up-to-date techniques, including f.e.t front end and integrated circuits for the f.m. i.f. and decoder stages. Ceramic filters are also used.

The kit price at £89.90 is competitive with equivalent commercial ready made units, but is still a little expensive for a kit.

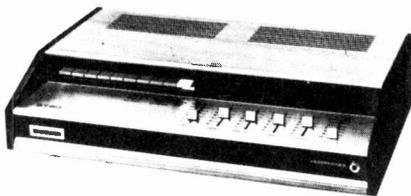
Another well established name in hi fi circles is looking to expansion at a rapid rate. No less than eight new products were shown on the Goodmans stand.

Well known for its wide range of quality loudspeakers, they are competing forcefully with the likes of the Rank Organisation. The new items include an attractive a.m./f.m. tuner amplifier the Model One-Ten at £135; the Module 80 Compact, a combined f.m. stereo tuner amplifier of high performance with record player type GL75 at £165; the Dimension-8 bi-directional speaker at £69 teak, £75 white finish.

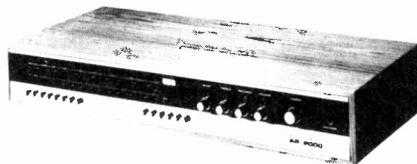
Goodmans also introduced a speaker kit, the DIN20 incorporating an 8in bass unit and an h.f. dome radiator with a crossover unit. This is a budget price kit of excellent quality for those with limited financial resources at £12.54 including purchase tax. Goodmans also expect to, release their new professional stereo tape recorder in 1972 at a price in the region of £400. The prototype shown at the Fair looks very impressive and uses slider controls, twin capstans, and switchable 2-speed NAB or DIN equalisation.



Duplex 25 electrostatic and cone speaker from Metrosound

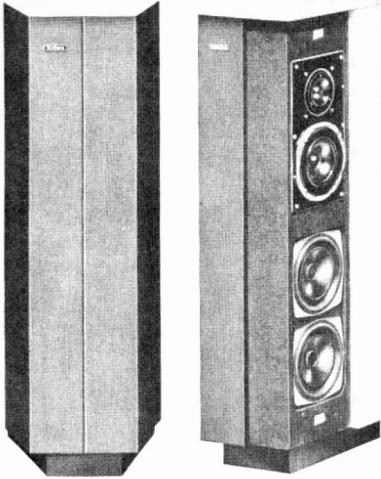


Metrosound ST60 amplifier

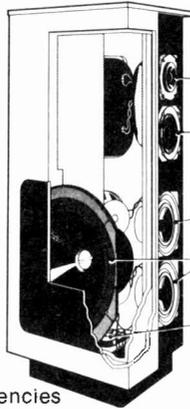


Heathkit tuner amplifier type AR-2000

**SEEN
AT
THE
FAIR**



Goodmans Dimension-8 bi-directional speaker system goes a long way to improving stereo spread at high frequencies



- High Frequency Dome Radiator
- Mid-range Unit
- Bass Units, four 5inch Bass Drivers
- Low Bass Radiator, 12inch parasitic resonator
- Crossover Unit

SEEN AT THE FAIR



The new four-channel stereo phones from Koss, the K2+2

BELT DRIVE

Past experiments on belt drive turn-tables have met with cynical comment, but progress to date is brought to fruition in the GL85 integrated transcription turntable unit and pick-up arm from Goldring.

The turntable is driven by a "non-stretch" flat belt from a low speed 16-pole synchronous motor. Motor speed is accurately controlled by an electronic stabiliser circuit. Two speeds are available and an illuminated stroboscope indicates speed accuracy.

An electronic sensing device raises the pick-up arm at the end of the record and switches off the motor. This unit is expected to be available in January and is to be supplied complete with plinth for £72.78 including purchase tax.

The Connoisseur BD2 turntable at £32 now has push button speed change.

STEREO PHONES

Among headphones on show, which seem now to be a common occurrence for demonstration at the Fair, Koss were dominant with the excellent PRO-4AA stereo phones popping up on several stands, not the least being our own. The first four-channel headphones were also demonstrated by Tape Music Distributors Ltd. the distributors for Koss. They are the K2+2, using four separate dynamic drivers, and are likely to sell for around £45.

A.K.G. introduced the K180 (at £30) high quality headset with balancing volume controls.

Wilmex were demonstrating the Japanese Stax SR3 electrostatic headset with their power driver switch-over unit type SRD5. At 420 grams these are comparatively lightweight. The SRD5 will power two pairs of SR3 phones. A complete set of one pair of phones and one power unit costs £45.40; a second pair of phones would cost £31. In spite of reassurances I don't particularly care for high voltages so close to my ears.

DEMONSTRATIONS

The Hi-Fi Theatre is an excellent way of getting to know people and several personalities in the world of audio engineering, with a selection of magazine writers, gave some fascinating demonstrations, albeit, we are pleased to record, without commercial prejudice.

This is an essential alternative to an otherwise biased demonstration that may be set up on manufacturers' stands. The range was very wide and we were pleased to note the "free-for-all" session on the Friday where various magazines collaborated to help the public audience with their hi fi problems. This session was later edited and broadcast on BBC Radio London in November.

WE WERE THERE

What of PRACTICAL ELECTRONICS? Judging by the sales of P.E. Gemini Amplifier reprints, especially at the exhibition, this project is still a very popular do-it-yourself amplifier design.

The amplifier, originally shown last year, was joined this year by its new companion the P.E. Gemini Tuner, a stereo f.m. tuner of compatible design, with integrated circuit phase lock loop decoder and high selectivity ceramic filters.

Full details of this new design will appear in PRACTICAL ELECTRONICS very soon.

Also represented on the P.E. stand was our new companion EVERYDAY ELECTRONICS, which showed among other items, the integrated circuit record player, that appeared in the November issue.

Finally, a note for your new 1972 diary; the other London audio exhibition, Sonex at Skyway Hotel, near London Airport, will be open to the public March 24 to 26 inclusive, preceded by two "trade only" days.



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IN5407	45p	2N3705	13p	40512	195p	ASy26	27p	BC259	37p	300R	38p	OC35	60p
IS44	9p	2N3706	13p	40602	52p	ASy27	36p	BC267	17p	C407	17p	OC36	65p
IS940	3p	2N3707	13p	40669	140p	ASy28	27p	BC268	17p	C762	19p	OC41	42p
2N696	17p	2N3708	10p	AC107	46p	ASy29	36p	BC269	17p	C1412	102p	OC42	46p
2N697	18p	2N3709	11p	AC126	20p	AU111	97p	BC300	49p	E2512	164p	OC44	42p
2N706	12p	2N3710	13p	AC127	20p	B30C250	24p	BC301	37p	EA403	10p	OC45	38p
2N930	29p	2N3711	13p	AC128	20p	B30C550/		BC303	60p	EB383	10p	OC70	21p
2N1131	29p	2N3731	120p	AC141H	34p	300	34p	BCY30	75p	EC401	18p	OC71	38p
2N1132	29p	2N3794	15p	AC141HK	37p	B1912	66p	BCY31	75p	EC402	17p	OC72	38p
2N1302	19p	2N3819	23p	AC142H	25p	B5041	72p	BCY70	18p	ER900	54p	OC75	40p
2N1303	19p	2N3875	23p	AC142HK	29p	BA102	25p	BCY71	33p	MC140	25p	OC81	25p
2N1304	26p	2N3904	35p	AC153K	22p	BC108	11p	BCY72	15p	M1481	120p	SD1	10p
2N1305	26p	2N3906	35p	AC176	16p	BA145	27p	BD121	10p	M1491	135p	OC83	25p
2N1306	33p	2N4036	55p	AC176K	17p	BA155	15p	BD123	105p	M1371	108p	OC84	25p
2N1307	33p	2N4058	13p	AC187K	17p	BA156	13p	BD124	100p	MJE521	92p	P346A	26p
2N1308	36p	2N4059	10p	AC188K	23p	BA156	13p	BD130	50p	MJE2955	165p	S2CN1	10p
2N1309	36p	2N4060	11p	*AC187K/		BB103/B	13p	BD131	79p	MJE3055	82p	SC141D	187p
2N1396	108p	2N4061	11p	189K	40p	BB103/G	16p	BD132	86p	MF102	37p	SC146D	24p
2N1599	122p	2N4062	12p	AC117	31p	BC108	11p	BD133	12p	MP56531	35p	SD1	10p
2N1613	23p	2N4124	18p	ACY18	19p	BC108	11p	BD136	44p	MP56534	30p	SD4	14p
2N1711	26p	2N4126	27p	ACY19	23p	BC109	12p	BD141	227p	NKT211	25p	V763	48p
2N1893	54p	2N4284	15p	ACY20	20p	BC122	21p	BDY20	92p	NKT212	25p	W106B1	25p
2N2147	95p	2N4286	15p	ACY21	21p	BC125	15p	BF115	23p	NKT213	25p	W106D1	83p
2N2218	34p	2N4289	15p	ACY22	21p	BC126	22p	BF167	18p	NKT214	23p	WO2	40p
2N2219	44p	2N4291	15p	ACY39	63p	BC140	30p	BF173	19p	NKT217	50p	VPO2	95p
2N2219A	38p	2N4292	15p	ACY40	47p	BC147	10p	BF177	25p	NKT261	21p	ZTX300	14p
2N2219A	38p	2N4410	24p	ACY41	18p	BC148	9p	BF178	31p	NKT271	18p	ZTX301	16p
2N2270	62p	2N4443	111p	ACY44	31p	BC149	10p	BF194	14p	NKT274	18p	ZTX302	22p
2N2369A	19p	2N4906	305p	AD140	60p	BC153	19p	BF195	15p	NKT275	23p	ZTX303	22p
2N2483	35p	2N4915	215p	AD142	50p	BC154	20p	BF244	30p	NKT403	65p	ZTX304	27p
2N2484	42p	2N4991	62p	AD149	58p	BC157	12p	BF254	14p	NKT404	61p	ZTX330	23p
2N2646	42p	2N5062	61p	AD150	50p	BC158	11p	BF255	15p	NKT405	79p	ZTX331	27p
2N2904	38p	2N5088	38p	AD161	33p	BC159	12p	BFX18	90p	NKT603F	90p	ZTX500	17p
2N2904A	42p	2N5163	25p	AD162	36p	BC167	11p	BFX29	31p	NKT631	30p	ZTX501	21p
2N2905	44p	2N5172	18p	*AD161/		BC168	10p	BFX40	25p	NKT674F	24p	ZTX502	25p
2N2905A	47p	2N5192	125p	162	60p	BC169	11p	BFX85	32p	NKT677F	22p	ZTX503	22p
2N2924	20p	2N5195	147p	AF114	24p	BC177	14p	BFX87	29p	NKT713	30p	ZTX504	52p
2N2925	21p	2N5457	49p	AF115	24p	BC178	13p	BFX88	26p	NKT773	25p	ZTX507	27p
2N2926	16p	2N5459	49p	AF116	22p	BC179	14p	BFX50	23p	OA47	8p	ZTX531	33p
2N3053	27p	40250	71p	AF117	22p	BC182L	11p	BFY51	20p	OA90	6p		
2N3054	60p	40251	87p	AF118	82p	BC183L	10p	BFY52	23p	OA91	5p		

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Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
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C	1/8W	5%	4.7Ω-470KΩ	E24	1	0.8	0.7
C	1/4W	10%	4.7Ω-10MΩ	E12	1	0.8	0.7
C	1/2W	5%	4.7Ω-10MΩ	E24	1.2	1	0.9
MO	1W	10%	4.7Ω-10MΩ	E12	2.5	2	1.9
WW	1/2W	2%	10Ω-1MΩ	E24	4	3.5	3
WW	3W	10% ± 1/20Ω	0.22Ω-3.9Ω	E12	7	7	6
WW	3W	5%	12Ω-10KΩ	E12	7	7	6
WW	7W	5%	12Ω-10KΩ	E12	9	9	8

Codes: C = carbon film high stability low noise
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 WW = wire-wound Plessey

Values:
 E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
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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.)

