

PRACTICAL ELECTRONICS

SEPTEMBER 1969

THREE SHILLINGS



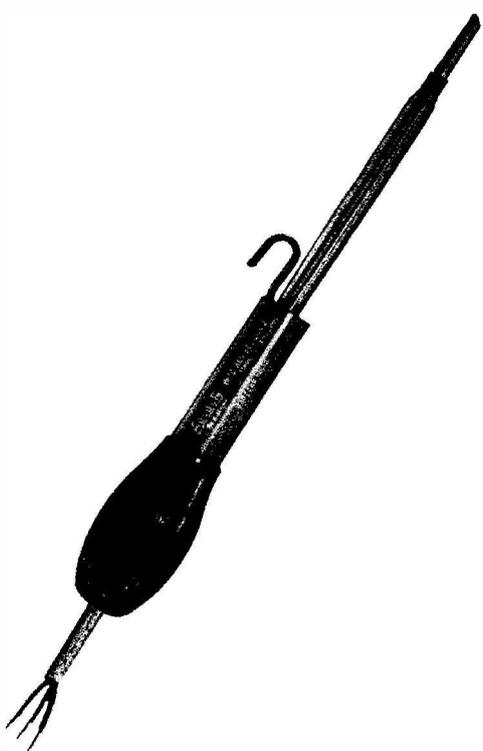
CINE-TAPE SYNC

Also inside:

INSULATION AND DIODE TEST SET



THE RELIABLE SOLDERING INSTRUMENT!



SEND COUPON FOR LATEST LEAFLET

ADCOLA PRODUCTS LTD
ADCOLA HOUSE
GAUDEN ROAD
LONDON SW4
01-622 0291/3

NAME

ADDRESS

.....

.....

PE170

ORGAN TRANSISTORS

ZTX300 .. 1/11	ZT1701 .. 22/6	ZS170 .. 1/11
ZTX302 .. 3/-	ZT3055 .. 20/6	OC28 .. 19/-
ZT44 .. 12/9	KR54 .. 27/6	ACY21 .. 5/4
ZT1613 .. 7/9	KR56 .. 24/9	ACY22 .. 4/-
ZT1700 .. 17/9	ZR12 .. 16/9	OAZ203 .. 12/-

Mullard LA2300 9/5
 All above transistors direct from manufacturer.
 Unmarked silicon planar transistors suitable for use in divider circuits:—1/6 each or £5 per 100.

LIGHT-SENSITIVE DEVICES

GIANT-SIZE SELENIUM SOLAR CELLS—PRODUCE UP TO 6MA FROM DAYLIGHT! 67mm diameter 10/- each. 50mm × 37mm. 2 for 10/-.
 Transistors similar to OCP71 2/- each.
ORP12 CADMIUM SULPHIDE LIGHT-SENSITIVE RESISTORS 9/- each. Light-sensitive diodes 10/- per dozen.

WIRE-WOUND RESISTORS

Mains dropper type. Up to 30 watts. Some multi-tapped. Fraction of normal price! 10/- per dozen.

MULLARD POLYESTER CAPACITORS FAR BELOW COST PRICE! 0-001µF 400V 3d., 0-0015µF 400V 3d., 0-0018µF 400V 3d., 0-0022µF 400V 3d., 0-01µF 400V 3d., 0-15µF 160V 6d., 0-22µF 160V 6d., 0-27µF 160V 6d., 1µF 125V 1/-.

RECORD PLAYER CARTRIDGES. COMPLETE WITH NEEDLES GP67/2 Mono 15/-, GP91/3 Compatible £1, GP93/1 Crystal Stereo 25/-, GP94/1 Ceramic 30/-.

TRANSISTORISED SIGNAL INJECTOR KIT 10/-.
SIGNAL TRACER KIT 10/-. **CAR REV. COUNTER KIT 10/-.**

VEROBOARD

2½ × 1" 0-15 matrix 1/3	17 × 3¾" 0-15 matrix 14/8
3½ × 2½" 0-15 matrix 3/3	3½ × 2½" 0-1 matrix 4/2
3½ × 3¾" 0-15 matrix 3/11	3½ × 3¾" 0-1 matrix 4/9
5 × 2½" 0-15 matrix 3/11	5 × 2½" 0-1 matrix 4/7
5 × 3¾" 0-15 matrix 5/6	5 × 3¾" 0-1 matrix 5/6
17 × 2½" 0-15 matrix 11/-	

Spot Face Cutter 7/6. Pin Insert Tool 9/6. Terminal Pins 3/6 for 36.
 Special Offer! Spot Face Cutter and 5 2½ × 1" boards. . . . 9/9 only.

PAPER CONDENSERS. Mixed bags 0-001µF to 5µF, 12/6 per 100.
SILVER-MICA, Ceramic, Polystyrene Condensers. Well assorted. Mixed types and values, 10/- per 100.

RESISTORS. Mixed types and values, ¼ to 1 watt. 6/6 per 100. 55/- per 1,000. Wire-wound resistors. 1 watt to 10 watts. Mixed values. 20 for 10/-.

TRANSISTORS. Mixed, unmarked, mainly O.K. 7/6 for 50.

12 VOLT TRANSISTORISED FLUORESCENT LIGHTS. HALF NORMAL PRICE.
 8 Watt 12" tube. Reflector type £2.19.6. 15 watt 18" Batten type £3.19.6.
IDEAL FOR CAMPING OR CARAVAN HOLIDAYS! A BRIGHT LIGHT FOR VERY LITTLE CURRENT!

ELECTROLYTIC CONDENSERS

0-25µF 3 volt	4µF 4 volt	10µF 25 volt	64µF 9 volt
1µF 6 volt	4µF 12 volt	20µF 6 volt	100µF 9 volt
1µF 20 volt	4µF 25 volt	25µF 6 volt	320µF 4 volt
1-25µF 16 volt	5µF 6 volt	25µF 12 volt	320µF 10 volt
2µF 3 volt	6µF 6 volt	25µF 25 volt	400µF 6-4 volt
2µF 350 volt	8µF 3 volt	30µF 6 volt	All at 1/- each.
2-5µF 16 volt	8µF 12 volt	30µF 10 volt	20 assorted
3µF 25 volt	8µF 50 volt	50µF 6 volt	(our selection)
3-2µF 64 volt	10µF 6 volt	64µF 2-5 volt	10/-.

Orders by post to:
G. F. MILWARD, DRAYTON BASSETT, NEAR TAMWORTH, STAFFS.

Please include suitable amount to cover post and packing. Minimum order 10/-. Stamped addressed envelope must accompany any enquiries.

For customers in Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8.

why the MULTIMINOR is still the best mini-meter

- It's still an Avometer yet fits in the pocket/held easily in one hand
- Has a d.c. sensitivity of $10,000\Omega/V$
- Measures up to 25kV and 25A with optional accessories
- Accuracy conforms to B.S.S. 89/54.

Get your own Multimeter today (complete with plastic case, leads, instruction booklet and a full year's guarantee) from your local supplier, or ask for details direct from Avo.



THORN
A Member of
the Thorn Group



Avo Limited
Avocet House, Dover, Kent
Telephone: Dover 2626
Telex: 96283

Now! A FAST EASY WAY TO LEARN BASIC RADIO AND ELECTRONICS



Build as you learn with the exciting new **TECHNATRON** Outfit! No mathematics.

No soldering—but you learn the **practical way.**

Now you can learn basic Radio and Electronics at home—the fast, modern way. You can give yourself the essential technical 'know-how' sooner than you would have thought possible—read circuits, assemble standard components, experiment, build . . . and enjoy every moment of it. B.I.E.T.'s Simplified Study Method and the remarkable new **TECHNATRON** Self-Build Outfit take the mystery out of the subject—make learning *easy and interesting.*

Even if you don't know the first thing about Radio now, you'll build your own Radio set within a month or so!

and what's more, **YOU'LL UNDERSTAND EXACTLY WHAT YOU ARE DOING.** The Technatron Outfit contains everything you need, from tools to transistors . . . even a versatile Multimeter which we teach you how to use. You need only a little of your spare time, the cost is surprisingly low and the fee may be paid by convenient monthly instalments. You can use the equipment again and again—and it remains your own property.

You LEARN—but it's as fascinating as a hobby.

Among many other interesting experiments, the Radio set you build—and it's a good one—is really a bonus; this is first and last a *teaching* Course. But the training is as rewarding and interesting as any hobby. It could be the springboard for a career in Radio and Electronics or provide a great new, spare-time interest.

A 14-year-old could understand and benefit from this Course—but it teaches the real thing. Bite-size lessons—wonderfully clear and easy to understand, practical projects from a burglar-alarm to a sophisticated Radio set . . . here's your chance to master basic Radio and Electronics, even if you think you're a 'non-technical' type. And, if you want to carry on to more advanced work, B.I.E.T. has a fine range of Courses up to A.M.I.E.R.E. and City and Guilds standards.

Send now for free 132-page book. Like to know more about this intriguing new way to learn Radio and Electronics? Fill in the coupon and post it today. We'll send you full details and a 132-page book—'ENGINEERING OPPORTUNITIES'—Free and without any obligation.



BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

Dept. 371B, Aldermaston Court, Aldermaston, Berkshire.

To: B.I.E.T., Dept. 371B, ALDERMASTON COURT, ALDERMASTON, BERKS.

I would like to know more about your Practical Radio & Electronics Course. Please send me full details and FREE 132-page book.

name.....
address.....
age.....

POST THIS COUPON NOW!

VALVES SAME DAY SERVICE NEW! TESTED! GUARANTEED!

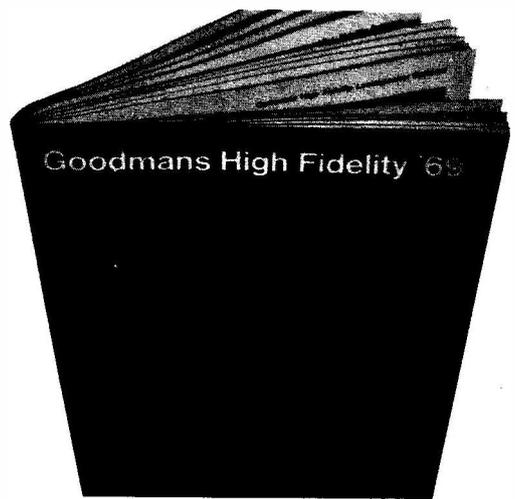
SETS 1R5, 1R5, 1T4, 3S4, 3V4, DAF91, DF91, DK91, DL92, DL94. Set of 4 for 12/6. DAF96, DF96, DK96, DL96, 4 for 26/6.

OZ4	4/6	20F2	13/6	DK96	7/-	EL41	10/6	PCL86	9/-	UC92	5/-
1A7GT	7/6	20P3	11/9	DL35	5/-	EL84	4/9	PCL86	8/6	UCC84	7/9
1R5GT	7/6	20P4	18/6	DL92	5/9	EL90	5/9	PEN44	12/6	UCC85	6/9
1R5GT	7/6	25L6GT	15/-	DL94	6/-	EL90	12/6	PEN36CL1	7/-	UCF90	8/9
1R5	6/9	25L4GT11	1/6	DL96	7/6	EM80	7/6	PFL290	12/6	UCF91	9/9
1R5	4/3	30C1	6/6	DX86	5/9	EM81	7/6	PL30	9/9	UCH81	6/9
1T4	2/9	30C15	13/-	DX87	5/9	EM84	6/6	PL81	7/3	UCL82	7/3
384	5/9	30C17	10/-	EABC80	6/6	EM87	7/6	PL82	7/6	UCL83	11/9
3V4	6/-	30C18	11/6	EAF32	8/9	EY31	7/6	PL83	7/-	UF41	10/6
3Y4G	4/6	30F5	16/-	EB91	2/3	EY80	6/6	PL84	6/6	UF80	7/-
3Y4GT	5/9	30PL1	13/9	EBC33	3/-	EZ40	7/6	PL60	9/9	UF85	6/9
6Z4G	7/6	30FL12	14/6	EBC41	9/9	EZ41	7/6	PL64	13/6	UF89	9/9
6/30L2	12/-	30FL14	12/-	EBF80	6/9	EZ80	4/6	PL508	22/6	UL41	18/6
6AL5	2/3	30L1	6/6	ECC31	3/9	EZ81	4/9	PL802	14/6	UL44	20/-
6AM6	3/6	30L15	14/-	ECC81	3/9	GZ32	6/9	PMS4	7/9	UL84	7/-
6AQ6	4/9	30L17	18/6	ECC82	4/9	GZ34	9/9	PX25	10/6	UM84	7/-
6AT6	4/-	30P4	12/-	ECC83	7/-	KT61	8/9	PY31	5/6	UY41	8/3
6AU6	4/6	30P12	13/9	ECC85	6/9	KT66	16/-	PY32	10/-	UY85	5/9
6BA6	4/6	30P19	12/-	ECC84	12/6	ME140015	-	PY33	10/-	VP48	10/-
6BE6	4/9	30PL1	13/9	ECF80	7/-	N78	14/9	PY81	5/3	VP191	21/-
6BJ6	7/-	30PL13	18/6	ECF82	5/9	PABC80	7/9	PY82	5/3	Z77	5/6
6BW6	13/6	30PL14	18/6	ECH35	6/9	PC86	10/3	PY83	5/9	AC107	3/6
6F13	3/6	35L6GT	2/6	ECH42	10/6	PC88	10/3	PY88	8/9	AC127	2/6
6F14	9/-	35W4	4/6	ECH81	5/9	PC86	5/9	PY800	7/6	AD140	7/6
6F23	14/3	35Z4GT	5/-	ECH84	7/6	PC97	8/6	PY801	6/9	AF128	12/-
6K7G	3/6	6083	12/6	ECL80	6/9	PC900	8/-	R19	6/6	AF115	2/-
6K9G	4/3	AC/VP210	-	ECL82	6/9	PCC84	6/9	R20	12/6	AF116	3/6
6L18	6/-	AZ31	9/6	ECL83	6/9	PCC85	6/6	TH21	9/9	AF117	5/3
6Y6GT	6/6	BT29	12/6	ECL86	8/3	PC88	9/9	U25	13/-	AF124	7/6
6X4	4/3	CC85	10/-	EP37A	6/6	PC89	10/6	U26	12/-	AF128	2/6
6X5GT	5/9	CL33	12/6	EP39	4/9	PC8189	11/6	U47	13/6	AF128	7/-
7B7	7/-	CY31	6/6	EF41	10/9	PC880	6/6	U49	13/6	AF127	3/6
7C6	6/9	DAC32	7/3	EF80	4/9	PCF82	6/6	U52	4/6	OC26	5/9
7Y4	6/6	DAF91	4/3	EF85	6/9	PCF86	9/6	U78	4/3	OC44	2/3
10P1	14/-	DAF96	6/6	EF86	6/3	PCF20013	6/6	U191	12/6	OC45	2/3
10P13	12/6	DF33	7/9	EF89	5/3	PCF800	13/6	U301	12/6	OC71	2/3
12A8	23/-	DF81	2/9	EF91	3/6	PCF801	9/9	U801	12/6	OC72	2/6
12A7	3/9	DF96	6/6	EF94	4/6	PCF802	9/6	UABC80	6/9	OC76	2/6
12A06	4/9	DH77	4/-	EF183	6/9	PCF805	11/6	UAF42	9/6	OC81	2/3
12A07	4/9	DK32	7/6	EF184	5/6	PCF808	12/-	UB41	6/6	OC81D	2/3
12AX7	4/9	DK91	5/9	EH90	6/3	PCL82	7/-	UBC41	6/6	OC82	2/3
12K6GT	7/-	DK91	5/9	EL33	8/9	PCL83	9/-	UBF80	6/6	OC82D	2/3
193C6617	6	DK92	9/3	EL34	10/3	PCL84	7/6	UBF89	6/9	OC170	2/3

READERS RADIO (P.E.)

85 TORQUAY GARDENS, REDBRIDGE, ILFORD, ESSEX. Tel. 01-550 7441

Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any Parcel Insured against Damage in Transit 6d. extra.



New Edition—Now Out

Thinking of High Fidelity—first read Goodmans 28 page High Fidelity Manual. It contains interesting articles on Stereo; an Introduction to High Fidelity; Stage-built systems; as well as full details of Goodmans High Fidelity audio products.

Send for your free copy

Please send me a free copy of Goodmans Manual

Name.....
Address.....

P.E.9

Goodmans Loudspeakers Limited

Axiom Works, Wembley, Middlesex. Tel: 01-902 1200

a complete stereo system for 28 gns!



The new Duo general purpose two way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally. Type I **SPECIFICATION:** Impedance 10 ohms. It incorporates Goodmans high flux 6 x 4in speaker and 2in tweeter. Teak finish 12 x 6 1/2 x 5 1/2 in. 4 guineas each, P. & P. 7/6. Type 2 as Type 1. Size 17 1/2 x 10 1/2 x 6 1/2 in. Incorporating Elac 10 1/2 x 6 1/2 in. 10,000 lines and 2 1/2 in. tweeter. 3 ohms impedance. 5 1/2 gns. + 7/6 P. & P. Garrard Changers from £7.19.6, P. & P. 7/6. Cover and Teak finish Plinth £4.15.0, P. & P. 7/6.

The Duoette

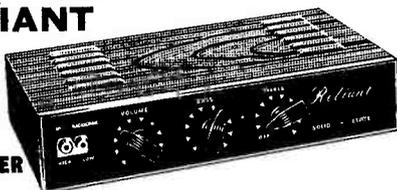
Integrated Transistor Stereo Amplifier

9 GNS + 7/6 P. & P.

The Duoette is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more. **SPECIFICATION:** R.M.S. power output: 3W per channel into 10 ohms speakers. Input Sensitivity: Suitable for medium or high output crystal cartridges and tuners. Crosstalk better than 30dB at 1Kc/s. Controls: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control. Tone Control: Treble lift and cut. Separate on/off switch. A preset balance control.

THE RELIANT

SOLID-STATE GENERAL PURPOSE AMPLIFIER



Specifications: Output: 10W R.M.S. Output impedance: 3 to 4 ohms. Inputs: 1. Xtal mic 10mV; 2. Gram/radio 250mV. Tone controls: Treble control range ±12dB at 10KHz; Bass control range ±13dB at 100Hz. Frequency response (with tone controls central): Minus 3dB points are 20Hz and 40KHz. Signal to noise ratio: better than -60dB. Transistors: 4 silicon Planar type and 3 Germanium type. Mains input: 220-250V a.c. Size of chassis: 10 1/2 in long, 4 1/2 in wide x 2 1/2 in deep. A.C. Mains: 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram and mike. Built and tested. 8 x 5 in speaker in P. Mk. 1 as above, less teak case 5 1/2 gns. + 7/6 P. & P.

RELIANT Mk. II 6 1/2 GNS + 7/6 P. & P. In teak-finished case



POCKET MULTI-METER

Size 3 1/2 x 2 1/2 x 1 1/2 in. Meter size 2 1/2 x 1 1/2 in. Sensitivity 1,000 O.P.V. on both a.c. and d.c. volts. 0-15, 0-150, 0-1,000 d.c. current 0-150mA. Resistance 0-100kohms. Complete with test leads, battery and full instructions, 42/6. P. & P. **FREE GIFT** for limited period only. 30V Electric Soldering Iron Value 15/- to every purchaser of the Pocket Multi-Meter.



OUR PRICE
12 for 30/-
Postage 4/6
extra

G.E.C. 13 amp surface mounting switched sockets in brown. Listed at 6/6.



12 for 21/-
Postage 4/6
extra

W. & D. 13 amp flush sockets in green.

CYLDON 2 TRANSISTOR U.H.F. TUNER. BRAND NEW. COMPLETE WITH CIRCUIT DIAGRAM

£2.10.0 + 1/- P. & P.

The Classic

8 1/2 GNS P. & P. 7/6

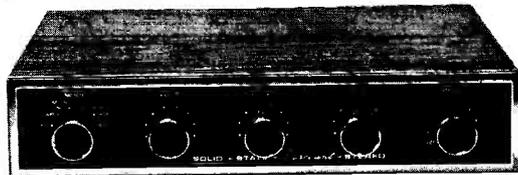
Specification: Sensitivities for 10W output at 1KHz. Tape head: 3mV (at 3 1/2 i.p.s.). Mag. P.U.: 2mV. Cer. P.U.: 80mV. Radio: 100mV. Aux.: 100mV. Tape/Rec. output: 100mV. Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. Tone control range: Bass ±13dB at 60Hz. Treble ±14dB at 15KHz. Total distortion: (for 10W output) <1.5%. Signal noise: <-60dB. A.C. mains 200-250V. Size 12 1/2 in long, 4 1/2 in deep, 2 1/2 in high. Teak finished case.



The Viscount

13 1/2 GNS + 7/6 P. & P.

Integrated High Fidelity Transistor Stereo Amplifier
SPECIFICATIONS: Output: 10W per channel into 3 to 4 ohms speakers (20W mono). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All Inputs 100mV into 1.8M ohm. Frequency response: 40Hz-20KHz ±2dB. Tone controls: Separate bass and treble controls. TREBLE 13dB lift and cut [at 15KHz]. BASS 15dB lift and 25dB cut [at 60Hz]. Volume controls: Separate for each channel. A.C. mains input: 200-240V. 50-60Hz. Size: 12 1/2 x 6 x 2 1/2 in teak finished case. Built and tested. P. & P. 7/6.
Viscount Mark II for use with magnetic pick-ups, specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1 kc. Input impedance 47k. 15 gns. + 7/6 P. & P.

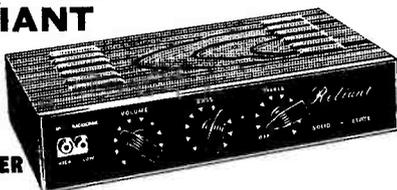


SPECIAL OFFER!

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 duo speaker systems, size 12" x 6 1/2" x 5 1/2", Plinth (less cover) and the DUETTO stereo amplifier. All above items 19 Gns + 20/- P. & P.

THE RELIANT

SOLID-STATE GENERAL PURPOSE AMPLIFIER



Specifications: Output: 10W R.M.S. Output impedance: 3 to 4 ohms. Inputs: 1. Xtal mic 10mV; 2. Gram/radio 250mV. Tone controls: Treble control range ±12dB at 10KHz; Bass control range ±13dB at 100Hz. Frequency response (with tone controls central): Minus 3dB points are 20Hz and 40KHz. Signal to noise ratio: better than -60dB. Transistors: 4 silicon Planar type and 3 Germanium type. Mains input: 220-250V a.c. Size of chassis: 10 1/2 in long, 4 1/2 in wide x 2 1/2 in deep. A.C. Mains: 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram and mike. Built and tested. 8 x 5 in speaker in P. Mk. 1 as above, less teak case 5 1/2 gns. + 7/6 P. & P.

RELIANT Mk. II 6 1/2 GNS + 7/6 P. & P. In teak-finished case

THE DORSET (600mW Output)



7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques make this simple to build. Sizes: 12 x 8 x 3 in. MAINS POWER PACK KIT: 9/6 extra.

Price £5.5.0

Plus 7/6 P. & P. Circuit 2/6 FREE WITH PARTS.

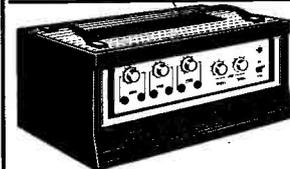
THE ELEGANT SEVEN Mk. III (350mW Output)

7-transistor fully tunable M.W.-L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. MAINS POWER PACK KIT: 9/6 extra.

Price £4.9.6 + 7/6 P. & P.



Circuit 2/6 FREE WITH PARTS.



50 WATT AMPLIFIER A.C. MAINS 200-250V

An extremely reliable general purpose amplifier—with six electronically mixed inputs. Suitable for use with: mics, guitars, gram, tuner, organs, etc. Separate bass and treble controls. Output impedance 3, 8 and 15 ohms.

Price 27 GNS + 20/- P. & P.

B.S.R. TD2 TAPE DECK

This tape deck takes 5 1/2 in spools complete with two-track heads. Size 13 1/2 in long by 8 1/2 in wide.

£8.19.6 Plus 7/6 P. & P.

THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross-over network. Peak handling power 10W. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40-60c/s. Frequency range 50c/s to 20kc/s. Size 13 1/2 in x 8 1/2 in x 4 1/2 in. By famous manufacturer. List price £7. Our price 7/6 plus 5/- P. & P. Similar speaker to the above minus tweeters in 3 & 15 ohms 4/6 + 5/- P. & P.

RADIO & TV COMPONENTS (ACTON) LIMITED

Goods not despatched outside U.K. Terms C.W.O. All enquiries s.a.e. ALL ORDERS BY POST TO OUR ACTON ADDRESS 21d High Street, Acton, London, W.3 also at 323 Edgware Road, London, W.2



**SINCLAIR
IC-10**

the world's most advanced high-fidelity amplifier

This remarkable amplifier has been in production for some months, and now that we have caught up with the backlog of orders, we can supply the IC.10 promptly. We wish to apologise for the delay in reaching full production, which was due to circumstances beyond our control. We hope that now you can purchase the IC.10 without difficulty, you will enjoy to the full the great possibilities this unique Sinclair device offers.

The Sinclair IC.10 is the World's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, which has an output power of 10 watts, is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick. This tiny chip contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, all of which are formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins.

Monolithic I.C.'s were originally developed for use in computer and space applications where their extraordinary toughness and reliability were even more important than their minute size. These same advantages make them ideal for linear applications such as audio amplifiers, but hitherto they have been confined to low power applications. The IC.10 thus represents a very exciting advance. Not only is it far more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal run-

away due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC.10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, the IC.10 is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout), etc.

The photographic masks required for producing monolithic I.C.'s are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. So we are able to sell the IC.10 at a price far below that of the components for a conventional amplifier of comparable power. At the same time, we give a 5 year unconditional guarantee on each IC.10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

sinclair

SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE.

Telephone 0223 52996

10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

■ Specifications

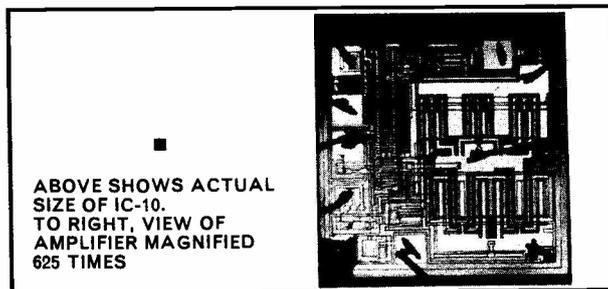
Power Output	10 watts peak, 5 watts R.M.S. continuous.
Frequency response	5Hz to 100kHz \pm 1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 \times 0.4 \times 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5M ohms for above sensitivity.

■ Circuit Description

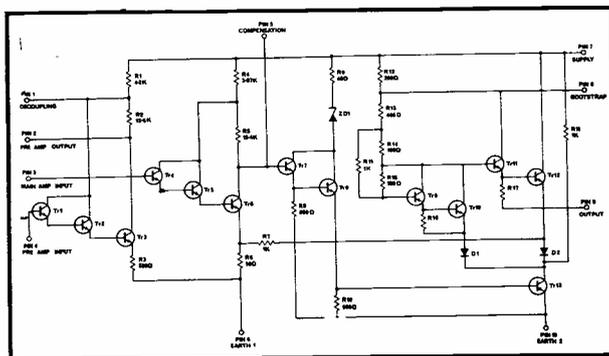
The circuit diagram of the IC.10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.

■ Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

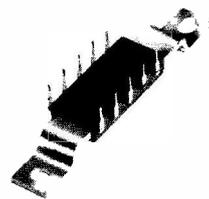


ABOVE SHOWS ACTUAL SIZE OF IC-10. TO RIGHT, VIEW OF AMPLIFIER MAGNIFIED 625 TIMES



■ Applications

Each IC.10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud hailer, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers. The transistors in the IC.10 have cut off frequencies greater than 500MHz so the pre-amp section can be used as an R.F. and I.F. amplifier making it possible to build complete radio receivers without any additional transistors.



SINCLAIR
IC-10

The complete IC-10 with the manual and 5 year guarantee costs just

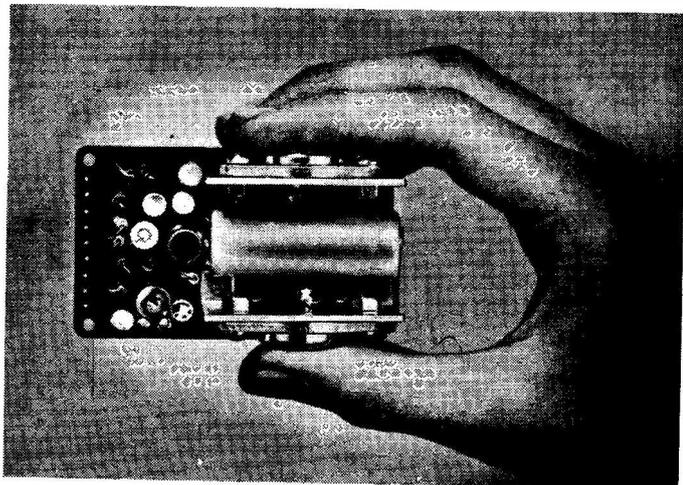
59'6

Post free

SINCLAIR RADIONICS LIMITED,
22 NEWMARKET ROAD, CAMBRIDGE
Telephone 0223 52996

**ORDER FORM AND MORE SINCLAIR
DESIGNS OVERLEAF**

SINCLAIR Z.12 12 WATT INTEGRATED HI-FI AMPLIFIER & PRE AMP



12 watts R.M.S. continuous sine wave output

This is the recommended amplifier for those requiring greater power than that provided by the IC.10. This eight transistor amplifier is the most successful of its kind ever designed. It has an excellent power to size ratio and is easily adapted to a wide variety of applications. The Z.12 performs satisfactorily from a wide range of voltages and it can easily be run from car batteries. This true 12 watt amplifier comes to you ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo, when the Sinclair Stereo 25 will be found the ideal control unit for use with it.

Size—3in × 1½in × 1½in. Class B Ultralinear Output: Frequency response from 15 to 15,000Hz ±1dB; Output suitable for loudspeakers from 3 to 15 ohms impedance. Two 3 ohm speakers may be used in parallel: Input 2mV into 2K ohms; Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak) Power requirements 6–20V d.c. from battery or PZ.4 Mains Supply Unit. Ready built, tested and guaranteed.

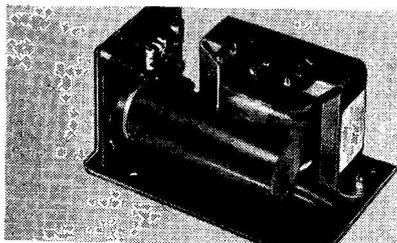
89/6



SINCLAIR STEREO 25

De Luxe Pre-amp and Control Unit to use with Z.12 Stereo assemblies. Switched inputs for PU (equalised to R.I.A.A. curve from 50 to 20,000Hz ±1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/Input are solid aluminium. Size—6½ × 2½ × 2½in plus knobs. Built, tested and guaranteed.

£9.19.6



SINCLAIR PZ4

STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V d.c. at 1.5A. Designed specially for use with two Z.12 or IC.10 Amplifiers together with Stereo 25. Built, tested and guaranteed.

99/6

sinclair

SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE.

Telephone 0223 52996

SINCLAIR MICROMATIC



Britain's smallest radio

This fantastic little British pocket receiver is available in kit form to build for yourself or ready built, tested and guaranteed. Its range and selectivity must be experienced to be believed; its power and quality everything you could want. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier; in fact, you will find your Micromatic performing where other sets cannot be heard at all. The neat black case with aluminium front panel and tuning control give the Micromatic elegantly modern appearance.

- High quality magnetic earpiece
- Choice of many stations
- Plays anywhere

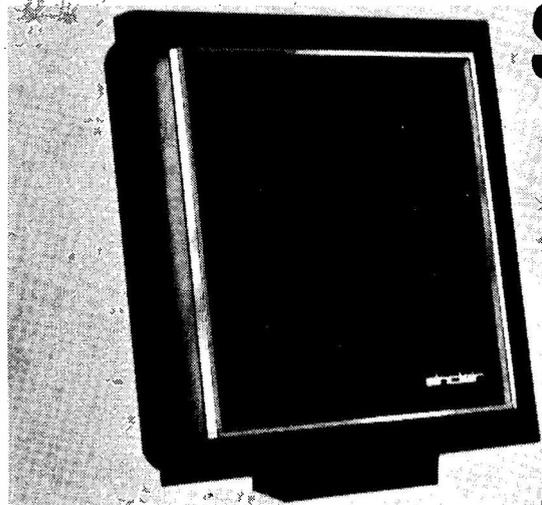
Kit with earpiece, solder and instructions. **49/6**
+ 1/1 P.T. Surcharge

Built, tested and guaranteed. **59/6**
+ 1/1 P.T. Surcharge

Mallory Mercury Cells RM.675 (2 reqrd.) each 2/9.

SINCLAIR Q.14

the most challenging loudspeaker design in years



It is more than a matter of saving money when you choose the Q.14. This is the loudspeaker that delights experts and critics alike for its fine forward quality, its clarity and exceptional adaptability. Designed on original lines and from unusual materials, the Q.14 will easily carry up to 14 watts and has very smooth response from 60 to 16,000Hz. Size—9½in square × 4½in deep, with matt black finish and solid aluminium bar embellishment. Input impedance—8 ohms.

The Q.14 costs about a quarter of what you might expect to pay for a good stereo speaker system. A pair used with two Z.12s and the Stereo 25 will give you superb high fidelity to stand comparison with far costlier equipment.

Try the Q.14 in your own home without delay. If it does not delight you, send it back and your money including cost of postage will be refunded in full.

£7.19.6

+ 2/11 P.T. Surcharge

THE SINCLAIR Q.14 LOUDSPEAKER has a seamless sealed acoustic pressure chamber contoured to ensure forward sounding presence and wide dispersal of sound. The driver unit employs a massive ceramic magnet, special cone suspension and aluminium speech coil resulting in brilliant transient response. The input impedance of 8 ohms makes the Q.14 particularly suitable for use with transistor amplifiers. It can be used as a bookshelf speaker, a corner reflect or flush mounted on any appropriate flat surface, etc.

GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question.

Full service facilities available to all purchasers.

ORDER FORM BRINGS PROMPT DELIVERY SENT TO YOU POST PAID

To: SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE.

Please send

NAME.....

ADDRESS.....

For which I enclose cash/cheque/money order.

PE 989

sinclair

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD,
CAMBRIDGE 0223 52996

Bargain—Car Radios. Our Price 9 gns. Negative or positive earth (switched) fully transistorised (12V) medium and long waves. Speaker and fitting kit supplied at no extra cost. P/P 5/-.

Sonotone 9TA and 9TA/HC. Diamond Cartridge brand new, boxed in manufacturers' carton 49/6 plus 2/6 p.p. Acos GP 91-1 and GP 91-3 stereo compatible cartridges, new in sealed manufacturers' cartons 22/6 plus 2/6 p.p.

BASF TAPE 25% OFF

5in 600ft. 14/- 900ft. 19/- 1200ft. 30/-
5½in 900ft. 19/- 1200ft. 24/- 1800ft. 39/-
7in 1200ft. 24/- 1800ft. 35/- 2400ft. 57/-

P/P 2/- per reel—over £5 FREE

HI-FI SPEAKER K12TC—12in 12 watt

Offers an exceptionally smooth and extended response, with very low level of distortion from the specially designed twin diaphragms.

Frequency Response: 30-16,000Hz.

Impedance: 15-160Hm

OUR SPECIAL PRICE 97/6

PLUS P/P 6/6

● **BARGAIN — Speakers, Hi-Fi — The Baker Selhurst Stalwart.** 12in round, 15 watt rating, 12,000 lines gauss, 15 ohms, response 45-13,000c/s. Bass resonance 40-50c/s, solid aluminium chassis. Our price £5.9.6. p/p 6/6

DULCI HI-FI UNITS

The Dulci range of tuners and amplifiers offer exceptional quality at a sensible price.

Amplifiers: 207 and 207M. Tuners: FMT7 and FMT7s. SEND NOW FOR FULL DETAILS

TRIO Stereo Moving Magnet Cartridge Model AD78K. Diamond Stereo LP Stylus. Frequency response 20-20,000c/s output. 7mV tracking pressure 2 grammes ± 0.5 gm. Fully guaranteed. Price 85/- p/p free.

● **Bargain—Changer decks at lowest prices ever**

Beautiful teak plinth and perspex cover to suit these units	GARRARD 1025	£8.0.0
5 Gns. P/P Free	2025	£8.10.6
	AT60 Mk. 11	£12.19.6
	SP25 Mk. 11	£12.0.0
	3500 with Son 9TA.HC diam. cart.	£10.19.6

Add 10/- p/p for each Garrard unit

SPEAKER ENCLOSURES

Type: INFINITE Baffle

Model 8: 8in plus 3 in tweeter

Model 138: 13in × 8in EMI

Both £4.19.6 each

Model 1012: 10in or 12in, plus 4in tweeter

£7.19.6

All enclosures are in oiled teak, fully built.

Please add 8/- p/p on each enclosure

● **BARGAIN — Speakers, Hi-Fi — The Baker Selhurst Guitar Group 25.** 12in round, 25 watt rating, 12,000 gauss, 15 ohms, response 30-10,000c/s, solid aluminium chassis, heavy duty cone. Our price £5.9.6. p/p 6/6



The greatest HI-FI Budget system today — can't be beaten—price or quality anywhere — look at these great features—then compare.

Teleton F2000 tuner amp. AM-FM with multiplex decoder and A.F.C.—2 x 5W channels R.M.S. Bass Volume Treble Balance controls, a truly outstanding unit

Garrard SP 25 Mk II Transcription deck

Teleton SA 1003 matching speaker enclosures

Sonotone 9 TA Diamond Cartridge

Plinth and Perspex cover

£	s.	d.
43	1	0
15	11	11
9	5	0
4	2	0
7	0	0
£78 19 11		

Exclusively offered by **WALDON** at the remarkably low price of **63 gns.**

E.M.I. HI-FI SPEAKERS

SET 450: 13 × 8 with two built-in tweeters and cross-over unit. Our Price 69/6. 3 or 15 ohm, 10W, 40-13,000Hz.

SET 850: 6½in bass plus 3½in tweeter and cross-over unit. 8 ohm, 10W, 65-20,000Hz. 79/6.

SET 250: 5in heavy duty bass plus 3in tweeter and cross-over unit. 8 ohm, 6W, 80-20,000Hz. 65/- Add 5/6 p/p for each speaker set

WALDON ELECTRONICS, 707 Blackburn Road, Bolton, Lancs. Bolton 54280

Kinver for Components

Selection from our range of STOCK transistors

ACY18 4/5	BC184L 3/2	TIS50 3/9	2N2924 4/4
ACY19 5/3	BC212L 3/9	2N696 4/9	2N2926 3/-
ACY20 4/6	BC213L 3/9	2N697 5/-	2N3053 6/8
ACY21 4/11	BC214L 4/-	2N706 3/3	2N3055 19/6
ACY22 2/10	BCY70 5/4	2N1132 10/9	2N3702 3/6
ASY27 6/2	BCY71 10/4	2N1302 3/11	2N3703 3/3
ASY28 8/-	BCY72 4/6	2N1303 3/11	2N3704 3/9
ASY28 6/2	BD121 18/-	2N1304 5/-	2N3705 3/4
ASY29 8/-	BFY50 5/-	2N1305 5/-	2N3707 4/-
BC107 3/3	BFY51 4/6	2N1306 6/5	2N3708 2/5
BC108 3/-	BFY52 5/-	2N1307 6/5	2N3819 9/-
BC109 3/3	BSY95A 3/11	2N1308 9/6	2N3820 18/9
BC182L 3/2	TIS44 1/9	2N1309 9/6	2N4058 4/6
BC183L 2/5	TIS49 2/6	2N2906 13/-	2N4059 3/5

Linear Integrated Circuits in stock

G.E. Type PA230 Low Level Amplifier	21/-
G.E. Type PA234 1 Watt Audio Amplifier	23/-
G.E. Type PA237 2 Watt Audio Amplifier	34/-
RCA Type CA3302 1 Watt Wide Band Amplifier	32/-
RCA Type CA3035 Ultra High Gain Amplifier	30/-
Mullard Type TAA263 General Purpose A.F. Amplifier	15/9
Mullard Type TAA310 Record/Playback Pre-Amplifier	32/-
Mullard Type TAA320 MOS FET with Bipolar Transistor	13/5
G.E. Type 2N5306 Darlingon Pair	11/6
G.E. Type D13T1 Programmable Unijunction Transistor	10/8

Add 1/- each to the above for data sheets for i.e. if required. Data sheets may be purchased separately at 1/6 each post free.

PROFESSIONAL COMPONENTS AT REALISTIC PRICES!

Send NOW for our COMPONENTS CATALOGUE, at only 2/- post free. This catalogue is packed with information on a host of up-to-the-minute components by leading manufacturers. Included are International Rectifier Products, Resistors, Capacitors, Veroboard, Plugs and Sockets, Switches, etc.

Please note that all goods supplied by us are brand new and guaranteed to fully conform to the manufacturer's published specifications.

DISCOUNTS: Order value of £5—10%; Order value over £10—15%. Cash with order please. Post and packing 1/6 per order.

"Overseas Orders Welcome"

KINVER ELECTRONICS LTD

STONE LANE, KINVER
STOUBBRIDGE, WORCS
Tel: 0456 22111

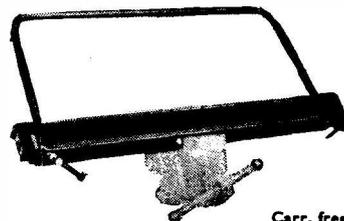
BUILD YOUR CIRCUITS ON VEROBOARD

—the Universal Wiring Board—obtainable from your local Retailer

Trade enquiries to: **NORMAN ROSE (ELECTRICAL) LTD.** 8 St. Chad's Place, Gray's Inn Road, London, W.C.1

Technical enquiries to: **VERO ELECTRONICS LTD.** Industrial Estate, Chandler's Ford, Hants

PARKERS SHEET METAL FOLDING MACHINES HEAVY VICE MODELS



With Bevelled Former Bars

No. 1. Capacity 18 gauge mild steel × 36in. wide	£14.0.0
No. 2. Capacity 18 gauge mild steel × 24in. wide	£8.0.0
No. 3. Capacity 16 gauge mild steel × 18in. wide	£8.0.0

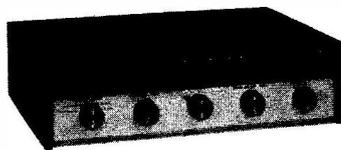
Also new bench models. Capacities 48in. × 18 gauge £40. 36in. × 18 gauge £27.10.0. 24in. × 16 gauge £26.10.0. Carriage free.

End folding attachments for radio chassis. Tray and Box making for 36in. model, 5/6 per ft. Other models 3/6. The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals. One year's guarantee. Money refunded if not satisfied. Send for details.

A. B. PARKER, Folding Machine Works, Upper George St., Heckmondwike, Yorks. Heckmondwike 3997

NEVER BUILT A KIT BEFORE?

Why not build one of these?



Solid-State Stereo FM Tuner/Amplifier, AR-17. 7 watts music power-per-channel. 28 transistor, 7 diode circuitry. 6 position source switch. Wonderful value and styling.
Kit K/AR-17 £39.0.0. Carr. 11/-.
Walnut or teak cabinet £3.10.0. extra.



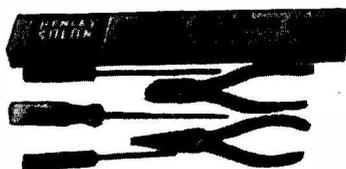
High performance Car Radio, Cr-1. 4 watts output will drive two speakers. 12V pos. or 12V neg. supply. Tastefully styled.
Kit K/CR-1 (less Spkr.) £12.12.0.
Carr 5/-.
8×5in. speaker £1.2.0. extra.



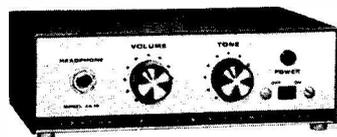
Low-cost 4 Band Receiver, GR-64. Covers 1MHz-30MHz in 3 SW Bands. Plus 550kHz-1620kHz AM band. Features bandspread tuning. 5in. Speaker.
Kit K/GR-64 £22.8.0. Carr. 9/-.



Solid-State VVM, IM-17. For the hobbyist. Tests home or car electrics, etc. 4 AC, 4 DC, 4 Res. ranges. Battery powered. Portable.
Kit K/IM-17 £12.18.0. Carr. 6/-.



Hobby Tool Kit, TK-1. Excellent low cost set comprising:—Solon Soldering Iron, 1 pair diagonal cutters, 1 pair needle nosed pliers, 3 sizes of screw-driver.
Only £2.4.0. Carr. paid.



Low Cost Solid-State Mono Amplifier, AA-18. The ideal basic audio amplifier. 4 watts music power output. Gram, Tape or Radio inputs. Modern clean styling.
Kit K/AA-18 £11.10.0. Carr. 5/-.

Practical electronics the easy way!

Leisure time takes on a new sparkle, a new interest when you add the creative fun you get from building a Heathkit model. Get the thrill of personal achievement when you switch on and realise that you've done something you doubted you could ever do. Your first step is FREE! just simply send for the latest Heathkit catalogue and see what a wide choice of models we offer. What ever your requirement, be it Hi-Fi, Audio, a Portable Radio, a Record Player, Amateur Radio, a SW Receiver, a Test Instrument or Educational Equipment ... There is something for everyone. And we are adding to our wide range continuously. Get your Free catalogue today.



DAYSTROM LIMITED
Gloucester GL2 6EE England
Tel.: Glos. 29451 Telex 43216

TO DAYSTROM LTD., GLOUCESTER
I want to save some money. Please send me your fully-detailed catalogue immediately

NAME _____
ADDRESS _____
 Include me on your mailing list

A LONG COOL LIFE

for your valuable components with the
S.D.C. DeC range of SOLDERLESS breadboards

S-DeC Available as single packs with accessories and control panel @ 29/6d or the DeCSTOR double pack containing 2 S-DeCs, accessories, control panel, all in a plastic storage container. Only 67/6d. A 4 DeC pack is available, only 117/6d.

T-DeC Now available to the amateur. 208 connection points. 38 independent junctions. Accommodates I.C.s using standard carriers. Three times the capability for only twice the price! Unit pack with control panel 50/-d.

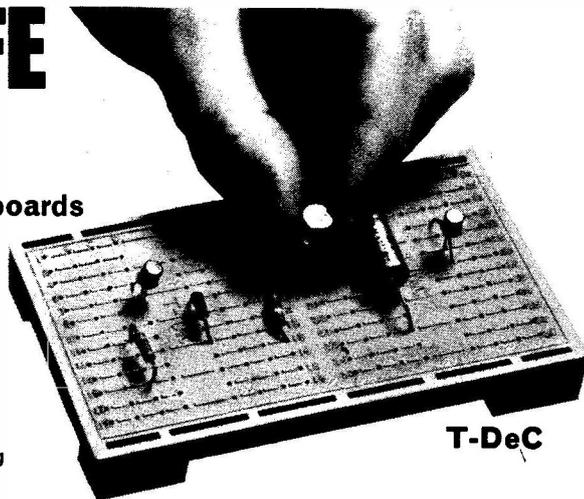
μ-DeC Primarily for use with integrated circuits; further details on request.

T-DeCs, S-DeCs and Accessories are all obtainable from leading suppliers throughout the U.K.

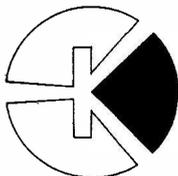
In case of difficulty complete the coupon and mail without delay.

Post to:

S.D.C. Electronics (Sales) Ltd.,
 34, Arkwright, Astmoor Industrial Estate,
 Runcorn, Cheshire. Tel: Runcorn 5041



T-DeC



Please send me:

..... T-DeC Pack S-DeC Single Pack

..... DeCSTOR Pack 4-DeC Pack

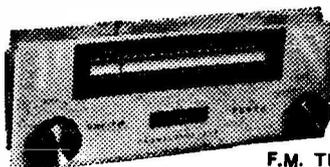
Tick here if you require further details of the μ-DeC
 I enclose PO/Cheque/Money Order value £ | | d.
 Money refunded if not satisfied.

Name

Address

MARTIN IS HIGH-FIDELITY

The first and still the most satisfactory unit assembly system



F.M. TUNER



STEREO CONTROL ASSEMBLY

ONLY FROM MARTIN

Cover the widest possible range of requirements. They are available for Mono, and can be doubled up for conversion to stereo, or as complete stereo units. 3 ohm and 15 ohm systems. Special pre-amp for low output pick-ups. Escutcheon panels to suit the arrangement you choose. Tuner is styled to match.

Start by sending for leaflets at once

MARTIN ELECTRONICS LTD.

UNITS INCLUDE:

- 5-stage input selector
- Pre-amp tone controls
- 10 watt amp. (3 ohms)
- 10 watt amp. (15 ohms)
- Mains power supply
- F.M. Tuner

Trade enquiries invited

154/5 HIGH STREET, BRENTFORD MIDDLESEX. ISLeworth 1161/2

MARTIN ELECTRONICS

154 High Street, Brentford, Middlesex

Please send Recordakit/F.M. Tuner/Audiokit Hi-Fi Leaflets. (Strike out items not wanted)

Name

Address

P.E. 9/69

SENSATIONAL STEREO OFFERS!

SAVE
UP TO
33 1/3%
OFF OUR
STEREO
SYSTEMS

NuSound
SOUND REPRODUCERS

As Britain's Largest Specialists our tremendous purchasing power enables us to offer you the famous makes—Garrard, Goldring, Rogers, Decca, Wharfedale, Arena, Philips, etc.—at unbelievably low prices. We offer 30 Hi-Fi Stereo Systems utilising these famous makes all showing substantial savings off our normal list prices.

Every Nusound Stereo System is complete with all leads, plugs, etc., fully guaranteed and backed by 100% Nusound after-sales service.

Illustrated literature and technical data sent by return of post (Dept. PE/ST).