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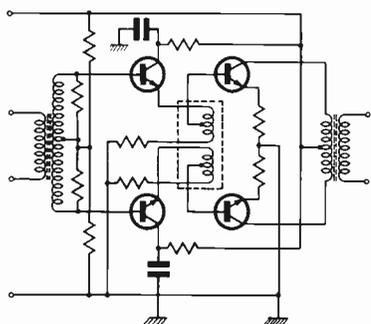
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PATENTS REVIEW...

IMPROVING AMPLIFIER PERFORMANCE

IN their new British Patent 1 232 324, Redifon Limited discuss multistage transistor amplifiers of the push-pull type, capable of operating over a wide frequency range with coupling of the stages directly and by an inductive device with a view to improving performance.

BP 1 232 324



Redifon explain that it is already known that a pair of transistors can be biased into class A conditions and coupled by way of a transformer so as to drive a further pair of transistors biased into class B conditions. It is also known that a pair of transistors can be biased into class B conditions and directly coupled to a further pair of transistors biased also into class B.

But, according to Redifon, in the transformer coupled arrangement there is difficulty in providing a driver transformer for the class B stage with a sufficiently low leakage reactance to transfer power over a wide frequency band with little distortion.

Various ways round problems like these have been suggested, but Redifon claim they have a novel idea in suggesting an amplifier with a first stage in class A and a second stage in class B, using an inductive device with a pair of tapped windings, arranged so that an output electrode of a transistor in the first branch of the first stage is connected to one end of one of the tapped windings, and an output electrode of a transistor of the second branch of the first stage is connected to one end of the other of these windings.

An input of a transistor in the first branch of the second stage is

connected to the tapping of the first tapped winding and an input electrode of a transistor in the second branch of the second stage is connected to the tapping of the other one of the tapped windings.

The two windings of the inductive device are connected in a sense such that power for driving each transistor of the second stage is provided by both the transistors of the first stage.

Redifon give a circuit diagram for an amplifier of this type and the specification also carries some specific component values. Because of the load sharing by the transistors of the first stage, regulation is improved and distortion due to the effect of intermittent load imposed by each second stage transistor, is reduced.

SYNTHETIC ANIMAL SOUNDS

IN the name of Santa Rita Technology Inc. of California, BP 1 228 405 is particularly interesting because of its possible application to the projected airport at Foulness.

As is well known it is often necessary to rid airport runways of birds. This can be done by generating alarm signals, but, as Santa Rita explain, recording natural animal sounds and replaying them over a public address system is quite often only short-lived in its effect. The birds in

some strange way seem to get used to the recording and recognise it as phoney.

Their new invention is a system for producing synthetic animal sounds and in its simplest form it comprises a signal generator for generating carrier signals in the frequency range 500Hz to 5,000Hz. The selected carrier is amplitude modulated by another tone in the range 50Hz to 300Hz and a straightforward electro-acoustic transducer is used to convert the modulated carrier signal into a sound signal.

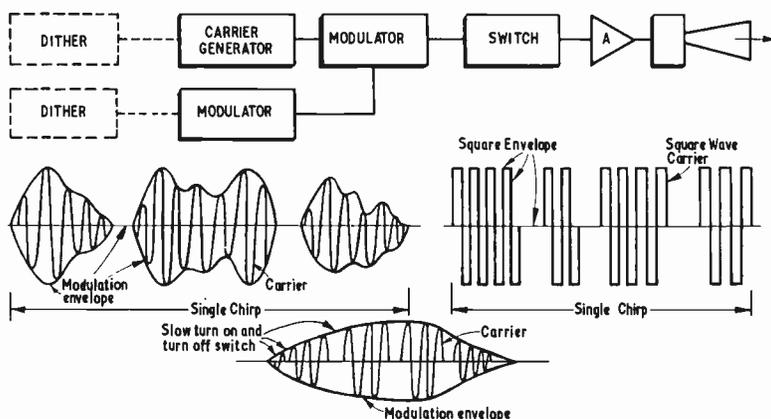
The sound generator can be arranged to turn the modulated carrier signal on and off at a rate of one to five times per second either sharply or gradually. And it may also have a dither arrangement for dithering the frequency of the modulating means over a two-to-one range. Moreover, the carrier signal can also be dithered over a frequency range comparable to the frequency of modulation.

Consequently, it is apparently easy to vary the sound signal components and so avoid the birds getting used to any one signal.

The specification shows a block diagram of the basic layout. Some waveforms show how the "chirps" produced can be either in square wave or sinusoidal form.

Santa Rita claim special success in the diversion of red-winged blackbirds from a landing strip for jets with a 3,000Hz carrier and a 100Hz dithered random square wave amplitude modulation signal.

BP 1 228 405



MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

RECHARGEABLE BATTERIES

Although rechargeable nickel cadmium cells are now quite common, it is claimed that the latest range, type NCC, from Ever Ready can be recharged to half their nominal capacity in 60 seconds using standard HP2 cells.

Now available to the constructor, the prices vary according to capacity and quantity ordered. Typically a U2 replacement would cost in the region of £2 for a single cell but would be proportionately reduced for larger quantities.

Button cells are normally supplied for higher voltage work and typically a 4.8V 550mAh cell, as used in radio control, would cost approximately £3.30.

Full technical details of the NCC range and stockists can be obtained from Ever Ready Company (Great Britain) Ltd, Special Battery Division, Hockley, Essex.

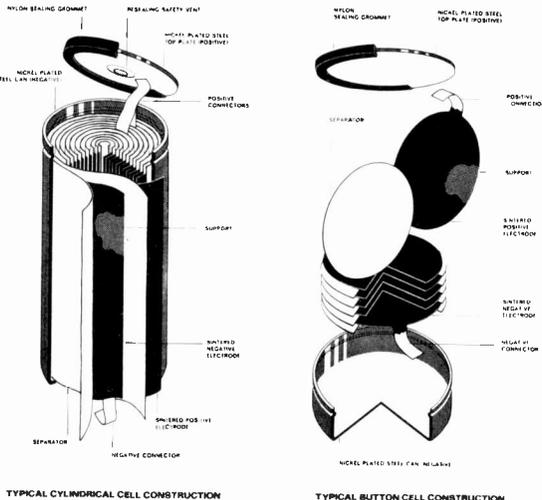
INVEST IN CATALOGUES

Time and again we get readers writing in asking where they can obtain certain items, ranging from resistors to infra-red emitting diodes. Apart from telling readers the source of supply we suggest that they should invest in some of the excellent components catalogues available from advertisers.

Typical of these are the latest component catalogues from such firms as: **Electrovalue** (64 pages, 10p), **Home Radio (Components) Ltd** (315 pages, 50p at shop or 70p by post), **Henry's Radio Ltd.** (350 pages, 40p at shop, 55p by post), **LST Electronic Components Ltd** (44 pages, no charge), and **G. W. Smith and Co. (Radio) Ltd.** (272 pages, 37½p at shop, 47½p by post).

The catalogues from Home Radio, Henry's and G. W. Smith contain special redeemable vouchers to help off-set the outlay for the catalogue.

The LST catalogue, available free, have added several new items to its opto-electronics section including inexpensive gallium arsenide light sources and planar silicon photo transistors.



Cell construction for the Ever Ready NCC range

There are many other interesting items listed in the LST catalogue including details of their data sheet service.

For our Midland readers, who often complain that they have to order from our London and Southern based advertisers, **Hawnt & Co. Ltd.** publish an excellent components catalogue.

Their latest edition (122 pages) contains sections on semiconductors, integrated circuits, capacitors, resistors and ferrites. Further details can be obtained from Hawnt & Co. Ltd., 112-114 Pritchett Street, Birmingham, B6 4EN.

VERSATILE PRINTED CIRCUIT BOARDS

The art of being able to pack a large number of circuit components on a small circuit board is a problem that plagues the professional as well as the amateur experimenter.

This problem has certainly been tackled, but whether conquered remains to be seen, by **NIP Electronics** with the introduction of a range of small printed circuit boards called "Nippiboards".

The board layout is based on the concept that transistor circuits follow common parameters for interconnection, with the addition of occasional requirements for feedback paths and cross-coupling. These paths are provided on the basic interconnection pattern, making it unnecessary to cut away the copper.

Link wires are kept to an absolute minimum and the board layout will, in most cases, follow closely the circuit diagram. This makes for easier circuit checking and servicing.

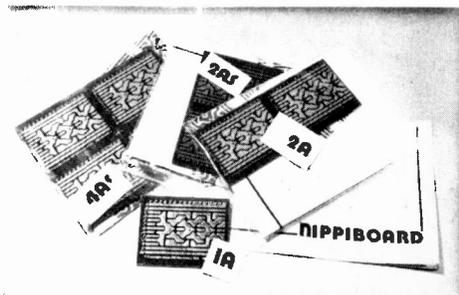
There are two ranges available: range "A" has an s.r.b.p. base and range "B" which has a fibreglass base. The s.r.b.p. base is cheaper and easy to work with, but the fibreglass base overcomes some of the problems of extreme atmospheric conditions. All boards are flux varnished to keep the copper clean and make soldering easier. Range "A" costs from 15p; range "B" from 18p for one basic pattern.

Typical of the kind of circuits that can be built up on the boards are amplifiers, oscillators, tone circuits, switching circuits, timers, car and home electronic aids. One basic pattern will accommodate up to four transistor stages, whether they be *pnp*, *npn*, *f.e.t.* or *u.j.t.* devices. Multiple pattern boards are also available for more complex circuits.

To date, the range of boards is only designed for transistor work. But we understand that a range designed specially for integrated circuits will be launched in the near future.

Details of prices and complete range of "Nippiboards" can be obtained from **NIP Electronics**, P.O. Box 11, St. Albans, Herts.

Nippiboards from NIP Electronics



The Crab Nebula in the constellation of Taurus. Catalogue No. M1 (NGC 1952)

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RADIO ASTRONOMY TECHNIQUES

By F. W. Hyde

PART 8

IN Part 3 the two aerial phase-switched interferometer was briefly described. It is now necessary to deal with this system in more detail since it is the next step in the project for those who have the space for it, as the same requirements as to base line apply here. The difference between the simple two-aerial system and the phase-switched system is the extra electronic units necessary and the aerial feeder modifications.

THE PHASE-SWITCHED INTERFEROMETER

When two aerials are spaced an exact number of wavelengths apart the aerial pattern will be such that the centre lobe will be at a maximum in the plane of symmetry. At this point the pattern is exactly the same as the simple interferometer, where the lengths of the feeders are exactly equal to each other. If now a length of cable equal to one half of a wavelength is introduced in one feeder line the pattern will change so that there is a displacement of the lobes. This displacement will bring the minimum point between lobes to the centre of the plane of symmetry, see Figs. 8.1a, b.