24 OXFORD ST., LONDON, W.1
Tel. 01-380 4638, 4639, 5735
50 yards Tottenham Court Road Tube
Open 6 days a week

MAINLINE

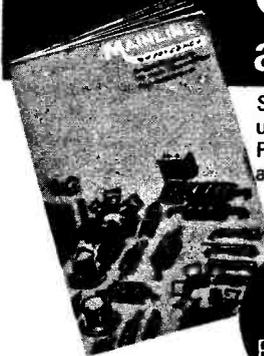
ELECTRONICS LIMITED

Service with the personal touch

Mainline Electronics is a new Service for users of electronic equipment and components in the field of experimental work.

Backed by one of Europe's leading Distributors and enjoying the support of the Industry, Mainline Electronics specialises in quality components from leading manufacturers. These products are characterised by excellent materials and workmanship, proved reliability and known performance. Service is the watchword of Mainline Electronics' activities. The company not only supplies the right components at the right price but, also supplies the necessary data through the data service published in the component guide.

Your Complete Professional Guide to Components and Prices



Send today for Europe's finest, most up-to-date and most comprehensive Price List of Semi-conductors and associated components, with details of manufacturers full application data.

4/-
Post Free

Get this invaluable reference now — to RCA — IR — SGS — Emihus — Semitron — CCL — Plessey — Morganite — Litesold to name but a few.

KONTAKT 60

FOR INACCESSIBLE CONTACTS—More than just a cleaner. KONTAKT 60 guarantees perfect cleaning of contacts chemically in accordance with today's technology.

KONTAKT offers the following advantages:—

1. Dissolves oxides and sulphides the safe way without attacking contact substances.
2. Contains carefully selected solvents which do not attack plastics whereas they do dissolve resinified contact greases and dirt.
3. Contains no silicone.
4. Contains a light lubricant in order to avoid the contact paths being corroded.
5. Prevents further oxidation setting in.
6. Prevents "creep" currents.

Because of these outstanding properties KONTAKT 60 is one of the best and most popular contact cleansing agents in the world.



Users include: Rolls Royce Ltd., C.E.G.B., South of Scotland Electricity Board, Trinity House Workshops, Kolster Brandes, Mullard, Plessey Cos., etc.

OTHER KONTAKT PRODUCTS ARE:

70 Protective Lacquer 80 Special Siliconized Polish
72 Insulating Spray 100 Antistatic Agent For Plastics
75 Cold Spray For Fault Location 101 Dehydration Fluid

Write for full details of above complete range of Kontakt products to:—

SPECIAL PRODUCTS DISTRIBUTORS LIMITED

81 Piccadilly, London, W.1 01-629 9556

The most accurate
pocket size
CALCULATOR
in the world

The 66 inch OTIS KING scales give you extra accuracy. Write today for free booklet, or send 82/6 for this invaluable spiral slide rule on approval with money back guarantee if not satisfied.

CARBIC LTD. (Dept. PE24)
54 Dundonald Road, London, S.W.19



A DOZEN OF THE BEST



70 Watts of Audio

Mainline introduce a trio of amplifiers the Mainline '12', Mainline '25', Mainline '70'.

The design of these audio amplifiers was the result of SGS and RCA combining their tremendous resources to produce these quasi circuits.

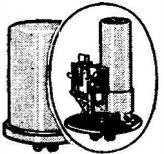
Each Kit complete with circuit diagram contains all semiconductor — resistors — capacitors and printed circuit board.

Mainline 12A — £7.0.0.
Prices: Mainline 25A — £8.5.0.
Mainline 70A — £10.10.0.

Mainline Electronics Limited,
Thames Avenue, WINDSOR, Berkshire.

(A member of the ECS Group of Companies)

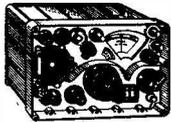
CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro-mechanical relay. (An inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amp. Size 2 11/16" dia. x 4". Supplied brand new at a fraction of original cost. \$/6 each P. & P. 2/6. (3 for 17/6 P. & P. 4/6).

RZ09 MK II COMMUNICATION RECEIVER

11V high grade communication receiver suitable for tropical use. 1.20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO, Aerial trimmer, internal speaker and 12 V a.c. internal power supply. Supplied in excellent condition, fully tested and checked.



£15
Carr. 20/-

TYPE 13A DOUBLE BEAM OSCILLOSCOPES

An excellent general purpose D/B oscilloscope. T.B. 2 c/s-750 Kc/s. Bandwidth 5.5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0.** Or complete with all accessories, probe, leads, lid, etc. **£25.** Carrage 30/-.



MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 μwatt to 6 watts.
£20. Carr. 20/-.

SOLARTRON CD. 1016 OSCILLOSCOPE

Double beam. d.c. To 5 Mc/s. Excellent condition. **£55** each. Carr. 20/-.

CLASS D WAVEMETERS

A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 5V d.c. Ideal for amateur use. Available in good used condition. **£19.8.** Carr. 7/6. Or brand new with accessories. **£7.19.6.** Carr. 7/6.

CLASS D WAVEMETERS No. 2

Crystal controlled. 1.2-19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CFS-1 MHz. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in tube. 115 x 160 x 230mm. Weight 8lb. 220/240V a.c. Supplied brand new with handbook **£22.10.0.** Carr. 10/-.

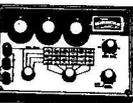


SOLARTRON CD. 711S. 2 OSCILLOSCOPES

Double beam. D.C. to 9Mc/s. Perfect order. **£25.** Carr. 50/-.

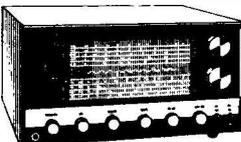
TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11.1 megΩ. 6 Ranges ±1%. L.I. μH - 1.11 HENRY'S 6 Ranges -2%. C. 10pF ±1.10 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:1100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7 1/2 x 5.2in. **£20.** P. & P. 5/6.

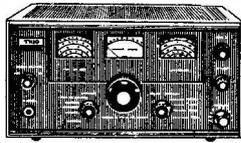


UNR-30 4-BAND COMMUNICATION RECEIVER

Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6. **13 gns.**



LAFAYETTE SOLID STATE NAG60 RECEIVER
5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s-500 kc/s and 550 kc/s-30 Mc/s P. 2 band and 8 mechanical filters. ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● 8 meter ● 24in. Bandsread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 14in x 9in x 8in. Weight 18lb. **EXCEPTIONAL VALUE. \$45.** Carr. 10/-.. S.A.E. for full details.



TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandsread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● 8 meter ● Sep. bandsread dial ● 1F 44Kc/s ● Audio output 1-5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 x 15 x 10in. With instruction manual and service data. **£42.10.0.** carriage paid. **TRIO COMMUNICATION TYPE HEADPHONES.** Normally **£5.19.8.** **OUR PRICE £3.16.0** if purchased with above receiver.

TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER

Covers all the amateur bands in 7 separate ranges between 3.5 and 29.7Mc/s, 7 valves, 2 transistors and 5 diodes plus 8 crystals; output 8 and 500 ohm and 5,000 ohm phone jacks. Crystal controlled oscillator. Variable BFO, VFO. A.V.C. ANL. 8 meter. SSB-CW. Stand-by switch. Special double gear dial drive with direct reading down to 1kHz. Remote control socket for connection to a transmitter. Audio output 1W. 115/250V a.c. mains. Superb modern styling. Size 7 x 13 x 10in. with instruction manual and service data. **£29.10.0.** Carr. Paid.

TRIO TS 510 AMATEUR TRANSMITTER

with speaker and mains P.S.U. **£212.** **IN STOCK!**

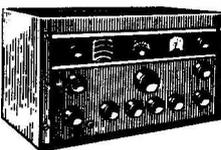
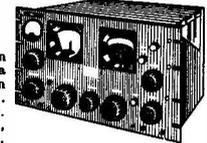


SPECIAL BONUS OFFER!

TRIO SP5D Matching Speaker Mate and TRIO H84 Communication Headphones. Normal Value **£10.7.0.** **FREE OF CHARGE** with every JR.500SE purchased.

HAMMARLUND SP600JX COMMUNICATION RECEIVER

High quality professional dual conversion communication receivers. Few available again in this country at a reasonable price. Frequency range 640 Kc/s-54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2.5 watt output into 600 ohms. Input 110/250V a.c. 20 valve circuit incorporating: Xtal filter, B.F.O., A.N.L., Xtal calibrator, 8 meter etc. Size 19 x 12 x 22in. (List **£520.**) Offered in excellent condition fully tested and checked. **£100** each.

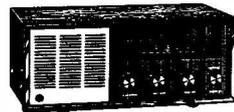


RCA COMMUNICATION RECEIVER AR88D

Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 585Kc/s-32Mc/s continuous. Output impedance 2.5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£27.10.0.** Carr. **£2.**

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

A completely new transistorised receiver covering 152-174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built-in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

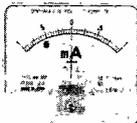


CLEAR PLASTIC PANEL METERS

First grade quality Moving Coil panel meters. Type MR 38P. 1 1/2" square fronts.

500-0-500μA	25/-	50mA	25/-	150V. D.C.	25/-
1mA	25/-	100mA	25/-	300V. D.C.	25/-
1-0-1mA	25/-	150mA	25/-	500V. D.C.	25/-
2mA	25/-	200mA	25/-	750V. D.C.	25/-
5mA	25/-	300mA	25/-	15V. A.C.	25/-
10mA	25/-	500mA	25/-	80V. A.C.	25/-
750mA	25/-	3V. D.C.	25/-	150V. A.C.	25/-
50-0-50μA	35/-	1 amp.	25/-	300V. A.C.	25/-
100μA	35/-	2 amp.	25/-	500V. A.C.	25/-
100-0-100μA	32/6	20V. D.C.	25/-	8 meter 1mA	25/6
200μA	32/6	20mA	25/-	100V. D.C.	25/6
500μA	37/6				

Full range of other sizes in stock. Send s.a.e. for leaflet.

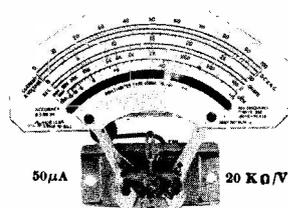


Variable Voltage Transformers

Brand new, guaranteed and carriage paid. High quality construction. Input 230 V. 50-60 cycles. Output full variable from 0-260 V. Bulk quantities available. 1 amp. **£5.10.0;** 2.5 amp. **£8.15.0;** 5 amp. **£9.15.0;** 8 amp. **£14.10.0;** 10 amp. **£18.10.0;** 12 amp. **£21.0.0;** 20 amp. **£27.0.0.**



AVOMETER MOVEMENTS



Spare movements for Model 8 or 9. (Fitted with Brand 9 scale) or basis for any multi-meter. Model New and Boxed **£9/6 P & P 3/6.**

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: -01 / -003 / -1 / -3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s-1.2Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. a.c. **£17.10.0.** Carr. 5/-.



LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0-20 Kc/s on 2 ranges. Output 500Ω or 6kΩ. Operation 200/250V. A.C. Supplied in perfect order **£12/10/-.** Carr. 10/-.

TE-85 VALVE VOLTMETER

High quality instrument with 25 ranges. D.c. volts 1.5-1,500V. A.c. volts 1.5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 5/-. Additional Probes available: R.F. 35/-, H.V. 42/6.



COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.c. equipped. Band width 1kc/s. Perfect order. **£25.** Carr. 30/-.

AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airtrac. Frequency coverage 20-80Mc/s. AM. C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/250/250V a.c. Size 12 x 8 1/2 x 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.



GEARED MAINS MOTORS

Paralux type SD19 230/250V a.c. Reversible. 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **£9/6.** Carr. 10/-.



TE-16A Transistorised Signal Generator, 5 ranges

400 kHz-30 MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide, easy to read scale. 800 kHz modulation. 5 1/2 x 5 1/2 x 3 1/2in. Complete with instructions and leads. **£7.19.6.** P. & P. 4/-.

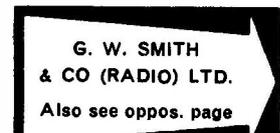
FIELD TELEPHONES TYPE L

Generator ringing, metal cases. Operates from two 1.5V. batteries (not supplied). Excellent condition. **£4.10.0.** per pair. Carr. 10/-.

AUTO TRANSFORMERS

0/115/230V. Step up or step down. Fully shrouded.

150 W. **£12.6.** P. & P. 3/6
300 W. **£2.7.6.** P. & P. 4/6
500 W. **£5.10.6.** P. & P. 5/6
1,000 W. **£7.10.6.** P. & P. 7/6
1,500 W. **£7.19.6.** P. & P. 8/6
7,500 W. **£15.10.0.** P. & P. 20/-



G. W. SMITH & CO (RADIO) LTD.
Also see oppo. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



A.F. SINE WAVE
20-200,000 c/s.
Square wave 20-30,000 c/s. O/P.
HIGH IMP. 21V
P.F. 500 3-8 V. P.P.
TF 100 kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor A.F. output and % mod. on R.F. 220/240 V a.c. £30.0.0. Carr. 7/6.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. £15.0.0. P. & P. 7/6. S.A.E. for details.

PEAK-SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

20c/s to 200 Kc/s on 4 bands. Square: 20c/s to 30Kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. £18.10.0. Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS

Excellent condition. Fully tested. £20. Carr. 15/-.

LAFAYETTE TE46 RESISTANCE-CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation. 200/250V a.c. Brand new £17.10.0. Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

VM.76 VALVE VOLTMETER R.F. measurements in excess of 100Mc/s and d.c. measurements up to 100V with accuracy of ±2% d.c. range 300MV to 1kV a.c. range 300MV to 300V RMS. Resistance 02-500MΩ. Price £72.

VM.78 A.C. MILLIVOLT METER. Transistorised 1 MV-300V. Frequency 1c/s to 1 Mc/s. Price £55.

VM.79 UHF MILLIVOLT METER. Transistorised. A.c. range 10M-37. D.c. current range 0.01A-0.3MA. Resistance 1 ohm-10 megohms. Price £125.

H1B AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. sine or square wave. Price £30.

J1B AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. Price £30.

J2B AUDIO SIGNAL GENERATOR. As per J1B except fitted with output meter. Price £35.

TT18 TRANSISTOR TESTER. £37.10.0 Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9967. B: 5-200. Ico: 0-50 microamps 0-5 mA. Resistance for diode 200 Ω-1 MΩ. Supplied complete with instructions, battery and lead. £5.19.6. P. & P. 2/6.

SONOTRONIC PORTABLE OSCILLOSCOPES

Ex-govt. scope, general purpose; 3in. c.r.t. Mains operated. Fully tested and checked. £12.10.0. Carr. 7/6.

SOLATRON MONITOR OSCILLOSCOPE

An extremely high quality oscilloscope with time base of 10μsec to 20msec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. £8.19.8. Carr. 30/-.

NEW CATALOGUE

Nearly 200 pages giving full details of a comprehensive range of COMPONENTS, TEST EQUIPMENT, COMMUNICATION EQUIPMENT AND HI-FI EQUIPMENT. Each section greatly enlarged and fully illustrated. Thousands of items many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.

SEND NOW-ONLY 7/6 P&P!

GARRARD

FULL CURRENT RANGE OFFERED, BRAND NEW AND GUARANTEED AT FANTASTIC SAVINGS

- SRP22 Stereo £5.19.6 *SL55 £11.19.6
- *1025 Mono £7.10.0 A70 MKII £12.10.0
- *1025 Stereo £7.15.0 *AT60MKII £13.5.0
- *2025 Stereo £7.19.6 *SL65 £14.14.0
- *2025T/C £17.6 A75 £15.17.0
- Mono/Stereo £8.17.6 401 £28.7.6
- *3000 Stereo £9.19.6 SL75 £23.10.0
- SP25 MKII £11.19.6 SL95 £35.0.0



Carriage/insurance 7/6 extra any model. WB4 Bases £3.19.6. Perspex covers £3.10.0. *Special offer base and cover available for these models at £4.15.0. Carr. 5/-.

Full range of Garrard accessories available.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

19 transistors, 8 diodes, 1HF music power, 30W at 8Ω. Response 30-20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3-16Ω. Separate L and R volume control. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10 1/2 x 9 1/8 x 7 13/16in. Operation 115/230V. A.C. £28. Carriage 7/6.

MULTIMETERS for EVERY purpose!

TE-51. NEW 20,000 Ω / VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200V a.c. 0/3/30/60/300/600/3,000V d.c. 0-60μA/12/300mA d.c. 0/60K/6 Meg. ohm. 92/6. P. & P. 2/6.

MODEL AS-100D. 100K Ω/VOLT. 6in. mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200V d.c. 0/6/30/120/300/600V a.c. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200MΩ. -20 to +17dB. £12.10.0. P. & P. 3/6.

MODEL TE-80 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/1300/600/1,200V d.c. 0/6/30/120/300/1,200V d.c. 0-0.3/6/60/600mA d.c. 16kΩ/160kΩ/1.6/16MΩ. -20 to +63dB. £7.10.0. P. & P. 3/-.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30μA/3/30/300mA/0.16K/160K/1.6M. £5.10.0. P. & P. 3/-.

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V a.c. and d.c. 0/1/100/500 mA d.c. 0/100K Ω 39/6. P. & P. 1/6.

TE-900 20,000 Ω VOLTAHMM MULTIMETER. 6in. full view meter. 2 colour scale, overload protection. 0/2.5/10/250/1,000/5,000V a.c. 0/25/12.5/10/50/250/1,000/5,000V d.c. 0/50μA/110/100/600mA 10A d.c. 20K/200K/20M Ω. £15.6. P. & P. 6/-.

MODEL TE-10A. 20K Ω/Volt. 5/25/50/250/500/2,500 V. d.c. 10/50/100/500/1,000V. a.c. 0/50μA/2.5 mA/250mA. d.c. 0/6K/6 megohm. -20 to +22dB. 10-0, 100 mfd. 0 0-100-0-1 mfd. 69/8. P. & P. 2/6.

PROFESSIONAL 20,000 O.P.V. LAB. TESTER. Automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts, d.c. and a.c. 0-500μA, 10mA, 250mA. Current: 0/20K, 200K, 2 megohm. Decibels: -20 to +22dB. £5.19.8. P. & P. 2/6.

MODEL TE 80. 20,000 O.P.V. 0/10/50/100/500/1,000V. a.c. 0/5/25/50/250/500/1,000V d.c. 0/5μA/5/50/500mA/0.6K/6K/60K/6 Meg. £4.17.6. P. & P. 3/-.

MODEL TE12. 20,000 O.P.V. 0/0.6/30/120/600/1,200/3,000/6,000V d.c. 1/6/30/120/600/2,000V a.c. 0/60μA/6/60/600mA/0.6K/600K/6meg/60. Megohm 50PF. 2 MFD £5.19.8. P. & P. 3/6.

★ TRANSISTORISED FM TUNER ★



TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6x4x2in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. £6.7.6. P. & P. 2/6. Stereo multiplex adaptors 99/6.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connecting 1000' applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £8.19.6. P. & P. 3/6.



SINCLAIR EQUIPMENT

- Z12 12 watt amplifier, 89/6
- FZ4 Power Supply Unit 59/6
- Stereo 25 Preamp., 49.19.6
- Q14 Speakers, 47.19.6
- Micromatic Radio Kit, 49/6, Built 59/6, IC10 59/6
- ALL POST PAID

SPECIAL OFFER

Two Z12 Amps., FZ4 Power Supply, Stereo 25 Preampifier, £22, or with two Q14 speakers, £37.

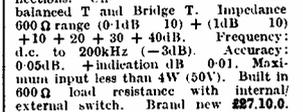
NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier £29. Carr. 5/- Self powered F.M. Tuner. £25. Carr. 5/-.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25-17,000 cps. 8 ohm imp. 67/6 P. & P. 2/6.

TE111. DECADE RESISTANCE ATTENUATOR. Variable range 0-111dB. Connections. Unbalanced T and Bridge T. Impedance 600 Ω range (0-1dB 10) + (1dB 10) +10 +20 +30 +40dB. Frequency: d.c. to 200kHz (-3dB). Accuracy: 0.05dB. +indication dB 0-01. Maximum input less than 4W (50V). Built in 600 Ω load resistance with internal external switch. Brand new £27.10.0. P. & P. 5/-.



RECORDING HEADS

Reuter i-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record playback, low imp. erasure. Brand new. 19/6. COMWOOD i-track heads. High imp. record/playback 65/-, Low imp. erasure 20/-, MARRIOTT i-track heads. High imp. record/playback 65/-, Low imp. erasure 20/-, Post extra.

AMERICAN TAPE

- First grade quality American tapes. Brand new! Discount on quantities.
- 3in. 225ft. L.P. acetate 3/6
 - 3 1/2in. 600ft. T.P. mylar 10/-
 - 5in. 600ft. std. plastic 8/6
 - 5in. 900ft. L.P. acetate 10/-
 - 5in. 1,200ft. D.P. mylar 19/6
 - 5in. 1,800ft. T.P. mylar 22/6
 - 6 1/2in. 1,200ft. L.P. acetate 12/6
 - 6 1/2in. 1,200ft. L.P. mylar 16/-
 - 6 1/2in. 1,800ft. T.P. mylar 22/6
 - 6 1/2in. 2,400ft. L.P. mylar 39/6
 - 7in. 1,200ft. std. acetate 15/-
 - 7in. 1,800ft. L.P. acetate 19/6
 - 7in. 1,800ft. L.P. mylar 20/-
 - 7in. 2,400ft. D.P. mylar 25/-
 - 7in. 3,600ft. T.P. mylar 45/-
- Postage 2/-, Over £3 post paid.

MAXELL TAPE CASSETTES

C60. 10/3; C90. 14/3; C120. 19/6. Post extra

G.W. SMITH & CO (RADIO) LIMITED
3 and 34, LISLE STREET, LEICESTER SQ. LONDON, W.C.2
311, EDGWARE RD. LONDON, W.2
01-437 8204
01-437 9155
01-262 0387
(ALL MAIL ORDERS TO: 3, LISLE STREET, LEICESTER SQUARE, LONDON, W.C.2)

Adamin

MODEL 15

MICRO SOLDERING INSTRUMENT



● **EXTREME VERSATILITY**

Range of 8 interchangeable bits, from 3/64" (.047") to 3/16", including new non-wearing PERMATIPS.

● **ULTRA-SMALL SIZE**

Length 7 1/4". Weight 1/2 oz. Max. handle dia. 7/16".

● **EXTRA-HIGH PERFORMANCE**

Heating time 90 secs. Max. bit temp. 390°C. Loading 15 watts — equals normal 30/40 watt iron.

● **ALL VOLTAGES**

The ADAMIN range includes five other models (5, 8, 12, 18 and 24 watts), Thermal strippers (PVC and PTFE) and a De-Soldering Tool. Please ask for colour catalogue A/37.



LIGHT SOLDERING DEVELOPMENTS LTD.

28 Sydenham Rd., Croydon, CR9 2LL

Telephone 01-688 8589 & 4559

prepare now for tomorrow's world

Today there is a huge demand for technologists such as electronics, nuclear and computer systems engineers, radio and television engineers, etc. In the future, there will be even more such important positions requiring just the up-to-date, advanced technical education which CREI, the Home Study Division of McGraw-Hill Book Co., can provide.

CREI Study Programmes are directly related to the problems of industry including the latest technological developments and advanced ideas. The individual tuition given by the CREI panel of experts in each specialised field is comparable in technological content with that of technical colleges.

Take the first step to a better job now — enrol with CREI, the specialists in Technical Home Study Education.

CREI Programmes are available in:
Electronic Engineering Technology * Industrial Electronics for Automation * Computer Systems Technology * Nuclear Engineering * Mathematics for Electronics Engineers * Television Engineering * Radar and Servo Engineering * City and Guilds of London Institute: Subject No. 49 and Advanced Studies No. 300.

 **CREI (London), Walpole House,
173-176 Sloane Street, London S.W.1.**
A Subsidiary of McGraw-Hill Inc.

Post this coupon today for a better future

To C.R.E.I. (London), Walpole House, 173-176 Sloane Street, London S.W.1.
Please send me (without obligation) details of your Educational Programmes
please tick
My interest is City and Guilds General
Name
Address
Electronics experience
PE17

BI-PRE-PAK LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC170	3/-
AC126	2/6	OC171	4/-
AC127	2/6	OC200	3/6
AC128	2/6	OC201	7/-
AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF114	4/-	2N711	10/-
AF115	3/6	2N1302-3	4/-
AF116	3/6	2N1304-5	5/-
AF117	3/6	2N1306-7	6/-
AF239	12/6	2N1308-9	8/-
AF186	10/-	2N3844A	5/-
AF139	10/-	Power Transistors	
BFY50	4/-	OC20	10/-
BSY25	7/6	OC23	10/-
BSY26	3/-	OC25	8/-
BSY27	3/-	OC26	5/-
BSY28	3/-	OC28	7/6
BSY29	3/-	OC35	5/-
BSY95A	3/-	OC36	7/6
OC41	2/6	AD149	10/-
OC44	2/6	AU110	30/-
OC45	2/6	2N3055	15/-
OC71	2/6	Diodes	
OC72	2/6	AA42	2/-
OC73	3/6	OA95	2/-
OC81	2/6	OA70	1/9
OC81D	2/6	OA79	1/9
OC83	4/-	OA81	1/9
OC139	2/6	IN914	1/6
OC140	3/6		

TRY OUR X PAKS FOR UNEQUALLED VALUE

XA PAK

Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.

PRICE £5 PER 1000

POST & PACKING 4/6 U.K.

XB PAK

Silicon TO-18 CAN type transistors NPN/PNP mixed lots with equivalents to OC200-1, 2N706A, BSY27/29, BSY95A.

PRICE £45.0 PER 500

PRICE £8 PER 1000

POST & PACKING 2/6 U.K.

XC PAK

Silicon diodes miniature glass types, finished black with polarity marked, equivalents to OA200, OA202, BAY31-39 and DK10, etc.

PRICE £4.10.0 PER 1000

POST & PACKING 2/6 U.K.

ALL THE ABOVE UNTESTED PAKS HAVE AN AVERAGE OF 75% OR MORE GOOD SEMICONDUCTORS. FREE PAKS SUSPENDED WITH THESE ORDERS. ORDERS MUST NOT BE LESS THAN THE MINIMUM AMOUNTS QUOTED PER PAK.

NEW TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries inc. Book of Instructions	10/-
B15	5	ASY66 Bidirectional Trans. Simultaneous 2 way signal	10/-
B77	2	AD161-AD162 NPN/PNP Trans. Comp. Output. Pair	10/-
B79	4	IN4007 Sil. Rec. Diodes 1000 P.I.V. 1 amp. Miniature	10/-
B81	10	Reed Switches, mixed types large and small	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1 M Ω	10/-
B91	8	NKT163/164 PNP Germ. TO-5 equivalent to OC44, OC45	10/-
B92	4	NPN Sil. Trans. AO6=BSX20, 2N2369 500 MHz, 360mW	10/-
B93	5	GET113 Trans. equiv. to ACY17-21 PNP Germ.	10/-
B94	6	NPN Sil. Planar Epitaxial Trans. CS4 similar to BSY38 or BC10B	10/-
B96	5	2N3136 PNP Sil. Trans. TO-18, HFE 100-300 I.C. 600mA. 200 MHz	10/-
B98	10	XB112 and XB102 equiv. to AC126, AC156, OC81/2, OC71/2, NKT271, etc.	10/-
B99	200	Capacitors, Electrolytics paper, silver mica, etc. Post and packing, this Pak 2/6	10/-

FREE!

PACKS OF YOUR OWN CHOICE UP TO THE VALUE OF 10/- WITH ORDERS OVER £4

Huge Clearance of UHF/VHF TUNER UNIT REJECTS

Stocks almost exhausted! Place your orders now!!!
FANTASTIC TRANSISTOR VALUE

TU. 2. CONTAINING 2 AF186's & 2 AF178's. PRICE 10/- EACH UNIT.

P & P

TU. 3. CONTAINING 2 AF186's & 2 AF178's.

2/6d.

PLUS WAVEBAND SLIDER SWITCH.

PRICE 12/6 EACH UNIT.

EACH UNIT

All the Units have many other components, e.g., Capacitors, Resistors, Coils, and Tuning Condensers, etc. ALL TUNER UNITS ARE SUPPLIED WITH CONNECTION DATA.

RETURN OF THE UNBEATABLE P.I PAK. NOW GREATER VALUE THAN EVER

FULL OF SHORT LEAD SEMICONDUCTORS AND ELECTRONIC COMPONENTS, APPROX. 170. WE GUARANTEE AT LEAST 30 REALLY HIGH QUALITY FACTORY MARKED TRANSISTORS PNP AND NPN, AND A HOST OF DIODES AND RECTIFIERS MOUNTED ON PRINTED CIRCUIT PANELS. IDENTIFICATION CHART SUPPLIED TO GIVE SOME INFORMATION ON THE TRANSISTORS.

PLEASE ASK FOR PAK P.I ONLY 10/-
2/- P. & P. on this Pak.

Make a Rev. Counter for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car. **20/-each**

FREE CATALOGUE AND LISTS for:-

ZENER DIODES TRANSISTORS, RECTIFIERS FULL PRE-PAK LISTS & SUBSTITUTION CHART

MINIMUM ORDER 10/- CASH WITH ORDER PLEASE. Add 1/- post and packing per order. OVERSEAS ADD EXTRA FOR AIRMAIL.

THERE IS ONLY ONE
BI-PRE-PAK LTD
BEWARE OF IMITATIONS

NEW UNMARKED UNTESTED PAKS

B78	12	Integrated Circuits, Data and Circuits of types, supplied with orders	10/-
B80	8	Dual Trans. Matched O/P pairs NPN. Sil. in TO-5 can	10/-
B82	10	OC45, OC81D and OC81 Trans. Mullard glass type	10/-
B83	200	Trans. manufacturer's rejects all types NPN, PNP, Sil. and Germ.	10/-
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	10/-
B86	150	High quality Germ. Diodes. Min. glass type	10/-
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	10/-
B87	100	Germ. PNP Trans. equiv. to OC44, OC45, OC81, etc.	10/-
B88	50	Sil. Trans. NPN, PNP, equiv. to OC200/1, 2N706A, BSY95A, etc.	10/-
B60	10	7 Watt Zener Diodes Mixed Voltages	10/-

PRE-PAK. N.605 POWER TRANSISTOR EQUIVALENT TO NKT301-2-3-4 **5/- each**

COMPLIMENTARY SET NPN/PNP GERM. TRANS. **2/6 pair**

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

BI-PRE-PAK LTD

DEPT. A, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX
TELEPHONE: SOUTHEND (0702) 46344



If it's
components
you're after...

... you need the

HOME RADIO CATALOGUE

Its the finest, most comprehensive Catalogue we have ever produced—this latest edition. It has 330 pages, over 8,000 items listed, over 1,500 of them illustrated. Everything for the keen constructor—including tools and test gear. With each Catalogue we supply a 30-page Price Supplement, a bookmark giving electronic abbreviations, and an order form. All for only 8/6d plus 3/6d post, packing and insurance. Moreover, every catalogue contains 6 vouchers, each worth 1/- when used as directed.



POST THIS COUPON NOW
with cheque or P.O. for 12/-

The price of 12/- applies only to catalogues purchased by customers residing in U.K.



Please write your Name and Address in block capitals

Name _____

Address _____



HOME RADIO (Components) LTD., Dept. PE,
234-240 London Road, Mitcham, CR4 3HD, Surrey

FEELING THE PULSE

An obsession with facts and figures threatens to become a national malaise. Like, for instance, those monthly balance of payments figures. Yet we are witnessing just the beginning of the deluge of data of all kinds we will have to contend with as the computer population continues its rapid rate of growth. For the computer, above all, has created a statistician's dream world.

In contrast to this perpetual "feeling of the pulse" is the occasional examination which, covering a longer period of time, is more meaningful in its revelations. Like the Annual Statistical Survey of the Electronic Industry published in July by the Electronics Economic Development Committee.

This survey shows that the gross output of the industry was valued at over £1,000 million, nineteen per cent above the 1967 level.

In the capital equipment sector, we read, the major growth was in the U.K. computer market. (From £98 million in 1967 to £136 million in 1968.) Unfortunately, the home based computer manufacturers could not keep pace with this demand, and a greater proportion of the market had to be supplied by imported equipment.

The survey suggests that the defence market, although of major importance, will decline in future years. Outstanding achievements have been made by firms producing and marketing radar and navigational aids, particularly in exports, which have increased 42 per cent in this group.

In other sectors of the industry the balance of trade is not always so good. In the case of consumer goods, imports have actually *increased*. This tendency is likely to continue, especially in view of the coming colour television on 625 lines.

Active components also show, on balance, a trade deficit. In spite of greatly expanded home production, imports rose by over 30 per cent. On the other hand, U.K. firms did export 32 per cent more than in the previous year.

Finally, in reading through the survey, it is satisfying to see the inclusion of amateur electronics in a chart showing the structure of the U.K. electronics industry.

Amateur electronics is indicated as one of the consumers ("domestic final demand") for (1) home produced components and (2) imported components. No values, it is stated, can be assigned to any of these different sections of the market. Perhaps this deficiency will be rectified on a later occasion. The figures should be interesting and instructive, for though relatively very small, the amateur share of the market is going to increase steadily in the future. At least that is *our* prediction—and made without the aid of a computer!

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

ANALOGUE SERVO SYSTEM	642
CINE-TAPE SYNCHRONISER	660
P.E. ORGAN—5	668
INSULATION AND DIODE TEST SET	675

SPECIAL SERIES

MODEL RAILWAY LOGIC SYSTEMS—I	652
COLD CATHODE TUBES—4	685

GENERAL FEATURES

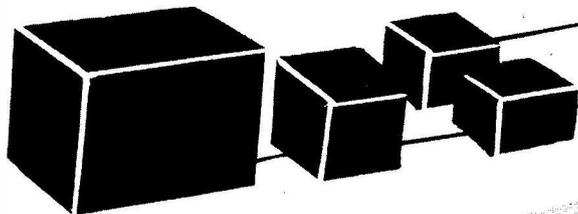
INGENUITY UNLIMITED	656
---------------------	-----

NEWS AND COMMENT

EDITORIAL	641
AUDIO TRENDS	648
SPACEWATCH	665
ELECTRONORAMA	666
NEWS BRIEFS	647, 682
MARKET PLACE	673
BOOK REVIEWS	694

*Our October issue will be published on
Monday, September 15*

ANALOGUE SERVO SYSTEM FOR RADIO CONTROL



By A.R. Miller

MOST modellers who own single channel radio control equipment often require a unit to add to their existing system to make it more comprehensive. Simple units, consisting of a transmitter, receiver and an actuator are particularly popular because of their versatility and low price compared with complete proportional units. Various units have already been described in the past in this magazine, giving details of equipment for model control.

Model control receivers are often very critical in operation because of the high radio frequency used. This is the point at which most would-be constructors get into difficulties, and in the end it is often cheaper to purchase ready-made equipment. Such equipment can be obtained for as little as ten pounds, compared with digital systems costing over one hundred pounds.

This article describes a cheap addition for a single channel system providing a function that compares favourably with far more complex systems. It utilises two servo amplifiers described in an article by Mr J. Tennant in the December 1967 issue of P.E. (unfortunately this issue is now unobtainable).

BASIC OPERATION OF THE SYSTEM

The only necessary modification to existing equipment is the addition of a pulser to the transmitter modulation system. The pulse frequency must be continuously variable between 3 and 10 pulses per second, with a centre frequency of 6 pulses per second. The mark to space ratio of these pulses must also be controllable.

A simple pulser suitable for this application may be constructed using an astable multivibrator as the pulse generating device, followed by an amplifying stage.

However a far better pulser can be made using a unijunction transistor sawtooth generator, followed by two stages to square off the waveform, and vary the mark to space ratio. The advantages of this type is that it is more stable in operation, and there is practically no interaction between controls.

The receiver used in the construction of this article must incorporate a relay—this is common in ready-made receivers—for this reason the pulse rate use in this design is very low.

Conventional practice with this type of pulse system is to use a "Galloping Ghost" actuator, employing an electric motor driving a spring loaded gear system providing mechanical control. Although this method sounds good in theory, this type of actuator has a marked disadvantage; the power supplied by the electric motor is quite low, and therefore it can only be used for small models. The system described here uses feed-back servos and thus overcomes the low power problem.

DECODER

Variation of the mark to space ratio causes the relay (RLA1 in Fig. 1) to vary the brightness of the bulb LP1. This variation in brightness is received by the photocell X1 the resistance of which is correspondingly varied, thus controlling the bias applied to the base of TR6. The mark to space ratio servo amplifier consists of transistors TR6 to 10, which differentiate this bias and feed it to motor MO1. This motor is ganged to VR4 which varies the feed back to the amplifier, and hence the motor drives the servo to a position dictated by the bias.

The purpose of the lamps and photocells (LP1, 2 and X1, 2) might not seem obvious. However, as stated,

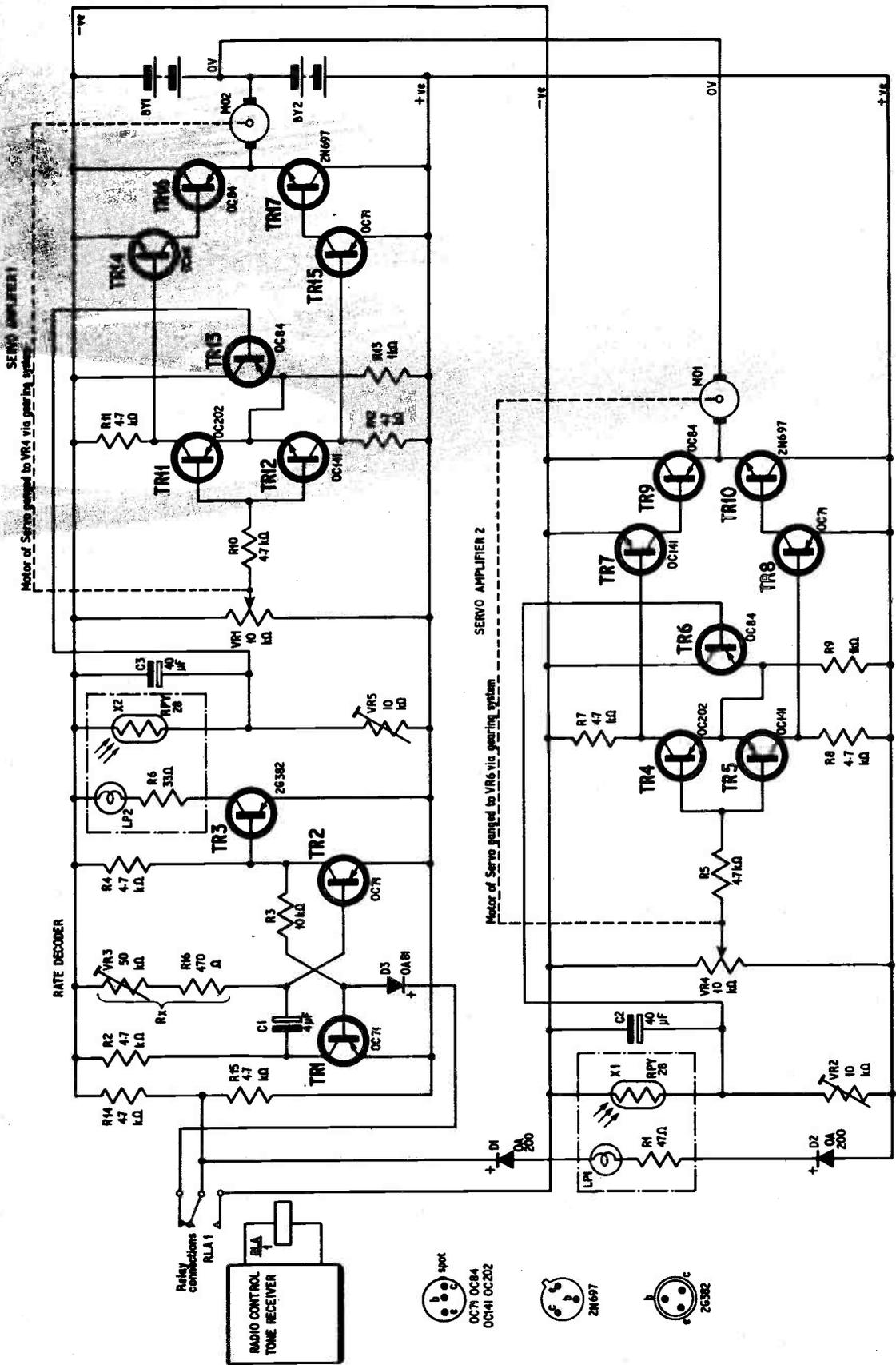


Fig. 1. The complete circuit diagram of the analogue servo system

this system does not use high frequency pulsing techniques. Consequently considerable smoothing of the input signal is necessary. Capacitance and resistance junctions were tried, but damped the movement of the servos to such an extent that they were practically inoperative. Eventually a system using lamps and bulbs was evolved and this is described here. It is surprisingly accurate, sensitive and reliable and, in comparison with other analogue circuits, it is also less complex. The two electrolytic capacitors C2 and C3 provide further smoothing of the input signal.

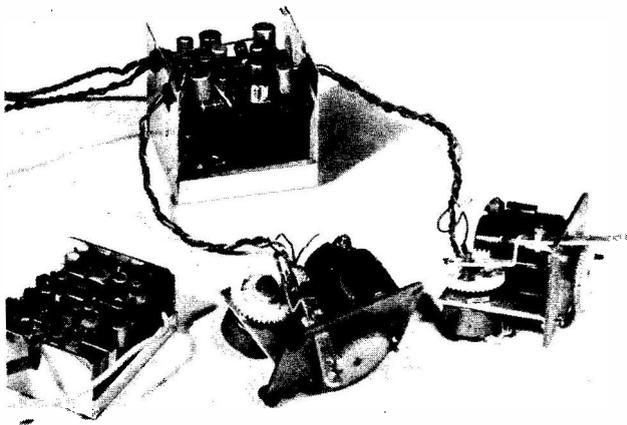
Bulbs do tend to consume a large amount of power, and this can be a problem when the supply is in the form of dry batteries; however, the bulbs used in the system are low wattage types so the power consumed is not too great. A resistor is incorporated in series with each bulb, to reduce the current so that the bulb glows dimly. At this point the power consumed is about 60mA at 4 volts. The mark to space ratio is nominally

output from TR3 collector will have a mark to space ratio of 50-50.

It is a characteristic of a monostable circuit that the pulse output time is independent of the pulse input time, consequently the rate decoder will not respond to variations in mark to space ratio from the receiver relay (RLA1). If the pulse frequency of the transmitter is increased, then TR3 is switched on for a longer period than it is switched off. This will mean that the bulb LP2 will glow more brightly, and vice-versa if the pulse rate is decreased. Hence, variations in the light intensity of LP2 control the rate servo motor via X2 in a similar manner as that with the mark to space servo.

SERVOS

A useful start when constructing the electronics of the system is to have the servo motors already made up; this is because most of the decoder circuitry is set up using the servos as the standard. The servos used in



This shows all the modules necessary for a complete installation. They are: the receiver, the electronic servo control and the two servos

50-50, therefore the bulb is only on for half the time period; consequently power consumption is roughly halved. The system is therefore quite economical on power.

The purpose of D1 and D2 in series with LP1 is to prevent unwanted current flowing back through D3 and interfering with the operation of the rate decoder when the polarity of the relay is reversed. Diodes used for D1 and D2 in the prototype were subminiature silicon types; almost any good small silicon diodes can be used.

RATE SERVO FUNCTION

The rate decoder provides the second servo function; this consists of a monostable multivibrator which provides a pulse independent of the mark to space ratio of RLA1. The time constant of this circuit is given by the equation $0.7.C1.Rx$ seconds. Now the centre pulse rate frequency of the transmitter is 6 pulses per second, therefore if we time the monostable circuit to give a $\frac{1}{2}$ of a second pulse when the relay is connected, this will mean that TR3 is switched on for $\frac{1}{2}$ second, and switched off for $\frac{1}{2}$ of a second. This means that the

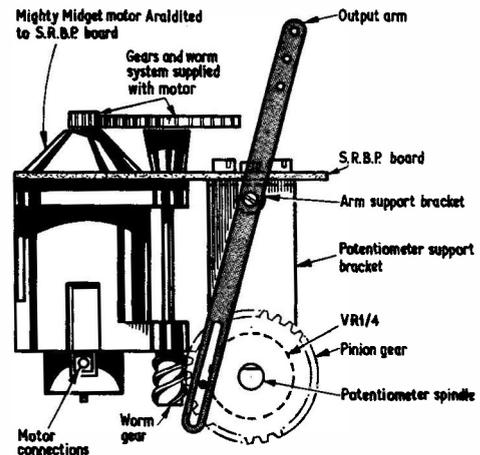


Fig. 2. Basic construction of the servo using a Mighty Midget motor

the prototype were constructed from "Mighty Midget" electric motors coupled through Ripmax 40/1 reduction worm gears to the feedback potentiometer and the final output drive, see Fig. 2. This motor which can be obtained from most model shops strikes a happy medium between reliability and cost—it could, at the time of writing be purchased for about £1.

The current drawn by the motor is quite small, and it will operate from a low voltage supply. Typical current ratings are 150mA running, and 250mA stalled; it is therefore within the capabilities of the amplifier output transistors. When purchased, the motor is complete with a 6/1 nylon reduction gear already fixed. This gear has a countershaft speed of between 600 and 800 r.p.m., consequently, after the wormgear drive, the servo takes about 2 seconds to complete the full travel of 180 degrees.

CONSTRUCTIONAL DETAILS

Once the servos have been constructed and are running smoothly, construction of the electronics can begin. Details of the printed circuit boards for the unit are given in Figs. 3 and 4.

Two different wiring boards are used in the system, and when each has been etched and drilled, using a $\frac{1}{8}$ inch drill, soldering work can begin. Due to the size of the lands on the board a soldering iron with a small bit is necessary. Multicore 22 gauge solder is preferable as this is much more convenient to work with. The printed wiring board for the servo amplifiers should be wired up first; this has two amplifiers on it side by side. Four resistors are used for each amplifier, and these should be soldered in first.

One channel should be selected, and the transistors for this channel soldered in. It may be necessary, before inserting the input transistor (TR6 or TR13) to solder in the signal input lead, this is made 6in long. When the transistors for one of the amplifiers have been inserted, then all the remaining leads for the amplifier are soldered to the board. A 50 kilohm potentiometer should now have its wiper connected to the signal input lead, and the two outside connections soldered to the positive and negative output leads.

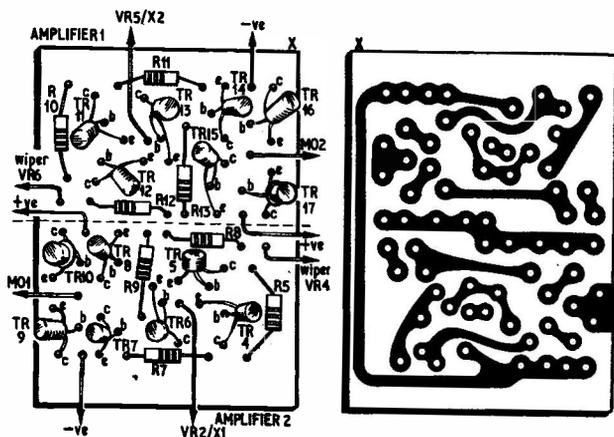


Fig. 3. Layout and wiring of the servo amplifier board. The board is shown full size

The servo motor is then connected to the drive transistors and to the centre tap of two 4.5V batteries or a 7.2V Deac pack. Next connect the positive and negative terminals of the battery pack to the appropriate points. When this has been done the servo should move to some point on its travel and stop in that position. If this happens, turning the 50 kilohm potentiometer should cause the servo motor to move to another position and stop again. If this does not happen disconnect the battery and try reversing the motor contacts.

Assuming the amplifier circuit is working correctly the potentiometer, motor and battery can be removed, and construction of the other channel can be carried out in a similar manner, testing the circuit by the same method. If it is noticed that either servo motor travels more quickly in one direction than in the other, then it may be that the output transistors are incorrectly matched. Transistors TR9, 10, 16 and 17 must be fitted with finned heat sinks.

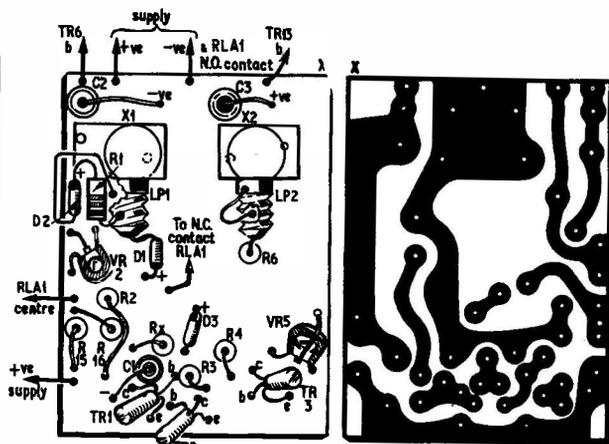


Fig. 4. Layout and wiring of the decoder board. The board is shown full size

COMPONENTS

Resistors

R1	47 Ω $\frac{1}{4}$ W (see text)	R8	4.7k Ω	R13	1k Ω
R2	4.7k Ω	R9	1k Ω	R14	4.7k Ω
R3	10k Ω	R10	4.7k Ω	R15	4.7k Ω
R4	4.7k Ω $\frac{1}{4}$ W	R11	4.7k Ω	R16	470 Ω $\frac{1}{4}$ W
R5	4.7k Ω $\frac{1}{4}$ W	R12	4.7k Ω		
R6	33 Ω $\frac{1}{4}$ W (see text)				
R7	4.7k Ω				

All 10%, $\frac{1}{8}$ watt carbon (except where stated)

Potentiometers

VR1	10k Ω carbon lin.
VR2	10k Ω skeleton preset
VR3	50k Ω (any linear potentiometer to find value of R _x)
VR4	10k Ω carbon lin.
VR5	10k Ω skeleton preset

Capacitors

C1	4 μ F elect. 6V
----	---------------------

Semiconductors

D1, 2	OA200 (2 off, see text)
D3	OA81
X1, 2	RPY28 light dependent resistor (2 off, Mullard)
TR1, 2, 8, 15	OC71 (4 off)
TR3	2G382
TR4, 11	OC202 (2 off)
TR5, 7, 12, 14	OC141 (4 off)
TR6, 9, 13, 16	OC84 (4 off)
TR10, 17	2N697 (2 off)

Miscellaneous

MO1, 2	"Mighty Midget" motors and gears (two off—see text)
LP1, 2	6V, 0.1A bulbs (two off)
BY1, 2	Centre tapped 7.2V 500DKZ Deac. battery pack or two 4.5V batteries (see text)
	Copper clad s.r.b.p. board (1 $\frac{3}{8}$ in \times 1 $\frac{7}{8}$ in, 2 off)
	22 s.w.g. aluminium for case (5 $\frac{1}{2}$ in \times 5 $\frac{1}{2}$ in)
	Finned heat sinks (4 off)

DECODER CONSTRUCTION

Having established the operation of the servos; construction of the decoder can begin. After making sure that the printed circuit board is clean, solder in VR5, then transistor TR3 and so on proceeding down the side of the board to Rx. At the holes for this resistor two wires should be soldered in and connected to R16 and the 50 kilohm potentiometer which was used for setting up the servos (VR3).

After this has been done and all parts of the decoder are in place, the bulbs and photocells can be positioned. Start with LP2 and the photocell X2. The RPY28 is flat in structure, and the leadout wires protrude from the underside; these wires should be positioned in the appropriate holes at the end of the board, so that the centre of the photocell stands about half a centimetre above the board.

A piece of thin stout connecting wire is soldered to the body of the bulb LP2 and inserted through a hole in the board as shown. The glass part of the bulb should be vertically above the photocell, with the element above the centre of the photocell. A 33 ohm $\frac{1}{4}$ watt resistor is soldered to the bulb, and to the circuit board (see Fig. 4). Do not insert LP1, D1, D2, VR5 or X1 yet. The necessary connecting wires can now be soldered in. Connect the relay of the receiver to VR1 wiper and to the positive end of the diode D3. Switch on the transmitter and start the receiver relay pulsing.

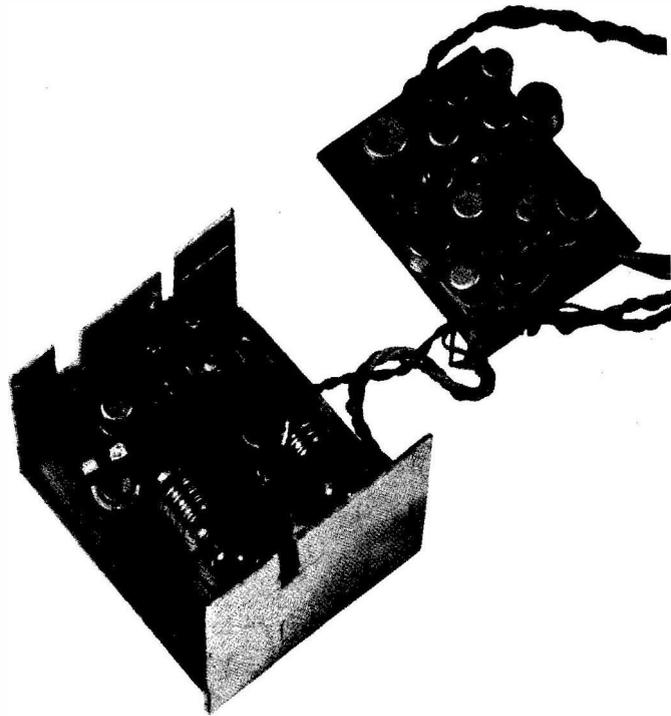
Connect a 7.2 volt Deac supply or two 4.5 volt dry batteries in series (whichever supply is to be used) to the respective supply rails of the decoder, noting the current that is flowing; it should be in the region of 50mA, pulsing in time with the relay. If LP2 does not flash try adjusting the 50 kilohm potentiometer (VR3). If it still does not work, it may be that the load resistor in series with the bulb is too great in value. Remove the bulb and put a milliammeter across the bulb connections; it should register about 40mA at 4 volts. If there is no current, check over the circuit for faults—check that the diode and supply polarity is correct.

As a last resort remove TR3, connect a voltmeter across the positions occupied by TR3 base and emitter, and check that there is a series of pulses of about 3 to 4 volts at this point. If this is happening then it may be that TR3 is defunct. If these pulses are not coming through then the monostable circuit is not working—check TR1 and 2. No trouble should in fact be encountered with this circuit as it is a simple one.

SETTING UP PROCEDURE

Assuming now that the decoder circuit is working correctly, set the transmitter control stick to its neutral position, then adjust the 50 kilohm potentiometer (VR3) until lamp LP2 appears to be on and off for equal periods; a more accurate value of this resistance (Rx) can be found by moving the mark to space control on the transmitter. Any variation of the mark to space control should not produce a perceptible variation in brightness of the bulb, however variation in pulse rate will have a marked effect in the brightness of the bulb.

If everything is operating correctly, potentiometer VR2 and photocell X1 may be soldered in. Another $\frac{1}{4}$ watt resistor is positioned in the hole next to VR5; the value in the prototype was found to be 47 ohms, although this may vary according to the characteristics of diodes D1 and D2. Diode D2 has its negative end connected to the board, and its positive end connected to R1. The leads of the diode and resistor are clipped



The electronics for the control system partially installed in the case

short, care being taken not to overheat the components during soldering. This done, diode D1 can be connected to the bulb at its negative end, and into the appropriate hole at its positive end. Connect the centre tap of the relay to the positive end of D1 and the normally open contact of the 'relay to the negative supply rail; the normally closed contact is connected to diode D3.

Switch on the transmitter and receiver and both bulbs should start flashing. If LP1 does not flash, check that the diodes are connected correctly and also that there are no other wiring faults. If LP1 still does not flash, try decreasing the load resistor (R1); if this has no effect remove the bulb and check for voltage and current as before.

It may be that the forward resistance of the diodes is too high and there is not quite sufficient current to light the lamp, in which case the diodes will have to be substituted. If LP2 stops flashing when LP1 starts, this is due to the back resistance of the diodes D1 and 3 being too low. Again the diodes will have to be substituted.

Once the decoder circuit is working correctly it can be linked to the amplifiers constructed previously. Connect up the amplifier 1 input to the junction between VR5 and X2 and amplifier 2 input to the junction between VR2 and X1.

Adjust VR2 and VR5 to their centre positions but do not turn on the transmitter yet. Switch on the supply to the amplifiers and decoder; the lamps should not flash but the servo motors should both travel to a point and stop. If this happens, cover one of the photocells; this should cause the appropriate servo to move to a new position; when the covering is removed the servo should return to its original position. Repeat the procedure for the other unit.

NEWS BRIEFS

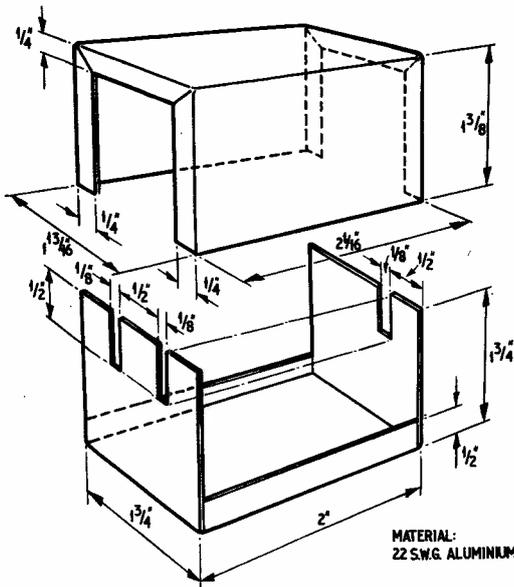


Fig. 5. The case used to house the prototype unit. Servo output wires are led out of the two slots at the left hand side. The opposite single slot carries the supply leads and relay connections. All external connections should be protected from the case by suitable grommets

The transmitter can now be switched on. Once this is done the bulbs should flash as before. Cover both photocells and lights, so that the light from one bulb does not interfere with that from the other. Moving the mark to space control on the transmitter should produce a corresponding movement in the mark to space servo; if the movement is biased to one side, then the servo can be centred by VR2. (The load resistor in series with the bulb is varied until the bulb just glows.)

When the mark to space servo has been set up, the frequency servo can be aligned. VR5 should be used to centre the servo so that there is equal travel on either side of the centre frequency position. The 50 kilohm potentiometer (VR3), which is still in the circuit, is now adjusted more finely until there is no interference from the mark to space ratio control. This done, the potentiometer and R16 can be removed from the circuit, and their resistance value which gave this balance point measured; this can be done with an ordinary ohmmeter. A $\frac{1}{2}$ watt resistor (Rx) of this value is then inserted in place of potentiometer VR3 and R16.

All that remains is for the circuit to be tidied up, and a case, and cover for the bulbs and photocells made. Details of a case are given in Fig. 5; this should be made from 22 gauge aluminium insulated on the inside with a plastics covering material to protect against short circuits.

The lamp housing used in the prototype was made from celluloid. This was formed into a suitable shape, and glued with balsa cement. Two coats of black polystyrene paint were applied on the outside, and a coat of silver on the inside to provide a better reflective surface.

The weight of the complete system including the cases was found to be approximately 15 ounces.

Laser Light Strikes Moon

SHORTLY after the Apollo 11 astronauts landed on the Moon, giant "pancakes" of laser light, two and a half miles across and ten feet thick, were arranged to strike their landing area and bounce off a special reflector in a scientific experiment designed to provide precise answers to age-old questions about the Moon.

The "pancakes" represent pulses of high-power laser light, one one-hundred-millionth (ten billionths) of a second in duration, fired from a rangefinder telescope on an Arizona mountain top—a rangefinder so precise it is able to measure the relative Earth to moon distance to within one and a half metres.

Dr. Renne S. Julian, senior scientist at Hughes Aircraft Company, California, which built the rangefinder system for the U.S. Air Force Cambridge Research Laboratories, said the ability to measure the range with such precision will provide valuable information about the lunar orbit, the moon's size, its true shape and its libration (rocking). It will also provide information about the mass distribution of the Earth and the movement of Earth land masses, or "continental drift".

The NASA retro-reflector placed on the Moon can be used by any country that wishes to use the device. It has been reported that Russia has a lunar rangefinder operating, and France and other countries are at work on similar devices.

Protected Instrument Landing

AIRFIELDS in the United Kingdom will be the first to use the new CPILS (correlation protected instrument landing system) as a result of a development contract awarded to Plessey Radar by the Ministry of Technology. The new system—being developed from an idea originating at RAE—will greatly improve the operational reliability of aircraft instrument landing systems.

The equipment being developed is the ground and airborne equipment for a microwave glide-path system. This combines all the advantages of conventional ILS currently in use at airports throughout the world, with greater accuracy and complete freedom from interference and site effects.

Unlike other proposed instrument landing systems from the U.S.A., U.K. and France, this system is fully compatible with existing ILS and therefore more likely to succeed in world-wide exploitation. Existing flight-deck instrumentation can be used, the only changes necessary in the aircraft being the addition of a smaller antenna and a minor modification to the receiver.

CPILS will meet the needs of airports where full auto-land facilities are required as well as those of less well-endowed airports where expense and siting difficulties preclude conventional ILS.

Degrees and the Practising Engineer

WILL a university degree become the only accepted qualification for professional engineers? Already there are ominous signs that this is so; for example there are efforts to hold the Higher National Diploma and Certificate to the "technician" level.

A determined fight against this tendency is being conducted by The Society of Engineers, as was announced by their President W. G. Taylor at a recent meeting. Other members of the Society also voiced their fears that many practising engineers would be excluded from any Register of Engineers that may be compiled in the future.

One industrialist has stated that students who have attained a good HNC turn out to be better than many graduates after they have received one or two years' training in the laboratory. This view is believed to be fairly widely held in industry.



COMMENTARY ON SOUND REPRODUCING EQUIPMENT

audio trends

HIS MASTER'S VOICE

By F. C. Judd

DURING the few months prior to the Annual Audio Festival (this year in October and now called the International Audio and Photocine Fairs) news of anything really new or of special technical interest is usually pretty scarce.

It appears at the moment however, that unit hi fi systems will be very much in evidence at the forthcoming fair, but one wonders whether this idea is not really degenerating into a trend toward "glorified" radiograms. Already some unit systems comprising a radio tuner, an amplifier and a record player are being made available all in one box. The small bookshelf type loudspeakers classified as hi fi might just as well be included.

NEW AUDIO EXHIBITION ANNOUNCED

News has been released that a second hi fi exhibition is now to be staged and run by the Federation of British Audio Promotions Limited, at which only "top performance" hi fi audio equipment that performs to, or better than, a minimum acceptable standard will be displayed and demonstrated.

The exhibition is to be held in the Skyways Hotel near the London Heathrow Airport from April 23 to 26, 1970, with the 23rd strictly reserved for the trade and technical press only. Each exhibitor, who may be a British or foreign manufacturer or U.K. distributor of equipment made outside the U.K., will have an identical and completely sound-proofed room for demonstration purposes, with separate rooms for static displays of their products. Tickets will be made available to the public via hi fi dealers and various other sources.

An exhibition of hi fi equipment with an agreed minimum performance standard ("only the best in audio" quote the organisers) is a very good idea, but who is going to draw that very thin line between "acceptable" and "unacceptable"?

We have no performance standard in this country like the German DIN 45-500 for domestic audio equipment

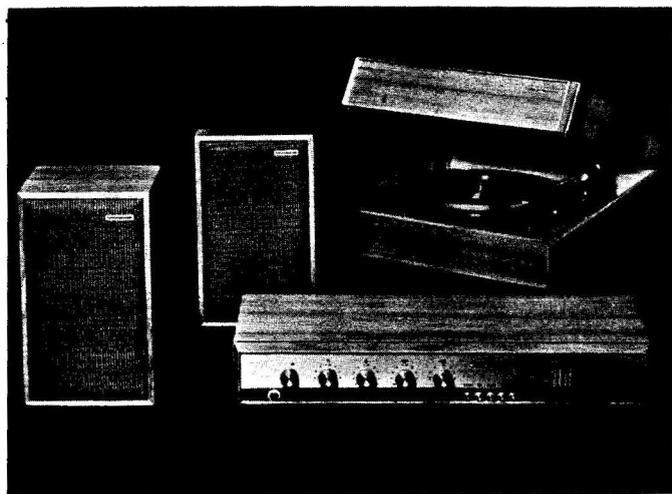
which could be adopted. The German standard is generally regarded in this country as not quite good enough for strictly hi fi and is perhaps one good reason why a British standard should be established anyway.

Another and equally good reason is because the term "hi fi", which at one time really did mean high fidelity, is now freely used to describe the sound reproduction qualities of anything ranging from a cheap transistor radio to genuine top performance audio equipment. Meanwhile, the full range of fidelity audio equipment by British and foreign manufacturers will be displayed and demonstrated at the combined International Audio and Photocine Fairs at Olympia from October 16 to 22.

LOW NOISE TUNERS AND AMPLIFIERS

Audio manufacturers and particularly the Japanese are now using field effect transistors with (pardon the pun) considerable effect, especially in a.m./f.m. tuners.

A tuner of Japanese origin, which I had the opportunity of testing recently, featured f.e.t.'s in the r.f. stages with a very great reduction in noise level and increased sensitivity. Completely noise free stereo could be obtained with an indoor aerial some 20 miles from the London (Wrotham) transmitter. This is something I have not found possible with other tuners not using f.e.t.'s.



Goodmans "Music Suite" complete stereo system

With the help of modern low noise transistors, a signal-to-noise ratio of 60dB or better is now fairly commonplace in top quality amplifiers and is the sort of figure that should be looked for, even with inputs for low sensitivity pick-up cartridges and tape heads which have a high degree of bass lift for equalisation.

One amplifier which performs quite well in this respect is the Nikko TRM 120 which has a rated output power of some 42 watts r.m.s. per channel or a combined music power from both channels of 120 watts. Not only is the output power genuine, but the amplifier also has a signal-to-noise ratio of around 60dB for all inputs.

For those who want "life size" sound and really high fidelity performance, this is the amplifier. It retails at £95 (equivalent to about 16/- per watt music power).

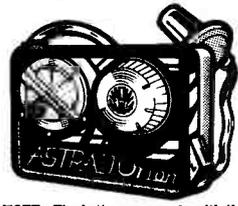
Lasky's

NEW LASKY'S SCOOP

THE WORLD'S SMALLEST 6 TRANSISTOR TWO WAVE-BAND RADIO RECEIVER FROM RUSSIA

THE ASTRAD ORION

Made to the highest Russian space-age standard—this remarkable micro-size set measures only 1 1/4 x 1 1/4 x 5/8 in. yet it contains 6 transistors and other components combined in a photo etched circuit, only 3/4 x 1/2 in.; tuning capacitor, ferrite rod (or core) aerial, battery, waveband selection, switch, etc. Output to a high impedance, crystal earpiece, giving ample volume (automatically adjusted) and clear tone. Brief tech. spec. Waveband coverage—Medium wave 525 to 1605kc/s, Long wave 150kc/s to 408kc/s. Sensitivity: 35mV max. Selectivity—10dB (at 30kc/s de-tuning). Power consumption 4mA max. Power source: 1 x 1.4V Mercury battery (Mallory type RM625 or equivalent).



* NOTE: The battery we supply with the Orion is a rechargeable type. Charger units will shortly be available enabling you to recharge the battery from AC mains 250V/240V supply. Price 19/6, post free if ordered now with radio—otherwise 2/-. If you purchase your charger now we will forward as soon as stocks arrive.

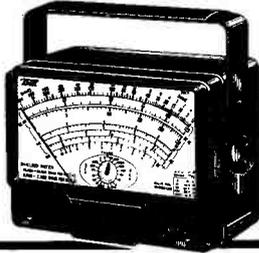
The Orion is supplied fully built and tested complete with battery*, left and right fitting earphone supports and attractive black and ivory plastic presentation/carrying case (matching the Orion). Never miss your favourite music, sport, news—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others.

LASKY'S PRICE 39/6 Post 2/6
Spare battery 3/6



Model 5025

50,000 O.P.V. Multimeter suitable for all professional and educational uses. Features 57 measurement ranges (±2% accuracy on full scale DC). High speed range selection, polarity reversal switch and overload meter protection circuit. SPEC.: DC/V ranges: 0-125 to 1,000V in 12 ranges (0-25 to 500V at 50K/O.P.V.). AC/V ranges: 1-5V to 1,000V in 10 ranges (1-5 to 500V at 5K/O.P.V.). DC current: 25µA to 10A; resistance: 0 to 10M ohms. Decibels: -20 to +81-8dB in 10 ranges. Operates on 2 x 1.5V U7 type batteries. Size 6 1/2 x 5 1/2 x 2 1/2 in. Complete with leads and battery.

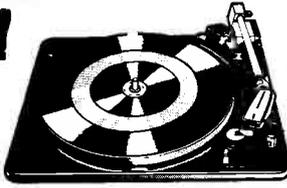


LASKY'S PRICE £13.10.0 Post 5/-



SP.25 Mk II

4-speed single player—less cartridge



LASKY'S PRICE £11.19.6 Post 5/-

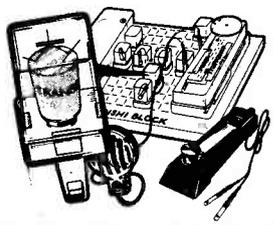
AUTOCHANGERS
1065 less cartridge . . . \$6 9 6
1065 with GCM21 mono cartridge (Stereo Compat) . . . \$6 19 6
2065TC with GCM21 mono cartridge (Stereo Compat) \$7 19 6
EL55 with J9006 stereo cartridge . . . \$11 19 6
EL65 less cartridge . . . \$14 15 0
AT90 Mk. II less cartridge . . . \$13 5 0
EL75 less cartridge . . . \$28 10 0
EL95 less cartridge . . . \$35 0 0
A70 Mk. II less cartridge . . . \$13 19 6
B.S.R.UA-47 less cartridge . . . \$5 9 6

SINGLE PLAYERS
AP75 with AD76K magnetic cartridge . . . \$21 0 0
AP75 less cartridge . . . \$18 10 0
SRP2 Mains model less cartridge . . . \$6 12 10
SRP2 Battery model less cartridge . . . \$7 15 3
TRANSCRIPTION DECKS 401 \$28 10 0
GARRARD BASES:
WB1 \$3. 6. 11; WB4 Mk. II \$5. 8. 11;
WB5 \$5. 8. 11.
CLEARVIEW PERSPEX COVERS:
SPC1 \$3. 5. 0; SPC4 Mk. II \$4. 6. 6.

Postage on all above 5/- extra

DENSHI BOARD KITS

NEW EXPERIMENTAL AND EDUCATIONAL CIRCUIT SYSTEM



The DENSHI BOARD system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are encapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. In addition each DENSHI BOARD KIT comes complete with an 80 page manual of circuits and data.

THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES: VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, CONTINUITY TESTER, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE, ETC., ETC.

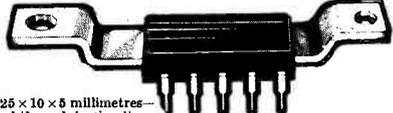
DENSHI BOARD KIT SR-1A comprises:
Base board; tuner block; 4 resistors; choke coil; transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces and 80 page manual. This kit permits the building of 16 basic circuits.

LASKY'S PRICE £4.19.6 Post 3/6

DENSHI BOARD KIT SR-2A as SR-1A but with the following additional parts:
2SB transistor for AF; 2 resistors; 1 capacitor; crystal microphone; test probes; electrode; additional connecting pieces; 9V battery. This kit permits the building of 30 circuits

LASKY'S PRICE £7.2.6 Post 3/6

EXCLUSIVE FIRST THE IC-403 INTEGRATED CIRCUIT AMPLIFIER MODULE AVAILABLE NOW!



These tiny modules—size only 25 x 10 x 5 millimetres—represent the most amazing breakthrough in circuit design since the introduction of the transistor. The actual circuit—no bigger than a pin-head—is encapsulated in solid plastic fused with the heatsink and connecting pins to make an almost indestructible unit. The IC-403 is an integrated power and pre-amplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output. Originally developed for computer and space projects—there are many applications for these unique devices, wherever high efficiency and ultra compact size is required, i.e. miniature P.A. and audio amplifiers, intercoms, electronic organs, tape recorders, etc. etc.

SPECIFICATION (ratings at 20°C): Output power typically 3W from 250mV input. Frequency response 20 Hz to 80KHz ± 3dB. Power amp. distortion 0-3% (at 1W, 400Hz). Pre-amp. gain 24dB. Power amp. gain 26dB. Max operating voltage 21V. Min. operating load 7.5. Noise level -75dB. Pre-amp. input imp. 2m/ohms. Pre-amp and power amp. D.C. input current 50N.A.

THE IC-403 IS AVAILABLE FROM STOCK EXCLUSIVELY FROM LASKY'S—COMP. WITH INS. DATA AND SUGGESTED CIRCUIT APPLICATIONS

LASKY'S PRICE 52/6 Post 2/6

GET YOUR LASKY'S AUDIO-TRONICS PICTORIAL
16 colour pages in large 16 x 11 in. format packed with 1,000's of items from our vast stocks. Hi-Fi, Radio, Electronics, Test equipment, Components, etc., etc. Send 1/- for post only and inclusion on our regular mailing list. (5/- overseas)

Lasky's Radio Limited

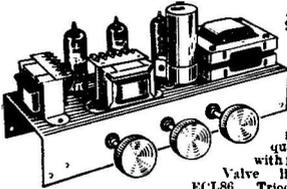
Branches
207 EDGWARE ROAD, LONDON, W.2 Tel: 01 723 3271
33 TOTTENHAM CT. RD., LONDON, W1 Tel: 01 636 2605
152, 3 FLEET STREET, LONDON, E.C.4 Tel: 01 353 2433

High Fidelity Audio Centres
42-45 TOTTENHAM CT. RD., LONDON, W.1 Tel: 01 580 2573
Open all days 9 a.m. to 6 p.m. Mondays to Saturdays
118 EDGWARE ROAD, LONDON, W.2 Tel: 01 723 9789
Open all days, Saturdays, early closing 1 p.m. Thursdays



ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL STREET, TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully insulated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up—ECL86 Triode Pentodes.

1 x E280 as full wave 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. x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price 8 gu. P. & P. 8/-.

TRANSISTOR STEREO 8 + 8 MK II

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit 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 specification: Freq. response $\pm 3dB$. 20-20,000/c/s. Bass boost approx. to $+12dB$. Treble cut approx. to $-16dB$. Negative feedback 18dB over main amp. Power requirements 25V at 0.6 amp. PRICES: AMPLIFIER KIT **£16.10.0**; POWER PACK KIT **£2.0.0**; CABINET **£2.0.0**. All Post Free. Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).



SPECIAL PURCHASE!
E.M.I. 4-SPEED PLAYER
Heavy 8 1/2in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with 4/6 stylus for LP/78. ONLY **£8.-**. P. & P. 6/6.

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing. B.S.R. UA25 with latest mono compatible cart. ... **£6.19.6**
All plus carriage and Packing 6/6.
LATEST GARRARD MODELS. All types available 1025 2025 SP25; 3000; A760 etc. Send S.A.E. for Latest Prices!
PLININ UNITS cut out for Garrard Models 1025, 2025, 3000, 3000, AT60, SP25. With Transparent Plastic cover. OUR PRICE 5 gu. complete. P. & P. 8/6.

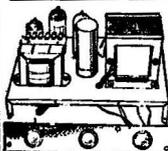
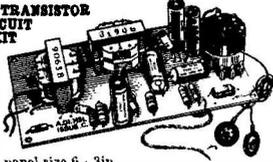
SONOTONE STANC compatible Stereo Cartridge with diamond stylus 50/- P. & P. 2/-.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. 22/6. P. & P. 2/-.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. 30/- P. & P. 2/-.
FEW ONLY! ACOS HIGH-G Mono Cartridge for EP and LP. Only 10/- P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT

Type TAI

- Peak output in excess of 1 1/2 watts.
- All standard British components.
- Built on printed circuit panel size 6 x 3in.
- Generous size Driver and Output Transformers.
- Output transformer fitted for 3 ohm and 15 ohm speakers.
- Transistors (GTT114 or 51 Mullard AC108D).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately.

SPECIAL PRICE 45/-. P. & P. 3/-.
Also ready built and tested, **52/6**. P. & P. 3/-.

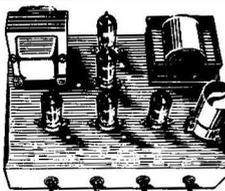


3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2in. x 4in. d. x 4 1/2in. h. Incorporates ECC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0**. P. & P. 6/-.
Speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0**. P. & P. 6/-.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 ohm 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 E280 rectifier. Simple instruction booklet 2/6 (free with parts). All parts sold separately, ONLY **£7.9.6**. P. & P. 8/6. Also available ready built and tested complete with 8 pin input sockets, **£9.5.0**. P. & P. 8/6.

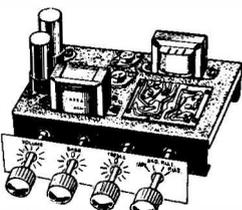


LOUDSPEAKER BARGAINS

5in. 3 ohm. 16/- P. & P. 3/-; 7 x 4in. 3 ohm. 21/- P. & P. 4/-; 10 x 6in. 3 ohm. 27/6. P. & P. 6/-; E.M.I. 8 5in. 3 ohm. with high flux magnet 21/- P. & P. 4/-; E.M.I. 13 1/2 x 8in. 3 ohm. with high flux ceramic magnet 42/- (15 ohm 46/-). P. & P. 6/-; E.M.I. 13 8in. 3 or 15 ohm. with two built-in tweeters and crossover network 4 gu. P. & P. 6/-.
BRAND NEW. 12in. 15W H/D Speakers, 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0**. P. & P. 7/6. Guitar models: 25w. 46; 35w. **£5.8.0**. E.M.I. 3in. **HEAVY DUTY TWEETERS**. Powerful ceramic magnet. Available in 3 or 8 ohms 15/- each; 15 ohms 18/6 each. P. & P. 2/6.
"M" TWIN COME LOUDSPEAKER. 10 watts peak handling. 8 or 15 ohm. 37/6 P. & P. 6/-.
35 OHM SPEAKERS
3 1/2in. 14/- P. & P. 2/6; 7 1/2in. 21/- P. & P. 4/-.
VYAIR AND KEXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price 13/6 yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

NEW! HSL.700 MONO TRANSISTOR AMPLIFIER

A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in asymmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200-240v. Controls: bass, treble, volume/on/off. Function selector for P.U1, P.U2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish. Size 9 1/2 x 5 x 4 1/2in. high. Performance figures:



Sensitivity—PU1—50mV, 56K input impedance. PU2—110mV, 1 meg input impedance. Tape—110mV, 1 meg input impedance. Radio—110mV, 1 meg input impedance. Output power measured at 1Kc—6.2 watts RMS into 3 ohms, 5.8 watts RMS into 15 ohm. Overall frequency response 30c/s—18Kc/s; Continuously variable tone controls. Bass, +8db to -; -12db at 100c/s. Treble, +16db to -30db at 10Kc/s. The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder pre amp but is also capable of being used in conjunction with a guitar by connecting to PU1 socket and the peak output power will then be in the region of 15 watts. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

OUR SPECIAL PRICE **£7.19.6**. P. & P. 7/6.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE 21/- P. & P. 1/6.
CARBON MIKE INSERTS. Brand New. 2 1/2in. dia. 5/- P. & P. 1/6.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, E280 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 3 d. x 6 h. Ready built and tested. PRICE 75/- P. & P. 6/-. ALSO AVAILABLE (mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.)

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14 1/2 x 12in., clearance 2in. below, 5 1/2in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 x 15 x 8in. PRICE 79/6. P. & P. 9/6.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS
Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V. half wave at 1 amp. or 10-20-30-40-50-60-80V. at 2 amps full wave. Size 3 1/2 x 3 1/2 x 3 1/2in. Price 39/6 P. & P. 6/-.
MAINS TRANSFORMER. Primary 200-240V two separate 1/2 wave secondaries giving approx. 16V at 1 amp and 20V at 1.2 amp; secs. can be connected in series for 36V at 1.5 amp. Ideal for transistor power supplies. Drop through mounting. Stack size 2 1/2 x 3 1/2 x 1 1/2in. 18/- P. & P. 0/-.
MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-9-9 at 500mA. 11/- P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. 14/6. P. & P. 3/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. 27/6. P. & P. 3/6.

Open all day Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon
Tube Station

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, LONDON, S.W.19 Tel. 01-540 3985
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)
PLEASE NOTE: P. & P. CHARGES
QUOTED APPLY TO U.K. ONLY.
P. & P. ON OVERSEAS ORDERS
CHARGED EXTRA.

SEND S.A.E. FOR NEW STOCK LIST		WENTWORTH RADIO 104 SALISBURY ROAD HIGH BARNET		01-449 3087	
ACY17	7/7	MAT100	7/9	NKT213	6/-
ACY18	4/6	MAT101	8/6	NKT214	3/9
ACY19	5/-	2N355	7/6	NKT215	4/9
ACY20	4/9	2N388H	8/6	NKT216	10/-
ACY21	5/-	2N694	5/6	NKT217	10/6
ACY22	5/-	2N696	5/6	NKT218	5/6
AF116	2/9	2N697	5/-	NKT219	5/6
AF117	2/9	2N706	5/3	NKT220	5/3
AF139	7/6	2N706A	3/3	NKT221	5/3
AF259	7/6	2N708	3/9	NKT222	5/3
BC107	4/-	2N709	11/9	NKT223	5/3
BC108	3/9	2N914	7/6	NKT224	3/3
BC109	3/9	2N916	5/6	NKT225	4/-
OC44	2/6	2N918	11/-	NKT226	4/-
OC45	1/8	2N929	7/-	NKT227	4/-
OC70	4/6	2N930	8/-	NKT228	4/-
OC71	2/3	2N1131	10/-	NKT229	4/-
OC72	2/6	2N1132	12/9	NKT230	4/-
OC73	3/9	2N3391	6/-	NKT231	4/-
OC75	3/9	2N3391A	6/9	NKT232	4/-

ORGAN BUILDERS!

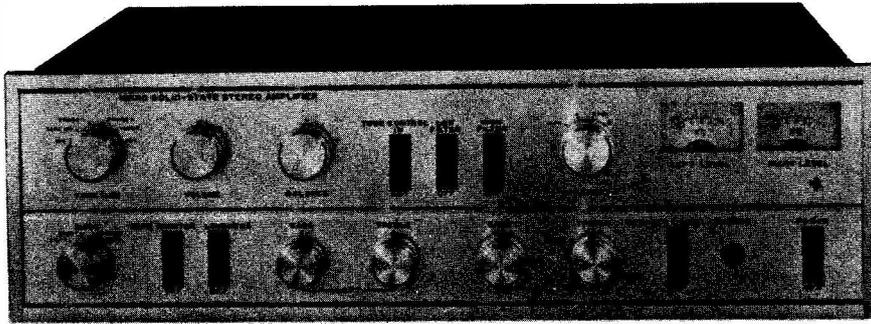
Use our bistable dividers for your tone sources and cut your costs by more than half.

A small printed board with four complete transistor dividers will cost you only 18/6 including postage so why pay more?

Removed from working equipment, each circuit is meticulously inspected and tested before dispatch.

Just send a S.A.E. for free details to:

Roger Allen
13 Millways
Great Totham, Essex



Japanese Nikko TRM120 stereo amplifier

Its U.K. distributors are Howland West Limited, 2 Park End, South Hill Park, London, N.W.3.

MUSIC SUITE

Those who are looking for something less powerful and much more compact may find the new Goodmans "Music Suite" more to their liking. This comprises three matching items which include the latest Goodmans 3000 integrated stereo tuner amplifier, their 3025 record player complete with pick-up arm and cartridge and a pair of 3005 loudspeakers all for £140 9s 4d.

This hi fi system will be in the shops by the time this article appears in print and will be featured at the forthcoming "Audio and Photocine Fairs".

The tuner amplifier features include preset tuning and push button station selection, automatic frequency control, a built-in stereo decoder, 12 watts r.m.s. output power per channel, inputs for pick-up and tape, and a socket for stereo headphones with automatic speaker muting.

LOW DISTORTION POWER AMPLIFIER MODULES

Home constructors will be interested in the transistor power amplifier modules available from Welbrook Engineering and Electronics Limited. The makers claim a distortion level of not greater than 0.1 per cent at all output levels, which is achieved by a special Welbrook circuit design.

These power stage modules which are used in the Welbrook integrated stereo amplifiers, are rated for 15 watts r.m.s. into 8 ohms or 10 watts r.m.s. into 15 ohms and require an input signal of 100mV for full output. Power requirements are 45V at 0.7A per

module. The Modules cost £8 each or two modules (for stereo) £15. Details from Welbrook Engineering and Electronics Limited, Brooks Street, Stockport, Cheshire.

RECORD PLAYER KIT

A kit of parts for building a record transcription unit should also prove attractive to construction minded hi fi enthusiasts. This is the Sugden kit for building their well-known Connoisseur BD1 record turntable which caters for 33½ and 45 r.p.m. discs and costs £11 13s 5d.

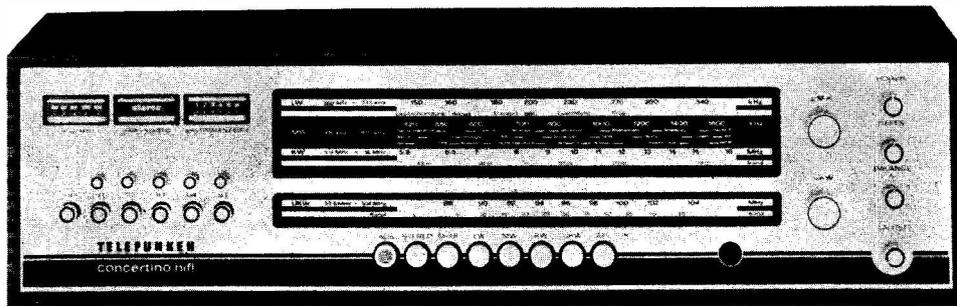
It will accommodate any of the popular pick-up arms and the only tools required for assembly are a screwdriver and pliers. Further details can be obtained from A. R. Sugden and Co. Ltd., Market Street, Brighouse, Yorks.

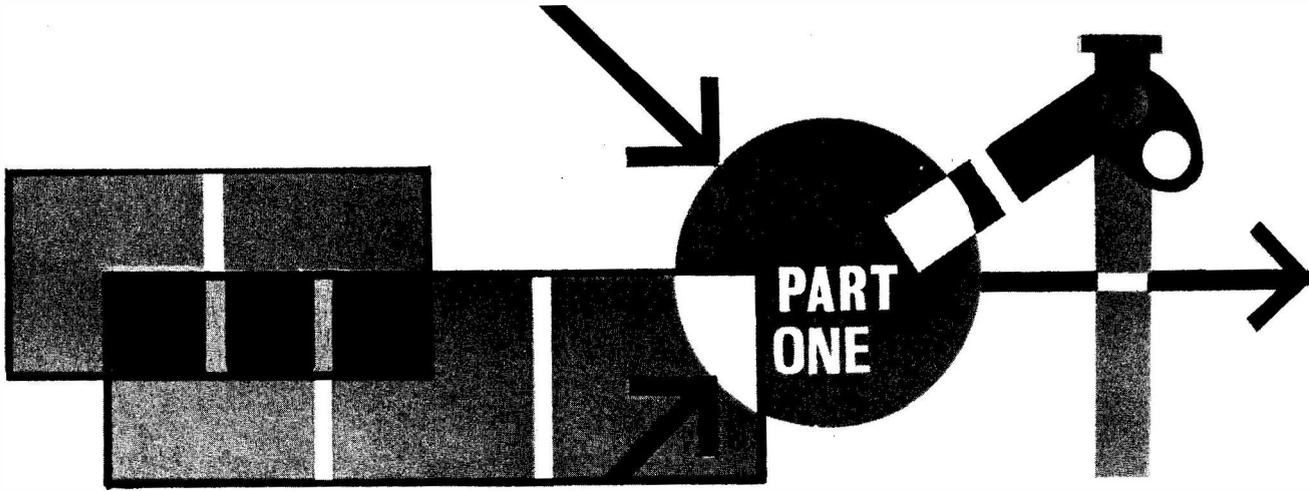
NEW TUNER AMPLIFIER

One final item is a new hi fi stereo tuner amplifier from Telefunken called the "Concertino". The tuner section covers the v.h.f./f.m. and short, medium and long wave bands and features a pre-tuned station selection system, an electronic tuning indicator and stereo decoder.

The makers claim 22 watts music power (15 watts r.m.s.) per channel and an overall performance to the German DIN 45-500 standard. The amplifier caters for pick-up and tape inputs, and has a conventional active tone control system for bass and treble. Price £103 19s 0d. Distributed in the U.K. by A.E.G. (Great Britain) Limited, 27 Chancery Lane, London, W.C.2.

Telefunken "Concertino" stereo tuner amplifier





By P. GOODES

Model railway is just one of several examples in which logic switching circuits can be fully exploited. This is the first of a short series describing these circuits and how they can be usefully employed to take over much of the complex operations of a large scale model railway system

A MODEL railway layout can eventually reach a size and complexity where it is more than a full time job to keep all trains and ancillaries running smoothly. Naturally, an excess of automation *can* take all the fun out of the hobby from the modelling angle, so it is the intention of this series to present a system which would be acceptable to the model enthusiast and electronics gadgeteer alike.

All the ideas to be described make use of simple standard switching circuits. These circuits comprise the bistable, the monostable, a relay buffer, the inverter, the AND gate, the OR gate, the divider, the shift register, and a motor control amplifier. The circuits have been designed to be straightforward and reliable and to use the minimum variety of components in an attempt to keep the cost within reasonable limits.

Constructional details are deliberately omitted because the final form of construction will depend on the complexity of the system to be used. It is expected that anyone contemplating the making of a logic system will be able to use established methods (to choice) of modular construction.

LOGIC SWITCHING

A logic sequence in electronics may be considered as a series of switching functions to give a particular result for a particular set of input conditions and a pre-determined set of operating instructions which are incorporated by the designer. Consider the circuit shown in Fig. 1.1a. The voltage across R may be either 12V when S1 is closed or zero when S1 is open. Thus we have two definite states whereby we can answer the

statement "S1 is open" by "true" or "false". It is normal in logic circuitry to represent these two states by 1 and 0 on paper, and electronically they may be represented by "voltage" and "no voltage", positive or negative. This is purely arbitrary but in this discussion it has been decided that -12V should be represented by 1 and zero represented by 0. A transistor may be considered to have two definite states, first when it is fully conducting, i.e. the collector voltage is approximately zero, and the transistor is thus effectively a short circuit. The second state is when the transistor is cut off so that no current flows through the transistor and the collector voltage to all intents and purposes is equal to the supply voltage (see Fig. 1.1b).

This then forms the basic electronic switch and various operations may be performed by inter-connecting these switches in different ways. Pulses are transmitted throughout the control circuit and the different elements prepared according to their characteristics, i.e. 1 or 0.

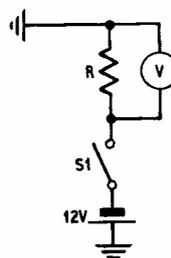


Fig. 1.1a. Simple electrical switching circuit

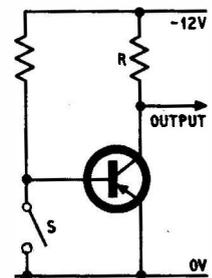
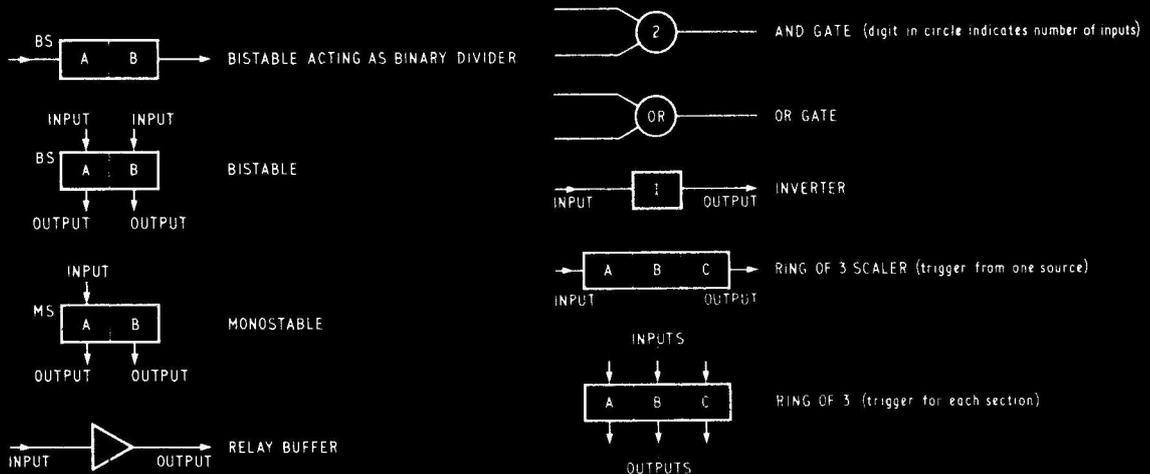


Fig. 1.1b. Simple transistor switching circuit

LOGIC CIRCUIT SYMBOLS



A number of standard circuits are employed. A brief description of these circuits is given here.

BISTABLE CIRCUIT

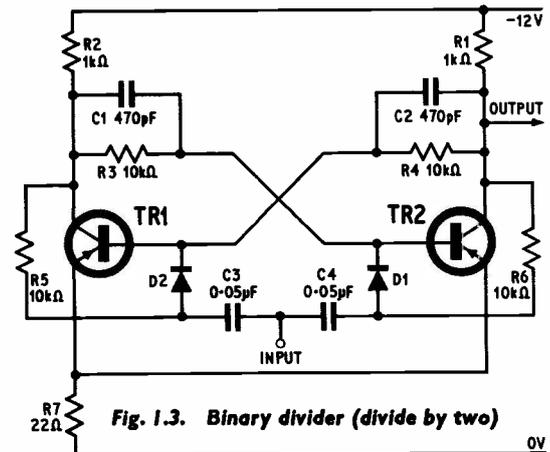
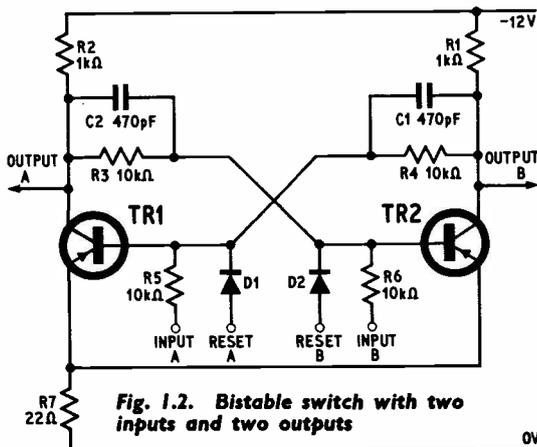
The circuit in Fig. 1.2 comprises two switches with their inputs and outputs cross-connected. Assume TR1 is conducting (state 0) and TR2 is cut off (state 1) due to TR1 collector voltage being at 0V (base-emitter junction is reverse biased). A negative trigger pulse applied to the base of TR2 causes it to start conducting and its collector voltage to rise. This rise is amplified and inverted by TR1 and fed back via C2 and R3 to assist the trigger in driving TR2 on. This regenerative effect finally results in the state where TR1 is cut off (state 1) and TR2 is conducting hard (state 0). Thus on receipt of a trigger pulse the output at TR2 collector has changed from 1 to 0 and the output from TR1 collector has changed from 0 to 1. The circuit will remain in this condition until a negative pulse is applied to the base of TR1 when the circuit will revert back to its original condition.

BINARY DIVIDER

The binary divider performs in a similar manner to the bistable described above, except that it may be triggered back and forth from a common pulse input. See Fig. 1.3. Diodes D1 and D2 perform the function of steering the positive spike of the differentiated input pulse to the transistor which is hard on, thereby cutting it off. Thus for every two pulses coming in, one comes out, i.e. the circuit has divided the incoming pulse train frequency by two.

MONOSTABLE CIRCUIT

The circuit in Fig. 1.4 may be used for generating a fairly accurate time delay or a pulse of a particular width. As can be seen the circuit is similar to the bistable, but one of the resistor coupling networks is replaced by a capacitor resistor network. Initially TR2 is conducting due to the base bias via R3, its collector voltage holding TR1 base sufficiently close to 0V for TR1 to be cut off. A negative trigger pulse (1) applied to TR1 base causes a rise in voltage at its



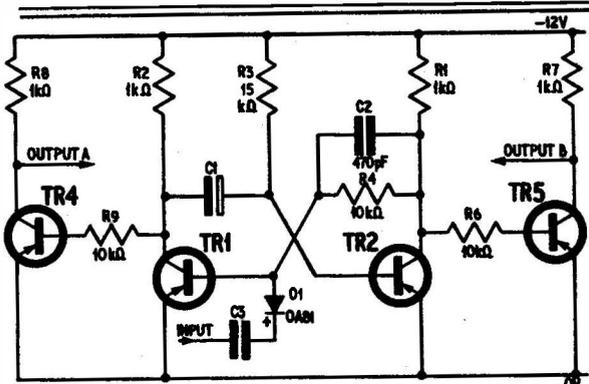


Fig. 1.4. Monostable with two outputs

collector. This is coupled via C1 to TR2 base which amplifies and inverts, assisting in driving TR1 hard on; hence TR2 cuts off. Capacitor C1 then discharges at a time constant $C_1 R_3$, and TR2 base voltage falls until it starts conducting. The collector of TR2 rises, cutting off TR1; the initial state is reached once more and remains so until another trigger pulse is received.

AND GATE

The AND gate for negative pulses is shown in Fig. 1.5. If any one input (A), (B) or (C) is at 0V then its associated diode is forward biased (i.e. an effective short circuit) and output (D) assumes this potential of 0V. However, if all three inputs are at a voltage of $-V$ volts, then each diode is reverse biased, representing a resistance of approximately 100 kilohms, and the output is approximately $-V$. An analogy may be drawn here to the simple circuit also shown in Fig. 1.5, where the output is negative only if all three switches are open. If any one is closed the output adopts 0V. This may be represented by the 1-0 notation bearing in mind that negative is represented by 1, and 0V is represented by 0.

OR GATE

The OR gate is shown in Fig. 1.6. If any one input (A), (B) or (C) goes negative, then the output at (D) is negative. The output is at 0V only if all inputs are at 0V. Here again an analogy may be drawn to a simple switching circuit as shown and the results are drawn up in the associated table.

RELAY BUFFER

This is a simple amplifier (Fig. 1.7) with an emitter follower at the input to offer a fairly high input resistance to the rest of the circuit. The output is used to operate a 230Ω relay when the input is 1. It may be turned into a single shot buffer by replacing R1 by a 0.33µF capacitor, in which case the relay operates and then falls out even if the 1 is maintained at the input.

The single shot unit is used in many cases where the relay is employed to operate a "points" motor coil. "Points" motor coils tend to get rather hot when permanently connected to the supply.

The diode across the relay coil acts as a transient suppressor to protect the transistor.

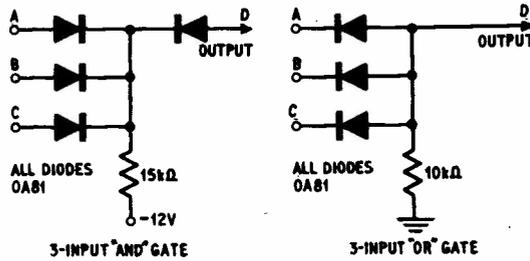
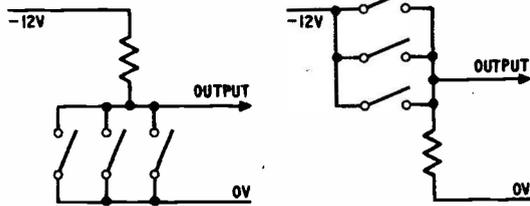
RING OF THREE SCALER

The ring of three scaler (or shift register) shown in Fig. 1.8 performs a similar function to a bistable except that it has three stable states whereas the bistable has only two.