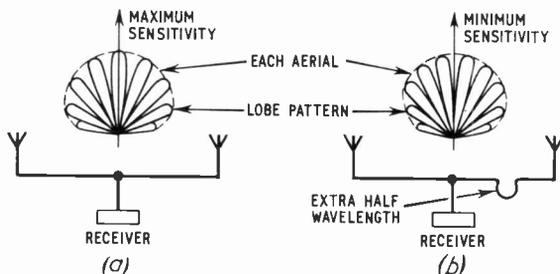


Fig. 8.1. The introduction of one half wavelength piece of cable into one feeder line displaces the aerial pattern as shown in (b)

As the aerial is moved with the rotation of the earth the aerial pattern can be changed at a pre-determined rate so that if there is a source of radiation in the aerial beam it can be scanned. The alternate "putting in" and "taking out" of the half wave section which does the scanning can be done by using an electronic switching system.

PHASE SWITCHING SYSTEM

The number of times that the half wave section is switched in and out of circuit is largely a matter of choice, and to some extent depends on the purpose of the project under study. The circuits that will be given will have different speeds of switch operation, but the results on the recorder will not noticeably vary. The record that appears on the chart is an indication of the intensity of the radiation in terms of the modulation of that radiation at the switching frequency. If the switch frequency is, say, 900Hz, then the radiation received by the aerial will have a component at 900Hz superimposed upon it. This can be amplified and detected in the system and the result recorded on the charts as shown in Figs. 8.2a, b, c. The pattern that appears is the result of the sequence through which the input to the receiver goes before being recorded. This sequence is as follows:

With the source of radiation in the centre of a lobe, that is at a maximum sensitivity, the length of the paths will be equal and the aerials will each send to the receiver the same level of signal. The two levels will add together so that the receiver will receive twice the value of the signal. When the half wave section is added the paths now being unequal, the resultant signal will be zero. Therefore the actual amplitude of the signal reverses in phase with the adding and subtracting of the half wave section.

The switching frequency is controlled by a circuit which provides a square wave to operate the switch and at the same time to operate a synchronous detector which reverses the phase of the output in

unison with the switch. The block diagram Fig. 8.3 shows the individual units in which it will be seen that in addition to the units already in operation, there are four new ones.

The switch generator is a multivibrator of the usual type, and may be a part of the unit which includes the narrow band amplifier and the synchronous detector. The actual arrangement is left to the individual constructor.

Each unit will now be described separately, starting with the phase switch for the aerial. There are variations of this: one type being a hybrid junction used as a balanced network made up largely of coaxial cable, and a more simple diode switch unit. Both give similar results but the hybrid junction needs more skill to construct and has to be replaced as a whole when the frequency is changed.

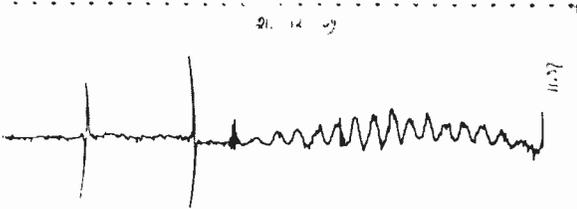
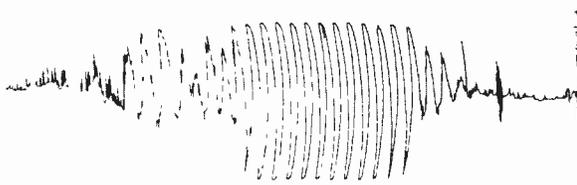
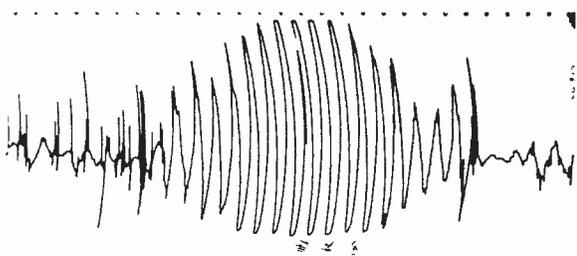


Fig. 8.2. Chart recordings of the sun
(a) quiet sun



(b) active sun, showing ionospheric effects at left side of recording



(c) very active sun at the time of a flare, again showing the effects of ionospheric disturbance

HYBRID JUNCTION PHASE SWITCH

The hybrid junction phase switch consists of a network of coaxial cable with the switching diodes as part of the assembly, see Fig. 8.4. The action of this switch can be understood by following the diagram and remembering that a "short" looks like an open circuit when seen through a quarter wavelength of transmission line.

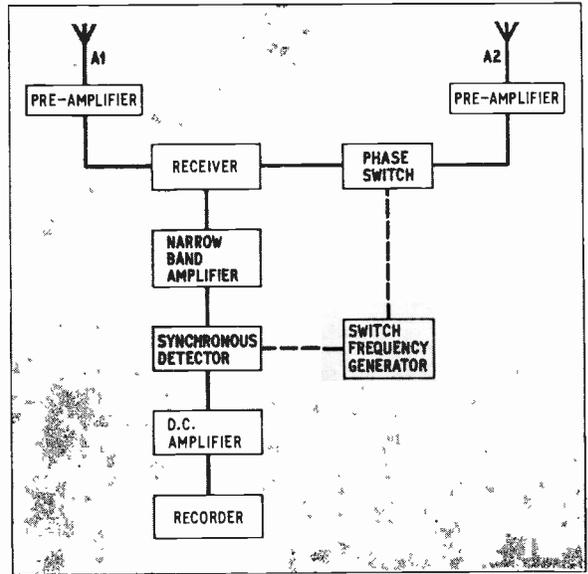


Fig. 8.3. Block diagram of the phase-switched interferometer. Units forming the original simple interferometer are shown in unshaded boxes

The switching frequency, which is provided by the switch frequency generator and its amplifier, is fed to the diodes via the choke and capacitor filter network. Suppose that the right-hand diode D2 is conducting, then at the junction of the quarter-wave section with the hybrid it will appear "open", the signal can therefore pass from the input via the first quarter-wave section through the three-quarter wave section to the output point and thence to the receiver.

At this time the left-hand diode D1 is non-conducting and therefore "open"; it appears as a short at the left-hand junction of the hybrid and no signal can pass. When the switch reverses then the left-hand side carries the signal and the right-hand side is blocked off.

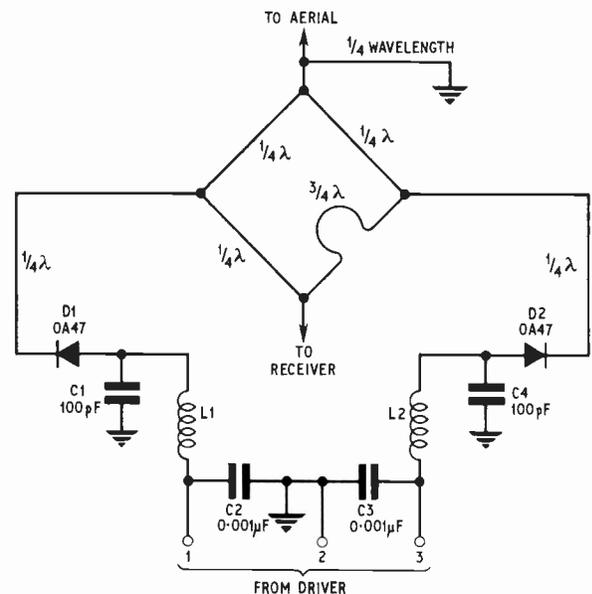


Fig. 8.4. A hybrid junction phase switch circuit

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BSY26	0-13	OC25	0-25
BSY27	0-13	OC26	0-25
BSY28	0-13	OC28	0-30
BSY29	0-13	OC35	0-25
BSY95A	0-13	OC36	0-37
OC41	0-13	AD149	0-30
OC44	0-13	AUY10	1-25
OC45	0-13	25034	0-25
OC71	0-13	2N3055	0-63
OC72	0-13		
OC73	0-17	Diodes	
OC81	0-13	AAY42	0-10
OC81D	0-13	OA95	0-19
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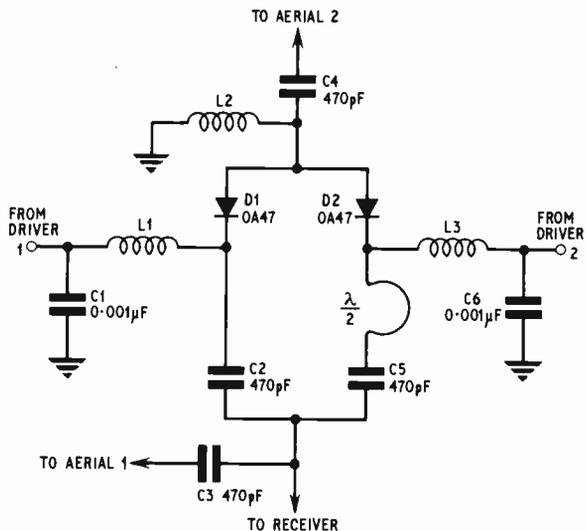


Fig. 8.5. A simple diode switch circuit

SIMPLE DIODE SWITCH

The simple diode switch consists of a network shown in Fig. 8.5 which uses diodes and a half-wavelength section for the frequency of operation. One advantage of this type of switch is that by having a number of half-wave sections, each for a different frequency, they can be conveniently plugged in to two aerial sockets thus making a very versatile assembly.

The sequence of operation in this switch is that the switching signal is fed into the points 1 and 2 via the filter network; in one direction a diode will conduct, say the left-hand side D1, at this time the other will be non-conducting so that the signal will pass via the conducting arm. When the switching voltage reverses, the diode on the right-hand side will conduct and the signal will pass via the half-wave section. When the switch is in operation the half-wave section will be alternately "in" and "out". The same conditions apply therefore as with the more complicated hybrid unit.

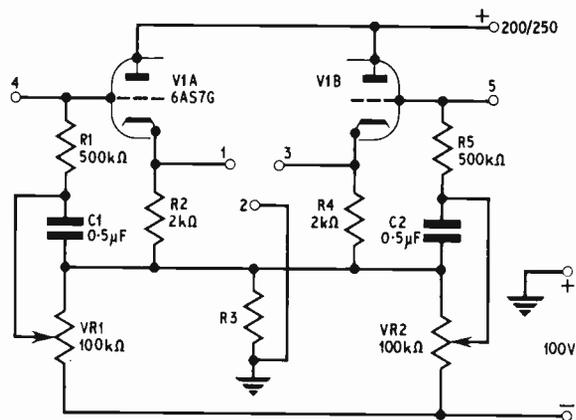


Fig. 8.7. Typical circuit for a driver amplifier for interposition between the switch frequency generator and the phase switch

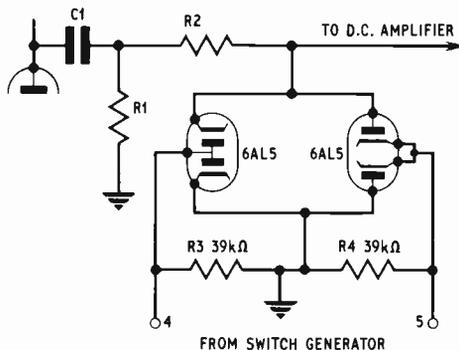


Fig. 8.8. Typical circuit for a phase sensitive detector

THE SWITCH FREQUENCY GENERATOR

The switch frequency generator is basically an audio oscillator operating at the frequency chosen for the switch. In this case it is a multivibrator which delivers about 30 volts peak-to-peak with a square wave form, and the circuit is shown in Fig. 8.6. The voltage output is sufficient for the operation of the synchronous detector, but needs a driver amplifier for the phase switch. The reason for this is that the diodes in the phase switch need to pass a current of the order of 50mA so that the power driver is necessary to accomplish this. The driver amplifier is shown in Fig. 8.7.