Any one transistor (say TR1) can be off, i.e. in state 1 and this holds the other two transistors hard on. Since TR1 collector is at about $-12V$ this means that diode D1 is forward biased via R10. When a 0 trigger is applied to the input line, D1 passes this to the capacitor C2. Diodes D2 and D3 do not conduct this pulse since they are reverse biased. Thus the 0 trigger is passed only to the base of TR2, cutting off TR2, causing TR1 and TR3 to conduct hard and biasing diode D2 ready for the next 0 pulse which will cut off TR3. Thus the impulses at the input cause each transistor in turn to adopt a 1 state.

The circuit may be used as a sequence counter or alternatively as a straightforward "divide-by-three" circuit.

The principle may be extended for use as a ring of five scaler by adding on transistors and inserting resistors to ensure that each base is connected to any collector via a resistor.



3-INPUT AND GATE

A	B	C	D
0	0	1	0
0	1	0	0
1	0	0	0
1	1	0	0
1	0	1	0
0	1	1	0
1	1	1	1
0	0	0	0

3-INPUT OR GATE

A	B	C	D
0	0	1	1
0	1	0	1
1	0	0	1
1	1	0	1
1	0	1	1
0	1	1	1
1	1	1	1
0	0	0	0

Fig. 1.5. Three-input AND gate and logic table

Fig. 1.6. Three-input OR gate and logic table

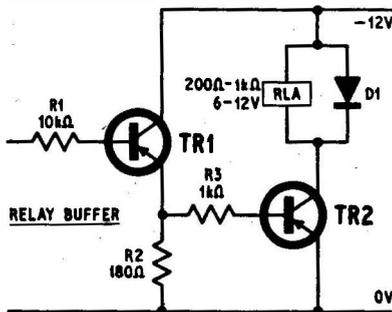


Fig. 1.7. Relay buffer stage. R1 may be replaced by a 1µF capacitor, for single shot buffer, R1 to be short circuit when used with AND gate

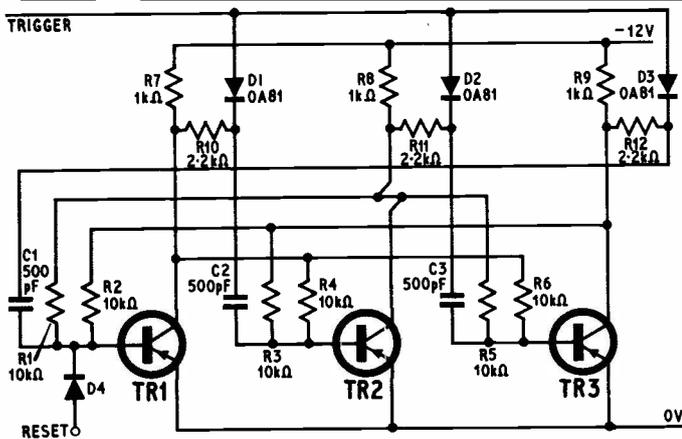


Fig. 1.8. Ring of three scaler

The circuit may be triggered from independent sources. In this case the triggering circuitry, D1 to D3, R10 to R12, C1 to C3 may be omitted and each transistor is triggered via diodes connected in a similar manner to the rest.

MOTOR CONTROL AMPLIFIER

In the circuit shown in Fig. 1.9 when input (A) is at zero, TR1 is cut off with approximately -12V on its collector. This causes TR2 and TR3 to be conducting hard and power to be applied to the motor. When a 1 input is applied to input (A), TR1 starts conducting hard causing TR2 and TR3 to cut off; thus the motor stops. Diode D2 is included in the motor circuit and acts as a quench on the back end of the motor when it stops. Resistor R4 acts as a dummy load, when there is no motor to be run.

When a straightforward stop or start action is required, input (A) is used. When used in conjunction with a slow down circuit, input (B) is used.

The speed of the motor may be adjusted by varying the supply to the amplifier by means of the rheostat on the ordinary train controller. If a separate unregulated d.c. supply is used, a base biasing arrangement on TR1 will control the motor speed.

Transistor TR3 should be mounted on a small heat-sink, and in the author's model a piece of aluminium $\frac{1}{8}\text{in} \times 2\frac{1}{2}\text{in} \times 1\frac{1}{2}\text{in}$ was found to suffice.

SLOW DOWN/SPEED UP

This circuit (Fig. 1.10) is basically a very simple version of the Miller integrator. It is controlled by some other circuit (e.g. monostable or bistable) and

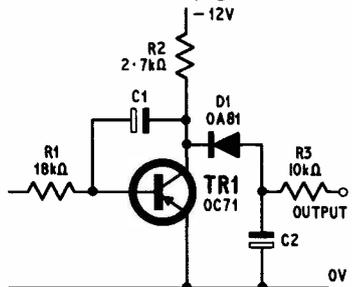


Fig. 1.10. Miller integrator used to slow down or speed up a motor

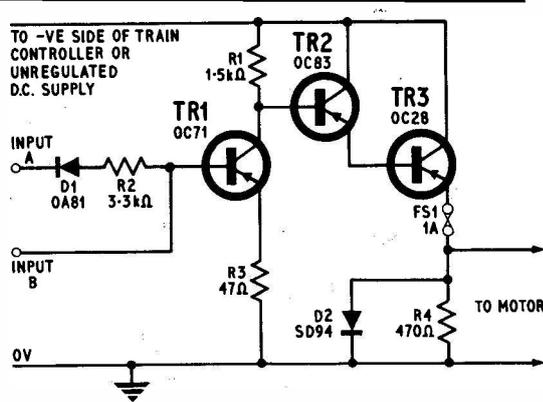


Fig. 1.9. Motor control amplifier

generates a rather poor ramp voltage. Normally there is a 1 at the input which means that the collector is at 0 volts. When a 0 is applied at the input the transistor tries to cut off, but is slowed down by the feedback via C1. This causes the collector voltage to fall with a relationship to time. As the transistor cuts off, C2 charges via D1.

When the input returns to 1, C1 discharges quickly and the collector of TR1 returns to 0V. D1 is now reversed biased and C2 has to discharge via R3 in series with the input resistance of the motor control amplifier. Capacitors C1 and C2 are selected values depending on external circumstances, for example, length of train, length of isolated sections in the signalling system and so on. Remember that C1 will basically determine the slowing down rate of the train and C2 the speed-up time. The author used $25\mu\text{F}$ for C1 and C2 and a fairly realistic effect was obtained.

The circuit may be used also to stop a train in a station for a given length of time by triggering from a monostable with a time constant equivalent to the time required to stop in the station.

INVERTER

This is a very simple one transistor amplifier (Fig. 1.11). When the input is 1, TR1 conducts hard causing a 0 in the output. When the input goes to 0, TR1 cuts off and a 1 output results. Thus where we did have a 1 we now have a 0 and vice versa. R1 may alternatively be connected from the base to -12V as in Fig. 1.12. A switch connected between base and 0V will give a 0 output when open and a 1 output when closed.

Next month: Interlocking Signalling Systems

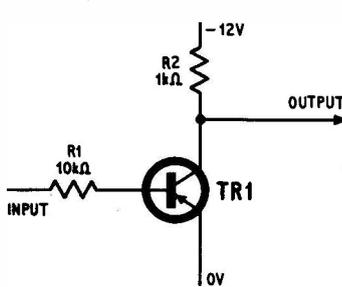


Fig. 1.11. Simple one transistor amplifier used as an inverter

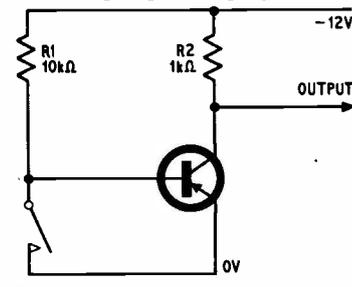
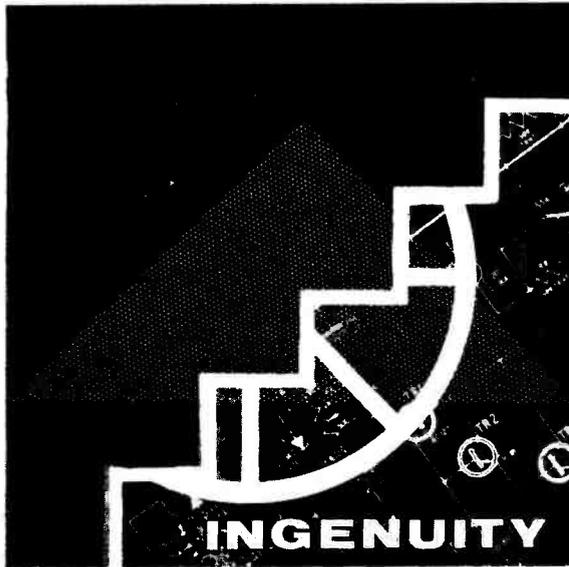


Fig. 1.12. Alternative bias and switching arrangement of the inverter



UNLIMITED!

A selection of readers' suggested circuits. It should be emphasized 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 merit.

STOCKS AND SHARES

ENCLOSE two ideas for giving an added interest to your recent article on an Electronic Stockmarket game published in the December 1968 issue.

Bank Raid Insurance

The first addition to the game is a simple timing circuit which is used as a bank raid insurance.

The time delay of the circuit shown in Fig. 1 is approximately 2 minutes, but this can be varied according to the value of capacitor C1 which can be any value from 500 μ F to 5,000 μ F depending on how long the games usually last. The relay RLA can be any sensitive 8-9V type with one set of make contacts.

The extra capacitor C2 and switch S3 shown dotted in the circuit diagram can be included to double the length of the insurance period if over three people are playing.

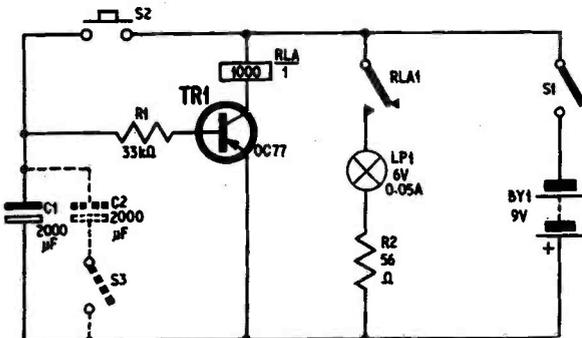


Fig. 1. Circuit-diagram of the bank raid insurance

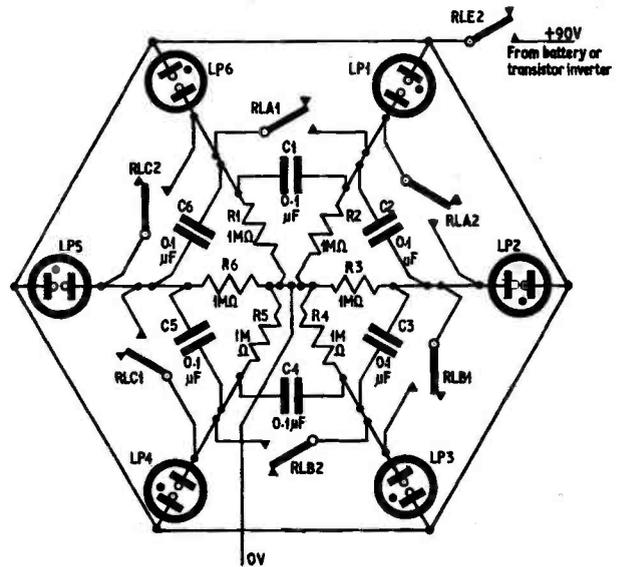


Fig. 2. The neon indicator arrangement for the electronic dice

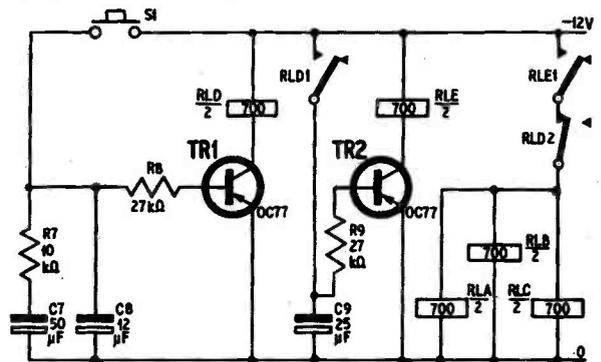


Fig. 3. Switching circuit for the electronic dice

The rules for the insurance are quite simple, and upon throwing a three a player may, if he wishes, forfeit his turn to transact or transfer his cash to his bank and instead "buy" insurance by pressing S2 and starting the timer. This insurance lasts until the lamp is extinguished and then the player is again vulnerable to a bank raid. Only one player may use this insurance at one time.

Electronic Dice

The final addition to the game is a completely automatic electronic dice. The circuit is shown in Figs. 2 and 3 and when S1 is pressed the neons light rapidly in turn for 2-8 seconds. The "throw" lights up for approximately 2 seconds, then the circuit switches itself off.

The neon bulbs can be arranged in a hexagon in a space on the Stockmarket top, with the circuit components mounted on the underside or installed in a separate case.

The relays used in the dice are 12V types with two sets of make and two break contacts. The neons are 65V miniature glass types and an ideal supply is a transistor inverter which gives 80-100 volts at approximately 5 milliamps or less, as the neons require very little power.

Andrew Copsey,
Pudsey, Yorks.

L.S.T. ELECTRONIC COMPONENTS LTD.

1N914	2/-	AC107	14M	BF159	15/-	OAZ243	3/6
1N113	2/6	AC126	4/6	BF163	9/6	OAZ243	3/6
1N130	2/6	AC128	4/6	BF173	7/6	OAZ239	3/6
1N131	2/6	AC176	7/6	BF180	6/6	OAZ239	3/6
1N132	2/6	AC176	7/6	BF180	6/6	OAZ239	3/6
2N201	4/-	AC188	12/-	BF184	7/6	OC19	3/-
2N202	3/9	ACV11	5/6	BPW35	7/6	OC22	13/-
2N281	5/-	ACV18	5/6	BPW58	7/6	OC22	13/-
2N374	5/-	ACV19	4/4	BPW59	4/6	OC23	13/-
2N381	5/-	ACV20	2/8	BPW60	4/6	OC24	13/-
2N371	5/-	ACV21	4/4	BPX13	4/8	OC25	13/-
2N385A	15/-	AD72	2/4	BPX29	8/6	OC28	12/-
2N386A	15/-	AD140	15/-	BSX11	8/6	OC29	15/-
2N406	4/-	AD149	11/8	BPY51	6/-	OC30	7/6
2N407	4/-	AD151	6/-	BPY52	6/-	OC30	7/6
2N408	4/-	AD162	6/-	BPY53	6/-	OC35	9/6
2N409	4/-	AD163	10/6	BSX20	3/6	OC35	9/6
2N408	4/-	AD164	10/6	BSX21	3/6	OC31	3/6
2N410	4/-	AD174	4/4	BSY27	4/-	OC42	4/-
2N411	7/6	AD175	4/4	BSY28	4/-	OC42	4/-
2N412	7/6	AD176	4/4	BSY29	4/-	OC42	4/-
2N413	7/6	AD177	4/4	BSY30	4/-	OC42	4/-
2N414	7/6	AD178	4/4	BSY31	4/-	OC42	4/-
2N415	7/6	AD179	4/4	BSY32	4/-	OC42	4/-
2N416	7/6	AD180	4/4	BSY33	4/-	OC42	4/-
2N417	7/6	AD181	4/4	BSY34	4/-	OC42	4/-
2N418	7/6	AD182	4/4	BSY35	4/-	OC42	4/-
2N419	7/6	AD183	4/4	BSY36	4/-	OC42	4/-
2N420	7/6	AD184	4/4	BSY37	4/-	OC42	4/-
2N421	7/6	AD185	4/4	BSY38	4/-	OC42	4/-
2N422	7/6	AD186	4/4	BSY39	4/-	OC42	4/-
2N423	7/6	AD187	4/4	BSY40	4/-	OC42	4/-
2N424	7/6	AD188	4/4	BSY41	4/-	OC42	4/-
2N425	7/6	AD189	4/4	BSY42	4/-	OC42	4/-
2N426	7/6	AD190	4/4	BSY43	4/-	OC42	4/-
2N427	7/6	AD191	4/4	BSY44	4/-	OC42	4/-
2N428	7/6	AD192	4/4	BSY45	4/-	OC42	4/-
2N429	7/6	AD193	4/4	BSY46	4/-	OC42	4/-
2N430	7/6	AD194	4/4	BSY47	4/-	OC42	4/-
2N431	7/6	AD195	4/4	BSY48	4/-	OC42	4/-
2N432	7/6	AD196	4/4	BSY49	4/-	OC42	4/-
2N433	7/6	AD197	4/4	BSY50	4/-	OC42	4/-
2N434	7/6	AD198	4/4	BSY51	4/-	OC42	4/-
2N435	7/6	AD199	4/4	BSY52	4/-	OC42	4/-
2N436	7/6	AD200	4/4	BSY53	4/-	OC42	4/-
2N437	7/6	AD201	4/4	BSY54	4/-	OC42	4/-
2N438	7/6	AD202	4/4	BSY55	4/-	OC42	4/-
2N439	7/6	AD203	4/4	BSY56	4/-	OC42	4/-
2N440	7/6	AD204	4/4	BSY57	4/-	OC42	4/-
2N441	7/6	AD205	4/4	BSY58	4/-	OC42	4/-
2N442	7/6	AD206	4/4	BSY59	4/-	OC42	4/-
2N443	7/6	AD207	4/4	BSY60	4/-	OC42	4/-
2N444	7/6	AD208	4/4	BSY61	4/-	OC42	4/-
2N445	7/6	AD209	4/4	BSY62	4/-	OC42	4/-
2N446	7/6	AD210	4/4	BSY63	4/-	OC42	4/-
2N447	7/6	AD211	4/4	BSY64	4/-	OC42	4/-
2N448	7/6	AD212	4/4	BSY65	4/-	OC42	4/-
2N449	7/6	AD213	4/4	BSY66	4/-	OC42	4/-
2N450	7/6	AD214	4/4	BSY67	4/-	OC42	4/-
2N451	7/6	AD215	4/4	BSY68	4/-	OC42	4/-
2N452	7/6	AD216	4/4	BSY69	4/-	OC42	4/-
2N453	7/6	AD217	4/4	BSY70	4/-	OC42	4/-
2N454	7/6	AD218	4/4	BSY71	4/-	OC42	4/-
2N455	7/6	AD219	4/4	BSY72	4/-	OC42	4/-
2N456	7/6	AD220	4/4	BSY73	4/-	OC42	4/-
2N457	7/6	AD221	4/4	BSY74	4/-	OC42	4/-
2N458	7/6	AD222	4/4	BSY75	4/-	OC42	4/-
2N459	7/6	AD223	4/4	BSY76	4/-	OC42	4/-
2N460	7/6	AD224	4/4	BSY77	4/-	OC42	4/-
2N461	7/6	AD225	4/4	BSY78	4/-	OC42	4/-
2N462	7/6	AD226	4/4	BSY79	4/-	OC42	4/-
2N463	7/6	AD227	4/4	BSY80	4/-	OC42	4/-
2N464	7/6	AD228	4/4	BSY81	4/-	OC42	4/-
2N465	7/6	AD229	4/4	BSY82	4/-	OC42	4/-
2N466	7/6	AD230	4/4	BSY83	4/-	OC42	4/-
2N467	7/6	AD231	4/4	BSY84	4/-	OC42	4/-
2N468	7/6	AD232	4/4	BSY85	4/-	OC42	4/-
2N469	7/6	AD233	4/4	BSY86	4/-	OC42	4/-
2N470	7/6	AD234	4/4	BSY87	4/-	OC42	4/-
2N471	7/6	AD235	4/4	BSY88	4/-	OC42	4/-
2N472	7/6	AD236	4/4	BSY89	4/-	OC42	4/-
2N473	7/6	AD237	4/4	BSY90	4/-	OC42	4/-
2N474	7/6	AD238	4/4	BSY91	4/-	OC42	4/-
2N475	7/6	AD239	4/4	BSY92	4/-	OC42	4/-
2N476	7/6	AD240	4/4	BSY93	4/-	OC42	4/-
2N477	7/6	AD241	4/4	BSY94	4/-	OC42	4/-
2N478	7/6	AD242	4/4	BSY95	4/-	OC42	4/-
2N479	7/6	AD243	4/4	BSY96	4/-	OC42	4/-
2N480	7/6	AD244	4/4	BSY97	4/-	OC42	4/-
2N481	7/6	AD245	4/4	BSY98	4/-	OC42	4/-
2N482	7/6	AD246	4/4	BSY99	4/-	OC42	4/-
2N483	7/6	AD247	4/4	BSY00	4/-	OC42	4/-

CHEAPEST EVER SOLID-STATE SALE

BEST VALUE IN BRITAIN

10 BFY50(1/2) Type NPN TO-18 case. NPN and PNP mixed. 10/-

40 Silicon Planar Transistors. TO-18 case. NPN and PNP mixed. Similar V405A, P346A, etc. Not tested or coded. Guaranteed minimum 50% good. 10/-

10 Silicon Planar PNP 3 watt similar BSX40 2N2904/A, etc. TESTED. Not coded. Gold plated cases. 10/-

30 Silicon Planar Transistors. TO-18 case. NPN type similar BC107/8/9 range. Not tested or coded. Guaranteed minimum 50% good. 10/-

3 Silicon Power Transistors similar to BUY11. TO-3 case. Not tested or coded. Gold plated cases. 10/-

20 Germanium Transistors 2G37B. Case SO-2. Fully tested to makers specifications PNP. Equal to OC71 range. Not coded. 10/-

25 Silicon NPN VHF Transistors. TO-18 case. Similar to BSY27, etc. Not tested or coded. 10/-

20 Silicon Planar Transistors. Plastic type. NPN. Similar to 2N3705/7 range. Not tested or coded. Guaranteed minimum 50% good. 10/-

20 Silicon Planar Transistors. Plastic type. PNP. Similar to 2N3702. Not tested or coded. Guaranteed minimum 50% good. 10/-

16 Silicon Rectifiers. Top-Hat case. 750mA + @ 100-1,000 pV. Guaranteed minimum 80% good. 10/-

12 Silicon Avalanche Rectifiers. Top-Hat case 1 amp @ up to 1,200 pV. Guaranteed minimum 80% good. 10/-

15 Silicon Epitaxial Planar Diodes. Sub-miniature. Type SD19 Plesey. Exact substitutes for 1N914, etc. 100% perfect. Not coded. 10/-

30 Part made Top-Hat Rectifiers (top connection broken, but plenty room to solder) 750mA up to 800 pV. Guaranteed minimum 80% good. 10/-

2G37B and SD19 are Manufacturers' tested devices. Other un-coded stock are given type numbers as a guide only. Money refunded if not satisfied. All above packs post free in UK. EXPORT SPECIAL: 10% of the above SALE goods are reserved for export until August 1969.



S-DeCs Single "DeC" with accessories and project manual... 29/6
"2-DeC" kit contains two "DeC's", component tray, accessories, instructive book, all packed in attractive plastic box... 49/6
"4-DeC" kit contains four "DeC's", accessories, manual, etc. 117/6

BOOKS FROM STOCK
"General Electric Transistor Manual", 660 pages of data and circuits... 29/6
"RCA Transistor Manual", 554 pages includes SCR circuits... 29/6
"Designers Guide to British Transistors", Excellent data book lists over 1,000 common types plus computer selected substitution chart... 25/-
(ADD 2/6 POST & PACKING FOR ALL BOOKS)

NEONS
Signal neons for many types of circuits type "N"
Price 1/6 each or 14/- dozen
HEATSHINKS, Suitable for 2 x OC35, etc. As used in commercial equipment. Type 100... 4/-
ALUMINIUM CHASSIS
6 x 4 x 2 1/2 in reinforced corners 4/9 each (P. & B. 1/6). Alty panel to fit. 1/6. Paxolin panel to fit. 2/- Many other sizes in stock up to 12 x 8 x 2 1/2 in (see catalogue)

X-LINE

- X-161 2 Watt Amplifier 29/-
- X-461 Siren 29/-
- X-471 Burglar Alarm 29/-
- X-441 Metronome 29/-
- X-761 Home Controller 29/-
- X-491 Lamp Flasher (Double) 29/-

MODULES YOU CAN OPEN!



Generous discounts to Retailers given on all "X-Line" products. Send for details now.

SILICON RECTIFIERS

PIV	200mA	750mA	2 Amp	10 Amp
50	4d	1/-	2/3	4/6
100	8d	1/6	2/3	4/6
200	1/3	2/-	2/9	5/-
400	2/-	2/6	4/-	9/-
600	—	3/6	4/6	11/-
800	3/-	—	7/9	11/3
1000	—	6/-	6/6	14/-

THYRISTORS - SCRs

PIV	1A	3A	10A	30A	100A
50	7/6	9/-	7/6	25/-	20/-
100	—	10/-	10/-	30/-	22/-
200	9/6	—	12/6	42/-	35/-
300	—	11/-	—	51/-	45/-
400	9/6	12/6	15/-	60/-	48/-
600	—	—	20/-	84/-	128/-
800	—	—	—	—	—

ZENER DIODES

1/2 Watt 10% Tolerance—
Voltages: 3.0 4.7 7.5 12 ALL
1.3 1.8 2.2 3.3 3.6 4.3 5.1 5.6 6.2 6.8 7.5 12 ONE
3-6 5-6 9-1 15 PRICE.
3-9 6-2 10 16
4-3 6-8 11 3/6 ea.
See IR Panel for 1 watt types.
Full range 5 watt also in stock

BC107/8/9 2/9

LOGIC

1-6 7-11 12+
uL500 11/- 9/6 3/4
uL514 11/- 9/6 3/4
uL723 14/- 12/6 11/9
5 page Data and Circuits article... 2/6
Larger quantity prices (100+ and 1,000+ on application)

2N3819 TEXAS FET 8/-

2N2646 GIG-20 JUNCTION 10/-

CRS3/40AF 12/6
SILENCE AVALANCHE TRISTOR 3A
25 + 11/- 100 + 18/3

SC41D DE TRAC 37/-

TD716 TUNNEL DIODE 12/-

BF180 HILLARD VHF AMPLIFIER 6/-

2N3055 115 WATT POWER SILICON NPN 15/-

2N2926 POPULAR PLANAR PNP 2/-

2N4871 MICROLEAK 6/9

LINEAR AMP. IC'S

CA3020 1/2 watt output 9 volt supply... 30/6
(price includes free circuit for Guitar/PA Amplifier!)

TA2463 Tiny Mullard linear only 17/4—data on request

CA3012 Wide band with built in regulation... 27/6

CA3014 3 stage amp. with Darlington output... 32/6

SL701 Plesey lin. amp. for PE circuits... 18/-

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 transducers can transmit and receive.
FREE: With each pair our complete transmitter and receiver circuit.
PRICE £5.18.0 Pair (sold only in pairs)

IOR

SOLAR CELLS
B2H 0.2-0.4 volts @ 2mA Selenium type... 12/6
B3M 0.2-0.4 volts @ 1-23mA Selenium type... 18/-
S1M 0.3-0.4 volts @ 15-16mA Silicon... 33/6
S4M 0.3-0.4 volts @ 25-40mA Silicon... 33/6

SOLAR DRIVE MOTOR
EP50A Runs from sunlight activity on S4M cells (above)... 39/6

PHOTOCONDUCTIVE CELL
CS120 20V 0.4 watt Res 110kohms Min. R @ 10°C = 7.2k R @ 100°C = 800 ohms... 19/8

SOLAR CELL KITS
DD190 Contains 4 Selenium photocells and free 24 page handbook... 9/11
K-421 Super assortment of 7 cells, 3 Selenium, 2 Silicon and 2 Cadmium Sulphide plus 24 page manual... 58/6

TRANSISTOR KITS
DD180 Contains 2 audio and 1 RF transistor plus free manual... 11/4
DD184 Contains audio, RF, and power transistors, Silicon cell and germanium diode. With FREE manual... 33/6

SILICON RECTIFIER KITS
DD175 Contains 4 100 pV 1/2 amp diodes... 9/11
DD176 Contains 2 200 pV 1/2 amp diodes... 5/11
DD177 Contains 2 400 pV 1/2 amp diodes... 9/11
ALL INCLUDE FREE 24 PAGE MANUAL

ZENER DIODES
Available in the following voltages with a dissipation of 1 Watt and tolerance on 10%. All supplied with free manual describing many interesting projects.
3.9V, 4.7V, 5.6V, 6.8V, 8.2V, 10V, 12V, 15V, 18V, 22V, 27V.
ALL ONE PRICE: 7/11

ZENER KIT
DD170 Bargain pack—contains 5 popular 1 watt diodes plus free project manual... 19/6

TRANSISTOR SUBSTITUTION
Our TR01-C to TR10-C range are universal replacements for over 700 JEDEC (2N-...) types. Prices in our FREE Catalogue.
FULL SEMICONDUCTOR CENTRE LISTINGS, DOZENS OF INTERESTING DEVICES IN OUR CATALOGUE.

COMPONENTS

RESISTORS 1/2 OR 1 WATT 5% LOW NOISE CARBON FILM
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms and decades (1.0, x 10, x 100, x 1,000, x 10,000) 1/2 Watt up to 8.2 Decadans (10% tolerance) PRICES: 1.25, 4d, 2s, 3s, 4d, 10s, 2s (your selection) and/or 1 watt mist)
SKELETON PRESET POT'S 20% Tol. Linear, Low noise. Available in sub-miniature or mini size. Horizontal or vertical 100, 250, 500, 1k, 2.5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2.5 Meg, 5 Meg. NEW PRICE: 1/- each or any selection of 12 pieces 16/-.

ELECTROLYTIC CAPACITORS (Mullard)—10% to 20% Tol.
Subminiature (all values in µF)
4V 8 32 64 125 250 500
6V 4 16 32 64 125 250
10V 4 16 32 64 125 250
16V 2.5 10 20 40 80 125
25V 1.6 4 8 16 32 50
40V 1 4 8 16 32 50
60V 0.64 2.5 5 10 20 32
Price 1/6 1/3 1/2 1/1 1/1 1/2

MINI- POLYESTER CAPACITORS Printed circuit type 250V d.c. working. 0.01, 0.015, 0.

PREMIER RADIO

23, TOTTENHAM COURT ROAD, LONDON, W1

Tel: 01-636 3451

OXFORD ST

TOTTENHAM COURT RD
DOMINION

TRANSISTOR STEREO AMPLIFIER

MODEL 2500



An excellent ten transistor Hi-Fi stereo amplifier. Output 5 watts per channel. Inputs for pick-up; tape and radio tuner. Also has tape output socket for direct recording. Controls: Bass, Treble, Volume, Selector, Power on/off and Stereo/Mono switch. Housed in black metal case with teak wood ends and attractive brushed aluminium front panel. Size 12" 5 1/2" 2 1/2" high. PRICE **£14.10.0**. Carr. 7/6. (This amplifier is used in our Budget Stereo System as advertised last month, available at 39 gn. Carr. 35/-)

has tape output socket for direct recording. Controls: Bass, Treble, Volume, Selector, Power on/off and Stereo/Mono switch. Housed in black metal case with teak wood ends and attractive brushed aluminium front panel. Size 12" 5 1/2" 2 1/2" high. PRICE **£14.10.0**. Carr. 7/6. (This amplifier is used in our Budget Stereo System as advertised last month, available at 39 gn. Carr. 35/-)

SPECIAL OFFER OF SHURE STEREO CARTRIDGES

Look at our special prices!

M2D	List £8.10.6	Premier Price £6.10.6
M44-5	List £14.9.1	Premier Price £11.11.0
M44C	List £12.19.5	Premier Price £10.10.0
M44E	List £17.8.4	Premier Price £13.19.6
M55E	List £20.15.1	Premier Price £16.19.6
M75-6	List £17.8.4	Premier Price £13.19.6
M75E	List £25.18.10	Premier Price £21.0.0

Post and Packing 1/6 each

SPECIAL PURCHASE!

EKCO "EXPLORER" CAR RADIO

Frustrated Export Order! A truly dependable and selective car radio giving world-wide reception. 8 transistor. 12v. Pos. or Neg. earth operation. 9 wave bands—M.W. 135-570 metres and 8 S.W. bands, 3.2 Mc/s—17.9 Mc/s (90, 60, 49, 41, 31, 25, 19, 16 Metre Bands). Size 2" h. x 7" w. x 5 1/2" d. Original price £30.

OUR PRICE **21 GNS.** P. & P. 7/6.

(Suitable Philips Speaker, baffle and brackets **£2.13.0**. P. & P. 5/-)

MULTI TESTERS



MODEL D14. A really versatile instrument that makes a handy pocket size tool. Measures a.c. or d.c. voltage in three ranges of 0-15-150-1,000 volts. Resistance 0-100,000 ohms. Current 0-150mA d.c. Size only: 3 1/2" x 2 1/2" x 1 1/2". Complete with battery, test leads and **49/6** P. & P instructions. 2/6.



POCKET SIZE MODEL. With wide-angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt d.c. 10,000 ohms/volt a.c. 19 Ranges: 0-5-25-50-250-500-2,500 volts d.c. 0-10-50-100-500-1,000 volts a.c. 0-50µA-2.5mA-250mA d.c. 0-6,000 ohms-6 megohms, 10µF-0.001 mF-1 mF. -20 to +22dB. Complete battery, test lead and instructions. **£4.19.6** P. & P. 3/6.



HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2 1/2" speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft lead and stereo jack plug. **59/6** P. & P. 5/-.

MONO HEADPHONES 2,000 ohm. 14/8 P. & P. 2/6.
STEREO STETHOSCOPE SET Low imp. 25/- P. & P. 2/-.
MONO STETHOSCOPE SET Low imp. 10/6 P. & P. 2/-.

MONO GRAM AMPLIFIER

2 1/2 watts output. Uses EL84 valve, double wound mains transformer. Ideal for use with any record deck. Volume/on/off and tone controls on flying leads. Output impedance 3 ohms. Size overall 5 1/2" w. x 5 1/2" h. x 3 1/2" d. 200/240V. ONLY **69/6**. P. & P. 5/-.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG FREE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

LPS 3'	250'	P.V.C.	5/6	DT6 5 1/2'	1800'	POLYESTER	22/6
TT8 3'	450'	POLYESTER	7/6	TT6 5 1/2'	2400'	POLYESTER	37/6
DT3 3 1/2'	600'	POLYESTER	11/6	SP7 7'	1800'	P.V.C.	12/6
SP5 5'	600'	P.V.C.	8/6	LP7 7'	1800'	P.V.C.	15/-
LP5 5'	900'	P.V.C.	10/-	DT7 7'	2400'	POLYESTER	25/-
DT5 5'	1200'	POLYESTER	15/-	TT7 7'	3600'	POLYESTER	50/-
LP6 5 1/2'	1200'	P.V.C.	12/6				

TAPE SPOOLS 3' 1/2", 5', 5 1/2", 7' 1/8". TAPE CASES 5', 5 1/2", 7' 2/8". Post and Packing 3' 1/2", 5', 5 1/2", 7' 2/8". (3 reels and over Post Free.)

"PREMIER" TAPE CASSETTES



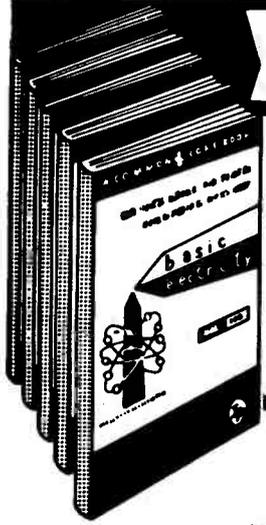
C60	(60 min.)	7/6
C90	(90 min.)	12/6
C120	(120 min.)	17/6

P. & P. 1/-.

YOURS FREE FOR 7 DAYS

The 'New Picture-Book' way of learning BASIC ELECTRICITY (5 VOLS.) ELECTRONICS (6 VOLS.)

You'll find it easy to learn with this outstandingly successful NEW PICTORIAL METHOD—the essential facts are explained in the simplest language, one at a time, and each is illustrated by an accurate, cartoon-type drawing. The books are based on the latest research into simplified learning techniques. This has proved that the PICTORIAL APPROACH to learning is the quickest and soundest way of gaining mastery over these subjects.



The series will be of exceptional value in training mechanics and technicians in Electricity, Radio and Electronics.

WHAT READERS SAY

"I am highly delighted with the books; I didn't know a complicated subject could be so easily presented."

J. K., Earlsfield.

"I am pleased to say how understandable your books are. I have now quite a sound knowledge of Electronics."

P. S., Southgate.

"I know your Manuals will prove invaluable for my training and career as a technician."

J. L., S. Shields.

A TECH-PRESS PUBLICATION

POST NOW FOR THIS OFFER!!

To The SELRAY BOOK CO., 60 HAYES HILL, HAYES, BROMLEY, KENT BR2 7HP
Please send me WITHOUT OBLIGATION TO PURCHASE, one of the above sets on 7 DAYS FREE TRIAL, I will either return set, carriage paid, in good condition within 7 days or send the following amounts. BASIC ELECTRICITY 75/-. Cash Price or Down Payment of 20/- followed by 3 fortnightly payments of 20/- each. BASIC ELECTRONICS 90/-. Cash Price or Down Payment of 20/- followed by 4 fortnightly payments of 20/- each. This offer applies to UNITED KINGDOM ONLY. Overseas customers cash with order, prices as above.

Tick Set required (Only one set allowed on free trial)

BASIC ELECTRICITY BASIC ELECTRONICS

Prices include Postage and Packing.

Signature
(If under 21 signature required of parent or guardian)

NAME

BLOCK LETTERS

FULL POSTAL ADDRESS.....

UNIUNCTION SUBSTITUTE

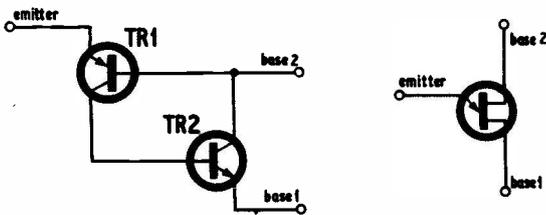


Fig. 1. Substitute for a unijunction transistor compared with the unijunction transistor symbol on the right

MANY experimenters have doubtless seen circuits which make use of a unijunction transistor (u.j.t.) and, not having a device of this type to hand, have fought shy of attempting to build this circuit.

A simple substitute for the unijunction transistor is shown in Fig. 1; the corresponding connections are as indicated.

Both transistors should be silicon, but the actual types used are not critical. I have had success with BSY95A, 2N929, 2N706 and BSY27 for TR1 and OC200 and OC202 for TR2.

When the emitter of TR1 is less positive than the base, neither transistor conducts, but when this emitter becomes more positive than the base 2, TR1 starts to conduct, so supplying current to TR2 base. This turns on TR2, which provides current for the base of TR1, causing TR1 to conduct harder. Very soon both transistors conduct heavily, and the impedance between emitter and base-1 falls to a low value, thereby reproducing the unijunction's characteristic.

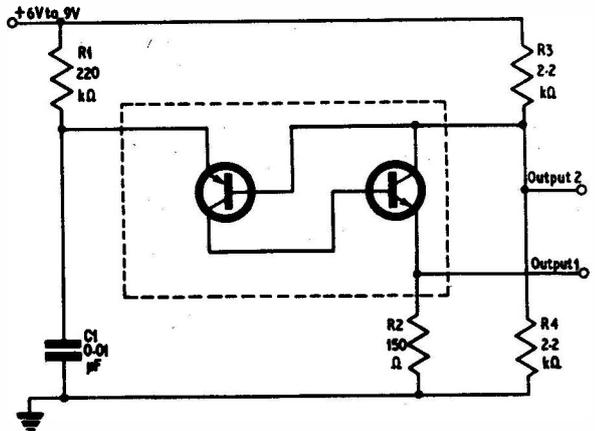


Fig. 2. Simple unijunction oscillator circuit with a frequency of operation of 1kHz

One of many applications of this substitute unijunction is in the oscillator circuit shown in Fig. 2, which has a frequency of operation of 1kHz. Capacitor C1 charges via R1, until the unijunction fires, so rapidly discharging C1. The cycle of operation then repeats.

Other uses are in timers and as trigger units for thyristors.

J. N. Watt,
Camberley,
Surrey.

LIGHT METER

THE circuit in Fig. 1 was designed to detect the small colour change of various chemical indicators when responding to an extremely weak substance.

When the intensity of light in the vicinity of the OCP71 changes, the pitch of the output tone from the speaker also changes. The output tone is produced by the action of C1 charging through VR1 until it reaches a certain potential, when it then switches the unijunction "on" allowing the capacitor to discharge through the loudspeaker; this cycle of operations is then repeated.

Any change in the intensity of the light falling on the OCP71 gives a variation in its resistance which leaks away part of the accumulated charge present at C1 and alters the output tone pitch. The greater the light intensity the more current leaked away and the lower the output pitch. The light sensitivity of the circuit is controlled by potentiometer VR2.

To set up the circuit the OCP71 is disconnected and VR1 adjusted over its whole resistance range. At maximum resistance a slow clicking will be heard; as the resistance is decreased the clicking rate rises until a tone is heard; this continues to rise until it disappears when the unijunction is switched on and C1 is being permanently discharged. Slowly increase the resist-

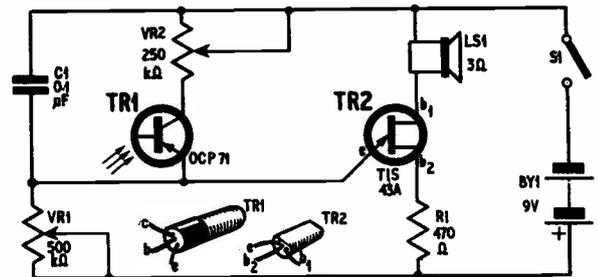
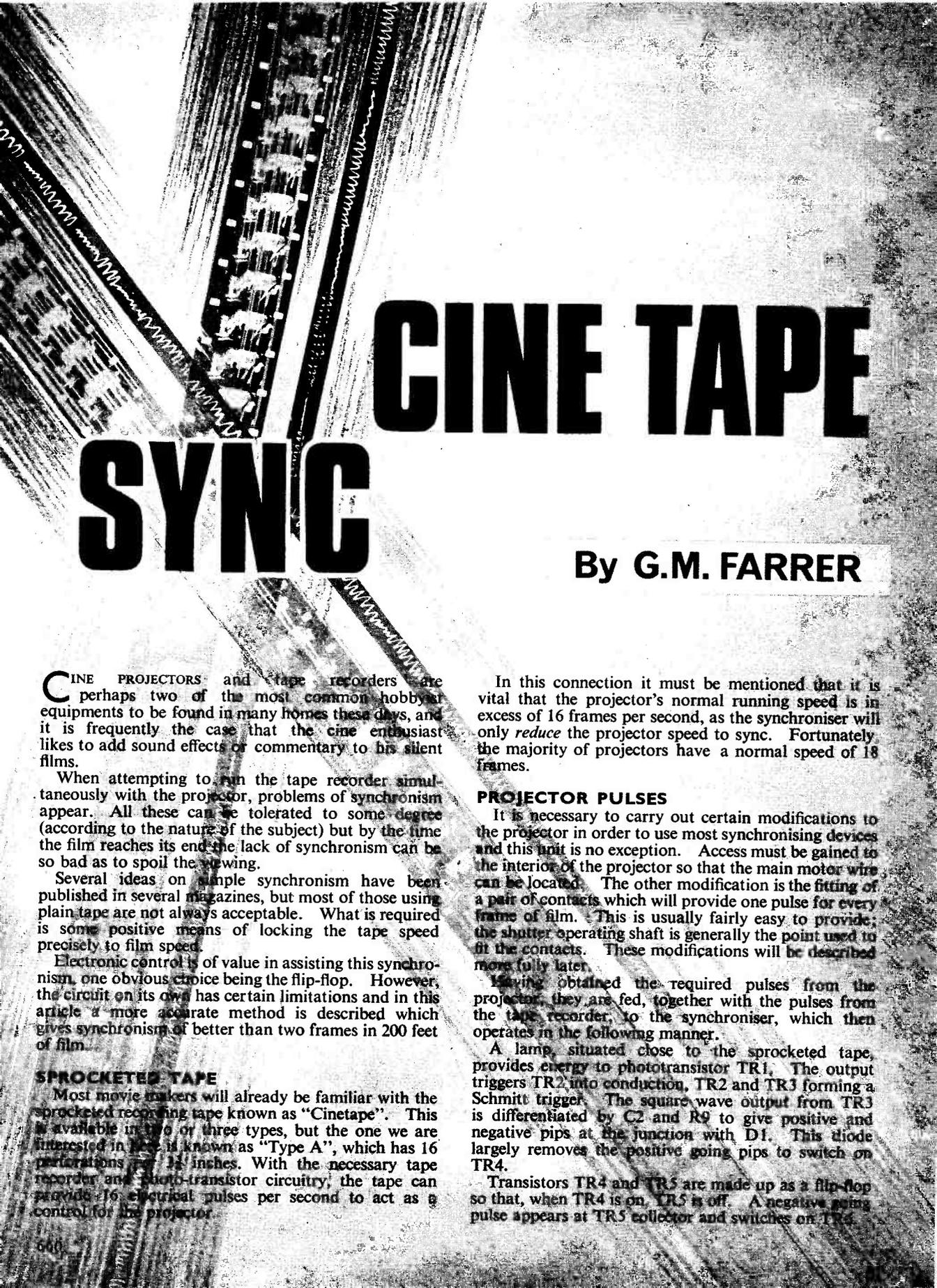


Fig. 1. Circuit diagram of the light meter and transistor wiring connection details

ance until a tone is once more heard and adjust the control for the highest pitch. Reconnect the OCP71 in the circuit and the instrument is ready for use. The base of the OCP71 is left disconnected.

According to lighting conditions and the setting of VR2, a tone may or may not be heard when the OCP71 is reconnected. In either case, this control should be adjusted for the lowest tone for maximum sensitivity in the lighting conditions present.

Clive Woods,
Leicester.



CINE TAPE SYNC

By G.M. FARRER

CINE PROJECTORS and tape recorders are perhaps two of the most common hobbyist equipments to be found in many homes these days, and it is frequently the case that the cine enthusiast likes to add sound effects or commentary to his silent films.

When attempting to run the tape recorder simultaneously with the projector, problems of synchronism appear. All these can be tolerated to some degree (according to the nature of the subject) but by the time the film reaches its end the lack of synchronism can be so bad as to spoil the viewing.

Several ideas on simple synchronism have been published in several magazines, but most of those using plain tape are not always acceptable. What is required is some positive means of locking the tape speed precisely to film speed.

Electronic control is of value in assisting this synchronism, one obvious choice being the flip-flop. However, the circuit on its own has certain limitations and in this article a more accurate method is described which gives synchronism of better than two frames in 200 feet of film.

SPROCKETED TAPE

Most movie makers will already be familiar with the sprocketed recording tape known as "Cinetape". This is available in two or three types, but the one we are interested in here is known as "Type A", which has 16 perforations per 1 1/2 inches. With the necessary tape recorder and photo-transistor circuitry, the tape can provide 16 electrical pulses per second to act as a control for the projector.

In this connection it must be mentioned that it is vital that the projector's normal running speed is in excess of 16 frames per second, as the synchroniser will only reduce the projector speed to sync. Fortunately the majority of projectors have a normal speed of 18 frames.

PROJECTOR PULSES

It is necessary to carry out certain modifications to the projector in order to use most synchronising devices and this unit is no exception. Access must be gained to the interior of the projector so that the main motor wire can be located. The other modification is the fitting of a pair of contacts which will provide one pulse for every frame of film. This is usually fairly easy to provide; the shutter operating shaft is generally the point used to fit the contacts. These modifications will be described more fully later.

Having obtained the required pulses from the projector, they are fed, together with the pulses from the tape recorder, to the synchroniser, which then operates in the following manner.

A lamp, situated close to the sprocketed tape, provides energy to phototransistor TR1. The output triggers TR2 into conduction, TR2 and TR3 forming a Schmitt trigger. The square wave output from TR3 is differentiated by C2 and R9 to give positive and negative pips at the junction with D1. This diode largely removes the positive going pips to switch on TR4.

Transistors TR4 and TR5 are made up as a flip-flop so that, when TR4 is on, TR5 is off. A negative going pulse appears at TR5 collector and switches on TR4.

Although TR7 is normally in a non-conducting state, due to R19 being returned to a positive voltage, it is switched on by the negative pulse from TR6. Sufficient power is made available for TR7 to operate the reed relay RLA, its contacts providing a relative short circuit to the control resistor in the motor circuit.

Capacitor C5 is held charged through R16 and R17 until the contacts on the projector are closed to provide a rapid short circuit across C5 and R17. Now C5 discharges through R17 and feeds a negative going pip to TR5 base by way of D2. This action is similar to that given by the Schmitt trigger, but by electro-mechanical means.

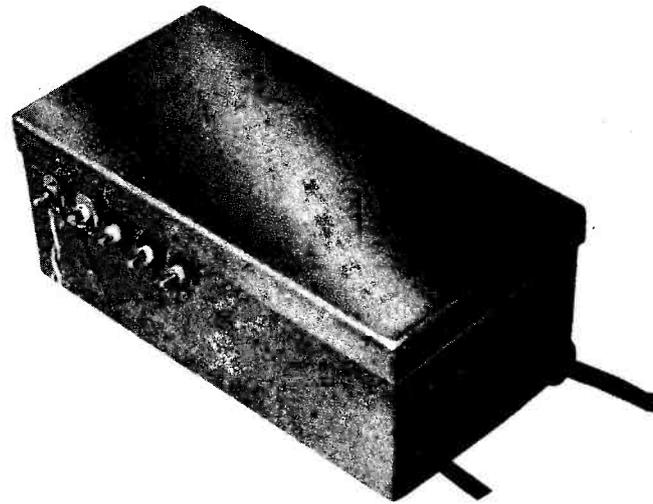
CONTROL CIRCUIT

The arrival of the pip at TR5 base will switch on TR5 again and switch off TR6 and TR7. Consequently the relay coil is de-energised, the short circuit removed from the control resistor and the motor restored to its controlled speed.

The other components in the control circuit, L1, L2, C7, C8, and R20, act as a transient suppression circuit to minimise radio interference. The inductors L1 and L2 have a sufficiently low d.c. resistance to be ignored in the control function.

It should now be seen that the tape pulse switches on the relay and the projector pulse switches it off again. This action continues all the time the unit is running, but if the projector speed increases slightly, the length of time that the relay holds on will be shorter due to the earlier arrival of the projector pulse.

If the projector speed drops then the reverse action takes place and thereby synchronism will be maintained. On the prototype, synchronism is held to less than two frames error in 200 feet of film.



The finished synchroniser incorporating transistor stages TR2 to TR7

Since the projector motor receives its power as a series of pulses, it is rather too much to expect a steady drive to be obtained unless the relay contacts have some partial by-pass. This is provided by resistor R21, which must have a power rating of about 10 watts as under some conditions a large proportion of the motor power is dissipated here.

The value of this resistor will be dependent to a large extent on the motor characteristics so that only a guide can be given. A probable figure will lie between 3 and 6 kilohms, but will need to be found by experiment.

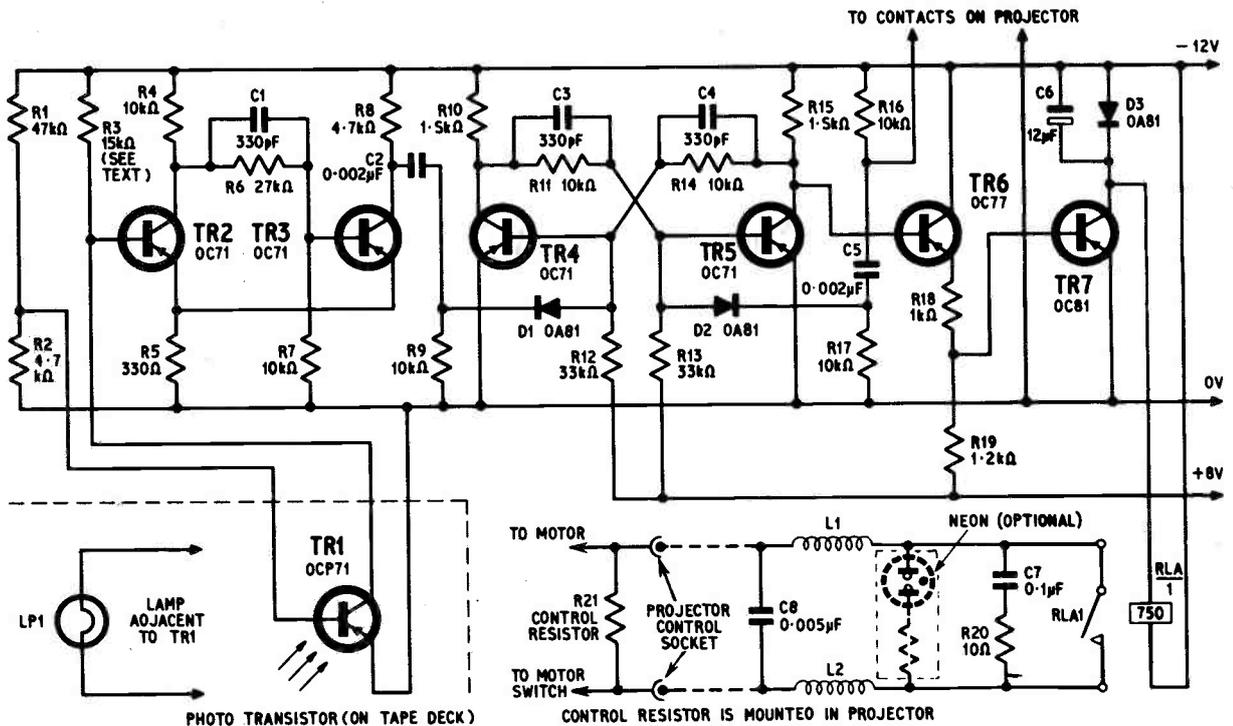


Fig. 1. Complete circuit of the synchroniser. LPI and TR1 are mounted on the tape deck

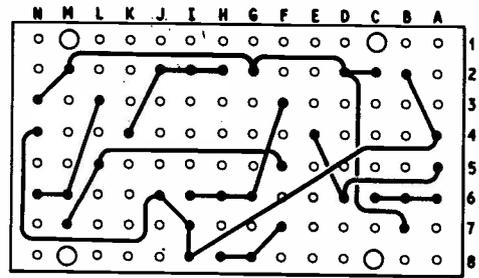
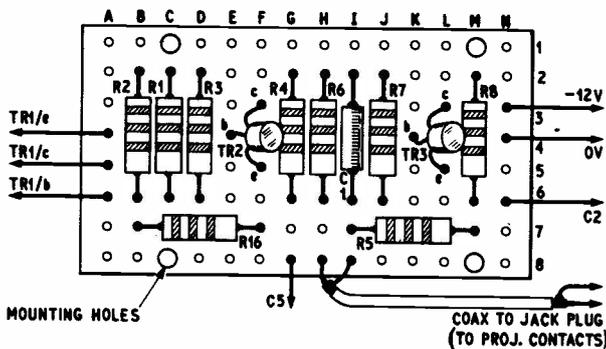


Fig. 2. Component layout and underside wiring of Board 1 (Schmitt trigger) later fitted in the synchroniser box

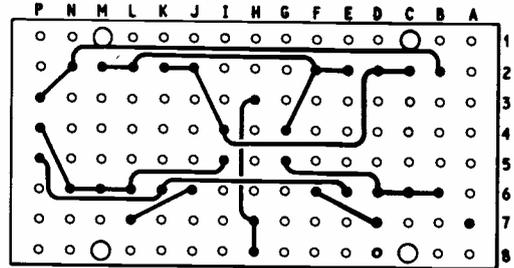
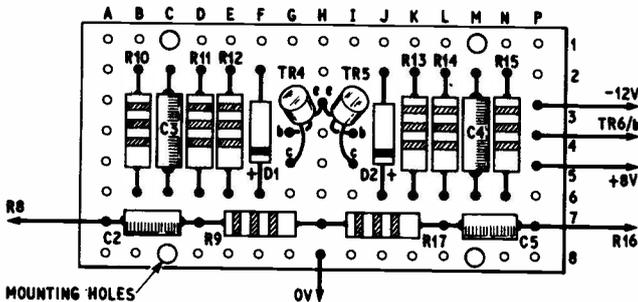


Fig. 3. Component layout and underside wiring of Board 2 (flip-flop) later fitted in the synchroniser box

CORRECT OPERATION

An indication of correct operation is by listening for a steady ticking from the relay contacts, or by fitting temporarily, or even perhaps permanently, a small mains voltage neon lamp across the reed contacts to give a regular flashing when operation is correct.

The other resistor which may require adjustment is R3, whose nominal value is 15 kilohms. It may be found that this value is correct, but due to gain spreads of transistors it may be necessary to choose a slightly higher or lower value here to obtain correct working of the Schmitt trigger circuit. In this connection an oscilloscope is very useful here.

If the collector of TR3 is monitored whilst the tape recorder is running with a length of "Cinetape", a good steady square wave at this point indicates a correct set up. Usually quite small changes in R3 (a potentiometer can be temporarily connected for this) have a

great effect due to direct coupling of the circuit, so go slowly. Values of 10 and 20 kilohms should be the outside limits required here.

If an oscilloscope is not available, then proceed as follows. A high resistance test meter should be connected across R8, and the "Cinetape" drawn slowly past the light scanning head. Correct operation is now shown by a sharp rise and fall of meter reading as the light pulses reach the OCP71. Once again, proceed slowly with R3 changes.

When first testing this unit, it is most important to have a correctly aligned scanning head (OCP71 and associated lamp). Obtain correct operation of the Schmitt trigger circuit before attempting to connect the projector or set the value of R21.

PERFORATED BOARDS

The actual construction of the synchroniser should present no difficulty as it follows quite normal lines. Component layout and wiring diagrams for perforated boards are shown in Figs. 2, 3, 4 and 5. The layout is in no way critical.

The prototype was, in fact, built in three separate units while the reed unit is mounted inside the projector itself. This way, the mains connections are kept tidily in the projector, although a further switch had to be fitted to enable normal operation to be achieved.

The method used will be dictated to some extent, of course, by the space available inside the projector and also how far one wishes to go in this project.

RELAY

The relay coil was wound on a former made up from a length of s.r.b.p. or other insulated tubing (fairly thin walled) with two square end plates of the same material made up as shown in Fig. 6. The plates are secured with Araldite.



Interior of the synchroniser box showing the Schmitt trigger and flip-flop

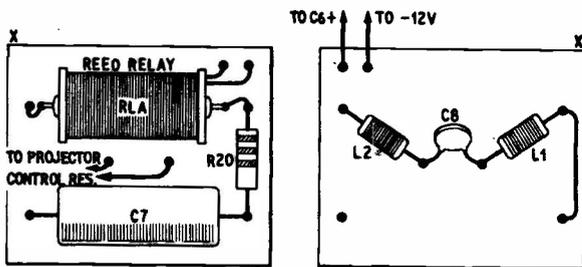


Fig. 4. Layout and wiring of components on the reed relay board, to be mounted in the projector

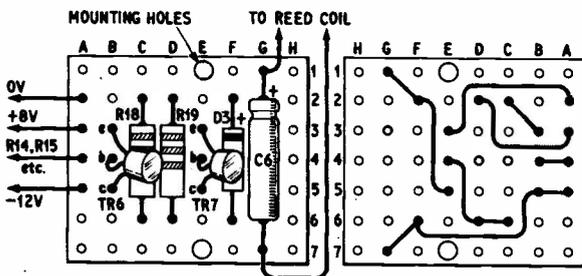


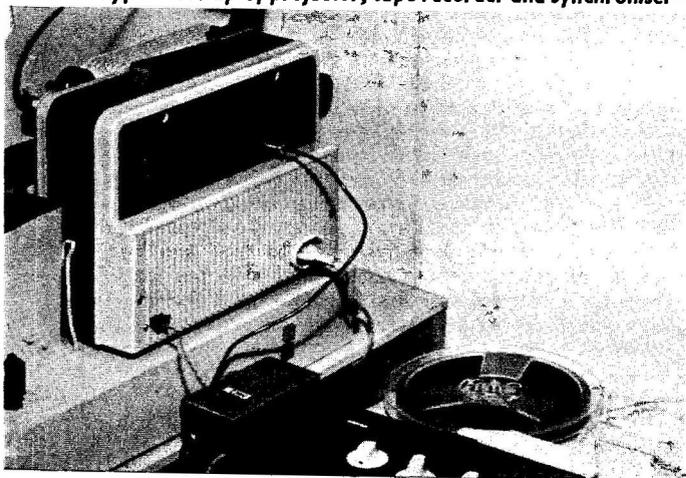
Fig. 5. Component layout and wiring of the switching unit (Board 3). This board may be made larger if desired to include the reed relay

Wind about 10,000 turns (or as many as needed to fill the bobbin) of 41 s.w.g. enamelled copper wire on to the former using a hand drill and long bolt. The coil former is fitted on to the bolt which is held in the drill chuck. If the gear ratio of the drill is determined first by counting the teeth on the gears, it is then easy to count the number of turns of the handle required to give approximately 10,000 turns of the chuck. Layer winding is not necessary but care must be taken not to allow turns to ride up and cause heaping of wire in one point. A layer of thin non-adhesive tape and thicker lead-out wires will prevent later damage to coil. The reed switch should slide comfortably into the coil centre with the end contacts protruding. These may be soldered to pins on the circuit board to hold the assembly in place.

PROJECTOR MODS

Coming now to the projector modifications, which is the most difficult part, it cannot be stressed too strongly

Typical set-up of projector, tape recorder and synchroniser



COMPONENTS. . . .

Resistors

R1	47k Ω	R12	33k Ω
R2	4.7k Ω	R13	33k Ω
R3	15k Ω (see text)	R14	10k Ω
R4	10k Ω	R15	1.5k Ω
R5	330 Ω	R16	10k Ω
R6	27k Ω	R17	10k Ω
R7	10k Ω	R18	1k Ω
R8	4.7k Ω	R19	1.2k Ω
R9	10k Ω	R20	10 Ω
R10	1.5k Ω	R21	3k Ω to 6k Ω
R11	10k Ω		10W wirewound (see text)

All $\pm 10\%$, $\frac{1}{4}$ W carbon except R21

Capacitors

C1	330pF	} mica or ceramic
C2	0.002 μ F	
C3	330pF	
C4	330pF	
C5	0.002 μ F	
C6	12 μ F elect. 25V	} paper 600V d.c. or metal foil 400V d.c., 250V a.c.
C7	0.1 μ F	
C8	0.005 μ F	

Inductors

L1 and L2 2 amp television suppressor chokes

Transistors

TR1	OC71 phototransistor
TR2, 3, 4, 5	OC71 or OC75 (4 off)
TR6	OC77
TR7	OC81

Diodes

D1, 2, 3 OA81 (3 off)

Reed Relay

RLA Coil wound from 41 s.w.g. wire (see text)
Reed XS2 (Hivac) or type 2RSR (Radiospares)
with normal open contacts

Miscellaneous

Jack plug and socket 2.5mm
Mains plug and socket 2-pin (e.g. P345)
or 3-pin (e.g. Type P438) (Bulgin)
Perforated s.r.b.p. (see drawings)
Metal case

that great care must be taken with insulation here, as mains voltages will be present. Never work on the projector while it is connected to the mains supply.

First locate the main motor lead and cut it. This lead must supply the motor only and not be a common lead to motor and lamp. If in any doubt, it would be advisable to consult either your photographic dealer or the manufacturer for guidance.

Having located and cut the required lead, the two ends should be taken to a mains rating socket fitted in some convenient position on the projector. The size and shape of this socket will depend on the space available but two suggestions are given in the components list, one being flat, the other round.

It may also be convenient to fit the control resistor into the projector adjacent to this point, but if so, bear in mind that it can get very hot, so it needs plenty of room for ventilation. Two plugs could be obtained to fit this socket. One is used to connect to the synchroniser; the other is fitted with a shorting link so that it may be inserted in place of the control plug for normal operation.

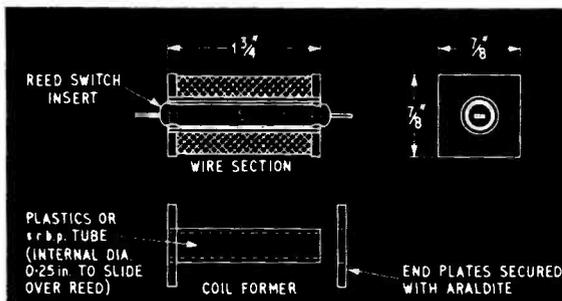


Fig. 6. Construction of reed relay coil former

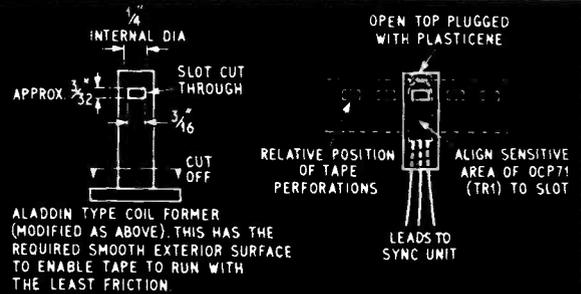


Fig. 8. Construction of the phototransistor housing and its relationship to the tape

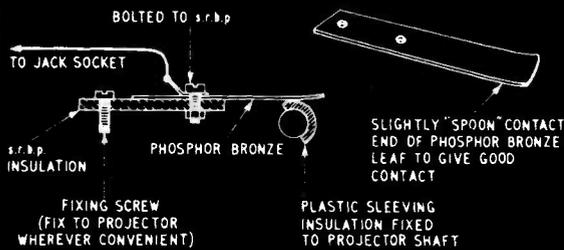


Fig. 7. Construction of the pulsing contact to be fitted to the projector near the sprocket spindle

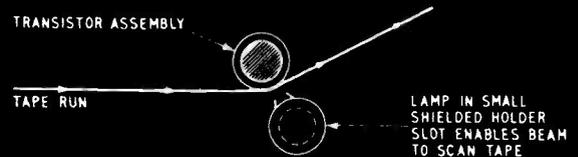
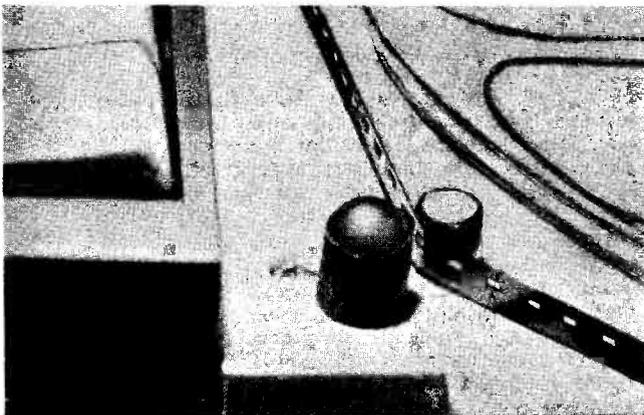


Fig. 9. Plan view of the positions of phototransistor, lamp, and Cinetape

The "pulse" contact is made from a piece of phosphor bronze strip and is insulated from the projector frame with a piece of s.r.b.p. This contact must not have any contact with the motor wiring, or case, or anything else except the 2.5mm jack tip connection. The sleeve connection on the jack should be connected to a part of the projector frame that is in contact with the shaft used for the pulse contact. Details are shown in Fig. 7.

OTHER USEFUL HINTS

It was found very satisfactory to use a length of small diameter co-axial cable for the 2.5mm jack plug connection to the synchroniser. The wires linking the motor with the reed relay control circuit should have thick insulation; mains cable would be suitable here.



The suppressor components should be fitted close to the reed relay to be most effective, so that these components will be in the synchroniser box if this is where the relay is fitted.

The tape recorder and synchroniser must, of necessity, be located close together, but the tape recorder and projector may be placed anywhere convenient, as the length of connection between them, within reason, does not affect the operation.

The prototype unit is powered by a small mains power supply unit, so the lamp supply was derived from this by using the 12 volt negative and 8 volt positive lines. The 20 volts so produced were found to be sufficient for the 28 volt bulb used. This lamp must be run from a d.c. source. If a.c. is used, the fluctuations of brilliance at mains frequency would cause spurious pulses to appear at TR1 and affect the operation.

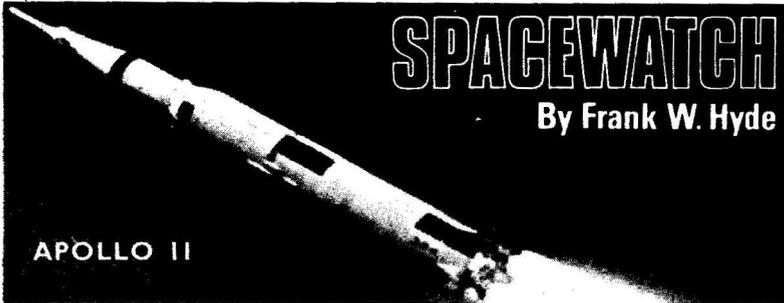
Exact details of photo-transistor and lamp assembly are not given as tape decks vary greatly in their design. A small plate to attach to the deck, upon which the lamp and OCP71 are assembled, can be made to individual requirements. Suggestions are shown in Figs. 8 and 9.

One small point about maintenance of consistent operation, which came to light during early tests: the slot in the OCP71 housing must be kept free of tape dust, otherwise erratic running of the projector will result. An occasional light brushing will keep it clean.

When the complete synchroniser is set up satisfactorily, it may be fitted into a case and connected up. Start marks should be made on both tape and film, which are lined up when subsequent runs are made. Projector and tape deck are then switched on simultaneously and should remain in synchronism as described earlier. ★

THE BIRTH OF A NEW PLANET

The asteroid belt which circles the sun and lies between the orbits of Mars and Jupiter has been well studied over many years. It is made up of groups or families which lie in well-known orbits. One of these, the family Flora, has been studied very closely by Dr Alfvén of the Royal Institute of Technology in Sweden. The individual members of this group have been very accurately



observed and it seems that the orbits of the three distinct sub groups that it comprises have a special significance. In each sub group the individual members each of the group have almost identical orbits.

Dr Alfvén points out that this would not be possible if there had been an explosion of a large body, nor could it result from the focusing effect of Jupiter's gravitational field. This is at variance with the widely held view that the asteroids were the debris of a former planet. The structure of the asteroid belt as revealed by Alfvén's work is incompatible with such a possibility. He now tends to support the view that it is possible that in fact the belt of units is a planet in the process of formation. This theory has many supporters now including Prof. Hoyle.

It is thought that the asteroids are an intermediate stage of planetary formation by the accretion of interstellar dust grains. This is of some significance since it is a means by which any star can collect a planetary system. It could mean that most of the stars which are like our sun will have planets like the solar system and doubtless some of them could be capable of supporting life as we know it.

A NEW AERIAL FOR SPACE VEHICLES

Goodyear Aerospace has developed an unusual type of aerial for use in space. It is a dish shaped reflector consisting of a number of hinged "petals" framed with Bondolite. This is extremely light in weight though rigid and is formed of a honeycomb sandwich of aluminium. It can be folded up to about a quarter of its full size and can fit inside a vehicle nose cone in a similar manner to an umbrella. When it is opened in space an aerial of 30 feet in diameter

is available. This is the largest dish ever designed for orbiting vehicles.

MARTIAN ATMOSPHERE

At the McDonald Observatory of the University of Texas astronomers have obtained the first conclusive proof of water on Mars. The amount of water vapour measured was equivalent to a film of liquid water 0.05mm thick in the southern hemisphere and about half that in the northern. Although the frozen caps

have been said to consist of carbon dioxide, this latest assessment indicates quite definitely that there is a considerable amount of water ice. The clouds sometimes seen also tend to confirm this view.

JUPITER ACQUIRES MORE SATELLITES

In 1967 L. Wilson of the University of London Observatories and E. L. G. Bowell of the Meudon Observatory in France put forward the proposition that there was an undiscovered satellite associated with Jupiter.

It is not always possible to devise a method of checking the calculations in matters of this kind. However the decametre radiation from Jupiter has provided one method of doing this. E. K. Bigg of the Radio Physics Observatory of Sydney applied a technique of record checking which he developed in 1964 with regard to the effect of the satellite "10" on the decametre radiations. He has found in the case of the predicted satellite of Wilson and Bowell a very significant correlation of a modulation period which must be regarded as confirmation of the existence of this thirteenth satellite. It is also significant that Bigg found evidence of another possible satellite in the records.

From this examination also he found a very strong confirmation of the effect of satellite "V" known as Amalthea. This particular item is of special interest to the writer for in 1964 in discussions with Bigg about "10" the writer put forward the idea of the important influence on the radiation from Jupiter by Amalthea. Later in a special interview with Patrick Moore in "The Sky at Night" programme the writer demonstrated the reasons for this influence. It is therefore gratifying to have confirmation of the hypothesis from such an important and independent source.

The success of this method of using the planet's own radiation will encourage more intense investigation of Saturn and Uranus for the decametric radiation.

At the moment there is no certainty of radiation in this region for these two planets, though there is some reason to believe that there is radiation from Saturn. If the decametric radiation can be detected then the same technique could be used for the confirmation of possible satellites, not yet discovered but strongly suspected, at least in the case of Saturn.

GERMANY IN SPACE

An agreement between America and Germany in a joint space research programme has been signed by the two countries. There are two main projects of which Helios is the principle and most ambitious. There are to be two solar probes and each of these is to fly past the sun at a distance of approximately 50 million kilometres off the sun. There are to be ten experiments aboard each time.

The first of the probes which will weigh about 210kg will be launched on January 4, 1974. This will be put into trans-solar orbit by an Atlas-Centaur rocket provided by NASA. After travelling for 95 days the probe will pass within 0.3 astronomical units of the sun; it will then go behind the sun for 185 days and reach the limit of its path. Then returning toward the earth it will go into solar orbit.

Communications will be tested as never before in this event, for the probe will be twice the solar distance from control on the earth. The radiation to which the probe will be exposed in this circuit will be some ten times greater than that received on Earth and special precautions will be needed to protect instruments from the heat.

HELIOS DESIGN

There are two designs being prepared for Helios, one by ERNO Raumfahrttechnik GmbH in Bremen and one by Messerschmitt-Bölkow in Munich. It may be that the two designs will be combined when the tenders are finalised. Germany will be responsible for the development and control of the probe itself and for seven of the ten experiments aboard each. The other three experiments will come from Goddard Space Flight Center in a collaboration unit of American, Australian and Italian scientists.

The primary object of the probes is to provide new information about the processes on the sun by the study of the solar wind, cosmic radiation and cosmic dust as well as the electric and magnetic fields. There will also be study of the cosmic radiation from distant systems and the chemical composition of interplanetary dust and micrometeorites.

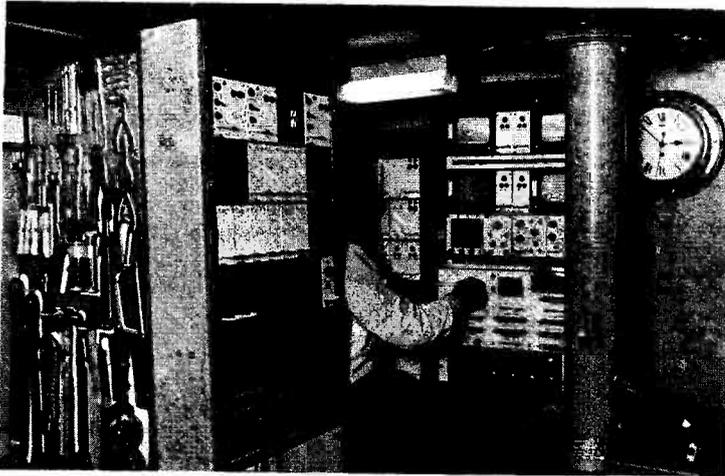
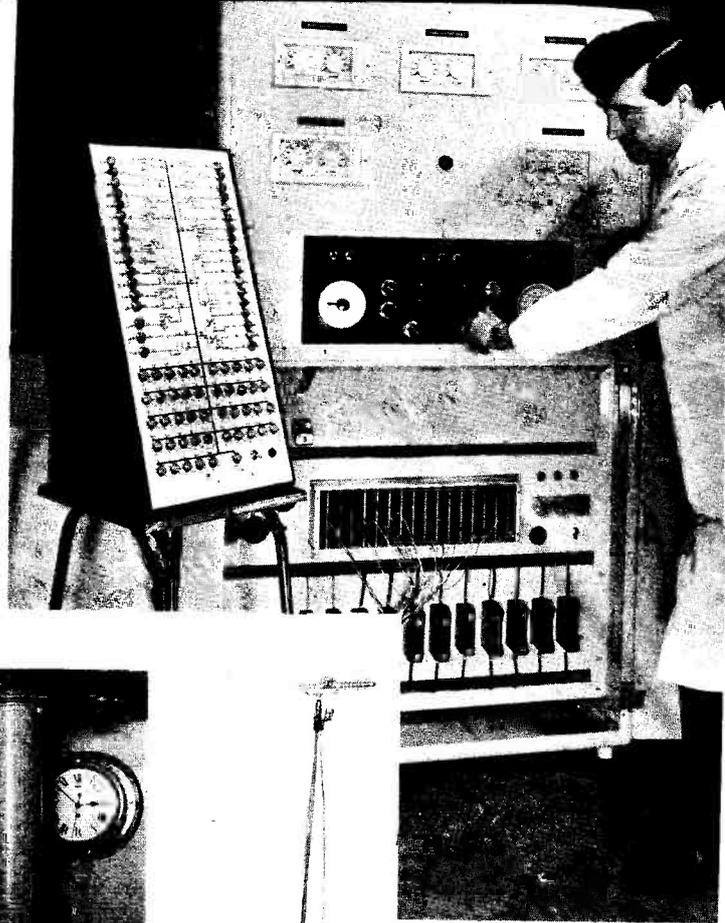
ELECTRONORAMA

Interplas '69

PLASTICS are used for many electronic applications and some of these were displayed at the Interplas '69 exhibition recently. Many circuit boards and modules were displayed and an astounding variety of cabinets, front panels, switches, knobs and other ancillary electronic components.

Manufacture of plastics parts is a fast expanding business and electronics is in turn playing its part in automating machines and processes. Bipel injection moulding machines will be available with solid state controls after October 1 and all the Bipel injection machines displayed at Interplas were fitted with the system.

The photograph shows a technician using a test unit to check circuitry in the control console for an injection moulding machine. The control system uses Norbit logic control modules mounted on plug-in circuit cards. The modules are encapsulated in plastics.



BBC Mobile Colour TV Demonstration Unit

THE BBC's Mobile Colour Television Demonstration Unit with Tricia Madden, is touring the country this Summer, giving demonstrations of colour television at Holiday Camps and other venues where large captive audiences can be guaranteed. With the added "selling power" of BBC-1 and ITV programmes appearing in colour later this year, it is hoped that the demonstrations will help to push sales of colour sets.

The pictures show the unit with mast extended, and the interior of the vehicle. A comprehensive tool kit is carried to cope with all emergencies! The left-hand rack contains sound apparatus; in background are u.h.f. receivers, distribution amplifiers picture monitors and systems control panel. Right foreground: base of telescopic mast atop control box which houses servo motor.



Britain's First Concrete T.V. Tower

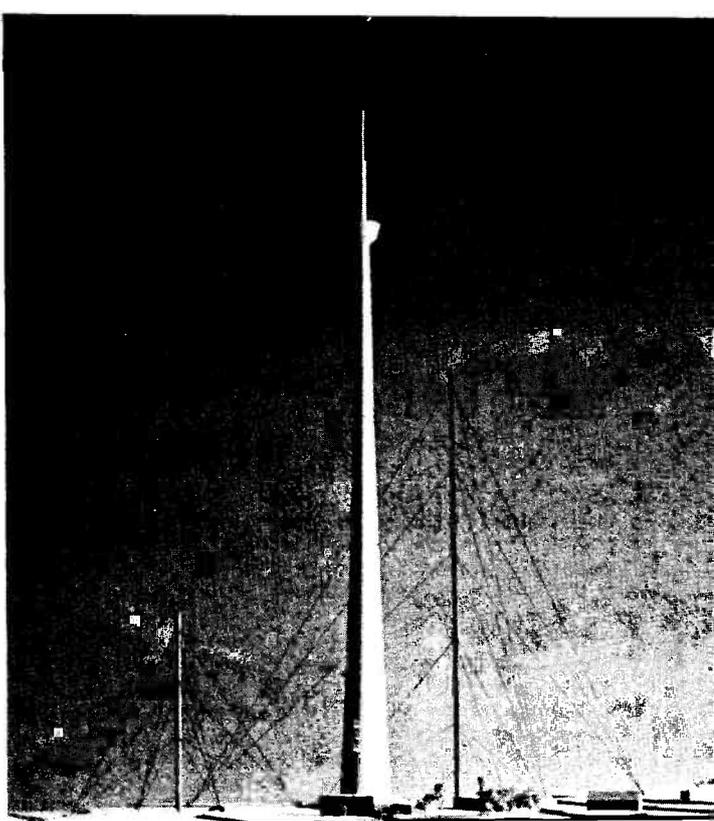
BOTH B.B.C.-2 and I.T.A. u.h.f. Yorkshire transmissions will share the existing 300ft B.B.C. aerial mast at Emley Moor in the autumn as an interim measure, until the completion of a new joint tower, 1,080ft high, late in 1970. The new tower will be of self-supporting reinforced concrete of exponentially tapered section, similar in design (but much higher) to that built in South Africa in 1961.

The decision to adopt concrete construction, as opposed to steel, has resulted from research into erection time, cost and service coverage and has no bearing on the collapse of the old tubular steel mast in March. (The enquiry into this incident has not been completed; fatigue tests are being carried out on the metal structure.)

The new tower will carry all television channels for I.T.A. and B.B.C., and will serve as a G.P.O. microwave link. Outside broadcasts can also be picked up and redistributed via the microwave equipment room at 900ft. Above this point a lattice steel construction 180ft high will be erected for carrying the transmitting aerials.

On completion, the 300ft mast and the 675ft Swedish mast will be dismantled.

A scale model of the new Emley Moor tower next to the existing steel masts (right). The G.P.O. microwave aerials are shown at about the "100ft high" position on the tower

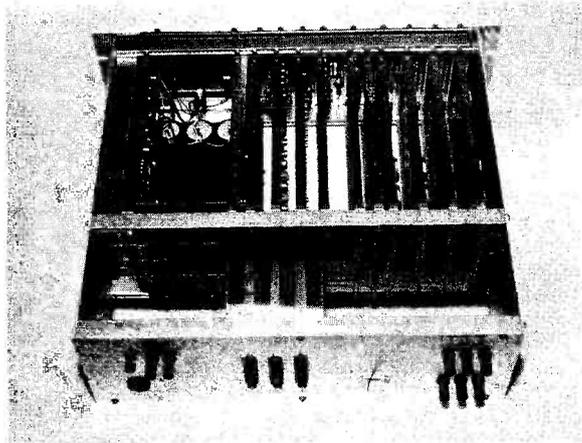


DVM to Data Logger

FOR those laboratories and workshops that possess a digital voltmeter, Solartron Electronic Group have now produced a box that can convert it, with a readout device, to a data logger.

The Data Transfer Unit is the first device to convert the digital output from a digital voltmeter into a form that can be accepted by a teleprinter, digital printer typewriter or magnetic recorder for direct logging. Consequently the user can go away and leave this set-up to take voltage readings for him, automatically, at any preset time interval, and write them down.

Reliability is inbuilt by using integrated circuits and flexible wiring cards with printed circuit fibre glass plug-in boards.



The photograph above shows an open top rear view of the Solartron DTU showing the printed circuit boards plugged into a motherboard and the flexible printed wiring to the rear panel input and output plugs. The lower photograph shows a research worker demonstrating the simplicity of operation of the DTU using a digital voltmeter and strip printer



THE ORGAN PART 5

By Alan Douglas, Sen. Mem. I.E.E.E.

MANY readers will know that a musical sound consists of a fundamental pitch note plus some harmonics or overtones. Harmonics are mathematically related frequencies; overtones, or partials are not so related. All can exist together.

BASIC VOICES

In most musical instruments, the harmonic texture, loudness, noise and other factors are constantly changing, even during the playing of a single note. But an organ is a sustained tone instrument, so the very complex factors associated with orchestral instruments are greatly simplified. It is for this reason that the organ is a poor imitator of orchestral instruments, and much more suited to the production of the sounds associated with simple pipes or tubes.

The church or concert organ is really based on diapasons and flutes, with other stops to artificially introduce powerful harmonics.

The theatre organ is based on the tibia, which is merely an exaggerated flute. Although reed stops are provided on the larger organs, to produce more harmonics, there is more concentration on string-like sounds which are extremely rich in harmonics, but low in amplitude. The net combination of strings, tibias and flutes tends to sound rather tubby, but takes on a curiously liquid and attractive sound when modulated by a tremulant. In short, the less harmonic the sound, the more one depends on the tremulant—or vibrato, as it is commonly called on electronic instruments.

SQUARE WAVE LIMITATION

It is clear then that there is going to be some tonal limitation if we decide on a theatre organ type of specification, and this is further dependent on the kind of waveform supplied by the generators; for no one waveform will form all sounds equally well, unless it be a multiplicity of sine waves for additive synthesis. Multiple waveform generators are expensive, and appeal more to the professional organists than to the average home performer.

As we have said, this organ uses a single square wave waveform for all its effects, and so we must accept the limitations imposed. However, we have considered the case of the average house, where a larger and more powerful organ might not be welcome, whilst at the same time the limited resources of the very small organs would soon be exhausted. It is indeed very difficult to try and strike a balance and it is impossible to please everyone.

We said in Part One that if all the playing facilities were put in at the start, the way would be open for future modifications; and this is perhaps the best way to look at it.

The constructor will be able to make tonal alterations after a little experience is gained and a number of alternative tone circuits will be given later. After all, there are only four basic types of organ tones and the many dozens of variations are only in degree or pitch range. In saying this, we do not of course include percussion, sustain, reverberation, glide or rhythm circuits which are now popular.

SUBRACTIVE FILTERS

It might be opportune here to expound a little on the principles underlying the various kinds of subtractive filter. Suppose that we have an initial waveform which contains 40 harmonics. Evidently this will mean many octaves in addition to the fundamental pitch. Of course, if they were pure octaves, then it would only make the sound very bright and perhaps shrill, but still a pure note. But in this band are many other frequencies, if the wave is square, and these will nearly all be odd harmonics. In Fig. 5.1 is shown a symmetrical square wave of the kind produced by the dividers. The accompanying graph illustrates the relative amplitudes, compared to the fundamental, of a representative number of constituent odd harmonics.

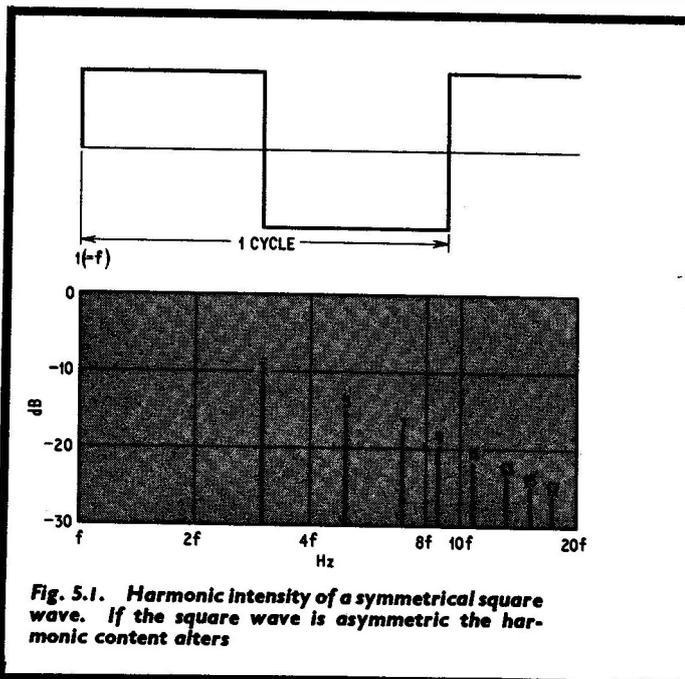


Fig. 5.1. Harmonic intensity of a symmetrical square wave. If the square wave is asymmetric the harmonic content alters

INTRODUCTION TO TONE CIRCUITS

The square wave itself is not an objectionable sound, but if more than one is combined, the harmonics can beat together and form sum and difference tones which are not concordant; and as we must be tuned to the equally tempered scale, there will be bound to be discords.

The presence of such discords has been proved to be only objectionable in certain kinds of sounds; in others, the discords actually heighten the effect—as in a trumpet stop in a pipe organ.

It is also found that if the fundamental pitch is removed, or greatly reduced in strength, that the harmonics do not sound so unpleasant. But in cases where the fundamental must predominate, as in flute tones, many harmonics produce discords. These are removed as far as possible by low pass filters. The tibia and diapason groups also require severe pruning of the upper harmonics. String-like tones require exactly the reverse, partial or complete removal of the foundation tones. All reed-like sounds are based on resonance methods, where a tuned LC circuit is excited first by its principal resonant frequency, and subsequently by harmonics of that frequency.

The width of the resonant band is controlled by the Q or sharpness of tuning of the circuits, which may be arranged to either accept or reject the resonance. So really all tone circuits are quite simple, and with adjustable L , C and R elements they can all be explored.

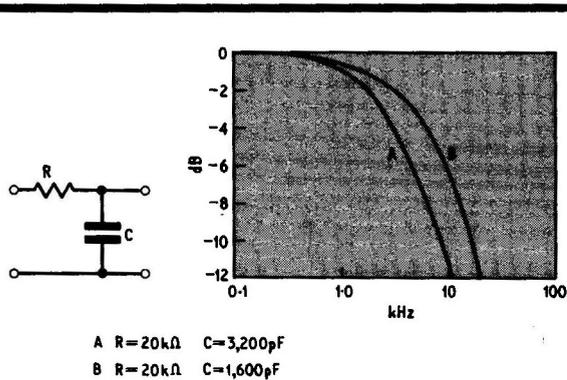


Fig. 5.2. Simple low pass RC filter section with response curves showing effect of varying capacitance with fixed resistance

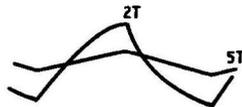


Fig. 5.3. Effect of varying low pass filter time constant on a square wave

LOW PASS FILTERS

A simple single stage low pass filter with its response for differing values of capacitance is shown in Fig. 5.2.

The time constant of the section shown is CR , and to ensure suppression of the higher harmonics at some point on the slope, CR must be at least five times greater than the time for the width of the incoming pulse. By varying this time constant, most conveniently done by adding sections of differing values to the first section, one can produce, from a square wave, effects as in Fig. 5.3. Note that the majority of the unwanted harmonics are brought down to a very low level.

However, this effect will clearly not be uniform over the whole keyboard and if complete harmonic suppression is required, then there must be several different time constants over the range of notes employed, since the frequency range exceeds 30 : 1.

But is complete suppression really desirable? Some say yes, some say no.

TAILORING THE HARMONICS

The author contends that traces of upper harmonics give character to even a flute tone, for whilst a pipe organ open metal flute is commonly fundamental and second harmonic, an orchestral flute can contain up to 8 harmonics—and few would deny that this latter is a more lively sound. Therefore in this organ we have allowed harmonics to appear in 16, 8, 4 and 2ft tones by careful grading of the time constants of the six low pass filter circuits used. Allied to this is the question of which is the most important part of the keyboard where the maximum effect is required? Here we subdue the bottom octave of the 16ft tibia (a tibia is really only a powerful flute; in pipe organs it is made of wood which gives it a duller tone than metal); we also reduce the bottom of the 8ft flutes but not so much, and the 4ft and 2ft registers are virtually untouched except for the very highest harmonics.

If one required a completely smooth and “sweet” sound from a flute, then one filter per octave would be the minimum number required. Some organs filter every five or six notes and a few of the larger ones filter on every single note. It is clear that it is quite easy to work out the time constants if the frequencies are accurately known.

IMPORTANCE OF BEING IN TUNE

In assuming the simple filters above, it is imperative that the organ be in tune. Very small departures from this condition bring about unpleasant results. This, by the way, is why we do not have a twelfth or $2\frac{2}{3}$ ft stop. Unless this is sinusoidal, it produces a rasping effect and to eliminate this, it has to be reduced in volume so that it cannot fulfil its function as a brightener at all. With a sine wave organ, it is a valuable stop; with a harmonically rich wave, the effect is better obtained from other stops.

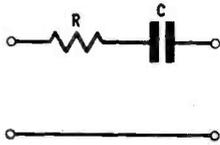


Fig. 5.4. Simple high pass filter section which removes the lower frequencies and passes the higher ones.

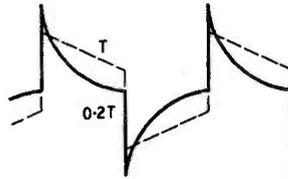


Fig. 5.5. Effect of varying high pass filter time constant in a square wave

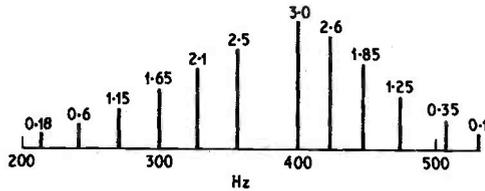


Fig. 5.7. A more exact analysis of the French Horn formant where the figures above the ordinates indicate relative amplitudes

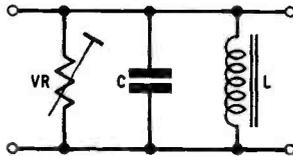


Fig. 5.8. Parallel resonant filter with shunted potentiometer, adjustment of which can both reduce the total response and broaden the resonance peak

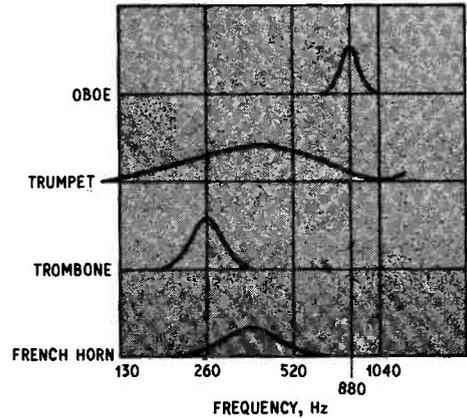


Fig. 5.6. Formants for four orchestral instruments

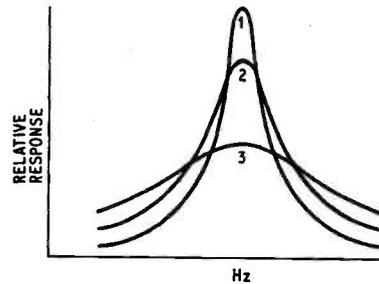


Fig. 5.9. The effect of shunting the resonant LC circuit with increasing resistance. Curve 1, the resistance is negligible; Curve 3, the resistance has increased considerably with a broadening of the response curve

PITCH AMPLIFIERS

The low pass filters employed consist of from two to four cascaded sections having various time constants. Since every shunt capacitor has its charging time controlled by a series resistor, and of course there are anti-robbing resistors as well in all the filters for this organ, there must be attenuation of the signal. Thus we apply a preamplifier for every pitch—but not every stop—and feed from the tone filters into a post amplifier (see Fig. 1.1). Incidentally, the output capacitors from these preamps are graded in some cases to further control the frequency pass band.

The tibias, 16, 8, 4 and 2ft and the flutes 8ft and 4ft are the stops using the low pass filters. Nevertheless, they all sound slightly different and this is how it should be, though they are all flutes. The characteristics, therefore, of this class of sound are strong lower notes and weak upper harmonics. We can get a reasonable approximation to pipe tone from these circuits.

STRING TONES

The next most important sound is the organ string or viole tones. It must be admitted that even in the best pipe organs, these sounds are nothing like orchestral

strings. This is evident, as they must operate on a fixed wind pressure, whilst strings under the influence of a bow continually change in character.

These sounds are very attractive and useful, so we provide five of them. Since it has become standard practice to include string tones on the accompaniment manual, we find the high pass filter in use here.

HIGH PASS FILTERS

The action of the high pass network is the exact reverse of the flute filters; we want to take away the fundamental tones and leave a lot of harmonics, though at a reduced loudness. Fortunately, the ear does not attempt to analyse the structure of such complex sounds, so the problem is made easier and simple filters suffice; in fact, they are all single section filters.

Because of the low power involved, we simply rely on the extremely high reactance of the very small series capacitors, so that the filter becomes a capacitive attenuator, having values of megohms. The circuit is shown in Fig. 5.4 and the effect on a square wave in Fig. 5.5.

This filtering does perhaps make the extreme bass notes a little thin, but string filters are notoriously difficult and it is thought that the circuit values shown

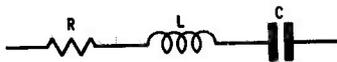


Fig. 5.10. Series resonant circuit

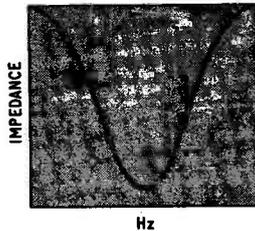


Fig. 5.11. Typical response curve for series resonant circuit

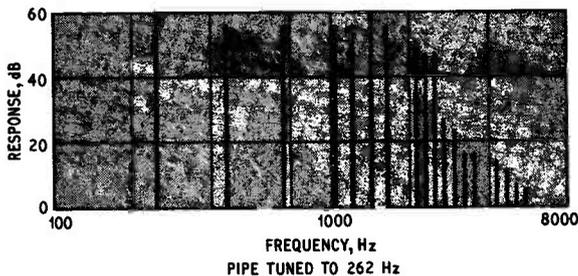


Fig. 5.12. Central analysis of pipe organ trumpet

will satisfy most constructors. One can of course go to six pipe organs and hear six quite different qualities of string sound from stops of the same name. The great thing is to avoid what is commonly called a wiry sound. We have 16ft, 8ft and 4ft strings on the solo manual, and 8ft and 4ft on the lower one.

This brings us to the final and most controversial kind of filters, the resonant circuits. These are widely employed in electronic organs to simulate reed or brass instrument kinds of sounds.

FORMANTS

It was found, during research into the sound producing mechanism of orchestral instruments in the latter part of the last century, that no matter what note was played on, say, an oboe, a French horn or a trumpet, a certain band of frequencies always appeared and this was called a formant. It is evident that if we produce a circuit which will resonate over the formant band, and add fundamental tones to it, we can imitate some of the instruments having this property.

To illustrate this, we show the formant bands for four instruments, the oboe, trumpet, trombone and French horn in Fig. 5.6. Fig. 5.7 gives a more detailed formant

analysis of the latter instrument. The numbers above the ordinates indicate relative amplitudes compared to the fundamental.

RESONANT CIRCUITS

A parallel-tuned circuit as shown in Fig. 5.8 will suffice for the resonant, or formant, band and this may be tuned by a capacitor as required. The coil should have a moderate Q , in the 20 to 100 range, because then the band can be broadened or narrowed by the variable resistor across it as in Fig. 5.9 and the sharpness or flatness of the formant can be reasonably imitated.

There are cases, however, when for special effects we want to take away a resonant band. For this a series resonant circuit is needed of the form shown in Fig. 5.10. In referring to the resonance curve of Fig. 5.11 it can be seen that the impedance falls to a relatively low value at the resonant frequency which means that the circuit functions as a selective shunt for a band of frequencies.

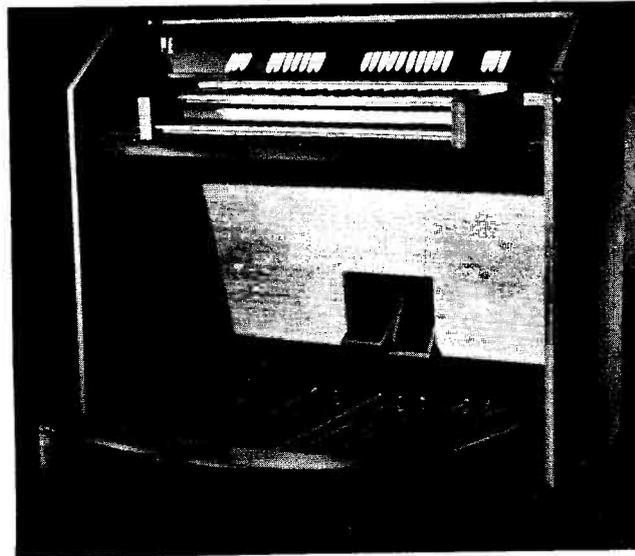
In the organ filter coils are wound on ferrite cores; this prevents any external field which would result in crosstalk and signal pickup in other parts of the tone circuits.