SYNCHRONOUS DETECTOR

As has been explained, the switching in and out of the half-wave section creates a condition where the receiver is fed with a signal which reverses in sign, hence the term phase switch. The reversal is in this case 180 degrees, so a system is required to follow this after the detection and amplification of the switch modulation. The diagram in Fig. 8.8

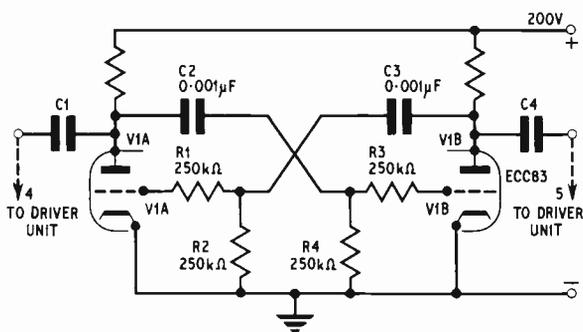


Fig. 8.6. Typical circuit for a switch frequency generator

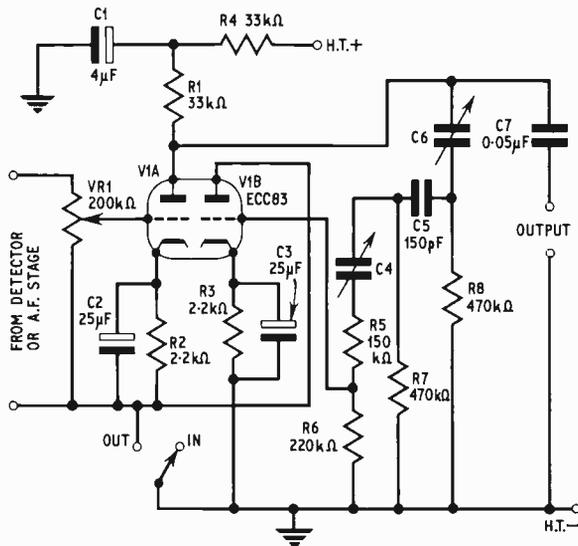


Fig. 8.9. Typical circuit for a narrow band amplifier set for switch frequency 900-1,000Hz

shows the details of the circuit for the synchronous detector, and this is fed from the narrow band amplifier and coupled direct to the d.c. amplifier.

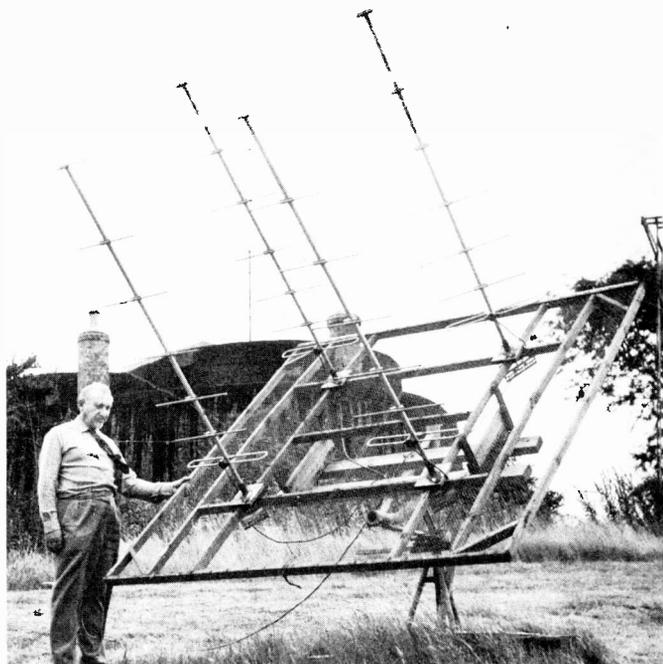
NARROW BAND AMPLIFIER

The narrow band amplifier is an important part of the system because it passes the signal at switch frequency and attenuates those signals which are not required. Strong signals from interference and radio signals which break through from commercial stations are largely eliminated.

The circuit shown in Fig. 8.9 is suitable for the switch frequency adopted. There may be a certain amount of insertion loss due to this amplifier; if this is so and the amplifier has been fed from the second detector of the receiver, then an additional stage of amplification can be interposed between the detector and the narrow band amplifier.

CONNECTING UP THE SYSTEM

The whole system is now ready to be connected up. It may be that there will be some snags in getting things right straight away. This raises the important point as to the stability of power supplies. If the units are checked individually for operation



A solar radio telescope aerial working at 200MHz

it should not be too difficult to get the system working satisfactorily. An oscilloscope would be a very useful adjunct in this connection, for all the systems can then be visually checked. For example the square wave pulses must be of equal width and amplitude. The phasing of the whole system can be more easily checked when an oscilloscope is used since each successive part of the system can be dealt with in sequence and any trouble quickly found.

Another point that perhaps should be emphasised again is the importance of good jointing and efficient bonding. Poor earth bonding can lead to many troubles, not least of which is spurious noise and breakthrough. If the area is one where there is a great deal of commercial activity it could be that there will be blocking of the pre-amplifiers. In this case it will be necessary to use some sort of filtering at the aerial input to offset this. Transistor pre-amplifiers are particularly prone to this trouble.

ACKNOWLEDGEMENT

The photographs of chart recordings Fig. 8.2 were taken by J. C. Codling, Clare Secondary School.

In the next article some more sophisticated units for the phase-switching system will be described.

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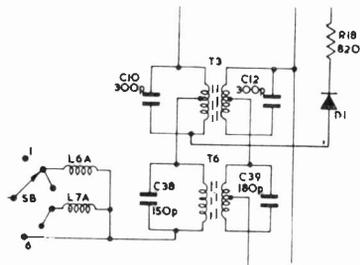
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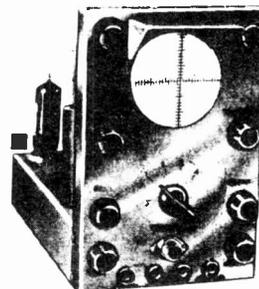


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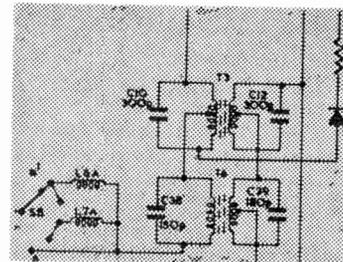
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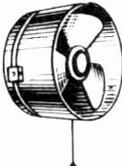
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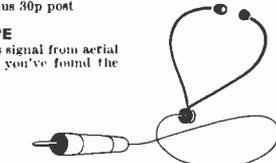
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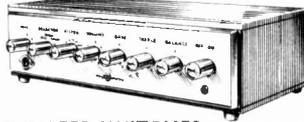
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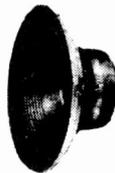
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2 poles	40p	40p							
3 poles	40p	40p	40p	40p	70p	70p	70p	85p	85p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1-20	£1-20
5 poles	40p	40p	70p	70p	85p	85p	85p	£1-45	£1-45
6 poles	40p	70p	70p	70p	85p	85p	85p	£1-70	£1-70
7 poles	70p	70p	70p	85p	£1-20	£1-20	£1-20	£1-95	£1-95
8 poles	70p	70p	70p	85p	£1-20	£1-20	£1-20	£2-20	£2-20
9 poles	70p	70p	85p	85p	£1-45	£1-45	£1-45	£2-45	£2-45
10 poles	70p	70p	85p	£1-20	£1-45	£1-45	£1-45	£2-70	£2-70
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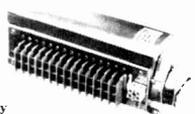
TANGENTIAL HEATER UNITS

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as circuit in this month's issue. Kit of parts **£1-20** post paid.

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BALANCED ARMATURE UNIT

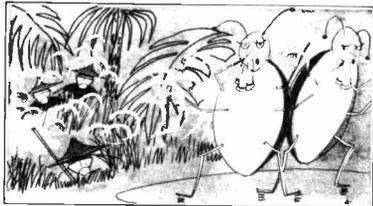
500 ohm, operates speaker or microphone, so useful in intercom or similar circuits. **33p** each, **£3-50** doz.



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Gerry Brown . . . ON THE FRINGE



OLFACTRONICS

I've just heard that a Nipponese company are making claim to an invention which amounts to an electronic "nose."

Naturally, smell sensors are not unknown, the Americans developed a device which could smell-out the Vietcong a few years back; this was a kind of funnel-shaped thing containing a microphone which had its fixing adjacent to a thin membrane. The membrane carried a number of sensitive (un-fed) bed-bugs which reacted to the natural body-odours of the enemy in a way which really had to be seen! The "tattoo" which they beat-out on the skin resulted in a signal that could be amplified after the microphone.

The device from Nippon, however, is quite different to previous sensors. For one thing, it can apparently differentiate between a number of different odours, and for another, it is entirely solid-state.

Several compounds are employed in the fabrication of the new device, typical of which are the oxides of tin, zinc, and the sesquioxide of iron. Whenever such gases as hydrogen, carbon dioxide, acetylene, or propane are applied to the sensor its conductivity decreases sufficiently to give an easily noticed indication, often without further amplification!

We can only hope that the art of olfactronics (my handle) will soon become sufficiently sophisticated to counter the current wave of destruction by detecting the smell of gelignite before it blows someone apart.

COOL GLOW

Right "out of the blue" (well, probably nearer purple) someone has come up with a rather interesting way of making a draught. It all came about when Oscar Blomgren of Inter-Probe, Chicago, tried applying an electric field to the task

of diverting an oxy-acetylene flame away from the inside of a blow-torch to prevent its deterioration. Instead, he got a cooling effect!

The cooling results from that funny effect you'll probably remember from experimenting with the school physics lab Wimshurst machine, electric wind. This, as you may recall, has nothing to do with flatulence but is associated with the purple-blue corona discharge that appears around any sharp, or pointed, parts of the machine's electrodes.

The vortex columns of air produced by the discharge are employed by Blomgren to cool the air near any heated surfaces. So efficient is this method of cooling that a glow-discharge produced by a 30kV potential, at only 200 μ A, is reported to have already reduced the temperature of an object from 1,675 degrees Fahrenheit to a mere 970 degrees Fahrenheit in a couple of seconds! An ideal device, one would think, where there was a special need for absence of motor-driven fans with their attendant vibration. Such noiseless cool must be a real "blow" for fan-makers!



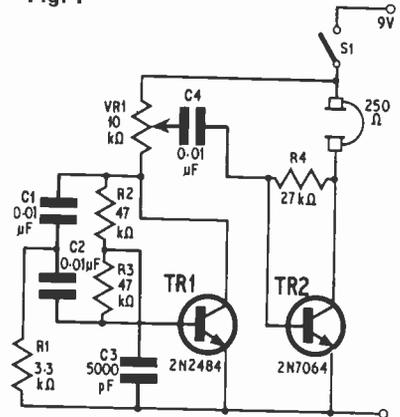
JABBER-JAMMER

It's quite on the cards that you can tolerate the majority of ambient noises like the intermittent tip-tap of the typewriter I am using right now, and the noise from a neighbour's transistor radio. Even so, the chances are that you will experience much more difficulty when attempting to concentrate on some abstruse problem when it is accompanied by the chatter of people in conversation nearby. How to overcome it is a perfectly reasonable question.

Just yesterday, I came to learn the answer to this, seemingly, difficult poser and Fig. 1 shows the easiest solution. The circuit comprises a simple audio oscillator connected direct to a hearing aid type earphone. The frequency of the device can be varied according to one's particular choice.

This done, it is then only necessary to bring the volume level up to a point which satisfies the compromise between being deafened by the oscillator, and going out of one's tiny mind as a result of the unwelcome intrusion into it by somebody's "yatter".

Fig. 1



CHILD CARE

The burning need for something that will protect (in particular) the very young from the sometimes malevolent intentions of child-snatchers is a problem that has been in the limelight recently. Even when no harm is intended, the resulting anguish can often, and quite understandably, be unbearable.

From time to time, like others before me, I have made several vain efforts to solve this very real threat to youngsters. Among the ideas have been some which relied upon a weight-sensing switch in the child's pram, or a simple switch arrangement attached to the pram harness. Limitations, unfortunately, exist in these ideas since no facility was provided which sensed movement of the carriage. Perhaps another switch associated with the brake would be the answer; so it goes on, until, ultimately, one is tempted to give the problem up. But, there are quite a few other ways of tackling this enigma.

Not unnaturally, it would be well on the way to meeting our requirements if the abduction alarm had, in addition to warning ability, a fail-safe feature. It was in this vein that I chanced to come upon an idea that might just be the answer. If the child to be protected carried a low power radio control transmitter (complete with sewn-in antenna) in its coat, a signal would be transmitted, certainly to within the immediate locale of an interested parent.

It could be arranged that "mother" held, at home, a receiver tuned to the signal transmitted from the child and which operated a bell every time the transmitter went out of range. It would then be a simple matter to determine whenever junior was either in the course of being kidnapped, or had just plain toddled off somewhere. Who knows, it might just be better than sending up distress rockets!

Unfortunately, the Post Office is hardly likely to approve of this particular form of "model control" —Ed.

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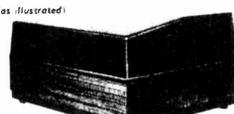
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SN7410	0.20 0.18	SN7497	0.40 0.00
SN7411	0.23 0.21	SN74100	1.65 1.58
SN7412	0.48 0.48	SN74104	1.52 1.40
SN7413	0.40 0.38	SN74105	1.52 1.40
SN7416	0.24 0.23	SN74107	0.52 0.49
SN7417	0.84 0.78	SN74110	0.80 0.75
SN7420	0.20 0.18	SN74111	1.67 1.45
SN7423	0.51 0.47	SN74118	1.30 1.25
SN7425	0.48 0.45	SN74119	1.92 1.80
SN7427	0.48 0.45	SN74121	0.50 0.47
SN7428	0.80 0.75	SN74122	1.44 1.35
SN7430	0.85 0.81	SN74123	2.95 2.70
SN7432	0.48 0.42	SN74145	1.80 1.75
SN7433	0.80 0.75	SN74150	3.52 3.40
SN7437	0.64 0.60	SN74151	1.40 1.35
SN7438	0.64 0.60	SN74153	1.40 1.35
SN7440	0.23 0.21	SN74154	2.20 2.10
SN7441A	0.87 0.83	SN74155	1.68 1.60
SN7442	0.85 0.81	SN74156	1.68 1.60
SN7445	2.88 2.70	SN74157	1.92 1.82
SN7444	2.88 2.70	SN74160	1.80 1.75
SN7445	2.50 2.40	SN74161	2.60 2.55
SN7446	1.00 0.95	SN74162	4.28 4.10
SN7447	1.00 0.95	SN74163	4.28 4.10
SN7448	1.00 0.95	SN74164	2.20 2.10
SN7449	1.00 0.95	SN74165	2.25 2.15
SN7450	0.20 0.18	SN74166	4.45 4.20
SN7451	0.20 0.18	SN74167	6.40 6.10
SN7453	0.20 0.18	SN74170	4.38 4.18
SN7454	0.20 0.18	SN74174	2.40 2.30
SN7450	0.20 0.18	SN74175	0.98 1.00
SN7470	0.40 0.38	SN74177	2.62 2.55
SN7472	0.32 0.30	SN74177	2.64 2.55
SN7473	0.43 0.41	SN74180	2.13 2.05
SN7474	0.43 0.41	SN74181	0.93 0.90
SN7475	0.45 0.44	SN74182	2.03 1.95
SN7476	0.45 0.44	SN74184	4.80 4.80
SN7480	0.70 0.65	SN74185	4.80 4.80
SN7481	1.40 1.38	SN74190	1.80 1.70
SN7482	0.87 0.82	SN74191	1.70 1.60
SN7483	0.87 0.82	SN74192	1.75 1.65
SN7484	2.00 1.85	SN74193	1.75 1.65
SN7485	3.62 3.40	SN74194	2.67 2.55
SN7486	0.33 0.30	SN74195	2.25 2.10
SN7490	0.67 0.64	SN74196	2.64 2.55
SN7491A	1.91 1.10	SN74198	5.95 5.65
SN7492	0.87 0.84	SN74199	5.95 5.65

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Data sheet 121p

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L702C	TO5 0.77	0.72	0.67
L703C	TO5 0.82	0.57	0.52
L703A	TO5 1.25	1.20	1.15
L709C	TO5 0.47	0.42	0.37
L709E	DIL 0.45	0.40	0.35
L710C	TO5 0.47	0.42	0.37
L710E	DIL 0.45	0.40	0.35
L711C	TO5 0.48	0.44	0.39
L711E	DIL 0.48	0.40	0.35
L716	TO5 1.87	1.75	1.70
L723C	TO5 0.90	0.85	0.80
L741C	TO5 0.80	0.75	0.65
L741C	DIL 0.70	0.65	0.60
LM741CN	DIL 0.70	0.65	0.60
SN7209P	DIL 0.45	0.40	0.35

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TA245	0.70
TA246	2.93
TA247	3.00
TA248	1.30
TA249	3.20
TA250	0.65
TA251	3.50
TA252	2.10
TA253	4.35
TA254	0.73
TA255	0.57
TA256	1.11
TA257	1.11
TA258	1.11
TA259	1.11
TA260	1.11
TA261	1.11
TA262	1.11
TA263	1.11
TA264	1.11
TA265	1.11
TA266	1.11
TA267	1.11
TA268	1.11
TA269	1.11
TA270	1.11

MULLARD LINEAR

TA271	1.30
TA272	4.00
TA273	2.42
TA274	2.63
TA275	0.70
TA276	2.93
TA277	3.00
TA278	1.30
TA279	3.20
TA280	0.65
TA281	3.50
TA282	2.10
TA283	4.35
TA284	0.73
TA285	0.57
TA286	1.11
TA287	1.11
TA288	1.11
TA289	1.11
TA290	1.11
TA291	1.11
TA292	1.11
TA293	1.11
TA294	1.11
TA295	1.11
TA296	1.11
TA297	1.11
TA298	1.11
TA299	1.11
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CA3001V1	2.69 2.40	CA3036	0.73 0.65		
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CA3002V1	1.80 1.60	CA3037A	2.53 2.25		
CA3004	1.80 1.60	CA3038	2.53 2.25		
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CA3007	2.83 2.34	CA3040	2.40 2.14		
CA3008	1.80 1.80	CA3041	1.09 0.97		
CA3008A	2.98 2.84	CA3042	1.09 0.97		
CA3010	1.37 1.23	CA3043	1.37 1.23		
CA3010A	2.53 2.25	CA3044	1.20 1.07		
CA3011	0.74 0.65	CA3044V1	1.20 1.07		
CA3011PRF	0.74 0.65	CA3045	1.22 1.09		
CA3012	0.89 0.79	CA3046	0.89 0.80		
CA3012V1	0.89 0.79	CA3047	1.37 1.23		
CA3013	1.05 0.94	CA3047A	2.53 2.25		
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2N2905	37p	2N5309	62p	BC184	11p	BSX00	45p	NKT333	20p
2N2905A	40p	2N5310	42p	BC184	11p	BSX01	45p	NKT334	20p
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2N2925	15p	2N5367	37p	BC184	11p	BSX07	45p	NKT340	20p
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2N3054	40p	2R502	32p	BC184	11p	BSX15	45p	NKT348	20p
2N3055	30p	2R503	45p	BC184	11p	BSX16	45p	NKT349	20p
2N3133	30p	3N128	27p	BC184	11p	BSX17	45p	NKT350	20p
2N3134	30p	3N139	1.27p	BC184	11p	BSX18	45p	NKT351	20p
2N3135	25p	3N140	77p	BC184	11p	BSX19	45p	NKT352	20p
2N3136	25p	3N141	77p	BC184	11p	BSX20	45p	NKT353	20p
2N3390	25p	3N142	55p	BC184	11p	BSX21	45p	NKT354	20p
2N3391	20p	3N143	87p	BC184	11p	BSX22	45p	NKT355	20p
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IN5145	22.37p	AA215	12p	BAY38	25p	OA47	8p
1844	9p	AA217	12p	BY100	17p	OA70	7p
18113	15p	BA100	16p	BY103	22p	OA73	10p
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All loudspeaker systems suitable.
Full output into 4 ohm.

All silicon transistors. F.E.T. at front end. Real value at **£42** plus £1 P. & P. and insurance.

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If purchased at the same time as the Psychedelic Light Control Unit.
If you require more information please send a S.A.E.

STEREO HEADSET

8 ohm impedance, complete with plug and 5ft lead. A very comfortable phone set. Listen to stereo without noise interrupting the pleasure.
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2 1/2in 8 ohm = 38p | 2 1/2in 25 ohm = 38p
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Plus 3p P. & P. on each Speaker

LOW VOLTAGE AMPLIFIER Few only at **£1.75**

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.

With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.



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10W 13in 8in ± two 2 1/2in tweeters and cross-over. All wired and ready for use. This ever-popular 450 in 3 8-15 ohm imp.
£3.50 plus 38p P. & P. each.

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Three Channel: Bass-Middle-Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed)
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2,000 Ω per phone ... **88p** G1105
Plus 10 P. & P. per pair.



EA1000 3 WATT AUDIO AMPLIFIER MODULE

An Audio Amplifier designed around the TA4621 Linear I.C.:
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Speaker Imp. ... 8-16 ohm
Frequency ... 50Hz-25kHz
Overall Size ... 2in x 3in x 2in
Ideal Amplifier for radios, record players, stereo units, etc.
Full technical data and diagrams with each module. All guaranteed and a bargain at



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Full control over 300 watts of incandescent lighting. Thyristor light dimmer mounted on a standard switch block ready to fit into a M.K. Box. Enjoy the pleasure of having the precise amount of light you require at any time.
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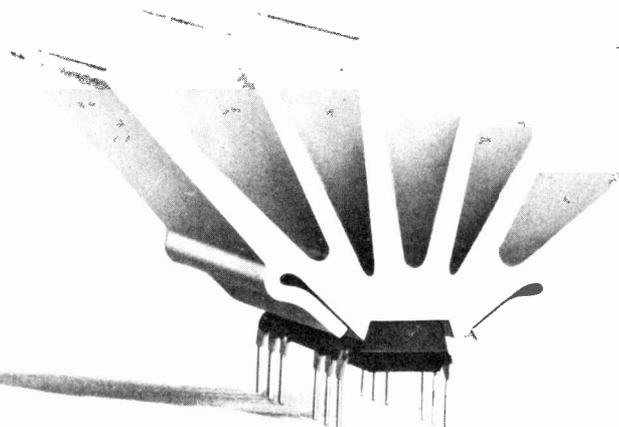
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new

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 \pm 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.