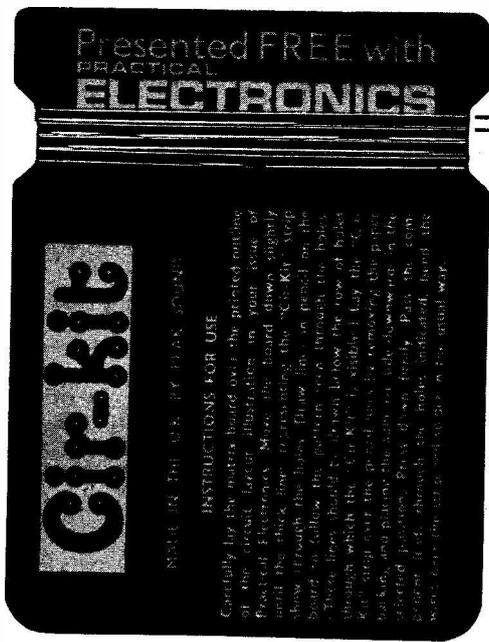
The Q value should not be too high, since the voltage across the coil at resonance is approximately Q times the impressed voltage. The capacitors to earth in circuits used for formants have values which not only tune the coils properly, but act as high-frequency shunts to earth for the higher harmonics which we do not want. But in fact there is some harmonic leakage which does not seem to impair the effect.

Spectral analysis of pipe organ reeds shows many harmonics outside those really required and the pipe is tuned to emphasise the fundamental; but still very many of the reed harmonics sound, as exemplified in Fig. 5.12, which is a spectral analysis of a pipe organ trumpet.

Next month we start the construction of the tone forming circuits.

Note: A few readers have experienced difficulty in aligning the Kimber-Allen keyboard with the Harmonics switch assemblies (see last month's article). If purchasing a Kimber-Allen keyboard, constructors are advised to make sure that a close match can be achieved. It may be necessary to cut slots to clear the dolly springs.





FREE! CIR-KIT

SAMPLE IN NEXT MONTH'S PRACTICAL ELECTRONICS

Instructions for using this constructional aid in a special feature article

AND THESE IMPORTANT FEATURES

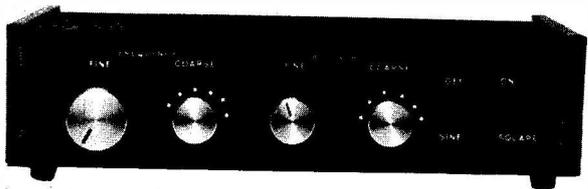
P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER



An unconventional triple conversion design for single sideband and double sideband reception. Advanced techniques including "up conversion" are incorporated in this receiver which covers the frequency range 2MHz to 28MHz. A built-in crystal comparator ensures accurate alignment. Optional arrangements for local oscillator and other unusual features add to the versatility of this forward-looking design. It is eminently suited to the requirements of radio hams and others with a serious interest in high frequency communications.

The first article in this constructional series appears in the October issue.

AUDIO GENERATOR



An indispensable accessory for audio enthusiasts. Neat modern styling makes this unit a most suitable companion for the hi-fi equipment in the lounge, or an impressive addition to the workshop test gear. It is a self-contained battery operated instrument covering frequencies from 15Hz to 200kHz, with low distortion sine or square wave output through a calibrated attenuator.

The free sample of Cir-kit is adequate for building one of the two modules which make up the audio generator.

PRACTICAL ELECTRONICS

ON SALE MONDAY SEPTEMBER 15

ORDER YOUR COPY NOW! 3/-

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.

TEST GEAR

Two new products are announced from Eagle Products. They are the EP100LN multimeter/transistor tester and a 30kV probe, type number DC30.

Both items are particularly suitable for the service engineer and EP100LN features a 100,000 ohms per volt movement which combines with a special socket for quick transistor checks.

The brief technical specification for the multimeter is: d.c. volts 0-12 to 600V f.s.d. in seven ranges; a.c. volts 6 to 600V f.s.d. in four ranges; d.c. current 12 μ A to 12A f.s.d. in five ranges; resistance 10 kilohms to 10 megohms in three ranges; and a decibel range of -20dB to +18dB.

The range of the transistor tester is: I_{co} 0-12 μ A; h_{tb} 0-0.9965; and h_{te} 0-280.

The DC30 probe, for use with the EP100LN meter and other models, allows a range of up to 30kV to be measured. It is ideally suited for colour television service work where correct e.h.t. voltages are very critical.

The price of the EP100LN is £16 16s, the DC30 £3 10s and more details of all Eagle products can be obtained from B. Adler and Sons (Radio) Ltd., Coptic Street, London, W.C.1.

MUSICAL NOTES

Some months ago we mentioned the "Mister Bassman" musical accompaniment instrument from D.E.W. Ltd., Ringwood Road, Fern-down, Dorset.

This company is now producing an improved Mk II Model B2 that can be tuned to any key by a single knob, so that a player used to the key of C, for instance, can accompany a group playing in such awkward keys as E-flat, B-flat, etc. whilst still using his well-learned technique of footwork in C.

Apart from an 8ft to 16ft octave change footswitch there is another for foot-off sustain with a variable time range of 0.5 to 5 seconds.

The price of the Model B2 is £37 plus 10s carriage.

TOOLS

Two tools for the toolbox are the Bib Model 3 wire stripper and cutter and the "King Klik" riveting tool. Both these new models are claimed to be improved versions of previous models, and the King Klik riveter has just gained recognition from the Council of Industrial Design.

The new riveter is excellent for any chassis work, still required in certain cases, and can be used where only one surface is accessible. The tool works with a plier action and has a swivel turret to take $\frac{1}{16}$ in and $\frac{1}{8}$ in diameter rivets.

The "King Klik" riveter is available singularly or in kit form which includes back-up plates, rivets and an instruction leaflet from Riveting Systems Ltd., Todmorden, Lancs.

The only obvious difference between the Bib Model 3 and previous wire strippers is the cutting aperture setting arrangement. The aperture setting for different diameter wires is now simply adjusted by a sliding screw set in one of the handles.

Manufactured by Multicore Solders Ltd., each wire stripper is packed on an instruction card and the recommended retail price is 5s 6d.

FIBRE OPTICS

The advance of fibre optics is providing many solutions in industry to old problems, and in certain instances cuts manufacturing and maintenance costs by the elimination of bulbs, hardware and wiring.

A new company has been formed called Fibre Light, and they have been appointed as authorised distributors of "Teknis" continuous lengths of glass fibre optic non-coherent light guides, in quantities of less than 1,000ft. The fibres are contained within a flexible p.v.c. sheath and the 0.013in multi-fibre bundle is capable of transmitting light over distances of up to 12ft.

The fibre can be used for piping light from one lamp to remote areas requiring illumination, or be used to influence a remotely mounted photocell of any changes of light intensity. There are numerous other applications and is already being used in cars, computers, security systems and liquid level sensing.

Obviously there are many other applications that will spring to the mind of the ingenious experimenter. An introductory 5ft length is available from Fibre Light, Teknis House, Stoke Road, Guildford, Surrey, price 19s 6d including postage and packing.



Bib Model 3 wirestripper

"King Klik" riveter from Riveting Systems

Eagle EP100LN multimeter and DC30 probe

Mk II Mister Bassman marketed by D.E.W.

FOR THE WORKSHOP

There are several interesting products this month worthy of consideration for the workshop or laboratory. The first of these is the new Speedread direct readout micrometer made by GKN Shardlow Metrology Ltd., Petre Street, Sheffield, S4 8LY.

Two versions are available, the Imperial measurement (inches) system and the Continental metric system. Each instrument is precision made and the precise measurement is shown numerically in windows on the barrel of the micrometer. A conventional vernier scale, for those who like doing it the hard way, is also incorporated to give measurements to finer limits.

At the moment the micrometers are available in size 0in to 1in (reading to 0.0001in) and 0 to 25mm (reading to 0.01mm, equivalent to 0.0004in).

Another measuring instrument that slide rule users will appreciate is the Otis King spiral slide rule marketed by Carbic Ltd., 54, Dundonald Road, London, S.W.19.

The instrument is in telescopic form and measures only 6in in length when closed and 10in fully extended. There are two models, K and L, for multiplication, division, and logarithms. Model K is for multiplication and division, while model L also gives logarithms enabling it to be used for roots and powers.

Both models cost £4 2s 6d post free and a leather carrying case is available at 8s 9d extra.

Numerous times when working in the workshop the need to cut holes of various shapes and sizes in varying materials is reached and how best to tackle this problem has to be overcome.

Although we have not had the pleasure of trying the Adel nibbling tool being marketed by West Hyde Developments, this would seem to be a most suitable product for cutting holes in chassis and cabinet panels. Suitable for card, p.v.c., aluminium, copper and steel the Adel nibbling tool cuts almost any shaped hole and works on the punch and die principle, claimed not to distort or "wrinkle" the material.

The tool is easily operated by hand, will cut up to 16 gauge aluminium or 18 gauge steel and is priced at 59s 6d plus 3s posting and packing. Spare punches cost 32s 6d plus 2s 6d posting and packing from West Hyde Developments Ltd., 30, High Street, Northwood, Middlesex.

Having enough mains power outlets is another problem for the workshop and Abbey Electrical Systems Ltd. produce a fairly large range of excellent distribution outlets for the workshop. Already completely wired and factory tested the 13A outlet Busboards, as they are called, are available in eight different combinations.

All units are completely insulated for maximum safety and fitted with a

mains indicator light. Intended for portable or static use the boards are claimed to be lightweight and virtually unbreakable under normal conditions of use.

Other uses for the mains outlet boards, apart from the workshop, are for offices, garages, public address systems and photographic studios.

More details and prices are available from Abbey Electrical Systems Ltd., 95, Victoria Street, St Albans, Herts.

COMPONENT BOXES

Storage space for components is always at a premium in any workshop and the new plastics storage cases from S. Leboff (Fobel) Ltd., Hyde House, The Hyde, Edgware Road, Colindale, N.W.9, should be a useful addition to any workshop.

Called Fobel "Storaboxes" they are available in three different sizes, each 5½in long. The main feature of these boxes is that they can be interlocked side by side or one on top of

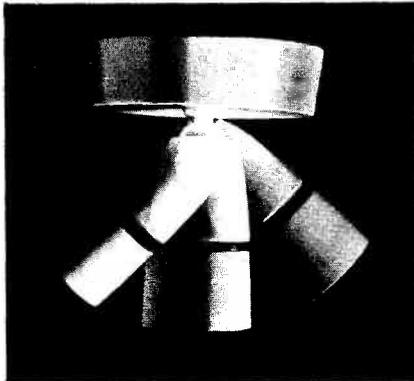
the other, enabling a combination of different sizes to be made up if required. The boxes can also be attached to a wall or shelf.

A single box and drawer with removable partition retails at 2s 6d, and a large box with two drawers subdivided by partitions retails at 8s 11d.

WORKSHOP LIGHT

A new panoramic batten bulb holder has been announced by Rock Electrical Accessories Ltd. Called the Monolink this holder would be very useful in the workshop and can be tilted at an angle of 45 degrees in most directions via a ball and socket joint.

The base of the bulb holder also constitutes the ceiling rose and is simply wired up and screwed in place of the existing ceiling rose. Full details can be obtained from Rock Electrical Accessories Ltd., Rock Works, 6 Commerce Road, Brentford, Middlesex.

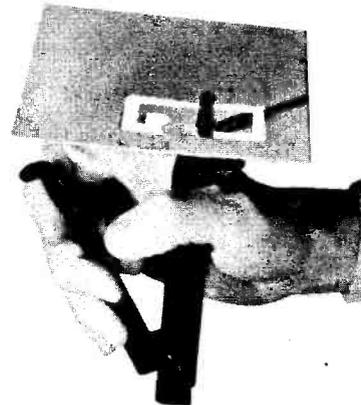
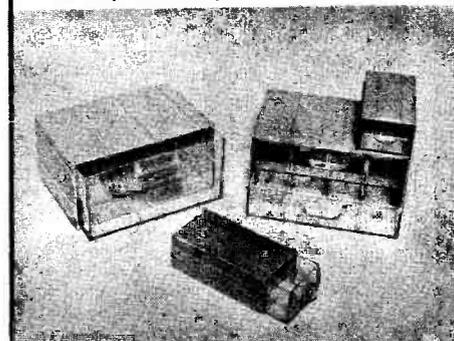


Monolink adjustable ceiling light from Rock Electrical Accessories



Speedread micrometer produced by GKN Shardlow Metrology

Interlocking storage boxes manufactured by S. Leboff (Fobel)



Adel nibbling tool from West Hyde Developments



Carbic Otis King spiral slide rule

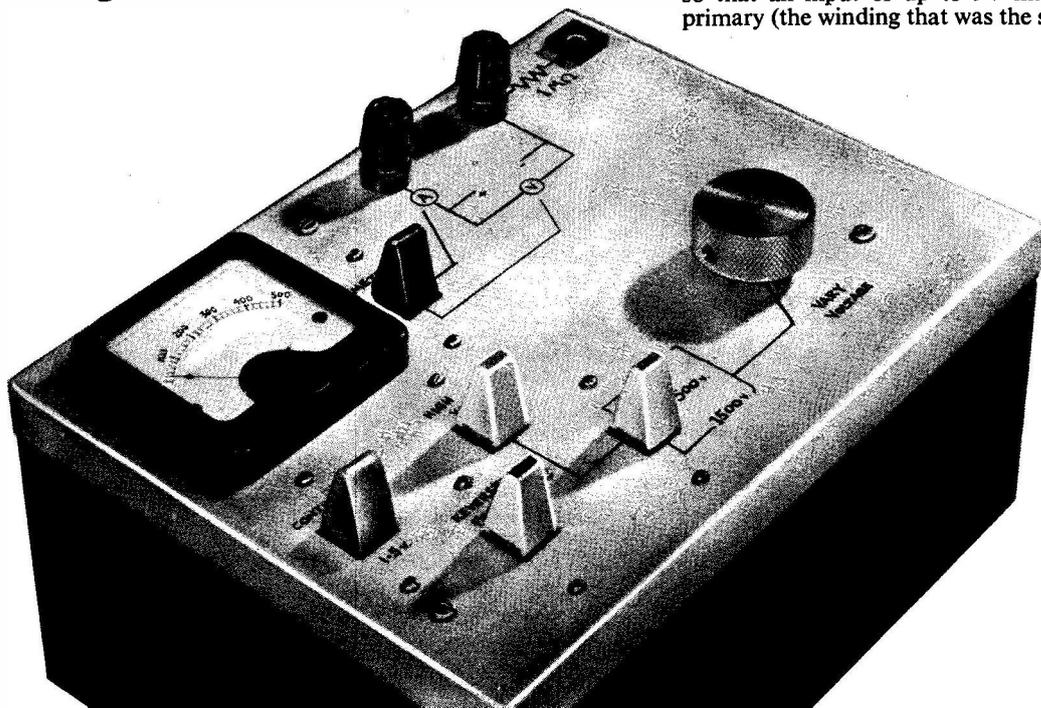
THIS circuit was developed to help check the characteristics of the "surplus untested" diodes that are at present remarkably cheap in bulk lots. The resulting test set can be used for a number of applications—details are given in the text.

The components used are not costly and the prototype was built mainly from spare parts. By carrying out stage by stage tests during construction, the performance available from the particular components used can be checked.

The high voltage supply around which the test set has been designed has also proved useful as an e.h.t. generator for oscilloscopes and insulation testers. The basic principles involved in the design of this supply will be described first and then constructional details of the tester will be given. By following this method it is hoped that constructors will be able to understand the operation of the supply and thus be able to use the design for a wide variety of applications.

INSULATION AND DIODE TEST SET

By D. H. King



TRANSFORMER ACTION

If a sinusoidal supply is available, then a transformer will transform the supply up or down as required, the output voltage being sinusoidal in waveform. It is often forgotten though that it is the changing input *current* that produces the changing magnetic flux, and it is the rate of change of this flux that induces the voltage into the secondary winding (and into the primary as a back e.m.f.) from which the secondary current is available. Thus a sinusoidal waveform is not necessary to drive a voltage step-up transformer; a near square wave primary current will produce high secondary voltages and will also result in less power loss in the current switching device.

The waveforms shown in Fig. 1 give the comparison between part of a 50Hz sine wave and a square wave changing in, say, 100 microseconds, by the same amount of current in a primary winding. The faster changing current induces the larger voltage in the secondary.

A simple transistor oscillator of the form shown in Fig. 2 will work quite well but has two distinct disadvantages. Firstly, the performance often varies enormously between use off load or with a loaded secondary because when off load the feedback is larger than when loaded, hence a promising secondary high voltage dies miserably when asked to supply more than a milliamp or two. Secondly, the switch, in this instance the transistor, is handling neither sine nor square wave but an unknown complex waveform that will give an unknown but probably low working efficiency. Because of these factors, a 100 per cent working design is difficult to achieve unless very tight specifications are maintained for all components.

The frequency of the supply determines the number of turns per volt required for a particular core cross section, so that if the frequency is increased above the lowest for which the transformer was designed, then so may the input voltage be increased in the same ratio. For example, a typical small valve output transformer, designed to handle down to approximately 80Hz, has a ratio of about 80 to 1 and produces 2 to 3 volts to feed the loudspeaker speech coil.

Now if this transformer is fed at 5,000Hz it will accept considerably higher voltages without saturating so that an input of up to 9V may be applied to the primary (the winding that was the secondary when used

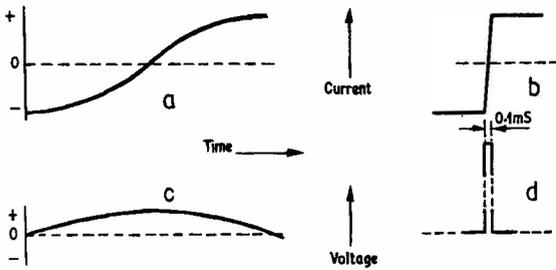


Fig. 1 (a). Half cycle of a 50Hz sine wave current lasting 10ms. (b) Same change of current as in (a) lasting 0.1ms. (c) Induced e.m.f. in coil as a result of (a). (d) Induced e.m.f. in coil as a result of (b); approximately 40 times the amplitude of (c)

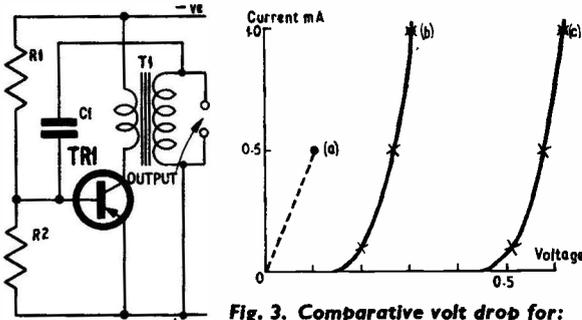


Fig. 2. A simple transistor oscillator

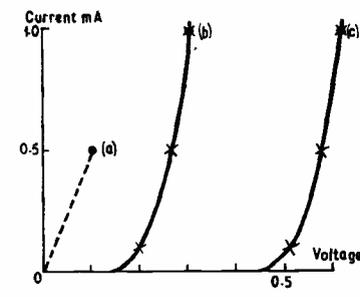


Fig. 3. Comparative volt drop for: (a) a 200 Ω , 500 μ A meter (b) a typical germanium junction (c) a typical silicon junction

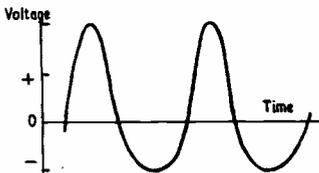


Fig. 4. Example of a non-symmetrical a.c. waveform

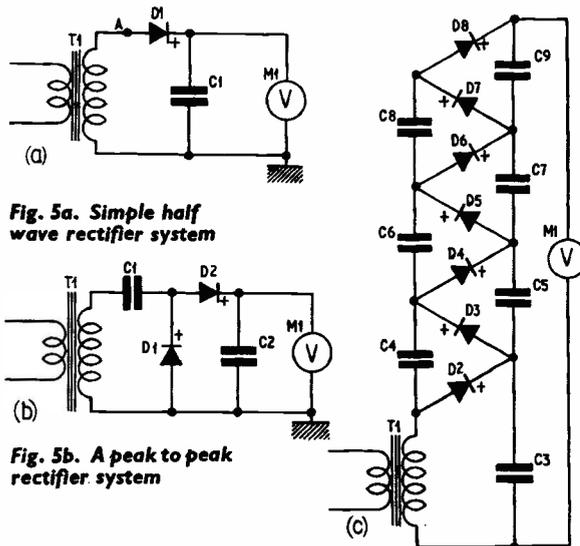


Fig. 5a. Simple half wave rectifier system

Fig. 5b. A peak to peak rectifier system

Fig. 5c. A seven stage voltage multiplier system with an off load voltage approximately seven times that obtained from the circuit of Fig. 5a. Diodes are reversed for a positive earth system

as an output transformer) giving 500 to 700V at the secondary. Smoothing problems are also reduced at the higher frequencies, since where one would need a 10 μ F reservoir capacitor for a 50Hz rectifier system, 1 μ F will have the same effect at 500Hz and at 5,000Hz only 0.1 μ F need be used; both capacitance and physical bulk are reduced.

TRANSISTORS

The transistor driving the transformer will have to handle the peak currents that are switched—possibly an ampere or more in spite of the average current being measured at a much lower value; also, the high back e.m.f. induced into the primary will be considerably higher than the low voltage supply used—60V has been measured at the collector during the switch-off period even though only a 5V supply was being used. This means that there is a strong chance of collector-emitter breakdown if a low voltage transistor is used but if the supply voltage is increased slowly during testing then the start of breakdown is seen on the supply ammeter and the supply may be switched off or reduced before the transistor suffers permanently.

It is worth remembering that whilst conducting, a germanium junction diode or the base-emitter junction in a transistor will drop about 0.3V (the barrier voltage) while silicon devices will drop from 0.6V to 1.0V.

With less voltage than this across the junction, the current flow through the junction will be effectively zero so that these voltage drops may be usefully employed (a) to identify the junction material, germanium or silicon; (b) to replace a low voltage Zener diode where the exact voltage is not critical; (c) to give a good indication of correct functioning of transistors in amplifiers (see Fig. 3).

RECTIFIER SYSTEMS

The half wave rectifier and reservoir capacitor action is well known, but a peculiarity of single ended oscillator fed transformers is that the secondary waveform will probably not be of equal amplitude above and below the electrical zero axis. Considering the waveform shown in Fig. 4 as the voltage at point "A" relative to the chassis in Fig. 5a, then the voltage stored on the reservoir capacitor C1 will be twice that obtained when the rectifier D1, or the secondary winding of T1, is reversed. This also accounts for disappointing results when using simple feedback oscillators of the type shown in Fig. 2.

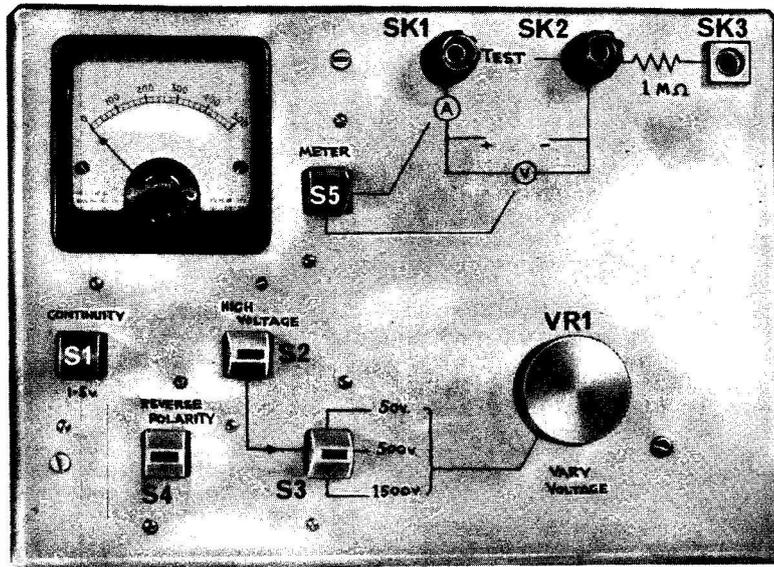
The voltage doubler system is thus seen to "double" the voltage obtained from a half wave system only if the positive and negative peaks are of the same amplitude, otherwise the system might be better known as a peak to peak rectifier system (Fig. 5b), this being its real action.

For really high voltages of a kilovolt or more a voltage multiplier ladder is recommended so that a low d.c. supply and fairly low voltage components may be used to obtain the final high voltage at small cost.

VOLTAGE MULTIPLIER

Consider a succession of half cycles, preferably square wave, and starting with the "live" end of the transformer (Fig. 5c) as positive relative to the chassis.

- (1) D2 conducts to charge C3 to the peak positive voltage.
- (2) D3 conducts to charge C4 to the sum of the winding peak negative voltage and the voltage stored on C3.



Front panel of the prototype, showing positioning of all switches, VR1, MI and the test terminals

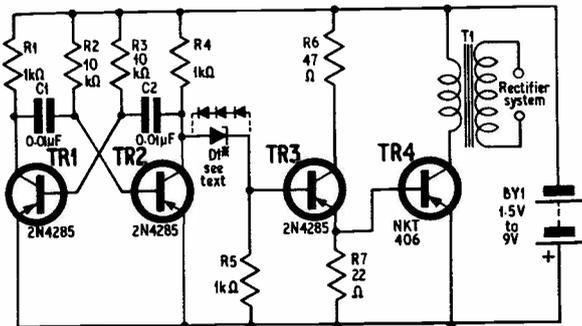


Fig. 6. The basic oscillator circuit used in the final supply system. T1 supplies the voltage multiplier

- (3) C3 is recharged via D2. The voltage stored on C4 is lifted or pumped via D4 on to C5, which now has the peak to peak voltage stored on it.
- (4) C4 is recharged via D3 to the peak to peak voltage. D5 is pumped so that C5 charges to the peak to peak voltage.

This continues for as long as you can afford to house the mounting heap of diodes and capacitors. The final result is that, apart from C3 which is charged to the positive going peak voltage, all other capacitors and diodes must withstand the peak to peak voltage (which may be fairly low) but a final voltage is obtained which is the sum of all the voltages stored on one of the stacks of capacitors.

The effective capacitance of the series arrangement of capacitors is smaller than each individual capacitance and all the output must be supplied by the stored charges, so do not hope for too large a current at, say, 2kV. One milliamp at 2kV represents a load of 2W and the transformer must be able to transfer this amount of power, while the switching transistor will be handling a low voltage but proportionately high current peaks, allowing for an efficiency of between 25 and 40 per cent.

FINAL SUPPLY CIRCUIT

Transistors TR1 and TR2 (Fig. 6) are a conventional astable multivibrator circuit, guaranteed to oscillate if the transistors are half good and the components near to the suggested values. The output is not a true square wave, but TR2 collector is switching pretty rapidly between effectively zero and the full supply voltage. TR4 cannot be fed directly with this voltage swing because the base-emitter junction of TR4 would not allow TR2 collector to rise higher than about 0.3V (for a germanium transistor TR4) and so the oscillation would be uncertain. TR4 is therefore fed from an emitter follower (TR3) and the 22 ohm emitter resistor R7 ensures that the leakage through TR4 is a minimum when TR3 is turned off.

Transistor TR4 would still clamp TR2 collector voltage to a low value via TR3 emitter-base junction, so a Zener diode, D1 is inserted. D1 may be either a low voltage Zener diode of about 1.5V less than the d.c. supply used, or a suitable number of silicon diodes used in their forward conducting sense. The result is that TR4 base is not turned on until TR2 collector has risen by at least two or three volts towards the supply line voltage. If only a 1.5V supply is used, omit D1.

Transistors TR1, TR2 and TR3 are *ppn* low-current types of 10mA 10V minimum ratings, either germanium or silicon as available; a wide range of cheap devices is suitable. TR4 is a power type, to handle up to 2A collector current and of as high a voltage rating as is cheaply available, say NKT406, OC28 or OC36.

Transformer T1 is a small valve output type, which should not be damaged since there may be up to a kilovolt between primary and secondary windings if the input voltage is increased too fast during testing. The winding ratio is not particularly important, but the higher the ratio, then the fewer the stages of multiplication that will be needed for the final high voltage. The transformer used in the prototype had a ratio of 40 to 1 but much higher ratios can be used if cheaply available; a higher ratio would require fewer multiplier stages to attain the same voltage.

CONSTRUCTION AND TESTING

The TR1, TR2, TR3 circuit was constructed on perforated board as shown (Fig. 7), producing a simple layout of the components on the two sides, a tag board is equally suitable. Before joining TR4 base to R7, connect the circuit so far built to the d.c. supply and listen to the output across R7 with an earpiece, or check with an oscilloscope that the frequency is in the region of 5,000Hz and squarish. A voltmeter across R7 should show the average voltage of 0.2 to 0.3V, indicating a peak drive voltage for TR4 of twice that amount, assuming a nearly square waveform at this point.

The free air dissipation of TR4 will be about 1.5W and so TR4 will need no heat sink unless an attempt is made to obtain a large output power. Thus the mounting of TR4 is simplified by bolting down to the circuit board; connect the base to R7. With the transformer secondary feeding a rectifier and capacitor only, and a voltmeter across the capacitor (as Fig. 5a), increase the d.c. supply in small steps. The voltmeter will show the peak voltage available, probably about 300V from a supply of only a few volts, while an ammeter in the supply circuit will give warning of TR4 breakdown if the supply voltage is increased too far.

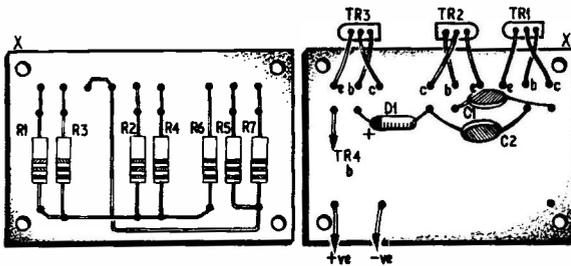


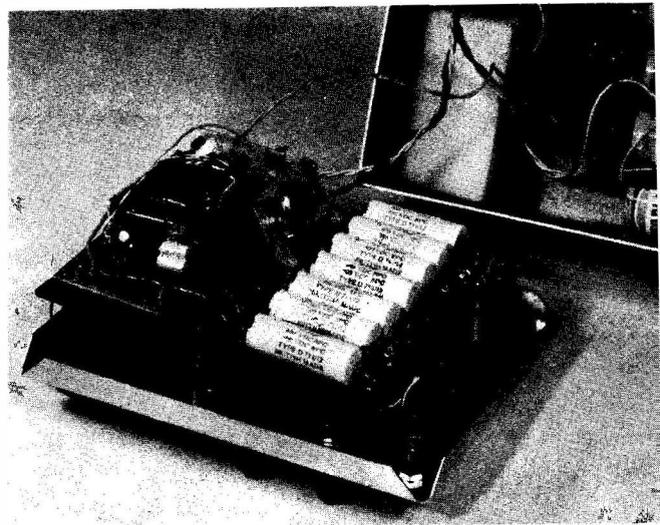
Fig. 7. Layout and wiring of the oscillator board. TR4 and T1 are mounted separately

Reverse the connections from the secondary winding of T1, switch on to the same voltage supply as before and note the d.c. voltage produced. This voltage will differ from that noted before and the sum of the two output voltages indicates the secondary peak to peak voltage induced for the particular d.c. input used.

There will probably be a healthy whistle (or even a shriek) coming from the core of the transformer; this is not dangerous and may be quietened by careful clamping, squeezing or waxing of the core.

Now build the voltage multiplier ladder network (Fig. 9) stage by stage; the size of board used will depend upon the size of the capacitors and upon the number of stages that prove to be needed. It is suggested that each time a stage of a capacitor and a diode is added, the resultant voltage is measured across a loading resistor that will draw a milliamp or two when connected between the chassis and the top of the latest capacitor to be added.

One faulty or leaky component causes the whole multiplier system to fail; do not forget to discharge each capacitor when you switch off during testing—the voltmeter will do for this—otherwise you will be reminded when you handle or go to modify the circuit. A bleeder resistor will be fitted finally, of course.



View of the rear of the prototype showing original positioning of components. Size of case and layout depend on the components used and the number of multiplier stages required

COMPONENTS

The resistors are $\frac{1}{4}$ W types for the transistor circuit, but on the high voltage side of the circuit remember that there are maximum voltage ratings to observe as well as the wattage rating to calculate. For $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and 1W resistors these maximum voltages are about 250, 350, 500 and 750V respectively. If the normal carbon composition types are used, and the maximum voltage is exceeded for any length of time, you may expect the resistance to vary unpredictably.

The diodes are low current rating types, having a p.i.v. rating to suit the particular circuit, so one of the "bulk" suppliers is suggested, assuming that a diode tester is not already available to test the characteristics of cheaper diodes.

Capacitors must be new, or tested to above their final working voltage for zero leakage; it is well worth while checking carefully through the various advertisement pages in this magazine to compare the economics of using a few high voltage diodes and capacitors with a high ratio transformer (100 to 1), or using rather more lower voltage components, with a slightly lower ratio transformer, at less total cost (and possibly greater reliability).

TYPICAL EFFICIENCY

This will depend very much upon the individual components used; one circuit using a peak to peak rectifier system, was fed from 6V and the following noted:

Input current 0.14A	Output 900V into voltmeter (20 μ A)
Input current 0.19A	Output 600V into 2M Ω (0.3mA)
Input current 0.28A	Output 500V into 390k Ω (1.3mA)

Another circuit with a seven stage multiplier, also fed from 6V:

Input current 0.5A	Output 1,600V into 3M Ω (about 0.5mA)
--------------------	--

TEST SET CIRCUIT

A simplified block diagram and functions of the tester are shown in Fig. 8. The high voltage generator has already been described; the TR1, TR2, TR3 circuit

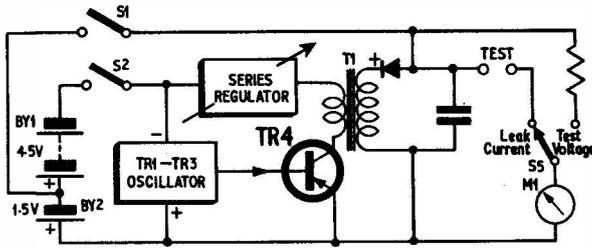


Fig. 8a. Basic circuit of the insulation and diode test set

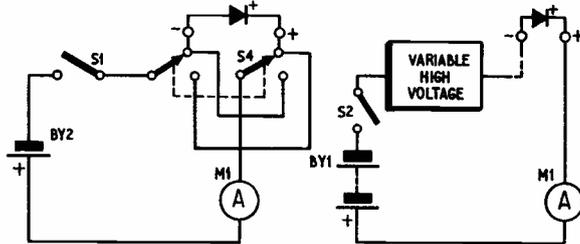


Fig. 8b. Circuit for low voltage checking

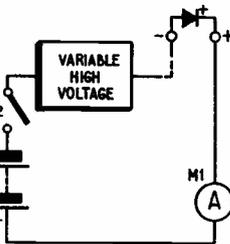
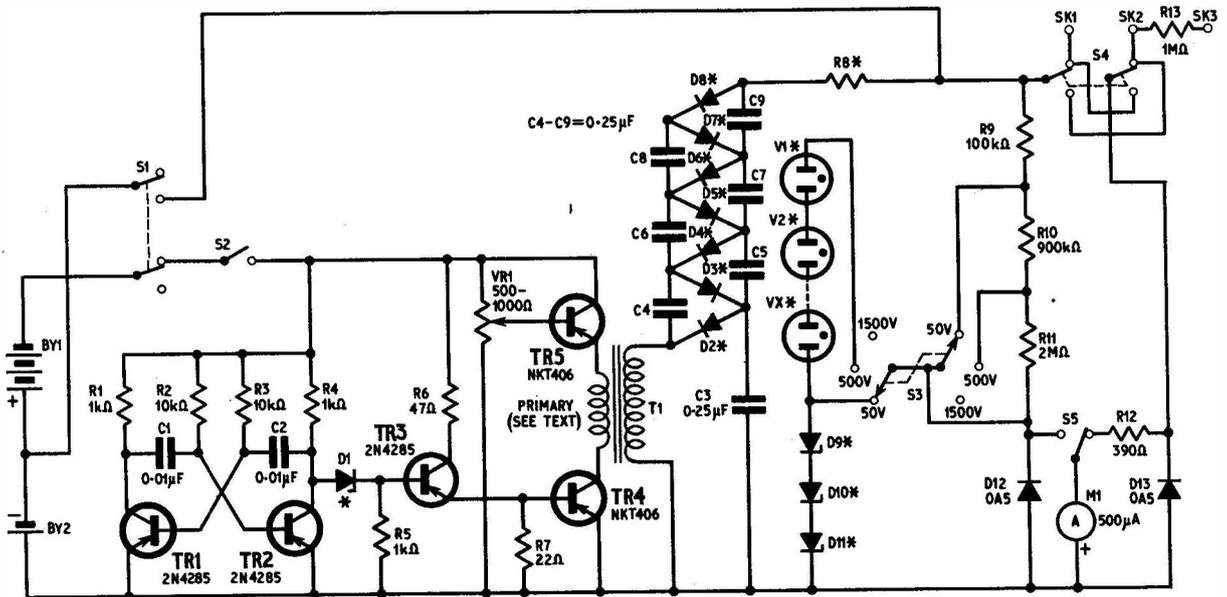


Fig. 8c. Circuit for high voltage check on leakage

is fed from 6V immediately upon switching on, but TR4 is fed via a simple series regulator thus giving full control of the output from zero to maximum voltage.

Switches S1 and S4 (Fig. 8b) are used first for simple diode or continuity checks enabling open or short circuit diodes to be rejected and the diode polarity to be confirmed, since the cathode (+ve) end of the diode connected to the positive test terminal should show zero current. Only 1.5V is used rather than the available 6V so that low voltage Zener diodes are not rejected. S4 will have the full test voltage across it at all times but since it is switching negligible currents, a normal toggle or biased type should operate satisfactorily at up to about 2kV. Any leakage will be seen on the meter, so this is self-checking.

The high voltage generator is energised by S2 as long as S1 is not operated; S2 must be spring biased to the OFF position so that there is no chance of accidents—even though the output current is limited. The voltmeter multiplier resistance is altered by S3 which also shunts the test terminals with Zener diodes or small neons in the lower voltage positions to avoid damage to the meter (Fig. 9). The Zeners and neons are not necessary initially however, and may be added after the rest of the unit is working and available to test the characteristics of these safety devices.



* SEE COMPONENTS LIST

Fig. 9. The complete circuit diagram of the insulation and diode test set

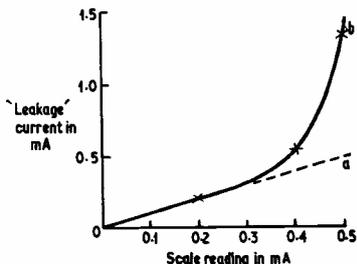
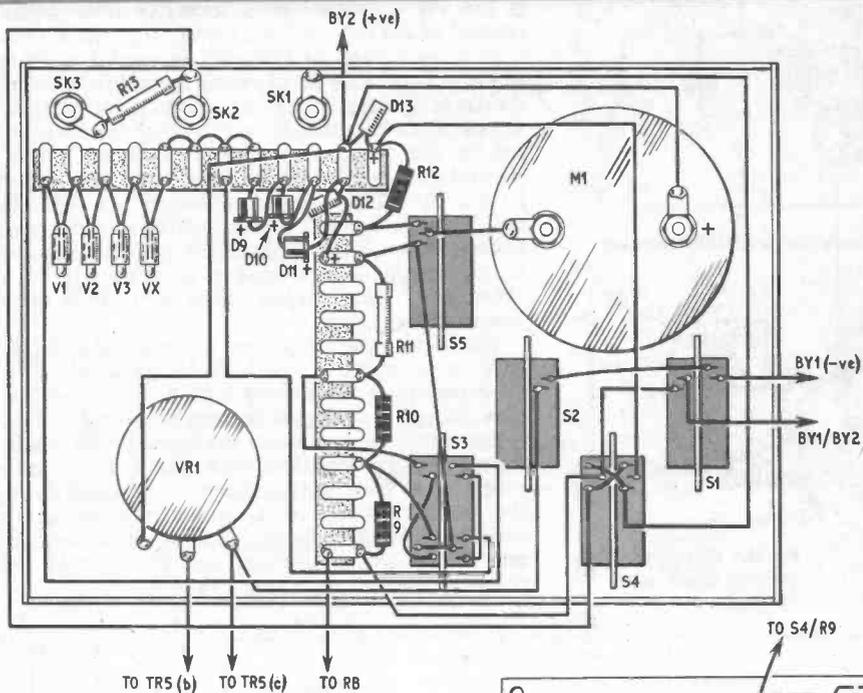


Fig. 10. Graph showing the effect of adding R12 (390 Ω) to the 500 μA, 190 Ω meter; "a" without R12, "b" with R12—no alteration of first half of scale linearity

To switch the meter movement across either D12 or D13, S5 is incorporated. D12 and D13 are germanium junction types—OA5 were used in the prototype but a germanium transistor base-emitter junction would do as well. Inclusion of these diodes ensures that the circuits are never left open as the meter is switched over, yet the meter when connected across a diode, "robs" the diode of its turn-on voltage and so all the current flows through the meter alone (see Fig. 3). R12 was added to decrease the sensitivity of the meter at full scale and yet leave the low scale readings unaltered to show small



COMPONENTS . . .

Resistors

- R1 1k Ω
 - R2 10k Ω
 - R3 10k Ω
 - R4 1k Ω
 - R5 1k Ω
 - R6 47 Ω
 - R7 22 Ω
 - R8 47k Ω to 100k Ω (see text)
 - R9 100k $\Omega \pm 2\%$, $\frac{1}{2}$ W
 - R10 900k $\Omega \pm 2\%$, $\frac{1}{2}$ W
 - R11 2M $\Omega \pm 2\%$, 4W
 - R12 390 Ω selected to suit meter and D13
 - R13 1M $\Omega \pm 2\%$, 1W
- All $\pm 20\%$, $\frac{1}{2}$ W carbon except where stated

Potentiometer

VR1 500-1000 Ω wirewound

Capacitors

- C1 0.01 μ F polystyrene
- C2 0.01 μ F polystyrene
- C3-9 0.25 μ F paper 600V (7 off)

Semiconductors

- D1 Low voltage Zener (see text)
- D2-8 600V p.i.v. silicon miniature (7 off, see text)
- D9-11 Zener diodes, total voltage 50-60V (3 off)
- D12, 13 OA5 germanium diode (2 off)
- TR1, 2, 3 2N4285 or any low current pnp type (3 off, see text)
- TR4, 5 NKT406, OC28 or OC36 (2 off, see text)

Switches

- S1 DPDT biased
 - S2 SPST biased
 - S3 2-pole 3-way
 - S4 DPDT biased
 - S5 SPDT biased
- } toggle, yaxley or GPO
1000 type

Miscellaneous

- VI-Vx Neons, total striking voltage about 500V
- M1 500 μ A moving coil meter
- T1 Small high ratio valve output transformer (see text)
- BY1, 2 High power 1.5V U2 battery (4 off)
- SK1, 2 Insulated terminals (2 off, red and black)
- SK3 Wander plug socket
- Perforated s.r.b.p. board 2 $\frac{1}{2}$ in \times 1 $\frac{3}{4}$ in
- Laminated plastics board
- Solder pins
- Mounting pillars (4 off)
- 12 way tag strip (2 off)
- Control knob
- Metal case (size depends on components used)

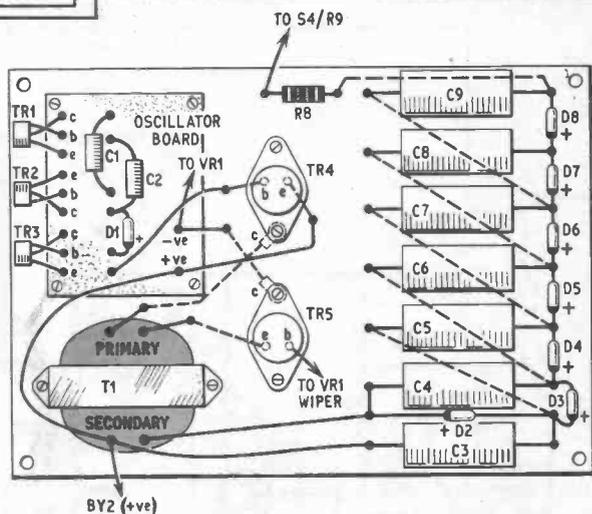


Fig. 11. Layout and wiring of the complete test set. The board must be made big enough to accommodate as many voltage multiplier stages as are required; it is mounted behind the front panel (top) on four pillars. Wiring shown dotted is on the underside of the board

COMPUTER MULTI-CORE CABLE
12 14/0076 copper cores, each one insulated by coloured P.V.C. then separately screened, the 12 metal braided cores laid together and P.V.C. covered overall making a cable just under 1/4 in. dia. but quite pliable. Price 7/6 per ft. Any length cut.

FLEX BARGAINS

SCREENED 3 CORE FLEX
Each core 14/0076 copper P.V.C. insulated and coloured, the 3 cores laid together and metal braided overall. Price **£3.15**—per 100yd coil.
15 AMP 3 CORE NON-KINK FLEX
70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3K w. fuses. Regular price 3/6 per yd. 50yd. coil. **£4.10** or cut to your length 3/6 per yd.
10 AMP 3 CORE NON-KINK FLEX
As above but cores are 28/0076 copper. Normal price 2/6 per yd. 100yd. coil **£7.10** or cut to your length 1/6 per yd.
6 AMP 2 CORE FLEX
As above, but 2 cores each 23/0076 as used for vacuum cleaners, electric blankets, etc., 39/6 100yd. coil.

15 AMP FOOT SWITCH



Suitable for sewing machine motor, drilling machine or in fact to switch any job where both hands are to be left free. Rated at 13A, 250V. Price **£2/6**.

3 DIGIT COUNTER



For tape recorder or other application, re-settable by depressing button. Price **8/6**.

TRANSDUCER



Made by ACOB, reference No. I.D.1001. For measuring vibration, etc., to be used in conjunction with "G" Meter. Regular price **£5**, our price **49/6**. Brand new and unused.

ISOLATION SWITCH

20A D.P. 250V. Ideal to control water heater or any other appliance. Neon indicator shows when current is on, 4/6. **£8/-** per dozen.



LIGHT CELL



Almost zero resistant in sunlight increases to 10K ohms in dark or dull light, epoxy resin sealed. Size approx. 1/4 in. dia. by 1/4 in. thick. Rated at 500MW. Wire ended. **8/6** with circuit.

INSTRUMENT BUZZER

6-12V, adjustable tone, a very neat metal case U.S.A. made unit approx. 1 1/4 in. thick. **6/6** each.



12 VOLT SOLENOID

For energizing Reed Switches, etc., size approx. 1 1/4 in. long by 1 1/4 in. diameter. Hole through solenoid approx. 1/4 in. **8/6** each.

MINIATURE WAFER SWITCHES



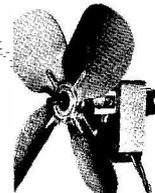
2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at **3/6** each. **50/-** dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. **10/-** post free.

AC FAN

Small but very powerful mains motor with 5 1/2" blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **17/6**, post 4/6. Mounts from back or front with 4BA screws.



CONTROL DRILL SPEEDS

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by fingertip control. Kit includes all parts, case, everything and full instructions **19/6** plus 2/6 post and insurance. Or available made up **29/6** plus 2/6 post.



500W IMMERSION HEATER

For small process tanks, etc., 200/240V. 4 1/4 in. into tank, 2 1/4 in. outside of tank, dia. approx. 1 in., chrome plated **14/6**. Post and insurance **4/6**.

THE FULL-FI STEREO SIX



The amplifier sensation of the year

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and tank finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S., split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch. Price is **£9.9.0** plus 7/6 post and insurance. Speakers (with tweeters) in oiled teak finish cabinets to match amplifier. **£8.8.0** pair.

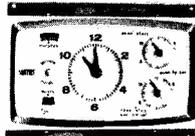
COMBINATION DIAL SWITCH



3 separate settings of the dial are necessary before this can be switched on or off. Combinations can be changed as required. A useful switch for security or novelty. Contacts rated at 1A. **35/-** each.

ELECTRIC CLOCK WITH 20 AMP SWITCH

Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so is extremely accurate. The two small dials enable switch on and off times to be accurately set—also on the left is another timer or alarm—this may be set in minutes up to 4 hours. At the end of the period a bell will sound. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—only **£8/-**, less than the value of the clock alone—post and insurance 2/6.



NICAD RECHARGEABLE BATTERIES

3-6V 500mA size 11 1 1/4 in. dia. type ref. DK2500 really powerful will deliver 1 amp for 1 hour. Regular price 32/6 our price **17/6** each. New and guaranteed. Other voltages available, single cell 1-2V **8/6**, 6 cell 6V **29/6**, 10 cell 12V **55/-**.



THIS MONTH'S SNIP

Horstmann "Time and Set" Switch



(A 15A switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around **£5**. Special snip price **29/6**, post and insurance **4/6**.

MOTORISED CAM SWITCH

Made by the famous meter company Chamberlain and Hookham, these have a normal mains 200-240V motor which drives a ratchet mechanism so geared to give one ratchet action per minute on a wheel with 60 teeth thus a complete revolution of the cam takes place in one hour. The cam operates 8 switches (6 changeover and 2 on/off thus 480 circuit changes per hour are possible). Contacts, rated at 15 amps have been set for certain switch combinations but can, no doubt, be altered to suit a special job. Also, in wet areas, wafers or devices can be attached to the shaft which extends approximately one inch. **47/6**, post and insurance **4/6**.



DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 1/2 in. x 13 in. sockets in metal box to take standard 13 amp fused plugs. S.p.s. complete with 6 feet of heavy cable and 13 amp plug. Similar panels advertised at **£5**. Our price **39/6**, plus 3/6 post and insurance.