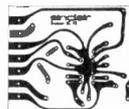
Supply Voltage 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

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

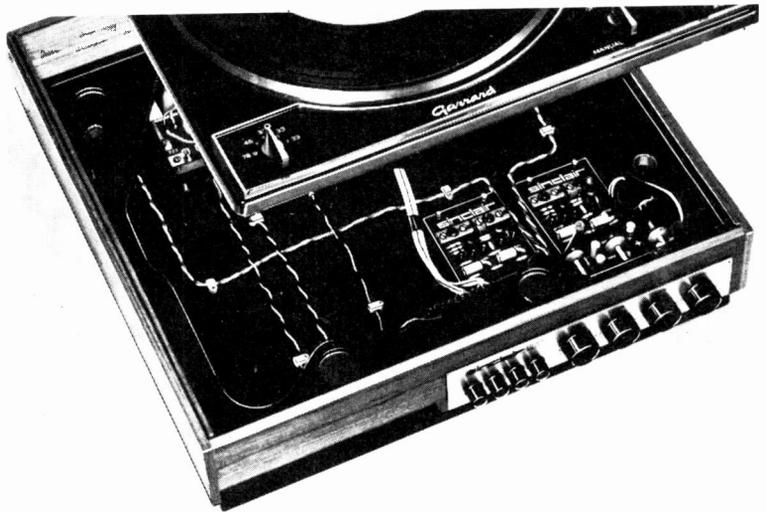
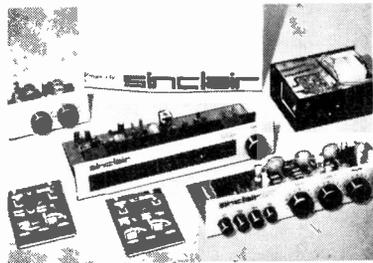
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Sinclair Project 60

The World's leading range of high fidelity modules



New!

Project 605

The easy way to buy and build Project 60

Sinclair Project 605 Amplifier



Project 605 is one pack containing: one PZ.5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

All you need for a superb 30 watt high fidelity stereo amplifier.

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

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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.

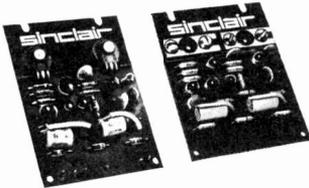
Typical Project 60 applications

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 trsfmr	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.

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 ± 1 dB.

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

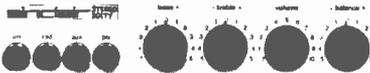
The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an 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:** 2 μ V for 30dB quieting, 7 μ V for lock-in over full deviation. **Squelch level:** 20 μ V. **A.F.C. range:** ± 200 KHz. **Signal to noise ratio:** > 65dB. **Audio frequency response:** 10 Hz—15 KHz (± 1 dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2 μ V. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC **Indicators:** Power on/tuning/stereo. **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 ± 1 dB: 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 207 mm.

Built tested and guaranteed.

£9.98

Power Supply Units

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.

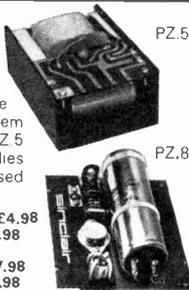
PZ.5 30 volts un stabilised **£4.98**

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

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P.E.1/72

Sinclair Q16/Micromatic

Q16 High fidelity loudspeaker

The Q16 employs the well proven acoustic principles specially developed by Sinclair in which a special driver assembly is meticulously matched to the characteristics of the uniquely designed cabinet. In reviewing this exclusive Sinclair design, technical journals have justly compared the Q16 with much more expensive loudspeakers. Its shape enables the Q16 to be positioned and matched to its environment to much better effect than is the case with conventionally styled enclosures. A solid teak surround with a special all-over cellular foam front is used as much for appearance as its ability to pass all audio frequencies without loss.

This elegantly designed shelf mounting speaker brings genuine high fidelity within reach of every music lover.

Specifications:

Construction: Special sealed seamless sound or pressure chamber with internal baffle.

Loading: up to 14 watts RMS.

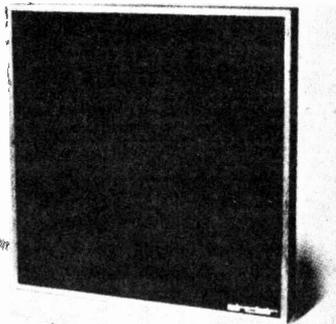
Input Impedance: 8 ohms.

Frequency response: From 60 to 16,000 Hz, confirmed by independently plotted B and K curve.

Driver unit: Special high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and special cone suspension for excellent transient response.

Size and styling: 9½ in. square on face x 4½ in. deep with neat pedestal base. Black all over cellular foam front with natural solid teak surround.

Price £8.98.



Britain's smallest radio

Considerably smaller than an ordinary box of matches, this is a multi-stage AM receiver brilliantly designed to provide remarkable standards of selectivity, power and quality for its size. Powerful AGC counteracts fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy. The plug-in magnetic earpiece provided, matches the Micromatic's output to give wonderful standards of reproduction. Everything including the special ferrite rod aerial and batteries is contained within the minute attractively designed case. Whether you build a Micromatic kit or buy this amazing receiver ready built and tested, you will find it as easy to take with you as your wrist watch, and dependable under the severest listening conditions.

Specifications:

Size: 36 x 33 x 13 mm (1.8 x 1.3 x 0.5 in.)

Weight: including batteries, 28.4 gm (1 oz.)

Case: Black plastic with anodised aluminium front panel and spun aluminium dial.

Tuning: medium wave band with bandspread at higher frequencies (550 to 1,600 KHz).

Earpiece: Magnetic type.

On/off switching: By inserting and withdrawing earpiece plug.

Kit in pack with earpiece, case, instructions and solder **£2.48.**

Ready built, tested and guaranteed, with earpiece **£2.98.**

Two Mallory Mercury batteries type RM675 required from radio shops, chemists, etc.



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CO-AXIAL CABLE	
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0.1 µF 50 volts		0.12 µF 35 volts	22 µF	15 volts
0.18 µF 20 volts		0.15 µF 35 volts	27 µF	120 volts
0.33 µF 35 volts		0.22 µF 50 volts	56 µF	15 volts
0.47 µF 35 volts		0.47 µF 50 volts	56 µF	20 volts
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1.0 µF 15 volts		0.68 µF 50 volts		
2.2 µF 3 volts		1.0 µF 35 volts	Standard	
2.7 µF 15 volts		1.0 µF 75 volts	6.8 µF	50 volts
2.7 µF 35 volts		1.8 µF 20 volts	7.5 µF	20 volts
3.0 µF 12 volts		1.8 µF 20 volts	8.2 µF	150 volts
10.0 µF 1.5 volts		2.7 µF 50 volts	12 µF	35 volts
		3 µF 12 volts	12 µF	50 volts
		3.3 µF 15 volts	39 µF	20 volts
		4 µF 20 volts	82 µF	20 volts
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An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly.
Method: Spray copper laminate board with light-sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light. (No need to use ultra-violet.)
 Spray with developer, rinse and etch in normal manner.
 Light sensitive aerosol spray £1
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We have huge numbers of components in quantities too small to advertise individually. In order to "clear the decks" we have made up parcels containing a mixture of carbon and wire-wound resistors, electrolytic and paper condensers, controls, transistors, diodes etc., for a tiny fraction of normal price. It is emphasised that these are mixed parcels only—contents cannot be stipulated! Sold only by weight.

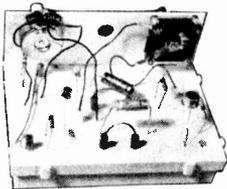
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Add 10p for P. & P. on orders under £5.

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SPECIAL PURCHASE!

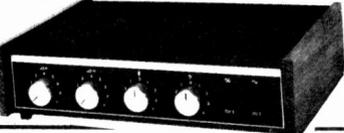
BRAND NEW FM MULTIPLEX STEREO DECODER UNITS. Manufactured by PHILIPS. Size 2" x 3 1/2" x 1". All transistor 24V. at 6mA. Supplied pre-aligned with full circuit diagram and connection details. £4 each. Post free.

LEAK MK 1 TRANSCRIPTION PICK-UP ARMS. Using the world famous gimbal pivot system. Complete but less pick-up head. £2.50. P. & P. 20p.

INPUT MATCHING TRANSFORMER. Beautifully made in heavy Mu-metal cylindrical case for minimum hum pick-up. Size 1 1/2" high x 1 1/4" dia. Ratio 150:1 approx. Especially suitable for matching dynamic or ribbon mikes or pick-up from low to high impedance or vice versa. 75p each. Post Free.

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HARVERSON SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



NEW IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD FOR EASY CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 16 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, attractive front panel, knobs, wire, solder, nuts, bolts - no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output 14W r.m.s. per channel into 8 ohms. Frequency response: 3dB 12-30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ±3dB 12-15,000Hz. Bass boost approx. to 12dB. Treble cut approx. to -16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1.0 amp. Overall size - 12" wide 8" deep x 2 1/2" high.

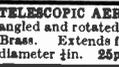
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT. £10.50 P. & P. 15p.
POWER PACK KIT. 43 P. & P. 30p.
CABINET. 43 P. & P. 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, £20.50. Post Free.

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

SPECIAL PURCHASE OF MANUFACTURER'S SURPLUS! All Transistor F.M. tuner head with twin A.M. Gang incorporated. Beautifully engineered with precision geared reduction drive. F.M. R.F. Transistor, oscillator/Mixer and first I.F. stage (10.7 Mc/s output) with optional AFC connection. Built on printed circuit panel and fully screened. Extremely flexible over range 88-108 Mc/s. Brand new and pre-aligned. Size 2 1/2" H. x 2 1/4" W. x 2 1/2" D. For 6V DC. @ 2.8mA. A.M. Gang fitted with trimmers which can be connected to standard A.M. aerial and oscillator circuits if required. **LIMITED NUMBER. Only £2.25 post free.** Connection details supplied.



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Beautifully made peak finish enclosure with most attractive Tegan-Vynair front. Size 16 1/2in high x 10 1/2in wide x 5 1/2" deep. Fitted with E.M.I. Ceramic Magnet 13in x 8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

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CABINET AVAILABLE SEPARATELY £4.50. Carr. 60p.

Also available in 8 ohm with EMI 13in x 8in. bass speaker with parasitic tweeter. £8.50. Carr. 65p.

LOUDSPEAKER BARGAINS

5in x 3 ohm 80p. P. & P. 15p. 7 x 4in 5 ohm £1.05. P. & P. 20p. 10 x 6in 3 or 15 ohm £1.90. P. & P. 30p. E.M.I. 8 x 5in 3 ohm with high flux magnet £1.82. P. & P. 20p. E.M.I. 13" x 8in 3 ohm with high flux ceramic magnet £2.10 (15 ohm £2.25). P. & P. 30p. E.M.I. 13 x 8in, 3 or 8 or 15 ohm with two built-in tweeters and crossover network £4.20. P. & P. 30p. E.M.I. 13" x 8" twin cone (parasitic tweeter) 8 ohm £2.25. P. & P. 30p.

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VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 5 1/2 in. wide. Usually £1.75 yd., our price 75p yd. length. P. & P. 15p (min. 1 yd.). S.A.E. for samples.

SPEAKER CABINET BARGAINS Beautifully made all wooden construction medium walnut front, gold anodised expanded aluminium grille and dark sides. Approx. size overall 11 1/2in high x 5in deep x 13 1/2in wide at base. Baffle cut out for 8in speaker. Could accommodate amplifier or radio together with speaker. FEW LEFT ONLY £1.38 post free.

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Adjustable headband with comfortable fixaform earmuffs. Wired and fitted with standard stereo 1/4in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE £2.95. P. & P. 15p.

SINGLE HEADPHONE. With aluminium headband. Approx. 200 ohm. 25p. P. & P. 8p.