G.E.C. 13A SOCKETS

Opportunity to re-equip your home or workshop, or if a contractor, to stock up for future jobs. We offer bakelite 13A sockets for flush or surface mounting made by the famous G.E.C. company and listed from **6/6** each. You can have a BOX OF 12 flush type **24/-**, surface type **29/6**, post and insurance **4/6** (Gross or more carr. free).

HI FI BARGAIN

FULL FI 12-INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms—Main resistance 60 c.p.s.—Chassis diam. 12 in.—12 1/2 in. over mounting lugs—Baffle hole 1 1/4 in. diam.—Mounting holes 4, holes—1 1/4 in. diam. on pitch circle 1 1/4 in. diam.—Overall height 5 1/4 in. A £5 speaker offered for only **£3.9.6** plus 7/6 p. & p. Don't miss this offer. 16in. 30 watt **£7.19.6**.



INDICATOR LAMP

Panel mounting, consists of neon lamp in red Plastic lens with resistor in leads for mains operation. **2/8** each, **24/-** dozen.

12V BLOWER

Heavy duty motor with centrifugal blower coupled to one end. Ideal for car heater. **12/6** plus 4/6 post.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **29/6**—twin stethoscope instead of earpiece **11/-** extra—post and ins. 2/6.



MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 5V., 9V., 12 volts for up to 500mA (Class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **10/6** plus 3/6 postage.

PROTECT VALUABLE DEVICES

From thermal runaway or overheating. Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected; simply make the contact thermostat part of the heat-sink. Motors and equipment can generally be protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90°-190° F. or with the dial removed range setting is between 80° to 800° F. Price **10/-**.



TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7 1/2 to 47in. Hole in bottom for 6BA screw. **7/6**.

REED SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor belt switching. These are simply glass encased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at **2/6** each, or **24/-** dozen. Suitable magnets are 1/- each.

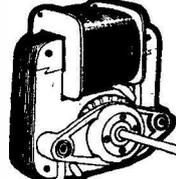
5A, 3 PIN SWITCH SOCKETS

An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Heraf) bakelite flush mounting sub-panel 5A switch sockets for only **10/-** plus 3/6 post and insurance. (20 boxes post free.)



MOVING COIL METER BARGAIN

Panel meters are always being needed and they are jolly costly when you have to buy them in a hurry—so you should take advantage of this offer: 2in. moving coil flush mounting meters only **9/6**. These are actually R.F. meters and cost about **£3** each but if you don't want them for R.F. then all you have to do is to remove the thermocouple and you will have a 2-3mA. meter which you can make into almost anything by adding shunts or series resistor. New and unused.



MAINS MOTOR

Precision made as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **9/6**. Postage **3/-** for first one then **1/-** for each one ordered. 12 and over post free.

5in x 5in PRINTED CIRCUIT BOARD

Ideal for dozens of projects. Heavy copper on 1/4 sheet, **1/6** each or **15/-** per dozen.

HEAVY DUTY MAINS TRANSFORMER

30V., 37A. Primary tapped 200/240 in 10V steps. A really beautiful "C" core transformer. Made by Parmeko, impregnated and varnished. Weight approx. 60 lb, size approx. 8in. wide, 6 1/2 in. deep and 8 1/2 in. high. Metal framed for free standing and fitted with E.S. screws. Probably priced **£40-£50** from Parmeko. Ex equipment, but perfect. **290** each, carriage paid.

ELECTRONICS (CROYDON) LTD

Dept. PE, 266 London Road, Croydon CRO 2TH
Also 102/3 Tamworth Road, Croydon

leaks. Fig. 10 shows the effect of this resistor used with a $500\mu\text{A}$ meter of 190 ohm internal resistance, but the effect will vary according to the particular diode and meter used.

The meter used was scaled 0-500 and so the voltage ranges chosen were 50, 500 and 1,500V. A more sensitive meter movement would load the circuit less because of the higher value resistors used in the volt-meter circuit and would also show up leakage more readily; a less sensitive meter is not recommended for the same reasoning.

CONSTRUCTIONAL DETAILS

The high voltage unit can be built up on a sheet of laminated plastics—perforated board is as convenient—while the meter, switches, voltage control and terminals are fitted to the front aluminium panel of the unit. The high voltage board (Fig. 11) is supported on pillars behind the front panel with all the interconnecting wires grouped together at one side so that the two parts may be “hinged” apart easily, without disconnecting, for testing or modification.

Do not try to miniaturise or cramp the layout; very close spacing could lead to unexpected leaks. Space should be found in the completed unit for a row of series connected high power U2 type cells so that the tester is self contained.

USE OF UNIT

Capacitor or insulation test: the chosen test voltage is applied; after allowing time for a capacitor to charge up, there should be zero leakage. An electrolytic capacitor may be expected to leak considerably and will not test satisfactorily with this tester since a ten minute forming period should be allowed first. If a current is indicated, the leakage resistance may be simply calculated from $R = \text{test voltage/leak current}$. The 1 meg-ohm resistor on the front panel is fitted because the final sub-circuits of electrical installations should have an insulation in excess of 1 megohm at 500V and a direct comparison can be quickly made if meter accuracy is in doubt.

Zener diode test: using the low voltage range the test voltage is increased until 0.5 to 1.5mA is indicated; the Zener breakdown voltage is now read from the meter by using S5, and it will be seen that this voltage will stay nearly constant as the current is varied from maximum to zero.

Rectifier diode test: increase the test voltage until leakage is indicated, then read off the test voltage. A rule of thumb for permissible leakage is to allow for one thousandth or 0.1 per cent of the forward current to leak at the maximum reverse voltage. If desired, a graph of leakage current against reverse voltage may be drawn to show the breakdown characteristics.

SAFETY

The maximum current available at the test terminals, under any conditions, is limited to 1.5mA by R8; the normal body resistance, hand to hand, lies between 10,000 and about $50,000\Omega$ so that the highest voltage that will be across a careless or accidental body should not exceed about 75V. Adjust R8 so that 1.5mA is the maximum available current. *Never be careless with capacitors that have just been tested at a high voltage and not allowed time to discharge;* the shock may not kill you, but by tripping over a stool you may easily break an arm or leg! ★

Earth Station Communicates

THE FIRST Earth station for satellite communication in the Middle East and Africa was officially opened at Bahrain on July 14. The inaugural telephone call was made by the Ruler of Bahrain, H.H. Sheikh Isa bin Sulman Al-Kalifa to H.R.H. the Duke of Edinburgh. Sheikh Isa made the call from the new Earth station before 300 guests. Prince Phillip received the call at Windsor Castle.

The station, owned and operated by Cable and Wireless Ltd., operates via the Intelsat III satellite stationed in orbit over the Indian Ocean and provides the States of the Arabian Gulf with direct links to the worldwide satellite system.

Bahrain is the third station to line up with the Indian Ocean satellite, following the U.K. and Japan. During the next 18 months Hong Kong, Germany, India, Indonesia, Italy, Kenya, Kuwait, Pakistan, Singapore and Spain are all expected to be using the satellite.

Computer Control

NOWADAYS computers are being used to control many processes and people. Two recently announced systems are a planned installation by Cable and Wireless to process passengers at Hong Kong's Kai Tak airport and an installation at the Port of New York Authority's £250 million World Trade Center (the world's highest building).

The Kai Tak system will help the processing of passengers, baggage and freight and will be especially useful when the “jumbo jets” come into service. Many other computerised control systems are already in operation around the world but this latest Cable and Wireless project will be different because it will offer individual and confidential processing to all airlines. The system will operate 24 hours a day and is planned to come into service in the autumn of 1970.

Costing nearly £3 millions, the installation at the World Trade Center is designed around a Honeywell DDP 516 real-time processor which will be linked to more than 6,500 sensors situated in and around the building. The computer which, in addition to its 16,384 word core memory, has a 196,000 word disc memory, will scan the sensors, extract the pertinent values and compare them with other variables or pre-set numerical limits. It will also make analyses of trends, efficiencies and operating profiles, taking into consideration, not only the conditions inside the World Trade Center, but also those outside the building at four different elevations. Monitoring temperature, humidity, wind direction and speed at these different points is necessary because the height of the building is such that it could be sunny on floor 110 but foggy at ground level!

Reconnaissance System Flown

THE COMBINED radar, infra-red linescan and camera pod designed by EMI Electronics for the Royal Air Force Phantom aircraft had its first flight trial recently.

The pod was attached below the belly of a trials Phantom which was flown from the Hawker Siddeley Aviation Ltd. airfield at Holme on Spalding Moor in Yorkshire.

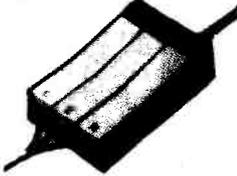
The aircraft flew at 400 knots at low level and in excess of Mach 1.3 at medium level. No difficulty was experienced and further trials are now proceeding.

The revolutionary reconnaissance system will enter service with the R.A.F. early in 1971.

LIND-AIR OPTRONICS LTD

See our vast range of Electronic Components and Accessories at our enlarged Component Centre 25 Tottenham Court Road

MAINS KEYNECTOR SAVES TIME—SAFELY!



One mains "Keyconnector" instantly and safely connects electrical appliances to mains supply without the use of a plug. A number of appliances may be used simultaneously up to the full 13 amp rating of this device. A red light glows when "live". The "Keyconnector" is fused and has its own robust switch which is interlocked to prevent connections when "live".

Invaluable to handymen, servicemen, demonstrators, etc.

39/6 P. & P.

VHF AIRCRAFT BAND CONVERTOR

When placed within 1in. of a MW band radio full coverage of VHF Aircraft Band 108-135Mc/s. can be obtained. All transistor, 9V battery operation. Fully tunable 18in. x 7 section telescopic aerial. Size 4x2 1/4in. 79/6. P. & P. 3/6.



MODEL MAKER'S MOTOR

No. 18EM. Voltage 11.5V. Current 400mA. Torque 12g.cm. Body size 1 1/2" x long 1" dia. Shaft 1/8" long 3/16" dia. Ideal for small models and toys. 5/6 each. P. & P. 1/3. 3 for 15/-.



DE-LUXE STEREO HEADPHONES

With soft rubber earpieces. Impedance 8-16 ohms. Frequency response 23-13,000cps. With lead and stereo plug. Only 59/6. P. & P. 3/6.



NEW STEREO/MONO HEADPHONES

8DE-7. Soft rubber earpieces with slide switch for mono/stereo listening abt ind. vol. controls. Impedance 8-16 ohm. Freq. response 25-18,000cps. With lead and stereo plug. 59.6. P. & P. 3/6.



VENNER SYNCHRONOUS MOTOR UNIT Brand New. Mains voltage (200/250V), 1 rev. per hour. Precision movement (enclosed in case), self starting, silent running. Shaft complete with knurled clamping nut. Overall dimensions: 2 1/2in diam., 2 1/2in deep (including shaft). Shaft diam. 3/16in. 57/6. P. & P. 3/6.

HI-TONE RECORDING TAPE

BRITISH MADE TOP QUALITY

J1001	3'	Long Play PVC	225ft	5/6	P. & P. 1/2
J1002	3'	Triple Play Poly	600ft	10/6	P. & P. 1/2
J1003	5'	Long Play PVC	900ft	10/-	P. & P. 1/8
J1004	5'	Double Play Poly	1200ft	18/-	P. & P. 1/8
J1005	5'	Long Play PVC	1200ft	18/6	P. & P. 2/-
J1006	5'	Double Play Poly	1800ft	22/6	P. & P. 2/-
J1007	7'	Standard Play PVC	1200ft	15/6	P. & P. 2/6
J1008	7'	Long Play PVC	1800ft	17/6	P. & P. 2/6
J1009	7'	Double Play Poly	2400ft	25/-	P. & P. 2/6
J1010	7'	Triple Play Poly	3600ft	50/-	P. & P. 2/6



Visit our Brand New Hi-Fi Demonstration Room, Tape, Record Bar and Scientific Show of Microscopes, Binoculars, Telescopes and Watches at 18 Tottenham Court Road



TFC C1001 MULTIMETER in leather case. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC volts 5-25, 125, 500, 2,500V. D.C. Current 0-50µA, 0-250mA Resistance 0-60K, 0-6 Megohm. Decibels -20 to +22dB. Size of meter 4 1/4 x 3 1/4 in. 85/- P. & P. 3/6.

TRANSFORMERS

AUTO WOUND TRANSFORMERS
All winding voltage ratings and tappings 0-115-200-220-240V, except MT113 0-115-210-240V

Model	Power	Size	Weight	Price
MT113	20W	2 1/4 x 1 1/4 x 1 1/4 in	11oz	12/6 (P. & P. 2/6)
MT64	75W	2 1/2 x 2 1/2 x 2 1/2 in	11b 14oz	21/9 (P. & P. 4/6)
MT4	150W	3 1/4 x 2 1/2 x 3 in	3lb	35/- (P. & P. 6/-)
MT65	200W	3 1/4 x 4 1/4 x 4 in	4lb	39/6 (P. & P. 6/-)
MT66	300W	4 x 4 x 3 1/4 in	6lb 7oz	59/4 (P. & P. 9/-)
MT110	400W	4 1/4 x 4 1/4 x 4 in	11b	65/- (P. & P. 10/-)
MT67	500W	5 1/4 x 4 1/4 x 4 in	12lb 8oz	89/- (P. & P. 10/6)
MT63	750W	4 1/4 x 6 1/4 x 5 1/4 in	13lb 4oz	95/7 (P. & P. 10/6)
MT84	1000W	4 1/4 x 6 1/4 x 5 1/4 in	16lb	142/2 (Carr. extra)
MT93	1500W	5 1/4 x 6 1/4 x 6 1/4 in	28lb 8oz	170/6 (Carr. extra)
MT94	1750W	5 1/4 x 6 1/4 x 6 1/4 in	31lb	196/- (Carr. extra)
MT95	2000W	6 1/4 x 8 1/4 x 6 1/4 in	40lb	212/2 (Carr. extra)
MT73	3000W	6 1/4 x 8 1/4 x 6 1/4 in	65lb 8oz	300/- (Carr. extra)

LOW VOLTAGE 12V RANGE

Model	Primary	Secondary	Weight	Price
MT111	0-5A	3 x 2 1/2 x 1 1/2 in	12oz	15/6 (P. & P. 2/6)
MT71	2A	2 1/4 x 2 1/4 x 2 1/4 in	11b	19/- (P. & P. 3/9)
MT69	4A	3 1/4 x 2 1/4 x 2 1/4 in	2lb 4oz	25/- (P. & P. 6/-)
MT70	6A	4 x 3 x 3 1/4 in	3lb 2oz	29/- (P. & P. 6/-)
MT72	10A	3 1/4 x 4 1/4 x 4 in	6lb 8oz	31/2 (P. & P. 9/-)
MT115	20A	4 1/4 x 4 1/4 x 4 in	11b 13oz	55/- (P. & P. 9/-)
MT187	30A	5 1/4 x 4 1/4 x 4 in	16lb 12oz	150/- (P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Model	Primary	Secondary	Weight	Price
MT68	1A	2 1/4 x 2 1/4 x 2 1/4 in	11b 7oz	22/6 (P. & P. 4/6)
MT114	3A	2 1/4 x 3 x 3 in	3lb 6oz	35/- (P. & P. 6/-)
MT73	5A	4 x 3 1/4 x 3 1/4 in	5lb 12oz	55/10 (P. & P. 6/-)
MT17	8A	4 1/4 x 3 1/4 x 4 in	7lb 8oz	72/7 (P. & P. 9/-)
MT115	10A	4 1/4 x 4 1/4 x 4 in	11b 13oz	95/- (P. & P. 11/-)

LOW VOLTAGE 30V RANGE

Model	Primary	Secondary	Weight	Price
MT112	0-5A	3 1/4 x 2 1/4 x 1 1/4 in	11b 4oz	17/4 (P. & P. 3/9)
MT79	1A	2 1/4 x 2 1/4 x 2 1/4 in	2lb	25/- (P. & P. 6/-)
MT20	3A	4 x 3 1/4 x 3 1/4 in	4lb 6oz	46/6 (P. & P. 6/-)
MT51	5A	4 1/4 x 3 1/4 x 4 in	6lb 8oz	60/9 (P. & P. 9/-)
MT88	8A	5 1/4 x 3 1/4 x 4 in	9lb 6oz	82/4 (P. & P. 11/-)
MT89	10A	5 1/4 x 4 1/4 x 4 in	12lb 2oz	105/6 (P. & P. 11/-)

LOW VOLTAGE 50V RANGE

Model	Primary	Secondary	Weight	Price
MT102	0-5A	2 1/4 x 2 1/4 x 2 1/4 in	11b 11oz	21/8 (P. & P. 6/-)
MT104	2A	4 x 3 1/4 x 3 1/4 in	5lb	45/6 (P. & P. 6/-)
MT106	4A	4 1/4 x 4 1/4 x 4 in	9lb 4oz	77/- (P. & P. 9/-)
MT118	8A	5 1/4 x 5 1/4 x 4 in	18lb 9oz	132/- (P. & P. 13/6)
MT119	10A	6 1/4 x 4 1/4 x 6 1/4 in	19lb 12oz	165/- (P. & P. 15/6)

LOW VOLTAGE 60V RANGE

Model	Primary	Secondary	Weight	Price
MT124	0-5A	3 1/4 x 2 1/4 x 2 1/4 in	2lb 4oz	24/- (P. & P. 6/-)
MT127	2A	4 1/4 x 3 1/4 in	5lb 6oz	52/10 (P. & P. 6/-)
MT123	4A	4 1/4 x 3 1/4 x 4 in	10lb 6oz	99/- (P. & P. 11/-)
MT122	10A	6 1/4 x 5 1/4 x 6 1/4 in	23lb 2oz	152/- (Carr. extra)

MAINS H.T. RANGE

Model	Primary	Secondary	Weight	Price
MT1AT	250-0-250V	80MA 6.3V 3-5A 5/6-3V 1A	3 1/4 x 3 in	25/- 6/-
MT6AT	250-0-250V	100MA 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	35/3 6/-
MT110	250-0-250V	120MA 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	44/9 6/-
MT11AT	300-0-300V	100MA 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	37/9 6/-
MT12AT	300-0-300V	120MA 6.3V 4A 5/6-3V 1A	4 x 3 1/4 in	46/2 9/-
MT33AT	300-0-300V	150 6.3V 4A 5/6-3V 1A	4 x 4 x 3 1/4 in	59/4 9/-
MT2AT	350-0-350V	80 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	38/6 6/-
MT7	350-0-350V	100 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	42/4 6/-
MT8	350-0-350V	120 6.3V 3-5A 5/6-3V 1A	4 x 3 1/4 in	50/- 6/-

BATTERY CHARGER TYPES

Model	Primary	Secondary	Weight	Price
MT77	1A	2 1/4 x 2 1/4 x 2 1/4 in	11b 6oz	15/- (P. & P. 4/6)
MT45	1.5A	2 1/4 x 2 1/4 x 2 1/4 in	11b 9oz	21/9 (P. & P. 4/6)
MT46	2A	3 1/4 x 2 1/4 x 2 1/4 in	2lb 4oz	25/4 (P. & P. 6/-)
MT47	3A	4 x 3 x 3 1/4 in	3lb 8oz	28/4 (P. & P. 6/-)
MT5	4A	4 x 2 1/4 x 3 1/4 in	3lb 11oz	33/- (P. & P. 6/-)
MT78	5A	4 x 3 1/4 x 3 1/4 in	5lb 12oz	42/- (P. & P. 6/-)
MT96	6A	4 x 3 1/4 x 3 1/4 in	6lb	49/- (P. & P. 6/-)
MT48	7A	4 x 4 x 3 1/4 in	6lb	56/7 (P. & P. 9/-)
MT146	8A	3 1/4 x 4 x 4 in	6lb 4oz	76/- (P. & P. 9/-)
MT49	9A	4 1/4 x 3 1/4 x 4 in	7lb 8oz	90/- (P. & P. 9/-)
MT147	10A	4 1/4 x 3 1/4 x 4 in	9lb 3oz	105/- (P. & P. 9/-)
MT50	12.5A	5 1/4 x 4 1/4 x 4 in	11b 14oz	125/- (P. & P. 11/-)

Amperages are d.c. with nominal selenium bridge rectifiers
MAINS ISOLATING RANGE also available

SHIBA 6SD MULTI-TESTER 50,000 s.p.v.
DC voltage: 5-25-50-250-500-2.5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50µA, 0-2-5mA, 0-250mA. Resistance: 0-6K, 0-6 Megohm. Decibels -20 to +22dB. Size 4 1/4 x 3 1/4 in. Complete with case 77/- P. & P. 3/6.

5-DeC BREAD BOARD



British made
Solderless breadboard panels, for fast reliable component connections. Single DeCs. One 8-DeC with Control Panel, Jig and Accessories for solderless connections to controls, etc., with booklet "Projects on 8-DeC" giving construction details for a variety of circuits. 20/6. P. & P. 2/6.
4-DeCKIT. Four 8-DeCs with two Control Panels, Jigs and Accessories and the booklet "Projects on 8-DeC" all contained in a strong attractive plastic case. Ideal for the professional user. 55.17.6. P. & P. 3/6.

PHARMAC DECKS



NR P22 less cartridge	25.9.6
1025 Stereo/Mono with cart.	26.19.6
2025 Stereo/Mono with cart.	27.19.6
3000D Stereo/Mono with cart.	29.19.6
3000E Stereo/Mono with cart.	31.19.6
SP25 less cartridge	31.19.6
SP25 with Decca Deram cart.	37.4.6
SL55 less cartridge	31.19.6
SL55 with Decca Deram cart.	37.4.6
SL65 less cartridge	31.4.9.6
Covers for above	22.19.6
Bases for above	22.10.0
AP75 less cartridge	215.18.0
SL75 less cartridge	228.7.0
SL85 less cartridge	228.19.6
Bases for above	24.19.6
SPECIAL OFFER!	
SP25 less cart., with base	313.10.0
P. & P. Decks 12/6, Cover 4/6, Base 4/6. P. & P. Deck/Cover/Base 17/-.	

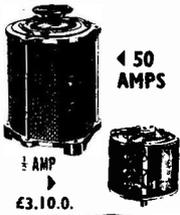
MINIATURE SOLDERING IRON
British made and designed for use with transistor circuitry but ideal for many other uses. A.C. 240V, 18W. Length 7 1/4 in. 1in slide on bit. Price 22/6. P. & P. 2/-.



LIND-AIR OPTRONICS LTD
18, 25 & 53 TOTTENHAM COURT ROAD, LONDON W.1
Telephone: 01-580 2255 4532 7679
Shops open 9-6 pm. Monday to Saturday. Thursday until 7 pm

MAIL ALL ORDERS
To Dept. PE969
54a Tottenham Court Road,
London, W.1

VARIABLE VOLTAGE TRANSFORMERS



INPUT 230/240v. A.C. 50/60—
OUTPUT VARIABLE 0-260v.
BRAND NEW

Keenest prices in the country.
All Types (and Spares) from
1/2 to 50 amp. from stock.

SHROUDED TYPE
1 amp, £5. 10. 0. 2.5 amps, £6. 15. 0.
5 amps, £9. 15. 0. 8 amps, £14. 10. 0.
10 amps, £18. 10. 0. 15 amps, £21. 0. 0.
20 amps, £25. 0. 0. 25 amps, £27. 0. 0.
37.5 amps, £32. 0. 0. 50 amps, £42. 0. 0.

OPEN TYPE (Panel Mounting)
1 amp, £3. 10. 0. 1 amp, £5. 10. 0.
2.5 amps, £6. 12. 6.

PORTABLE TYPE
1.5 amp. portable fitted metal case, voltmeter, lamp, switch, etc. £9.5.0.
Similar to above 2.5 amp. £11.7.6.

PORTABLE TYPE
£9. 5. 0.

L.T. TRANSFORMERS

All primaries
220-240 volts

Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36 v. at 5 amps.	£4/5/0	6/-
2	30, 40, 50 v. at 5 amps.	£6/5/0	6/6
3	10, 17, 18 v. at 10 amps.	£4/10/0	4/6
4	6, 12 v. at 20 amps.	£5/17/6	6/6
5	17, 18, 20 v. at 20 amps.	£6/12/6	6/6
6	6, 12, 20 v. at 20 amps.	£6/5/0	7/6
7	24 v. at 10 amps.	£4/15/0	5/6
8	4, 6, 24, 32 v. at 12 amps.	£6/10/0	6/6

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250v. A.C. operation.

EXPERIMENTERS ECONOMY KIT
1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube — instructions £5.5.0 plus 5/- P. & P.

NEW INDUSTRIAL KIT
Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor and 1-80 f.p.s. Price 9 gns. 7/6 P. & P.

HY-LIGHT STROBE

This strobe has been designed and produced in response to wide public demand, for use in large rooms, halls and the photographic field. It has four times the light output at 30 f.p.s. and utilizes a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Light output approx 4 joules. Price £10.17.6. P. & P. 7/6.

100 WATT POWER RHEOSTATS (NEW)

AVAILABLE IN THE FOLLOWING VALUES

1 ohm, 10 a.; 5 ohm, 4.7 a.; 10 ohm, 3 a.;
25 ohm, 2 a.; 50 ohm, 1.4 a.; 100 ohm, 1 a.;
250 ohm, 7 a.; 500 ohm, .45 a.; 1,000 ohm,
280 mA.; 1,500 ohm, 230 mA.; 2,500 ohm, 2 a. Diameter
3 1/2 in. Shaft length 3/4 in., dia. 1/8 in. All at 27/6 each.
P. & P. 1/6.

50 WATT. 1/5/10/25/50/100/250/500/1,000/1,500/2,500
ohm, 21/- P. & P. 1/6.
25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500
ohm, 14/- P. & P. 1/6.

**PARVALUX TYPE SD19 230/250 VOLTS A.C.
REVERSIBLE GEARED MOTOR.**

30 r.p.m. 40lb. ins. Position of drive
spindle adjustable to 3 different angles.
Mounted on substantial cast aluminium
base. Ex-equipment. Tested and in first
class running order. A really powerful
motor offered at a fraction of makers'
price. 6 GNS. P. & P. 10/-

NICKEL CADMIUM BATTERY Sintered Cadmium
Type 1-2 v. 7AH. Size: height 3 1/2 in., width 2 1/4 x 1 1/8 in.
Weight: approx. 13 oz. Ex-R.A.F. Tested. 12/6. P. & P. 2/6.
1.2 volt 35 AH 30/- each plus 4/- P. & P.

DRY REED SWITCHES

2 x 1 amp Dry Reeds (makes contacts). Mounted in 870
ohm 9-18 v. coil. Size 3" x 3 1/2" x 1 1/2". New. Price 8/6
per pair. Post Paid. Six of the above mentioned units
(12 Reeds). Fitted in metal box. Size 4" x 3 1/2" x 1 1/2".
Mfg. by Elliott Bros. New. 45/- each. Post Paid.

LIGHT SENSITIVE SWITCH

Kit of parts, including ORP12 Cadmium Sulphide Photo cell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price 25/- plus 2/6 P. & P. ORP 12 including circuit, 10/6 each, plus 1/- P. & P.

A.C. MAINS MODEL Incorporates Mains Transformer, Rectifier and special relay with 3.5 amp mains c/o contacts. Price inc. circuit 47/6 plus 2/6 P. & P.

LIGHT SOURCE AND PHOTO CELL MOUNTING

Precision engineered light source with focusible lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair £2.15.0. P. & P. 3/6.

NEW MODEL HIGH FREQUENCY TRANSISTORISED MORSE OSCILLATOR

Adjustable tone control. Fitted with moving coil speaker, also earpiece for personal monitoring. Complete with morse key. 45/- plus 3/6 P. & P.

MINIATURE UNISELECTOR SWITCH

Ex-Equipment
3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Tested. 22/6, plus 2/6 P. & P.

DEMONSTRATION TRANSFORMER (STENZYL TYPE)

Two separate removable coils tapped at 0. 110. 220 volts, and 6. 12. 36 volts respectively. A composite apparatus designed for class demonstration. Electro magnetic induction, jumping ring, induction lamp, relationship between field intensity and ampere turns, induction melting, are just a few of the possible experiments. New modified model. £14.10.0, P. & P. 10/-

RELAYS

New SIEMENS, PLESSEY, etc. miniature plug in relays complete with base, at highly COMPETITIVE PRICES

Coil	Working Voltage	Contacts	Price
280	6-12	2 c/o	14/6
280	9-18	4 c/o	15/6
700	12-24	2 c/o	12/6
700	12-24	4 c/o	15/6
700	16-24	4M 2B	12/6
1250	20-40	2 c/o H.D.	12/6
2500	30-50	2 c/o H.D.	12/6
9000	40-70	2 c/o	10/-

H.D. — Heavy Duty. POST PAID

SEALED RELAYS

230 volt AC Coil. Three c/o 5 amp. contacts. 17/6d. post paid. LONDEX 4 c/o 3 amp contacts. 18/6 inc. base. post paid.

MINIATURE RELAYS

30-36 D.C. operation. 2 c/o. 500 M.A. contacts. 3,200 DM. coil. Size only 1 x 1/2 x 1/2. 8/6 post paid.

'AVO' MODEL 47A

Ex-Admiralty in good condition, complete with instructions, leads and case. £9/19/6, P. & P. 10/-.

'AVO' MODEL 48A

Ex-Admiralty in good condition with instructions, leads, plus D.C. Shunts for 120 Amp and 480 Amp. A.C. Transformer for 60 Amp. and 240 Amp. Multiplier for 3600 volt. Complete outfit in fitted case. £15/0/0, P. & P. 10/-.

INSULATED TERMINALS

Available in red, white, yellow black, blue and green. New 17/- per doz. 2/- P. & P.

PRACTICAL INTEGRATED CIRCUITS

Constructional projects in microelectronics for the amateur experimenter

by A. J. McEvoy & L. McNamara

18/- Postage 1/-

RADIO AND TELEVISION SERVICING 1968-69 MODELS, by J. Harris. 80/- Postage 4/6.

110 SEMICONDUCTOR PROJECTS FOR THE HOME CONSTRUCTOR, by R. M. Marston. 18/- Postage 1/-.

RADIO COMMUNICATION HANDBOOK, by R.S.G.B. 63/- Postage 4/6.

TRANSISTOR RADIO SERVICING MADE EASY, by Wayne Lemons. 20/- Postage 1/-.

AMATEUR SSB RADIO GUIDE, by Harry D. Hooton. 30/- Postage 1/-.

THE RADIO AMATEUR'S HANDBOOK, by A.R.R.L. 45/- Postage 4/6.

THE HI-FI AND TAPE RECORDER HANDBOOK, by G. J. King. 40/- Postage 1/6.

SERVICING WITH THE OSCILLOSCOPE, by G. J. King. 28/- Postage 1/-.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST of British and American Technical Books
19-21 PRAED STREET
LONDON, W.2
Phone: PADdington 4185
Closed Saturday 1 p.m.

4-STATION INTERCOM



Solve your communication problems with this 4-Station Transistor Intercom system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from Master to Subs and Subs to Master. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 7/6.

MAINS INTERCOM
No batteries—no wires. Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control. Price 18 gns. P. & P. 9/6 extra.

INTERCOM/BABY ALARM



Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

Transistor TELEPHONE AMPLIFIER



Why not boost business efficiency with this incredible De-Luxe Telephone Amplifier. Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery 9/6 extra. P. & P. 3/6. Full price refunded if not satisfied in 7 days.

WEST LONDON DIRECT SUPPLIES (PE/8)
189 KENSINGTON HIGH STREET, LONDON, W.8

SERVICE TRADING CO

All Mail Orders—Also Callers—Ample Parking Space
57 BRIDGMAN ROAD, LONDON, W.4 Phone 995 1560
SHOWROOM NOW OPEN CLOSED SATURDAY

Personal callers only
9 LITTLE NEWPORT ST.
LONDON, W.C.2. Tel. GER 0576

COLD CATHODE TUBES

By J.B. Dance M.Sc.

ARC DISCHARGE TUBES

COLD cathode gas filled glow trigger tubes and their circuits were discussed last month. However, there are a number of other types of gas filled device which can be switched to the conducting state by the application of a triggering pulse to a starter electrode. Some of these tubes operate in the glow discharge region, whilst others operate in the arc region where a much greater current flows.

ARC DISCHARGE TUBES

The flash tube operates in the arc discharge mode, but can be used only under pulsed conditions. Flash tubes are used in stroboscopes, electronic flash equipment for photography, and in doped crystal lasers.

Some of the tubes used for stroboscopic purposes have an internal triggering electrode, whereas the triggering electrode of most types of flash tubes designed for photographic and laser applications consists of a wire secured to the outside of the tube.

Another type of arc discharge tube is used as a protective device; when the potential between the trigger and cathode of such a tube becomes much higher than normal, the tube fires and this prevents the voltage surge from damaging other equipment.

FLASH TUBES

The operation of a flash tube involves the rapid discharge of a capacitor through the tube. The basic circuit is shown in Fig. 4.1. Both the main capacitor,

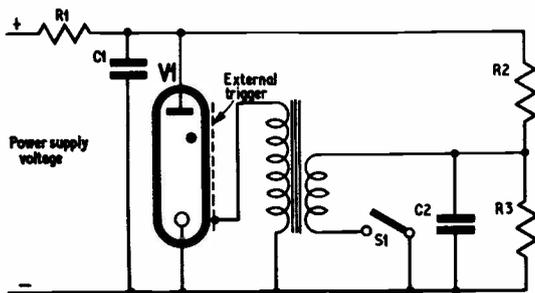


Fig. 4.1. A simple flash tube circuit

C1, and the triggering capacitor, C2, charge from the power supply through the resistor R1.

When they are adequately charged, switch S1 may be closed so that a pulse of current flows from C2 through the transformer winding. This results in a high potential (typically some kilovolts) being developed across the secondary winding of the transformer.

This high potential is applied to the external triggering electrode and distorts the electric field in the gas so much that ions are formed and the main discharge is initiated. The main capacitor, C1, then discharges through the flash tube.

The energy stored in this capacitor is $\frac{1}{2}C_1V^2$ where V is the potential across it. If the potential across C1 before the flash occurs is V_1 and that after the flash is V_2 , the energy given up by the capacitor is $\frac{1}{2}C(V_1^2 - V_2^2)$. The efficiency of such tubes is quite high.

A photographic flash tube is normally filled with either argon or with a mixture of krypton and xenon, since these gas fillings produce a flash which has a spectral energy distribution very similar to that of daylight. Although this energy distribution actually changes with time (becoming more red towards the end of the flash), the overall distribution is very similar to that of daylight.

Fairly long tubes are normally used for photographic and laser work, since this enables a greater efficiency to be obtained. In order that a reasonably long tube can be manufactured in a comparatively compact form, flash tubes are often manufactured in the form of a helix or a U-shape.

The duration of the flash from a tube is typically of the order of one hundred microseconds for tubes operating at a few kilovolts, but is about a millisecond for low voltage tubes. If the inductance and resistance in series with a high voltage tube is reduced to the absolute minimum, flashes of less than ten microseconds can be obtained.

The amount of power which can be passed to a tube is limited. If an excessive amount of power is dissipated in a tube, gas may be evolved from the walls of the tube or some parts of the tube may be damaged. The tube may then fail to operate when a further trigger pulse is applied.



English Electric flash tube type XL604 with the trigger electrode wire round the outside of the tube

STROBOTRON

The electrode structure of a typical flash tube designed for stroboscopic purposes is shown in Fig. 4.2. This type of tube employs an internal triggering electrode, G1, which consists of a wire entering the cup shaped cathode, K. The anode is some distance away from the other electrodes.

A positive potential (about 100 volts) is applied to G2. If a suitable negative going pulse (about 40 to 100 volts) is then applied to G1, the tube will fire. The current rises rapidly to about 5 amps, but the discharge ceases when the anode to cathode voltage falls to about 20 volts, this being the potential required to maintain the arc discharge.

Tubes of this type are known as "Neostrons" (Ferranti) or "Strobotrons" (Sylvania).

The arc discharge tubes discussed above cannot be operated in such a way that a continuous current flows, since such a current would damage them permanently. Another type of triggered tube known as an "Arcotron" was developed by the Cerberus Company of Switzerland in 1961.

Arcotron tubes can pass a continuous current of a few amperes and can be used to replace hot cathode thyatron tubes or thyristors. However, it is understood that these tubes are no longer recommended for use in currently designed equipment and they will not therefore be discussed further. A special type of arc discharge tube is being manufactured by the Cerberus Company for use in the ignition system of Wankel rotary engines.

GLOW THYATRION

The glow thyatron, developed a few years ago, is very similar to the common trigger tube, but the discharge is initiated by the controlled introduction of ions from an auxiliary discharge into the main gap. The auxiliary discharge takes place continuously when the tube is operational, the introduction of the ions being controlled by the potential applied to a grid.

Glow thyatrons have the advantage that they require a very much smaller control voltage than normal trigger tubes, but their input impedance is much smaller. They are therefore especially suitable for use with transistor circuits. Glow thyatrons have pure metal cathodes and therefore the tubes have close tolerances, a long life and are very reliable when correctly used.

The electrode structure of the glow thyatron is shown in Fig. 4.3. The auxiliary discharge takes place between the auxiliary cathode, denoted HK ("Hilfskathode"), and the main cathode K. The auxiliary cathode HK is normally connected via a current limiting resistor to a source of negative potential and the main cathode (which is usually at approximately earth potential) acts as the anode for the auxiliary discharge.

Some electrons from the auxiliary discharge penetrate through a hole in the cathode into the space between the latter and the grid, G. In this space the electric field strength is a function of both the grid and the anode voltages.

If the grid is sufficiently negative with respect to the cathode, the electrons passing through the hole in it are quickly decelerated and return to the cathode.

If, however, this negative grid voltage is reduced, the electrons are accelerated by the field from the anode (which, to some extent, penetrates through the holes in the grid). They therefore pass into the grid-anode space and create ions by the avalanche effect discussed in previous articles. A discharge is thus initiated between the main cathode and anode.

As in the case of the trigger tube, the glow thyatron is not affected by changes of grid potential once it has been switched to the conducting state. The anode voltage must be reduced in order to return the tube to the initial state where the main gap is non-conducting.

FIRING CHARACTERISTIC

The firing characteristic of a glow thyatron is shown in Fig. 4.4. This curve shows the conditions required for main gap conduction in a tube, through which an auxiliary discharge current of $160\mu\text{A}$ is passing and which is being used in circuit with a 220 kilohm grid resistor. The curve does not apply once the main gap has been switched to conduction.

At points on the lower left parts of the graph the tube will not fire across the main gap. As the grid

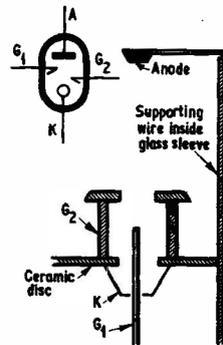


Fig. 4.2 (left). Sectional view through a stroboscope tube

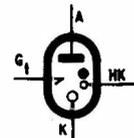


Fig. 4.3. Circuit symbol of a glow thyatron



Glow thyatron type GT21 (left)

Electrode structure of the glow thyatron (right)

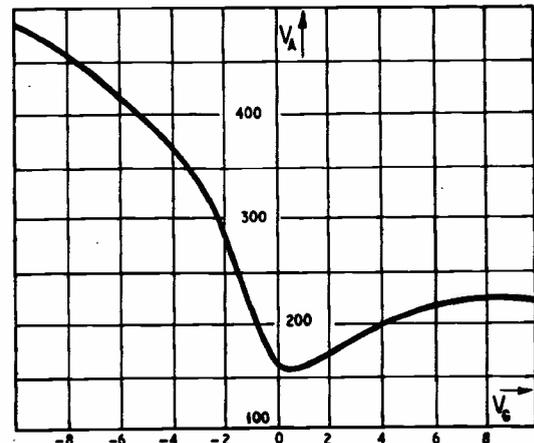
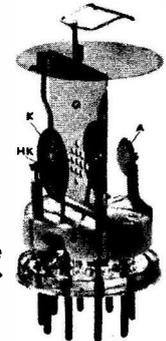


Fig. 4.4. Typical firing characteristic of a glow thyatron

DE LUXE PLAYERS

PORTABLE CABINET As illustrated. To fit standard 75/- player or autochanger. **RCS AMPLIFIER 3 WATT.** Ready made and tested. This is a 2-stage unit using a triode pentode with a coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on chassis with knob. Supplied with loudspeaker and valve UCL182. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6**



Post 5/8 each item

SINGLE PLAYERS MONO
EMI Junior Matins 22.19.6
Garrard 3EP22 26.19.6
Garrard SP25 MkII 14.19.6

AUTOCHANGERS MONO
Balfour Princess 35.19.6
BSB Operetta UA25 48.19.6
M470 transcription 113.19.6
Garrard AT760 MkII 218.19.6

All fitted LP78 styli and pickup cartridge complete. Stereo/mono pickups 20/- extra except 3000.

GARRARD TEAKWOOD BASE WB.1. Ready cut-out for mounting 1025, 3000, SP25, AT60, etc. **65/-**

GARRARD PLASTIC COVER SFC.1. for WB.1 BASE. Durable tinted attractive appearance. **65/-**

PICK-UP ARM Complete with E.M.I. LP-78 XTAL Styli 29/6
XTAL GP67 17/6; Stereo Ceramic 35/-; Powerpoint 55 15/-

CRYSTAL MIKE INSERTS

1 1/2" dia. 6/8; ACOG 1 1/2" 9/8; BMS, 1 1/2" dia. 9/8
QUALITY RIBBON MIKE WITH GOOSENECK 11.11.0

PORTABLE TRANSISTOR AMPLIFIER PLUS DYNAMIC MICROPHONE

A self-contained fully portable mini p.a. system. Many uses - ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player Amplifier, etc. Attractive redine covered cabinet, size 12 x 9 x 4in., with powerful 7 1/2in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP3 battery. Brand new in Makers' carton with full makers' guarantee. World famous make. **Only 90/- Post Free**



Only 90/- Post Free

WEYRAD P50 - TRANSISTOR COILS
RASW 6 in. Ferrite Aerial Spoke Coils. 6d.
with car aerial coil. 12/6
Osc. P50/IAC 5/4
L.F. P50/2CC 470 kc/s 5/7
3rd I.F. P50/3CC 6/-
Telescopic Chrome Aerials 6in. extends to 20in. 5/-
Ferrite Rods Only 8 x 1/4in. 4/-; 6 x 1/4in. 3/-

VOLUME CONTROLS
Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. 1/2" 3/4" D.P. 5/-
STEREO 1/5 10/6. D.P. 14/6
Edge 5K. S.F. Transistor, 5/-
Wire-Wound 3-WATT POTS. Wide-Range 3-WATT T.V. Type. Knurled Knob. Values 10Ω to 30 K. 4/6
Carbon 30 K to 2 meg.

80ohm Coax 8d. yd.
BRITISH AERIALITE
AERIAL-AIR SPACED 40 yd. 20/-; 60 yd. 30/-
FRINGE LOW LOSS 1/6
Ideal 825 lines

WIRE-WOUND 3-WATT POTS. WIDE-RANGE 3-WATT STANDARD SIZE POTS. LONG SPINDLE 50 OHMS to 100 K. 7/6

VEROBOARD 0-15 MATRIX
2 1/2 x 5in. 3/8; 3 1/2 x 3in. 3/8; 3 1/2 x 3in. 3/8; 3 1/2 x 5in. 5/2
EDGE CONNECTORS 16 way 5/-; 24 way 7/6
PINS 36 per packet 3/4. FACE CUTTERS 7/6
S.B.F.P. Board 0-15 MATRIX 2 1/2in. wide 6d. per lin., 3 1/2in. wide 9d. per lin., 4in. wide 1 1/4 per lin. (up to 17in.).
S.B.F.P. undrilled 3 1/2in. Board 10/- 8in. 3/-
BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2 1/2in. sides. 7 x 4in.; 9/6; 9 x 7in.; 6/6; 11 x 2in.; 6/6; 11.7in. 7/6; 13 x 4in.; 9/6; 14 x 1 1/2in.; 12/6; 15 x 1 1/2in.; 15/-
ALUMINIUM PANELS 18 s.w.g. 12 x 12in. 8/6; 14 x 19in. 5/6; 12 x 2in. 4/6; 10 x 7in. 3/6; 8 x 6in. 2/6; 6 x 4in. 1/6

Q MAX CHASSIS CUTTER
Complete: a die, a punch, an Allen screw and key
4in. 16/-; 4in. 17/6; 4in. 19/6; 4in. 24/-; 2 1/2in. 44/3
4in. 16/-; 4in. 19/6; 4in. 20/6; 4in. 29/-; 2 1/2in. 57/3
4in. 16/9; 4in. 19/6; 4in. 21/6; 4in. 29/-; 2 1/2in. sq. 36/6

WAVE-CHANGE SWITCHES WITH LOW SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKETS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4p. 3-way, 6 p. 2-way, 1 waf. 12/-, 2 waf. 18/-, 3 waf. 24/-, 4 waf. 30/-, 5 waf. 30/-
Extra wafers 6/- each up to 5 max.
TOGGLE SWITCHES, sp. 2/6; sp. 2/6; sp. 3/6; dp. 3/6; dp. 4/6

ALL PURPOSE HEADPHONES
H.R. HEADPHONES 2000 ohms Super Sensitive. 35/-
LOW RESISTANCE HEADPHONES 3-8 ohms. 39/6
DE LUXE PADDED STEREO PHONES 8 ohms. 79/6

"THE INSTANT" BULK TAPES ERASER AND RECORDING HEAD DEMAGNETISER
200/250 v. A.C. Leadlit S.A.E. **42/6**



Minimum Post and Packing 2/6. RETURN OF POST DESPATCH. HI-FI STOCKISTS. CUSTOMERS FREE CAR PARK. CALLERS WELCOME.

BARGAIN STEREO/MONO SYSTEM

Attractive Slim Player Cabinet with B.S.E. Stereo Autochanger 4 + 4 AMPLIFIER and TWO matched 6" in. LOUDSPEAKERS. Carr. 10/6 **£19.19.6**
(Only 4 pairs of wires to join)

NEW TUBULAR ELECTROLYTICS
2/350V .. 2/3 100/25V .. 2/-
2/350V .. 2/3 200/25V .. 2/6
3/450V .. 3/3 500/25V .. 4/-
16/450V .. 3/3 8 + 9/450V 3/6
32/450V .. 3/9 8 + 16/450V 3/9
25/25V .. 1/9 16 + 16/450V 4/3
50/50V .. 2/- 32 + 32/50V 4/6

SUB-MIN. ELECTROLYTICS 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250MF 15V 2/-; 500, 1000MF 15V 3/6; 2000MF 25V 7/-

CERAMIC 500V 1pF to 0.01MF
PAPER 350V-0.1 9d. 0.5 2/8; 1mf 3/-; 2mf 150V 3/-
500V-0.001 to 0.05 9d. 0.1 1/-; 0.25 1/6; 0.5 3/-
1.000V-0.001, 0.002, 0.004, 0.01, 0.02, 1/8; 0.047, 0.1, 2/6

SILVER MICA. Close tolerance 1%, 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/8; 6,800pF-0.01, mid 6/-; each

TWIN WAVE. 200pF +175pF, 10/6; 365pF, miniature 10/-; 500pF standard, with trimmer, 12/6; 500pF midjet less trimmer, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 19/6. Single "O" 385pF 7/6. Twin 10/6.

SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each.

TUNING. Solid dielectric, 100pF, 300pF, 500pF, 7-26.

TRIMMERS. Control 100pF, 200pF, 500pF, 1000pF, 100pF, 150pF, 1/3; 250pF, 1/6; 600pF, 750pF, 1/8; 1000pF, 2/6.

CONTACT COOLED 1-wave 60mA 7/6; 85mA 9/6; BY 106 10/-.

Full wave Bridge 75mA 10/-; 150mA 19/6; RT. rect. 10/-.

NEON PANEL INDICATORS 250V, AC/DC 3/8.