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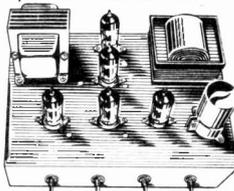
BRAND NEW E.M.I. LIGHTWEIGHT PICK-UP ARM WITH ARM REST. Fitted mono t/o stylus and cartridge for LP/78, ONLY £1. P. & P. 8p.

QUALITY RECORD PLAYER AMPLIFIER MK II A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. W. x 3 1/2" H. Ready built and tested. PRICE £2.75. P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker. DE to fit cabinet below. PRICE £4.88. P. & P. 50p.

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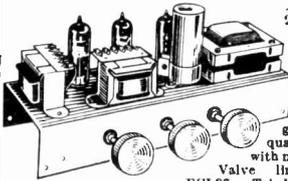
10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram. A law records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 12p (Free with parts). All parts sold separately. ONLY £7.97. P. & P. 55p. Also available ready built and tested complete with std. input sockets, £9.97. P. & P. 55p.



FANTASTIC "POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER. Size only 1 1/2in x 1 1/4in x 1 1/2in deep. Only 19oz. Can replace cone speakers in any application and is particularly useful for those with limited space. Extremely rugged and shockproof. Operating temperature -20°F to +175°F. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £5.75 each. P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully plated valve line-up with full wave rectification giving adequate smoothing with negligible hum.

Valve line-up: ECL86 Triode Pentodes. 1 x EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price £8.92. P. & P. 45p.

4-SPEED RECORD PLAYER BARGAINS Mains controls. All brand new in maker's packing. **LATEST B.S.R. C109/A21 4-SPEED AUTOCANGER.** With latest mono compatible cartridge £6.97. Carr. 60p. With stereo cartridge £7.97. Carr. 50p. **SUITABLE PLINTH UNIT FOR ABOVE** with rigid plastic cover. £5.75 complete. P. & P. 50p. **LATEST GARRARD MODELS.** All types available 1025, 2025, SP25, 3000, AT60, etc. S.A.E. for Latest Prices! **PLINTH UNITS** cut out for Garrard Models 1025, 2025, 3000, 3000, 3500, etc. With rigid transparent plastic cover. Special design enables above models to be used with cover in position. Also suitable for housing AT60 and SP25. OUR PRICE £5.75 complete. P. & P. 50p.

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3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis size 7 1/2in w. x 4in. d. x 4 1/2in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4i watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only 24.75. P. & P. 35p.

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A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer. FEW ONLY. **OUR ROCK BOTTOM BARGAIN PRICE** £2.75 P. & P. 85p.

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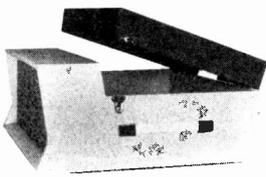
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Really smart appearance with space for R.C.S. Amplifiers and most modern autochangers. Size 18 x 15 x 8in. Chrome fittings. Carrying handle. Two tone rexine covered. Red/Grey or Mottled Blue and Grey or Wood Grain effect. **£4** Post 25p

BSR C.109 SUPERSLIM STEREO & MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 18 months' guarantee. AC 200/250v. Size 13 1/2 x 11 1/2 in. Above motor board 3 1/2 in. below motor board 2 1/2 in. with STEREO and MONO XTAL **£7.75** Post 25p.



GARRARD SINGLE PLAY TA MK II. Ideal Discotheque or Hi-Fi. Stereo/Mono. **£10**

GARRARD PLAYERS with Sonotone 9TA Cartridges. Stereo Diamond and Mono Sapphire. SP25 Mk II 216. Model 3500 Stereo and Mono Autochanger 214. Post 25p.

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made tested. 2-stage with triode pentode valve, 3 watts output. Tone and volume controls. Isolated mains transformer. Knobs, loudspeaker, valves ECL82, E28Z0, Response 50-12,000 cps. Sensitivity 200mv. **£4**

R.C.S. TEAKWOOD BASE. Ready cut out for mounting (state player make and model). **£2.75**

R.C.S. PLASTIC COVERS FOR ABOVE BASE. **£2.75**

EMI PICK-UP ARM. With mono xtal and stylus 1 1/2". HI-FI PICK-UP CARTRIDGES. Diamond Stereo/Mono 9TA £2.50; GP94 £2.50; GP93 £2.00; Mono GP91 1 1/2"; GC8 1 1/2"; ACOS L.P. only 50p.

E.M.I. WOOFER AND TWEETER KIT

£5.75 POST 25p

Comprising a fine example of a Woofer 10 1/2" 6in. with a massive Ceramic Magnet, 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3 1/2 in. square has a special lightweight paper cone and magnet flux 10,000 lines.

Impedance Standard	8 ohms
Maximum power	12 watts
Useful Response	35 to 18,000 cps
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WEYRAD P50 - TRANSISTOR COILS

RA2W Ferrite Aerial	65p	Spare Cores	3p
500/1AC	30p	Driver Trans. LFPT4	50p
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VOLUME CONTROLS 80ohm Coax 4p yd.

Long spindles. Midgest Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p.

VEROBOARD 0-15 MATRIX 2 1/2 x 5in. 2p. 2 1/2 x 3 1/2 in. 17p. 3 1/2 x 3 1/2 in. 26p. 3 1/2 x 5in. 30p. EDGE CONNECTORS 18 way 25p; 24 way 38p.

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BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2 1/2 in. sides 6 x 4in. 40p; 8 x 6in. 53p; 10 x 7in. 65p; 12 x 8in. 85p; 14 x 9in. 90p; 16 x 9in. 90p; 18 x 9in. 90p.

ALUMINIUM PANELS 18 s.w.g. 8 x 4in. 9p; 8 x 6in. 15p; 14 x 8in. 16p; 10 x 7in. 19p; 12 x 5in. 20p; 12 x 8in. 25p; 16 x 6in. 28p; 14 x 9in. 34p; 12 x 12in. 40p.

1 1/2 in. DIAMETER WAVELENGTH SWITCHES. 25p. 2 p. 2-way, or 2 p. 6-way, or 2 p. 4-way 25p each. 1 p. 1.2-way, or 1 p. 2-way, or 1 p. 3-way 25p.

TOGGLE SWITCHES. sp. 14p; dp. 18p; dp. dt. 23p.

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200/250 v. A.C. **£2.35** Post 18p
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All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifier and Double Wound Mains Transformer input 200/240v a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. **£2** Post Free Details S.A.E.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. D.C. operation. Size 1 1/2 x 1 1/2 x 1". Response 25 cps. to 25 Kc/s, 26db gain. For use with valve or transistor equipment. Full instructions supplied. Brand new. **90p** Post 10p Guaranteed. Details S.A.E.

NEW TUBULAR ELECTROLYTICS	CAN TYPES
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4/350V 14p	500/25V 20p
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32/450V 20p	32+32/250V 18p
25/25V 10p	8+16/450V 20p
50/50V 10p	16+16/450V 25p
100/25V 10p	32+32/350V 43p
	100+50+50/350V 48p

SUB-MIN ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 2000mF 15V 10p; 500, 1000mF 12V 18p; 2000mF 25V 42p. CERAMIC 1p to 0.01mF. 4p. Silver Mica 2 to 5000pF. 4p. PAPER 350V-0.1 4p, 0.5 15p; 1mf 15p; 2mf 15p. 500V-0.001 to 0.05 4p; 0.1 5p; 0.25 8p; 0.47 25p. SILVER MICA. Close tolerance 1%. 2.2-500pF 8p; 560-2.200pF 10p; 2.700-5.600pF 20p; 6.800pF-0.01, mtd 30p each. TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 385pF+385pF with 25pF+25pF, 60p; 500pF slow motion, standard 4p; small 3-gang 500 pF £1.80. SEORT WAVE SINGLE. 10pF, 50p, 25pF, 55p, 150V, 55p. CERON TELCOPI. 0.1 5p; 0.25 8p; 0.47 25p. TRIMMERS. Solid dielectric. 100pF, 500pF, 35p each. COMPRESSION. 30, 60, 70pF, 5p; 100pF, 150pF, 5p; 250pF, 10p; 600pF, 750pF, 10p; 1250pF, 10p. SILICON REC. 40-LUCAS 2B5000 Bridge 70v. 5 amp 21p. RECTIFIERS CONTACT COOLED half wave 60m 35p. SILICON BYZ13 30p; BY102 30p; BY127 30p. Full wave Bridge Rectifiers 75mA 50p; 150mA 98p. EX-GOVT. RECTIFIERS 250V 200mA 30p. NEON PANEL INDICATORS 250V AC/DC Red or Amber 20p. RESISTORS. 1 w., 1/2 w., 20% 1p; 2 w. 5p. 10 1/2, 10M. HIGH STABILITY. 1 w. 2% 10 ohms to 1 meg. 10p. Ditto 5% Preferred values 10 ohms to 10 meg. 4p. WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each; 21 watt, 1 ohm to 8.2 ohms 10p.

PHILIPS TRANSISTOR FM STEREO MULTIPLEX DECODER

As used in LEAK Troughline Trans. Brand New. Pre-aligned with 9 semiconductor. 24V d.c. at 6mA. Complete with circuit and connection details. **£4** Post Free 3 1/2 x 2 x 1 in.

MAINS TRANSFORMERS All post 25p each

250-0-250 80 mA. 6.3 v. 4 amp.	£1.40
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E.M.I. 13 1/2 x 8in. LOUSPEAKERS

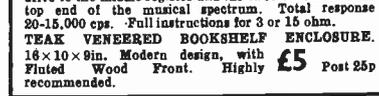
With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4** Post 15p

With flared tweeter cone and ceramic magnet. 10 watt. Bass ref. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 15p

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10W MINI-MODULE £3.25 LOUSPEAKER KIT

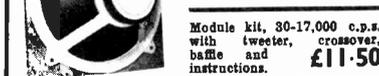
Triple speaker system combining on ready cut baffle. 3 in. chipboard 15 in. 8 1/2 in. separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and 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. 16 x 10 x 9in. Modern design, with Fluted Wood Front. Highly recommended. **£5** Post 25p



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3 or 8 or 15 ohm 3 or 8 or 15 ohm 8 or 15 ohm

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AC178	30p	BF104	20p	OC46	15p		25p
AC179	30p	BF158	18p	OC70	10p	2N2219	20p
AC180	30p	BF159	25p	OC71	15p	2N2219A	
AC181	30p	BF180	25p	OC72	25p		25p
AC182	30p	BF184	18p	OC75	25p	2N2220	25p
AC183	30p	BF190	15p	OC76	25p	2N2221	20p
AC184	30p	BF195	15p	OC77	40p	2N2221A	
AC185	30p	BF197	15p	OC81	20p		25p
AC186	30p	BF198	15p	OC81D	20p	2N2222	20p
AC187	30p	BF199	15p	OC82	40p	2N2222A	
AC188	30p	BF200	15p	OC83	25p		25p
AC189	30p	BF201	15p	OC84	25p	2N2369	15p
AC190	30p	BF202	15p	OC139	25p	2N2369A	
AC191	30p	BF203	15p	OC140	40p		15p
AC192	30p	BF204	15p	OC141	40p	2N2646	40p
AC193	30p	BF205	15p	OC170	25p	2N2904	40p
AC194	30p	BF206	15p	OC171	25p	2N2904A	
AC195	30p	BF207	15p	OC200	40p		25p
AC196	30p	BF208	15p	OC201	75p	2N2905	25p
AC197	30p	BF209	15p	OC202	80p	2N2905A	
AC198	30p	BF210	15p	OC206	90p		25p
AC199	30p	BF211	15p	OC212	50p	2N2906	20p
AC200	30p	BF212	15p	ORP12	50p	2N2906A	
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AC204	30p	BF216	15p	TIP29A	50p		25p
AC205	30p	BF217	15p	TIP30A	50p	2N2925	15p
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AC223	30p	BF235	15p	ZTX505	15p	2N3824	50p
AC224	30p	BF236	15p	ZTX506	15p	2N3825	50p
AC225	30p	BF237	15p	ZTX507	15p	2N3826	50p
AC226	30p	BF238	15p	ZTX508	15p	2N3827	50p
AC227	30p	BF239	15p	ZTX509	15p	2N3828	50p
AC228	30p	BF240	15p	ZTX510	15p	2N3829	50p
AC229	30p	BF241	15p	ZTX511	15p	2N3830	50p
AC230	30p	BF242	15p	ZTX512	15p	2N3831	50p
AC231	30p	BF243	15p	ZTX513	15p	2N3832	50p
AC232	30p	BF244	15p	ZTX514	15p	2N3833	50p
AC233	30p	BF245	15p	ZTX515	15p	2N3834	50p
AC234	30p	BF246	15p	ZTX516	15p	2N3835	50p
AC235	30p	BF247	15p	ZTX517	15p	2N3836	50p
AC236	30p	BF248	15p	ZTX518	15p	2N3837	50p
AC237	30p	BF249	15p	ZTX519	15p	2N3838	50p
AC238	30p	BF250	15p	ZTX520	15p	2N3839	50p
AC239	30p	BF251	15p	ZTX521	15p	2N3840	50p
AC240	30p	BF252	15p	ZTX522	15p	2N3841	50p
AC241	30p	BF253	15p	ZTX523	15p	2N3842	50p
AC242	30p	BF254	15p	ZTX524	15p	2N3843	50p
AC243	30p	BF255	15p	ZTX525	15p	2N3844	50p
AC244	30p	BF256	15p	ZTX526	15p	2N3845	50p
AC245	30p	BF257	15p	ZTX527	15p	2N3846	50p
AC246	30p	BF258	15p	ZTX528	15p	2N3847	50p
AC247	30p	BF259	15p	ZTX529	15p	2N3848	50p
AC248	30p	BF260	15p	ZTX530	15p	2N3849	50p
AC249	30p	BF261	15p	ZTX531	15p	2N3850	50p
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AC255	30p	BF267	15p	ZTX537	15p	2N3856	50p
AC256	30p	BF268	15p	ZTX538	15p	2N3857	50p
AC257	30p	BF269	15p	ZTX539	15p	2N3858	50p
AC258	30p	BF270	15p	ZTX540	15p	2N3859	50p
AC259	30p	BF271	15p	ZTX541	15p	2N3860	50p
AC260	30p	BF272	15p	ZTX542	15p	2N3861	50p
AC261	30p	BF273	15p	ZTX543	15p	2N3862	50p
AC262	30p	BF274	15p	ZTX544	15p	2N3863	50p
AC263	30p	BF275	15p	ZTX545	15p	2N3864	50p
AC264	30p	BF276	15p	ZTX546	15p	2N3865	50p
AC265	30p	BF277	15p	ZTX547	15p	2N3866	50p
AC266	30p	BF278	15p	ZTX548	15p	2N3867	50p
AC267	30p	BF279	15p	ZTX549	15p	2N3868	50p
AC268	30p	BF280	15p	ZTX550	15p	2N3869	50p
AC269	30p	BF281	15p	ZTX551	15p	2N3870	50p
AC270	30p	BF282	15p	ZTX552	15p	2N3871	50p
AC271	30p	BF283	15p	ZTX553	15p	2N3872	50p
AC272	30p	BF284	15p	ZTX554	15p	2N3873	50p
AC273	30p	BF285	15p	ZTX555	15p	2N3874	50p
AC274	30p	BF286	15p	ZTX556	15p	2N3875	50p
AC275	30p	BF287	15p	ZTX557	15p	2N3876	50p
AC276	30p	BF288	15p	ZTX558	15p	2N3877	50p
AC277	30p	BF289	15p	ZTX559	15p	2N3878	50p
AC278	30p	BF290	15p	ZTX560	15p	2N3879	50p
AC279	30p	BF291	15p	ZTX561	15p	2N3880	50p
AC280	30p	BF292	15p	ZTX562	15p	2N3881	50p
AC281	30p	BF293	15p	ZTX563	15p	2N3882	50p
AC282	30p	BF294	15p	ZTX564	15p	2N3883	50p
AC283	30p	BF295	15p	ZTX565	15p	2N3884	50p
AC284	30p	BF296	15p	ZTX566	15p	2N3885	50p
AC285	30p	BF297	15p	ZTX567	15p	2N3886	50p
AC286	30p	BF298	15p	ZTX568	15p	2N3887	50p
AC287	30p	BF299	15p	ZTX569	15p	2N3888	50p
AC288	30p	BF300	15p	ZTX570	15p	2N3889	50p
AC289	30p	BF301	15p	ZTX571	15p	2N3890	50p
AC290	30p	BF302	15p	ZTX572	15p	2N3891	50p
AC291	30p	BF303	15p	ZTX573	15p	2N3892	50p
AC292	30p	BF304	15p	ZTX574	15p	2N3893	50p
AC293	30p	BF305	15p	ZTX575	15p	2N3894	50p
AC294	30p	BF306	15p	ZTX576	15p	2N3895	50p
AC295	30p	BF307	15p	ZTX577	15p	2N3896	50p
AC296	30p	BF308	15p	ZTX578	15p	2N3897	50p
AC297	30p	BF309	15p	ZTX579	15p	2N3898	50p
AC298	30p	BF310	15p	ZTX580	15p	2N3899	50p
AC299	30p	BF311	15p	ZTX581	15p	2N3900	50p
AC300	30p	BF312	15p	ZTX582	15p	2N3901	50p
AC301	30p	BF313	15p	ZTX583	15p	2N3902	50p
AC302	30p	BF314	15p	ZTX584	15p	2N3903	50p
AC303	30p	BF315	15p	ZTX585	15p	2N3904	50p
AC304	30p	BF316	15p	ZTX586	15p	2N3905	50p
AC305	30p	BF317	15p	ZTX587	15p	2N3906	50p
AC306	30p	BF318	15p	ZTX588	15p	2N3907	50p
AC307	30p	BF319	15p	ZTX589	15p	2N3908	50p
AC308	30p	BF320	15p	ZTX590	15p	2N3909	50p
AC309	30p	BF321	15p	ZTX591	15p	2N3910	50p
AC310	30p	BF322	15p	ZTX592	15p	2N3911	50p
AC311	30p	BF323	15p	ZTX593	15p	2N3912	50p
AC312	30p	BF324	15p	ZTX594	15p	2N3913	50p
AC313	30p	BF325	15p	ZTX595	15p	2N3914	50p
AC314	30p	BF326	15p	ZTX596	15p	2N3915	50p
AC315	30p	BF327	15p	ZTX597	15p	2N3916	50p
AC316	30p	BF328	15p	ZTX598	15p	2N3917	50p
AC317	30p	BF329	15p	ZTX599	15p	2N3918	50p
AC318	30p	BF330	15p	ZTX600	15p	2N3919	50p
AC319	30p	BF331	15p	ZTX601	15p	2N3920	50p
AC320	30p	BF332	15p	ZTX602	15p	2N3921	50p
AC321	30p	BF333	15p	ZTX603	15p	2N3922	50p
AC322	30p	BF334	15p	ZTX604	15p	2N3923	50p
AC323	30p	BF335	15p	ZTX605	15p	2N3924	50p
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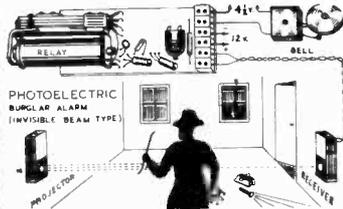
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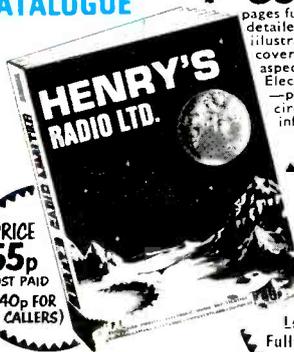
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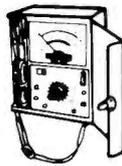
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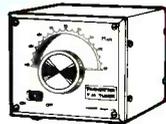
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CHASSIS (P) (less cartridge)	ASSEMBLED (P) (with cover)	ASSEMBLED (with cart. P and C) 2025TC/9TAHCD
*SP25 Mk. IIII £1.30	MP60 (TDIP) £17.65	9TAHCD £13.95
†AP76 £19.97	HT70 PC £24.00	5P25/3-G800H £18.95
●MP60 £11.30	PL12AC £36.50	AP76-G800 £29.95
●MP610 £15.10	GL69/2 PC £32.00	GL69/2-G800 £35.95
●HT70 £16.60	GL75 PC £42.50	GL75 £45.00
GL69/2 £21.97	TD150AB TX11 £45.50	GA202 £45.00
GL75 £22.00	GA308 £34.75	Electronic £59.95
DUAL 1215 £39.00	BD2 £32.25	

CHASSIS WITH CARTRIDGE (P) SPECIAL PRICE WITH *2025TC/9TAHCD £9.50 CARTRIDGE—ADD *3000/9TAHCD £9.98 All magnetic—Recommended Y940 (AD76K) TEAK *PI/TI Std. £3.00 mended Y940 (AD76K) PLINTH *BN1 Deluxe £8.00 £3.25; AT6 £4.95; G850 WITH *P4/T4 Std. £4.25 £4.25; AT71 £9.60 COVER *BN4 Deluxe £8.00 G800 or G800H £6.55; (Gate) *P6/T6 Std. £3.00 M44.7 or C £7.45; 909X deck) ●BSR Deluxe £6.25 £7.32

Post, etc.: Chassis 50p, with Plinth/Cover 70p, Plinth/Cover 30p, Carts. 15p.

300mW TRANSISTOR AMPLIFIER MODEL 4-300

Fully assembled 4TR Amplifier. Size 5 1/2 x 1 1/2 in., 1-10mV adjustable sensitivity. Output 3-8 ohms. Fitted Vol. control; 9 volt operated. Thousands of uses plus low cost. £1.75 p.p. 15p (or 2 for £3.25 p.p. 15p).



SINCLAIR PROJECT 60 PACKAGE DEALS — SAVE POUNDS



2 x Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £16.75, Carr. 40p. Or with PZ6 power supply £18.25. Carr. 40p. 2 x Z50 amplifier, stereo 60 pre-amp, PZ8 power supply £20.25. Carr. 40p. Transformer for PZ8 £2.45 extra. New! Project "60S" stereo system £21.50. Any of the above with Active Filter unit add £4.75 or with pair O16 speakers add £16. Also new FM Tuner £20.25. 2000 Amplifier £24.50, p.p. 50p. 3000 Amplifier £31.50. Also IC12 £2.50.

"BANDSPREAD" PORTABLE TO BUILD



Printed circuit all transistor design using Mullard RF/IF Module. Medium and Long Wave bands plus Medium Wave Bandspread for extra selectivity. Also slow motion geared tuning, 600mW push-pull output, fibre glass PVC covered cabinet, car aerial. Attractive appearance and performance.

TOTAL COST TO BUILD £7.98, p.p. 32p (Batt. 22p). All parts sold separately—Leaflet No. 2. "7T" PORTABLE (as previously advertised) £6.98, p.p. 35p from stock—Leaflet No. 1.

*Components in stock for most published designs—send large SAE with list for parts quote for your circuit.

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