RESISTORS. Preferred values, 10 ohms to 10 meg.
10 1/2, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000, 15000, 20000, 25000, 30000, 40000, 50000, 60000, 70000, 80000, 90000, 100000, 150000, 200000, 250000, 300000, 400000, 500000, 600000, 700000, 800000, 900000, 1000000, 1500000, 2000000, 2500000, 3000000, 4000000, 5000000, 6000000, 7000000, 8000000, 9000000, 10000000, 15000000, 20000000, 25000000, 30000000, 40000000, 50000000, 60000000, 70000000, 80000000, 90000000, 100000000, 150000000, 200000000, 250000000, 300000000, 400000000, 500000000, 600000000, 700000000, 800000000, 900000000, 1000000000, 1500000000, 2000000000, 2500000000, 3000000000, 4000000000, 5000000000, 6000000000, 7000000000, 8000000000, 9000000000, 10000000000, 15000000000, 20000000000, 25000000000, 30000000000, 40000000000, 50000000000, 60000000000, 70000000000, 80000000000, 90000000000, 100000000000, 150000000000, 200000000000, 250000000000, 300000000000, 400000000000, 500000000000, 600000000000, 700000000000, 800000000000, 900000000000, 1000000000000, 1500000000000, 2000000000000, 2500000000000, 3000000000000, 4000000000000, 5000000000000, 6000000000000, 7000000000000, 8000000000000, 9000000000000, 10000000000000, 15000000000000, 20000000000000, 25000000000000, 30000000000000, 40000000000000, 50000000000000, 60000000000000, 70000000000000, 80000000000000, 90000000000000, 100000000000000, 150000000000000, 200000000000000, 250000000000000, 300000000000000, 400000000000000, 500000000000000, 600000000000000, 700000000000000, 800000000000000, 900000000000000, 1000000000000000, 1500000000000000, 2000000000000000, 2500000000000000, 3000000000000000, 4000000000000000, 5000000000000000, 6000000000000000, 7000000000000000, 8000000000000000, 9000000000000000, 10000000000000000, 15000000000000000, 20000000000000000, 25000000000000000, 30000000000000000, 40000000000000000, 50000000000000000, 60000000000000000, 70000000000000000, 80000000000000000, 90000000000000000, 100000000000000000, 150000000000000000, 200000000000000000, 250000000000000000, 300000000000000000, 400000000000000000, 500000000000000000, 600000000000000000, 700000000000000000, 800000000000000000, 900000000000000000, 1000000000000000000, 1500000000000000000, 2000000000000000000, 2500000000000000000, 3000000000000000000, 4000000000000000000, 5000000000000000000, 6000000000000000000, 7000000000000000000, 8000000000000000000, 9000000000000000000, 10000000000000000000, 15000000000000000000, 20000000000000000000, 25000000000000000000, 30000000000000000000, 40000000000000000000, 50000000000000000000, 60000000000000000000, 70000000000000000000, 80000000000000000000, 90000000000000000000, 100000000000000000000, 150000000000000000000, 200000000000000000000, 250000000000000000000, 300000000000000000000, 400000000000000000000, 500000000000000000000, 600000000000000000000, 700000000000000000000, 800000000000000000000, 900000000000000000000, 1000000000000000000000, 1500000000000000000000, 2000000000000000000000, 2500000000000000000000, 3000000000000000000000, 4000000000000000000000, 5000000000000000000000, 6000000000000000000000, 7000000000000000000000, 8000000000000000000000, 9000000000000000000000, 10000000000000000000000, 15000000000000000000000, 20000000000000000000000, 25000000000000000000000, 30000000000000000000000, 40000000000000000000000, 50000000000000000000000, 60000000000000000000000, 70000000000000000000000, 80000000000000000000000, 90000000000000000000000, 100000000000000000000000, 150000000000000000000000, 200000000000000000000000, 250000000000000000000000, 300000000000000000000000, 400000000000000000000000, 500000000000000000000000, 600000000000000000000000, 700000000000000000000000, 800000000000000000000000, 900000000000000000000000, 1000000000000000000000000, 1500000000000000000000000, 2000000000000000000000000, 2500000000000000000000000, 3000000000000000000000000, 4000000000000000000000000, 5000000000000000000000000, 6000000000000000000000000, 7000000000000000000000000, 8000000000000000000000000, 9000000000000000000000000, 10000000000000000000000000, 15000000000000000000000000, 20000000000000000000000000, 25000000000000000000000000, 30000000000000000000000000, 40000000000000000000000000, 50000000000000000000000000, 60000000000000000000000000, 70000000000000000000000000, 80000000000000000000000000, 90000000000000000000000000, 100000000000000000000000000, 150000000000000000000000000, 200000000000000000000000000, 250000000000000000000000000, 300000000000000000000000000, 400000000000000000000000000, 500000000000000000000000000, 600000000000000000000000000, 700000000000000000000000000, 800000000000000000000000000, 900000000000000000000000000, 1000000000000000000000000000, 1500000000000000000000000000, 2000000000000000000000000000, 2500000000000000000000000000, 3000000000000000000000000000, 4000000000000000000000000000, 5000000000000000000000000000, 6000000000000000000000000000, 7000000000000000000000000000, 8000000000000000000000000000, 9000000000000000000000000000, 10000000000000000000000000000, 15000000000000000000000000000, 20000000000000000000000000000, 25000000000000000000000000000, 30000000000000000000000000000, 40000000000000000000000000000, 50000000000000000000000000000, 60000000000000000000000000000, 70000000000000000000000000000, 80000000000000000000000000000, 90000000000000000000000000000, 100000000000000000000000000000, 150000000000000000000000000000, 200000000000000000000000000000, 250000000000000000000000000000, 300000000000000000000000000000, 400000000000000000000000000000, 500000000000000000000000000000, 600000000000000000000000000000, 700000000000000000000000000000, 800000000000000000000000000000, 900000000000000000000000000000, 1000000000000000000000000000000, 1500000000000000000000000000000, 2000000000000000000000000000000, 2500000000000000000000000000000, 3000000000000000000000000000000, 4000000000000000000000000000000, 5000000000000000000000000000000, 6000000000000000000000000000000, 7000000000000000000000000000000, 8000000000000000000000000000000, 9000000000000000000000000000000, 10000000000000000000000000000000, 15000000000000000000000000000000, 20000000000000000000000000000000, 25000000000000000000000000000000, 30000000000000000000000000000000, 40000000000000000000000000000000, 50000000000000000000000000000000, 60000000000000000000000000000000, 70000000000000000000000000000000, 80000000000000000000000000000000, 90000000000000000000000000000000, 100000000000000000000000000000000, 150000000000000000000000000000000, 200000000000000000000000000000000, 250000000000000000000000000000000, 300000000000000000000000000000000, 400000000000000000000000000000000, 500000000000000000000000000000000, 600000000000000000000000000000000, 700000000000000000000000000000000, 800000000000000000000000000000000, 900000000000000000000000000000000, 1000000000000000000000000000000000, 1500000000000000000000000000000000, 2000000000000000000000000000000000, 2500000000000000000000000000000000, 3000000000000000000000000000000000, 4000000000000000000000000000000000, 5000000000000000000000000000000000, 6000000000000000000000000000000000, 7000000000000000000000000000000000, 8000000000000000000000000000000000, 9000000000000000000000000000000000, 10000000000000000000000000000000000, 15000000000000000000000000000000000, 20000000000000000000000000000000000, 25000000000000000000000000000000000, 30000000000000000000000000000000000, 40000000000000000000000000000000000, 50000000000000000000000000000000000, 60000000000000000000000000000000000, 70000000000000000000000000000000000, 80000000000000000000000000000000000, 90000000000000000000000000000000000, 100000000000000000000000000000000000, 150000000000000000000000000000000000, 200000000000000000000000000000000000, 250000000000000000000000000000000000, 300000000000000000000000000000000000, 400000000000000000000000000000000000, 500000000000000000000000000000000000, 600000000000000000000000000000000000, 700000000000000000000000000000000000, 800000000000000000000000000000000000, 900000000000000000000000000000000000, 1000000000000000000000000000000000000, 1500000000000000000000000000000000000, 20000000000000

R.S.T. VALVE MAIL ORDER CO.
BLACKWOOD HALL, WELLFIELD RD., S.W.16
Special 24 Hour Mail Order Service

AZ31	10/-	KT81(7CS)	UCL82	6/9	12AX7	6/3	2N2147	12/6	GET880	9/-	
CIC	20/-	22/6	UCL53	10/-	12BA6	6/3	2N2160	16/0	GET885	5/6	
CV30	12/6	KT81(GRC)	UF41	10/6	12BE6	6/3	2N2869	4/6	GET884	2/6	
DAF91	4/6	KT88	35/-	7/6	13E1	2/6	2N2890	30/1	GET841	16/1	
DAF96	7/6	KTW61	8/6	UL84	7/-	12K7GT	6/-	2N2904	10/-	GJ3M	3/6
DC90	10/6	KTW62	10/-	UU8	21/-	12Q7GT	6/-	2N2904A	12/6	GJ3M	3/6
DF91	4/6	ML4	17/6	UU7	21/-	20L1	20/-	2N3819	13/-	GJ7M	6/6
DF96	7/6	N78	19/-	UU8	21/-	20P4	20/-	28002	20/-	HD2967	4/-
DH3/91	6/6	PC86	11/6	UY41	8/6	20P6	20/-	28003	19/-	HG5002	4/-
DH77	4/9	PC88	11/6	UY26	5/6	20Z4	6/3	28004	11/-	JE9A	22/6
DK91	6/-	PC97	8/9	VP4B	26/-	28Z5GT	8/-	28006	48/-	JK10A	15/-
DK92	9/-	PC900	8/6	VR150/30	6/6	28Z6GT	8/6	28006	20/-	JK10B	15/-
DK96	7/9	PC84	6/6	VR150/30	6/6	30C16	15/-	28012	50/-	JK19A	22/6
DL66	25/-	PC89	10/6	W81	12/6	30C17	15/-	28012A	55/-	JK21A	12/6
DL62	6/9	PCC189	10/6	X81	48/-	30C18	15/-	28013	20/-	K830A	5/-
DL66	7/6	PCF80	0/9	Z86	16/-	30F6	17/-	28018	90/-	MA110	5/6
DL810	12/6	PCF86	9/-	Z819	26/-	30FL1	16/-	28108	60/-	MAT190	7/9
DL816	30/-	PCF801	9/9	Z759	23/-	30FL12	19/-	28201	12/6	NKT128	6/6
DL819	30/-	PCF802	9/9	Z803T	15/-	30FL14	18/6	28300	9/-	NKT142	6/6
DY4390	7/0	PCF806	13/-	OA2	6/-	30L15	17/-	28702	15/-	NKT211	6/6
DY96	6/-	PCL82	7/9	OB2	6/-	30L17	17/-	48L	45/-	NKT214	4/6
DY87	5/-	PCL83	10/3	OC3	5/6	30P12	16/-	AC107	10/-	NKT216	7/6
E880C	12/-	PCL85	8/3	OD4	4/6	30P19	16/-	AC126	6/6	NKT217	6/6
E180F	17/6	PCL86	9/3	1CP31	48/-	30PL13	16/-	AC127	7/6	NKT218	6/6
E182CC	22/6	PENB4	20/-	IR6	6/-	30PL14	15/-	AC128	6/6	NKT221	5/6
EAB3C0	6/6	PEN45DD	22/21	2E26	20/-	36L6	8/6	AC176	7/6	NKT223	5/6
EAF42	10/-	2E26	12/-	2E26	20/-	36L8GT	9/-	AC177	7/6	NKT224	4/6
EB31	3/-	2E26	12/-	2E26	20/-	36L8GT	9/-	AC178	5/6	NKT225	3/6
EB33	6/3	2E26	12/-	2E26	20/-	36L8GT	9/-	AC179	6/6	NKT226	5/6
EB34	9/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC180	6/6	NKT227	5/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC181	11/-	NKT228	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC182	11/-	NKT229	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC183	11/-	NKT230	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC184	11/-	NKT231	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC185	11/-	NKT232	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC186	11/-	NKT233	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC187	11/-	NKT234	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC188	11/-	NKT235	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC189	11/-	NKT236	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC190	11/-	NKT237	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC191	11/-	NKT238	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC192	11/-	NKT239	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC193	11/-	NKT240	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC194	11/-	NKT241	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC195	11/-	NKT242	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC196	11/-	NKT243	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC197	11/-	NKT244	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC198	11/-	NKT245	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC199	11/-	NKT246	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC200	11/-	NKT247	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC201	11/-	NKT248	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC202	11/-	NKT249	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC203	11/-	NKT250	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC204	11/-	NKT251	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC205	11/-	NKT252	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC206	11/-	NKT253	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC207	11/-	NKT254	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC208	11/-	NKT255	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC209	11/-	NKT256	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC210	11/-	NKT257	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC211	11/-	NKT258	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC212	11/-	NKT259	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC213	11/-	NKT260	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC214	11/-	NKT261	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC215	11/-	NKT262	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC216	11/-	NKT263	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC217	11/-	NKT264	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC218	11/-	NKT265	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC219	11/-	NKT266	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC220	11/-	NKT267	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC221	11/-	NKT268	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC222	11/-	NKT269	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC223	11/-	NKT270	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC224	11/-	NKT271	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC225	11/-	NKT272	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC226	11/-	NKT273	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC227	11/-	NKT274	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC228	11/-	NKT275	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC229	11/-	NKT276	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC230	11/-	NKT277	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC231	11/-	NKT278	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC232	11/-	NKT279	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC233	11/-	NKT280	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC234	11/-	NKT281	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC235	11/-	NKT282	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC236	11/-	NKT283	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC237	11/-	NKT284	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC238	11/-	NKT285	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC239	11/-	NKT286	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC240	11/-	NKT287	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC241	11/-	NKT288	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC242	11/-	NKT289	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC243	11/-	NKT290	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC244	11/-	NKT291	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC245	11/-	NKT292	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC246	11/-	NKT293	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC247	11/-	NKT294	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC248	11/-	NKT295	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC249	11/-	NKT296	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC250	11/-	NKT297	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC251	11/-	NKT298	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC252	11/-	NKT299	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC253	11/-	NKT300	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC254	11/-	NKT301	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC255	11/-	NKT302	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC256	11/-	NKT303	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC257	11/-	NKT304	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC258	11/-	NKT305	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC259	11/-	NKT306	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC260	11/-	NKT307	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC261	11/-	NKT308	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC262	11/-	NKT309	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC263	11/-	NKT310	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-	AC264	11/-	NKT311	8/6
EB39	4/9	2E26	12/-	2E26	20/-	36L8GT	9/-				

voltage is made less negative at an anode potential of between 200 and 450 volts, the tube will fire as the operating point on the graph crosses the curve.

It is also possible to fire the main gap by increasing the anode voltage, but this has little practical application the anode voltage, but this has little practical application. At positive grid voltages, the firing characteristic rises again somewhat, since the electrons tend to pass to the grid instead of to the anode.

There are some small tolerances in the actual position of the firing characteristic from tube to tube, variations of up to 1 volt in the grid potential required to fire the tube being permissible. Temperature effects on the firing characteristic are generally fairly small (less than 0.5 volt change in the grid potential at which firing occurs over the range -30 to $+90$ degrees C).

However, if the glow thyatron becomes hot due to a fairly large anode dissipation, the grid voltage must be reduced a little more than normally before the tube can

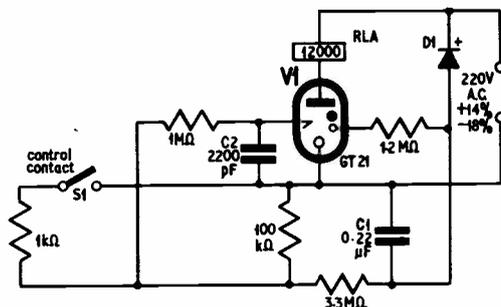


Fig. 4.5. A glow thyatron used to control a relay

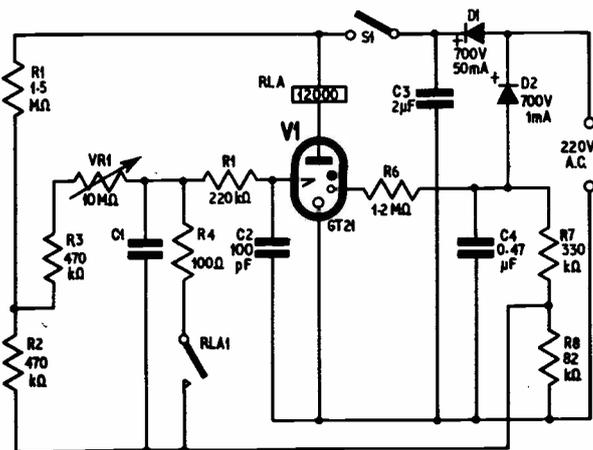


Fig. 4.6. Delay circuit using the thyatron

be made to conduct again. The magnitude of the auxiliary current has little effect on the firing point. However, the flow of grid current results in the firing point being dependent on the value of the grid resistor used.

The glow thyatron has the advantage of a short ionisation time, partly because ions are always present in the tube from the auxiliary discharge. When the grid of the tube is switched suddenly from -10 volts to zero, the typical ionisation time lies between 0.5 microsecond, for an anode supply voltage of 400, and 200 microseconds for an anode voltage of 200.

The deionisation time varies over a range of about 400 to 1,200 microseconds for anode currents of between 5 and 40mA and supply voltages in the range 300 to 400.

Some typical circuits published by the manufacturers of the glow thyatron are given below. The tube has been allocated the coding GT21.

RELAY CONTROL

The circuit in Fig. 4.5 may be used to operate a relay from a very sensitive pair of small contacts, which could not themselves pass the current required to operate the relay directly. Only a low voltage appears across the relay contacts and no sparking therefore occurs. Thus the amount of wear on the small contacts is negligible. Even if the contacts have a resistance of several thousand ohms, the circuit will function satisfactorily.

During the negative half cycles of the mains supply, a negative potential is applied to the tube anode, the diode D1 will conduct so that capacitor C1 becomes charged. During the next half cycle of the main supply voltage, when the anode of the tube is made positive with respect to the cathode, the grid is held negative with respect to the cathode by some of the charge from C1 which passes to C2. The tube does not therefore strike in the main gap.

Capacitor C1 also supplies the current required by the auxiliary cathode HK via the 1.2 megohm current limiting resistor.

When the control contacts are closed, the grid potential becomes little different from that of the cathode potential owing to the resistance values employed. Thus the glow thyatron fires on the half cycles of the mains supply voltage during which its anode is positive.

The use of the alternating mains supply voltage in this way ensures that the tube is extinguished at the end of each half cycle and also eliminates the cost of a mains transformer. However, it must not be forgotten that one of the contacts is connected directly to one side of the mains. An isolating transformer must be used if the contacts are likely to be touched by a person or an earthed object.

The current passing through the relay consists of half-wave rectified pulses at the mains supply frequency. In order that the relay contacts shall not "chatter", the relay should contain a suitable number of shorted turns. Alternatively a capacitor of value about $1\mu\text{F}$ may be connected across the relay to supply a current during the half cycles when the tube is not conducting.

The voltage across the open contacts cannot exceed 13 volts and the maximum current which passes through the contacts is $100\mu\text{A}$. The open contacts should have an insulation resistance of not less than 0.5 megohm.

A DELAY CIRCUIT

A circuit for producing time delays is shown in Fig. 4.6. When the control contacts S1 are closed, capacitor C1 commences to charge via the resistor chain. When the potential across C1 is great enough, the glow thyatron tube fires on each half cycle of the mains supply voltage during which its anode is positive with respect to its cathode.

The time delay may be altered by changing the value of C1 or VR1, since this alters the time required for C1 to charge to the firing voltage. The contacts RLA1 are used to discharge capacitor C1.

As in the case of the circuit in Fig. 4.5, the auxiliary cathode negative supply voltage and the quiescent negative grid potential are obtained by half-wave rectification of the mains supply by means of diode D2.

COINCIDENCE CIRCUIT

A simple coincidence circuit is shown in Fig. 4.7. The glow thyratron is in the non-conducting state if one or more of the inputs A, B or C is at zero volts with respect to the cathode, owing to the negative potential applied to the grid of the tube via R3. If, however, all of the inputs are at a positive potential of not less than 6V (at input impedances of not more than 15 kilohms) the tube fires and the relay is energised.

This type of circuit may be used with a counting circuit to form a batch counter, which initiates an operation at any pre-determined number of counts.

PHOTOELECTRIC CONTROL

The circuit in Fig. 4.8 may be used when it is desired to energise a relay when the light falling on a photodiode increases above a certain level. As the light intensity falls, the circuit will cause the relay to be de-energised again. However, the circuit incorporates a "switching interval", that is the level of illumination at which the relay becomes de-energised is less than that at which it becomes energised. This avoids the possibility of the circuit repeatedly switching itself on and off as the level of illumination rises and falls by very small amounts.

The diode D1 ensures that the grid of the glow thyratron never becomes appreciably positive. The diode D2 provides a half wave rectified supply for the auxiliary cathode and the grid bias voltage to hold the tube in the non-conducting state.

In the circuit in Fig. 4.8, the photocell X1 has a high resistance when the level of illumination is low. A negative potential is therefore applied to the grid of the glow thyratron. When light falls onto the photocell, however, its resistance falls to a value which is much smaller than that of the 6.8 megohm resistor in series with it. Thus the voltage across the cell (and hence the grid to cathode voltage) becomes small and the tube fires.

The photodiode used should pass a dark current of not more than 25 microamps and when illuminated should pass not less than 50µA. Suitable diodes are the Texas H11 or the Siemens TP51 II. The diode D1 should have a peak inverse voltage rating of at least 50 volts and a maximum reverse current of 5µA. The Texas 1S130 or the Mullard OA200 are suitable. The diode D2 should have a peak inverse voltage rating of at least 700 volts and should be able to pass a forward current of 5mA.

The relay should have a suitable number of shorted turns or alternatively a suitable capacitor must be placed across it. The switching interval may be eliminated by connecting the relay between points 1 and 2 and by short-circuiting the points 3 and 4 (Fig. 4.8).

If it is desired to use the circuit for switching at relatively high levels of illumination, R3 and R2 should be reduced in value.

ELECTRONIC TOUCH BUTTON

The GK11 electronic touch button is another unique type of trigger tube. It is operated by the touch of a person's finger on an external trigger electrode, which is attached to the outside of the tube. It may, for example, be used as a touch button for calling a lift.

When the appropriate touch button is touched, the tube is switched to the conducting state and remains illuminated until the anode to cathode voltage is reduced below the maintaining voltage for this gap which, in the case of a lift call button, would occur when the lift arrived at the floor in question. Touch buttons can also be used in various types of instruments.

The construction of the GK11 is shown in Fig. 4.9. The tube itself contains an internal anode and cathode, the trigger electrode being connected to the touch plate by means of a small spring.

A high resistivity transparent material such as polythene must be employed between the touch plate and the front mounting panel. The red glow from a conducting tube passes through this material which acts as a lens.

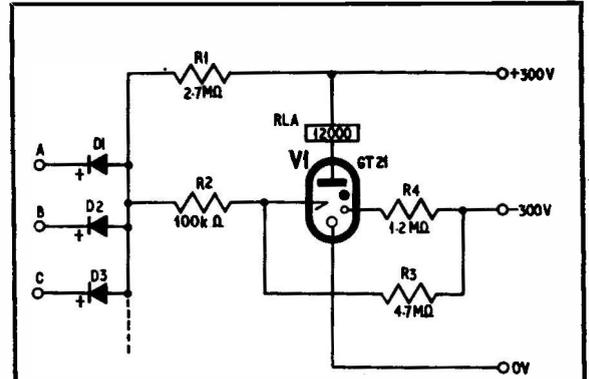


Fig. 4.7. Thyratron coincidence circuit

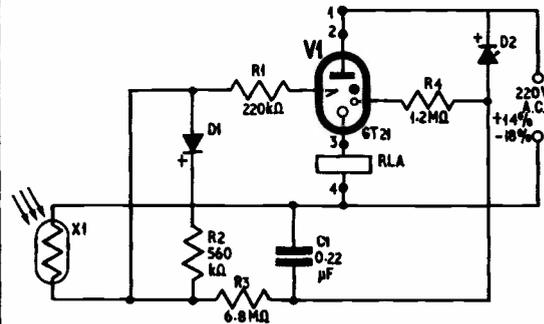


Fig. 4.8. The relay is energised when the photocell is illuminated



Touch button type GK11

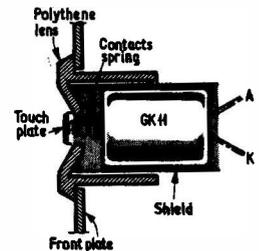


Fig. 4.9. Section of a touch button housing

VALUE ALL THE WAY

INTEGRATED CIRCUITS

BI-PAK MONOLITHIC DIGITAL CIRCUITS (10 lead TO-8)

BP805A, 6-Input AND gate, 9/8 each.
 BP814A, 7-Input NOR gate, 3/8 each.
 BP816A, Dual 3-Input NOR gate, 9/8 each.
 BP816A, Dual 2-Input NOR gate (expandable), 9/8 each.
 BP820A, J-K Binary element, 11/8 each.
 BP882A, Dual 2-Input OR gate, 9/8 each.

BI-PAK MONOLITHIC AMPLIFIERS (TO-5 8 lead)

BP700C, Operational amplifier, 18/- each.
 BP701C, Operational amplifier (with Zener output), 18/- each.
 BP702C, Operational amplifier (with direct output), 18/- each.
 BP601, Wide band amplifier, 18/- each.
 BP521, Logarithmic wide band amp., 14/- each.
 BP210C, General purpose amplifier (TO-5 8 lead), 18/- each.
 I.C. Operational Amplifier with Zener output. Type 701C. Ideal for P.E. Projects. 8 Lead TO-5 case. Full data.

Our price **12/6** each.
 5 off 11/- each. Large Qty. Prices quoted for.

OTHER MONOLITHIC DEVICES

BP424, Zero voltage switch, 9/8 each.
 This device is a monolithic I.C. that acts as combined threshold detector and trigger circuit for controlling a triac. It is designed to pulse the gate of a thyristor at the point of zero supply voltage, and therefore eliminate radio frequency interference when used with resistive loads.

D13D1 Silicon Unilateral switch 10/- each.
 A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuit available on request.

FAIRCHILD (U.S.A.) FTUL MICROLOGIC

INTEGRATED CIRCUITS
 Epoxy case 18-5 lead temp 18°C to 55°C.
 UL900, Buffer, 18/- each.
 UL814, Dual two-input gate, 10/8 each.
 UL923 J-K flip-flop, 14/- each.
 Complete data and circuits for the Fairchild I.C.'s available in booklet form priced 1/8.

MULLARD I.C. AMPLIFIERS

TAA245, Operational amplifier, 70/- each.
 TAA263, Linear AF amplifier, 18/8 each.
 TAA293, General purpose amplifier, 21/- each.
CASAGO RCA (U.S.A.) LINEAR INTEGRATED CIRCUITS
 Audio Power Amplifier, 50/- each.
 Owing to the mass of I.C. printed matter often required by customers in connection with the I.C.'s themselves we ask you to help us in the cost of reproducing this literature by adding 2s. towards same. This is only necessary when a number of different sheets are required.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Evt. EX2800 1/- each. Any Qty.

ADI61 NPN ADI62 PNP

MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.

For mains driven output stages of Amplifiers and Radio receivers.

OUR LOWEST PRICE OF 18/6 PER PAIR

HIGH POWER SILICON PLANAR TRANSISTORS TEXAS 28034 NPN TO-3.

VCB100 Ic 4A Tt 15M/cs
 VCE100 Ptot. 40W hFE(min.) 60 Price 18/- each

FREE

One 10/- Pack of your own choice free with orders valued 24 or over.

SEMICONDUCTOR HANDBOOK (VOLUME 2)

with introduction to basic circuits, registered transistor and diode types, full specifications. Eleven languages including English, Dutch, French, German, Swedish, Spanish and Italian. 240 pages of semiconductor information. Price 28/8. Money refunded if not fully satisfied.

NPN DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indicators. 250mW. OUR PRICE 10/- EACH, 50 OR OVER 8/6 EACH. FULL DETAILS.

SIL. G.P. DIODES

300mV 30 10/-
 25FV (Min.) 100 25/-
 Sub-Min. 500 45/-
 Fully Tested 1,000 29/-
 Ideal for Organ Builders.

CADMIUM CELLS

ORP80 ORP81 8/- each ORP12 8/6

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 3-16V.

400mW (DO-7 Case)..... 2/8 each
 1-W (Top-Hat)..... 3/6 each
 10W (SO-10 Stud)..... 5/- each
 All fully tested 5% tol, and marked state voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS Coded and Guaranteed

Pak No.	EQVT.	
T1	8 2G3710	OC71 .. 10/-
T2	8 2G374	OC75 .. 10/-
T3	8 2G3744A	OC81D .. 10/-
T4	8 2G381A	OC81 .. 10/-
T5	8 2G382T	OC82 .. 10/-
T6	8 2G384A	OC84 .. 10/-
T7	8 2G385A	OC85 .. 10/-
T8	8 2G378	OC78 .. 10/-
T9	8 2G389A	2N1302 .. 10/-
T10	8 2G417	AP117 .. 10/-

KING OF THE PAKS Unequalled Value and Quality SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	Price
U1	120 Glass Sub-min. General Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/BF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10/-
U4	40 Germanium Transistors like OC81, AC128	10/-
U5	60 200mA Sub-min. Sil. Diodes	10/-
U6	40 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	10/-
U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U10	30 PNP Silicon Planar Transistors TO-5 sim. 2N1152	10/-
U11	12 Silicon Rectifiers EPOXY BY196/127	10/-
U12	30 PNP-NPN Sil. Transistors OC200 & 28104	10/-
U13	150 Mixed Silicon and Germanium Diodes	10/-
U14	150 Silicon Planar Transistors TO-5 sim. 2N697	10/-
U15	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U16	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U17	8 6-Amp Silicon Rectifiers BY213 Type up to 600 PIV	10/-
U18	30 Silicon NPN Transistors like BC108	10/-
U19	12 1.5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/-
U20	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U21	10 1-amp Glass Min. Silicon Rectifiers High Volts	10/-
U22	30 Mad's like MAT Series PNP Transistors	10/-
U23	30 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/-
U24	26 300Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U25	30 Fast Switching Silicon Diodes like IN914 Micro-min	10/-
U26	30 Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc. 8 Assorted Pieces	20/-
U27	10 1 amp SCE's TO-5 can up to 600 PIV CRS1/25-600	20/-
U28	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/-
U29	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/-
U30	25 Zener diodes 400mW D07 case mixed Volts, 3-18	10/-
U31	15 Plastic case 1 amp Silicon rectifiers IN4000 series	10/-
U32	30 Sil. PNP alloy trans. TO-5 BCY26, 28302/4	10/-
U33	25 Sil. Planar trans. PNP TO-18 2N2906	10/-
U34	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10/-
U35	30 Sil. alloy trans. SO-2 PNP. OC200 28322	10/-
U36	20 Fast Switching Sil. trans. NPN. 400Mc/s 2N3011	10/-
U37	30 RF Germ. PNP trans. 2N1303/5 TO-5	10/-
U38	10 Dual trans. 6 lead TO-5 2N2060	10/-
U39	30 RF Germ. trans. TO-1 OC45 NKT72	10/-
U40	10 VHF Germ. PNP trans. TO 1 NKT967 AP117	10/-

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

QUALITY-TESTED PAKS

6 Matched Trans. OC44/45/51/81D	10/-
20 Red Spot AF Trans. PNP	10/-
16 White Spot BF Trans. PNP	10/-
5 Silicon Rects. 3 A 100-400 PIV	10/-
3 10 A Silicon Rects. 100 PIV	10/-
2 OC1 140 Trans. NPN Switching	10/-
1 1A A SCR 100 PIV	10/-
3 Sil. Trans. 28303 PNP	10/-
4 Zener Diodes 240mW 3-12V	10/-
3 200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3 Zener Diodes 1W 33V 5% Tol.	10/-
4 High Current Trans. OC43 Eqty.	10/-
2 Power Transistors 1 OC200 1 OC255	10/-
5 Silicon Rects. 400 PIV 250mA	10/-
4 OC75 Transistors	10/-
1 Power Trans. OC200 100V	10/-
10 OA202 Sil. Diodes Sub-min.	10/-
2 Low Noise Trans. NPN 2N2929/30	10/-
1 Sil. Trans. NPN VCB 100 2T86	10/-
8 OA81 Diodes	10/-
4 OC72 Transistors	10/-
4 OC77 Transistors	10/-
4 Sil. Rects. 400 PIV 500mA	10/-
5 GET884 Trans. Eqty. OC44	10/-
5 GET883 Trans. Eqty. OC45	10/-
2 2N708 Sil. Trans. PNP High Gain	10/-
3 OT31 LF Low Noise Germ. Trans.	10/-
6 IN914 Sil. Diodes 75 PIV 75mA	10/-
8 OA95 Germ. Diodes Sub-min. IN600	10/-
3 NPN Germ. Trans. NKT773 Eqty.	10/-
2 OC23 Power Trans. Germ.	10/-
2 OC25 Power Trans. Germ.	10/-
4 AC136 Germ. PNP Trans.	10/-
4 AC127/128 Comp. pair PNP/NPN	10/-
3 2N1207 PNP Switching Trans.	10/-
7 CG62H Germ. Diodes Eqty. OA71	10/-
3 AF116 Type Trans.	10/-
12 Assorted Germ. Diodes Marked	10/-
4 AC136 Germ. PNP Trans.	10/-
4 Silicon Rects. 100 PIV 750mA	10/-
3 AF117 Trans.	10/-
7 OC81 Type Trans.	10/-
3 OC171 Trans.	10/-
5 2N2926 Sil. Epoxy Trans.	10/-
7 OC71 Type Trans.	10/-
2 2S701 Sil. Trans. Texas	10/-
3 12 Volt Zener 400mW	10/-
2 10 A 600 PIV Sil. Rects. 1048E	10/-
3 BC106 Sil. NPN High Gain Trans.	10/-
1 2N910 NPN Sil. Trans. VCB 100	10/-
2 1000 PIV Sil. Rect. 1-5 A 2A3310 AF	10/-
3 BSY95A Sil. Trans. NPN 200Mc/s	10/-
3 OC200 Sil. Trans.	10/-
3 GET880 Low Noise Germ. Trans.	10/-
1 AF139 PNP High Freq. Trans.	10/-
3 NPN Trans. 1 ST141 & 2ST140	10/-
4 Mad's 2 MAT104 & 2MAT120	10/-
3 Mad's 2 MAT104 & 1 MAT121	10/-
4 OC44 Germ. Trans. AP	10/-
3 AC127 NPN Germ. Trans.	10/-
1 2N3904 Sil. PNP Trans. Motorola	10/-
3 Sil. Power Rects. BY213	10/-
1 Sil. Power Trans. NPN 100Mc/s. TK901A	15/-
6 Zener Diodes 3-16V Sub-min.	15/-
1 2N1132 PNP Epitaxial Planar Sil.	15/-
3 2N697 Epitaxial Planar Trans. Sil.	15/-
4 Germ. Power Trans. Eqty. OC16	15/-
1 Unijunction Trans. 2N2646	15/-
2 Sil. Trans. 200Mc/s 60Vcb 2T83/84	15/-
1 Tunnel Diode 2N1404 & 1N1405	15/-
2 2N2712 Sil. Epoxy Planar HFE225	15/-
8 BY100 Type Sil. Rects.	20/-
25 Sil. and Germ. Trans. Mixed, all marked. New	20/-

PRINTED CIRCUITS EX-COMPUTER

Packed with semiconductor and components, 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards 10/- Plus 2/- P. & P.

GERM. RECTIFIER SINGLE-PHASE BRIDGE. Mullard type. GEX541-B.P. Output Vits. 48V. Output I.C. 5A. List Price 58/- OUR PRICE 12/6 EACH.

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. OUR PRICE 5/- each.

150 VCB MIXIE DRIVER TRANSISTOR. Sil. BSX31 & C407. 2N1293 FULLY TESTED AND CODED ND120. 1-24 2/8 each. TO-5 NPN 25 up 3/- each.

PLEASE NOTE. To avoid any further increased Postal Charges to our Customers and enable us to keep our "By Return Postal service" which is second to none, we have re-organized and streamlined our Dispatch Order Department and we now request you to send all your orders together with your remittance, direct to our Warehouse and Dispatch Department, postal address: **BI-PAK SEMICONDUCTORS**, Dispatch Dept., P.O. BOX 4, WARE, HERTS. Postage and packing still 1/- per order. Minimum order 10/-

FET'S

2N 3819 10/-
 2N 3820 25/-
 MPF105 8/-
 OCP71 Type 2/6

UNI-JUNCTION

UT46, Eqty. 2N2646, Eqty. T1843, BEN3000

7/6 EACH

25-99 5/- 100 UP 4/-

TESTED SCR'S

PIV 1A	7A	16A	30A
25	7/6	8/6	9/6
50	7/6	8/6	9/6
100	8/6	10/6	11/6
200	12/6	15/6	18/6
300	15/6	18/6	21/6
400	17/6	20/6	23/6
500	20/6	23/6	26/6
600	22/6	25/6	28/6

SIL. RECTS. TESTED

PIV 750mA 2A	10A	30A
50	1/-	2/6
100	1/6	3/6
200	1/6	4/6
300	2/6	4/6
400	2/6	5/6
500	3/6	6/6
600	3/6	6/6
800	3/6	7/6
1000	5/6	8/6
1200	6/6	11/6

BI-PAK



**500 CHESHAM HOUSE
 150 REGENT STREET
 LONDON, W.1**

TECHNICAL TRAINING

in radio television and electronics

Whether you are a newcomer to radio and electronics, or are engaged in the industry and wish to prepare for a recognized examination, ICS can further your technical knowledge and provide the specialized training so essential to success. ICS have helped thousands of ambitious men to move up into higher paid jobs—they can help you too! Why not fill in the coupon below and find out how?

Many diploma and examination courses available, including expert coaching for:

- C. & G. Telecommunication Techns'. Certs.
- C. & G. Electronic Servicing
- R.T.E.B. Radio/T.V. Servicing Certificate
- Radio Amateurs' Examination
- P.M.G. Certs. in Radiotelegraphy
- General Certificate of Education, etc.

Examination Students coached until successful

NEW SELF-BUILD RADIO COURSES

Learn as you build. You can learn both the theory and practice of valve and transistor circuits, and servicing work while building your own 5-valve receiver, transistor portable, and high-grade test instruments, incl. professional-type valve volt meter—all under expert tuition. Transistor Portable available as separate course.

POST THIS COUPON TODAY

for full details of ICS courses in Radio, T.V. and Electronics

INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 151, Intertext House, Stewarts Rd., London, S.W.8

Please send me the ICS prospectus—free and without obligation.

(state Subject or Exam.)

NAME

ADDRESS

9/69

INTERNATIONAL CORRESPONDENCE SCHOOLS

SEMICONDUCTORS

BRAND NEW AND FULLY GUARANTEED

IN914	1/6	2N2904	8/-	ACY18	5/-	BD124	12/-	MJ490	22/6
IN916	1/6	2N2904A	8/-	ACY19	5/-	BF115	4/6	MJ491	20/6
IS010	3/-	2N2905	6/-	ACY20	4/-	BF117	10/6	MPF102	8/6
IS020	3/6	2N2905A	8/-	ACY21	5/-	BF167	6/6	MPF103	7/6
IS021	4/-	2N2906	8/-	ACY22	4/-	BF173	7/6	MPF104	7/6
IS025	5/-	2N2906A	8/-	ACY28	4/-	BF180	9/-	MPF105	8/-
IS113	3/-	2N2907	8/-	AD140	8/-	BF181	8/6	NKT0013	8/6
IS120	2/6	2N2907A	8/-	AD149	8/-	BF184	7/6	NKT216	10/6
IS121	3/6	2N2923	5/-	AD161	7/6	BF194	6/6	NKT217	8/6
IS130	2/6	2N2924	5/-	AD162	7/6	BFX12	3/6	NKT261	4/6
IS131	2/6	2N2925	5/6	AF114	3/-	BFX13	3/6	NKT262	4/6
IS132	2/6	2N2926	5/6	AF116	3/-	BFX29	19/6	NKT264	4/6
IS44	2/-	2N2926	5/6	AF117	5/-	BFX30	8/6	NKT271	4/6
2G301	4/-	Green	3/-	AF118	12/6	BFX35	8/6	NKT272	4/6
2G302	4/-	Yellow	2/9	AF118	12/6	BFX43	8/6	NKT274	4/6
2G303	4/-	Orange	2/6	AF124	5/-	BFX44	8/6	NKT275	4/6
2G371	3/-	2N3011	5/-	AF127	5/-	BFX84	8/-	NKT281	5/6
2N696	5/6	2N3053	6/6	AF139	7/6	BFX85	10/-	NKT403	13/-
2N697	5/6	2N3054	12/6	AF181	8/6	BFX86	8/-	NKT404	12/6
2N698	4/6	2N3055	19/6	AF186	11/-	BFX87	10/6	NKT405	13/-
2N706	2/6	2N3702	4/6	AF239	7/6	BFY11	4/6	NKT613	6/6
2N706A	2/6	2N3702	4/6	AFZ12	5/6	BFY11	4/6	NKT657	5/6
2N708	4/6	2N3704	5/6	ASY26	5/6	BFY11	4/6	NKT771	5/6
2N929	5/6	2N3705	4/6	ASY27	8/6	BFY11	4/6	NKT773	5/6
2N930	6/6	2N3706	4/6	ASY28	5/6	BFY17	4/6	NKT781	6/-
2N1090	6/6	2N3707	4/6	ASY29	4/6	BFY18	4/6	NKT2029	10/-
2N1091	6/6	2N3708	4/6	ASZ20	7/6	BFY19	4/6	NKT8011	8/6
2N1131	9/6	2N3709	4/6	ASZ21	4/6	BFY41	13/6	NKT8011	8/6
2N1302	9/6	2N3710	4/6	ASZ21	4/6	BFY43	13/6	NKT8012	19/6
2N1302	4/6	2N3711	4/6	BAK13	2/6	BFY50	4/6	NKT8013	22/6
2N1303	4/6	2N3819	9/-	BAK16	2/9	BFY51	4/6	OA5	2/6
2N1304	5/6	2N3820	23/6	BAK16	2/9	BFY52	4/6	OA7	2/6
2N1305	5/6	2N3823	17/6	BAK16	2/9	BFY52	4/6	OA79	1/9
2N1306	6/6	2N4058	6/6	BC107	3/6	BFY52	4/6	OA81	1/6
2N1307	6/6	2N4059	6/6	BC108	3/6	BFY76	9/6	OA85	1/6
2N1308	8/-	2N4060	6/6	BC109	3/6	BFY90	12/6	OA90	1/6
2N1309	8/-	2N4061	5/-	BC113	6/6	BSX19	5/6	OA91	1/6
2N1507	5/6	2N4062	6/6	BC116	12/6	BSX20	5/6	OA92	1/6
2N1613	6/6	2N4254	9/6	BC118	6/6	BSX21	8/6	OA93	1/6
2N1711	6/6	2N4255	9/6	BC125	13/6	BSX26	10/6	OA99	1/9
2N1889	8/-	2N4284	3/6	BC147	10/6	BSX27	10/6	OA99	1/9
2N1893	8/-	2N4285	3/6	BC148	4/6	BSX28	6/6	OA99	1/9
2N2102	13/6	2N4286	3/6	BC149	5/6	BSX29	10/6	OA99	1/9
2N2147	17/6	2N4287	3/6	BC167	3/6	BSY26	4/-	OA99	1/9
2N2148	12/6	2N4288	3/6	BC168	3/6	BSY27	4/-	OA99	1/9
2N2160	14/6	2N4289	5/6	BC169	3/6	BSY28	4/-	OA99	1/9
2N2193	5/6	2N4291	3/6	BC212L	5/-	BSY29	4/6	OC100	3/6
2N2193A	5/6	2N4292	3/6	BCY30	7/6	BSY38	4/6	OC202	6/6
2N2194A	5/6	2N40361	12/6	BCY31	4/6	BSY39	4/6	OC26	6/6
2N2217	6/-	2N4362	15/6	BCY32	5/6	BSY40	4/6	OC28	6/6
2N2218	6/-	2N4289	5/-	BCY33	5/6	BSY51	10/6	OC35	6/6
2N2219	6/-	3N128	18/6	BCY34	4/6	BSY52	6/-	OC36	6/6
2N2220	5/-	AAZ13	2/-	BCY38	5/6	BSY53	9/-	OC45	3/6
2N2221	5/-	AAZ15	2/6	BCY39	6/6	BSY54	6/-	OC71	2/6
2N2221	5/-	AAZ17	2/6	BCY40	7/6	BSY95A	3/6	OC72	2/6
2N2722	5/-	AC107	8/6	BCY42	5/-	BY100	4/6	OC75	4/6
2N2368	6/6	AC126	4/6	BCY43	6/6	BYX10	3/6	OC81	4/6
2N2369	7/6	AC127	3/-	BCY44	7/6	BYZ10	9/6	OC83	4/6
2N2489A	5/-	AC128	4/6	BCY70	5/6	BYZ11	7/6	OC81D	3/6
2N2539	4/6	AC176	6/-	BCY71	9/6	BYZ12	6/-	OC140	6/6
2N2540	4/6	AC187	12/-	BCY72	5/-	BYZ13	5/-	OC140	6/6
2N2646	11/6	AC188	12/-	BD12	3/6	MJ480	20/6	OC200	5/6
2N2696	6/6	ACY17	5/-	BD121	19/-	MJ481	27/6	OC201	5/6

RECORDING

TAPES

Fully Guaranteed

7"	STD	1,200'	7/3
7"	LP	1,800'	12/3
7"	D/P	2,400'	19/-
5 1/2"	STD	900'	6/6
5 1/2"	LP	1,200'	9/-
5 1/2"	D/P	1,800'	14/9
5"	STD	600'	5/3
5"	LP	900'	7/3
3"	D/P	1,200'	10/9
3"	D/P	185'	2/3
3"	LP	225'	3/-
3"	D/P	300'	4/-

Spools: 8 1/2" 6/3 33/6
2 1/8, 5 1/2" 2/3, 5" 2/3,
4" 2/10, 3 1/2" 1/9, 3" 9d,
2 1/2" 1/10.

Post and Packing up to 3 reels 2/9, otherwise 4/6.

SPEAKERS (3 ohm)

10"	4"	6"	37/6
9"	4"	23/6	
8"	4"	19/6	
7"	4"	15/6	
5"	3"	12/6	
3"	9/6	5" 14/6	
3"	27/6	12" 39/6	

Post and Packing 1/6

SEND 6d. STAMP FOR CATALOGUE
P.P. for Components
1/6 per order

THYRISTORS

1 AMP: 50V 5/-, 100V 5/6, 200V 7/-, 400V 9/6.
3 AMP: 50V 6/-, 100V 7/6, 200V 8/-, 400V 10/-,
ZENERS. 1 1/2 WATT 2.7-33V 4/6
400m/w 3.0-33V 5/-

INTEGRATED CIRCUITS—R.C.A.

CA3005 30/-, CA3011 20/-, CA3012 25/-,
CA3013 30/-, CA3014 30/-, CA3018 25/-,
CA3019 25/-, CA3020 27/6, CA3021 42/6,
CA3022 35/-, CA3023 32/6, CA3026 27/6,
CA3028A 25/-, CA3028B 35/-, CA3035 35/-,
CA3036 30/-,
R.C.A. C.D.

L900, 914 11/-, L923 14/-,
DATA SHEETS FOR RCA DEVICES 2/- per type

Presets std., horiz. or vert. 1/6
Potentiometers, Log/Lin 3/3 each

MFD	V	Price	MFD	V	Price	MFD	V	Price
1	15	1/6	25	10	1/6	200	6.4	1/9
1	40	1/9	25	25	1/6	200	16	2/-
2	15	1/6	25	50	1/6	250	25	2/9
2	350	2/0	32	15	1/6	250	50	3/9
2.5	16	1/9	32	450	1/6	320	10	1/6
4	15	1/6	40	6.4	1/6	400	16	2/9
4	40	4/9	40	16	1/6	500	6	2/6
4	350	2/3	50	12	1/6	500	25	3/9
5	15	1/6	50	25	1/6	2000	50	4/9
6.4	6.4	1/9	50	50	2/-	640	16	3/6
8	18	1/6	64	25	1/6	1000	12	3/9
8	40	1/6	80	6.4	1/6	1000	16	4/-
8	450	3/-	80	16	1/6	1000	25	5/-
10	15	1/6	100	6.4	1/6	1000	50	9/-
10	25	1/6	100	12	1/6	2000	25	8/6
12.5	25	1/6	100	25	1/6	2000	50	12/6
16	18	1/6	100	50	2/6	2500	25	9/6
25	6.4	1/6	125	4	1/6	5000	25	12/6

VEROBOARD

3 1/2" x 2 1/2" 3/6
3 1/2" x 3 1/2" 4/3
Cutter 9/-
3 1/2" x 5" 5/6
17" x 3 1/2" 16/-
5" x 2 1/2" 4/3

RESISTORS

1/2 watt 10%, 4d.
1 watt 5%, 5d.
1 and 1 watt, 6d.
3 watt, 5%, 1/6
5 watt 2/-
1 watt Metal Oxide, 1/9

A. MARSHALL & SON

28 CRICKLEWOOD BROADWAY, LONDON, N.W.2
01-452 0161/2/3 CALLERS WELCOME

CIRCUITS

The basic circuit for the electronic touch button is shown in Fig. 4.10. The tube does not strike when nothing is touching the touch plate, since the rectified mains voltage is below the striking voltage of the main gap of the tube.

If a person's finger is placed on the touch plate, however, a capacitive current passes between the cathode and the touch plate. Enough ions are formed to initiate a discharge in the main gap and hence energise the relay. The tube can control an anode current of over 10mA.

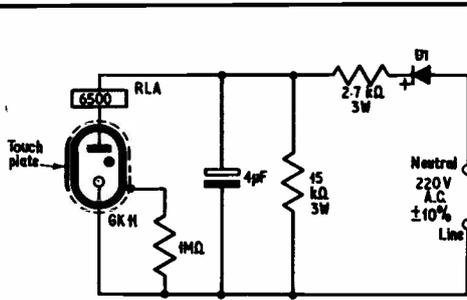


Fig. 4.10. The touch button controls a relay

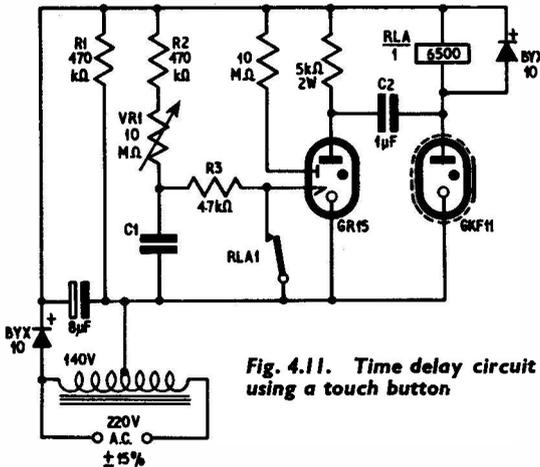


Fig. 4.11. Time delay circuit using a touch button

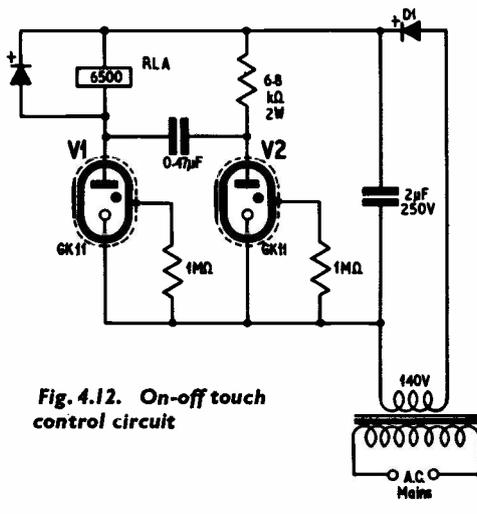


Fig. 4.12. On-off touch control circuit

Even if the person touching the touch plate is wearing gloves, the capacitance can exceed 5pF; this is quite adequate to cause the tube to fire. Any earthed object or any object with a large capacitance to earth can be used to cause the tube to strike.

Once the tube has fired, the touch plate will have no further effect. The anode voltage must be reduced in order to cause the tube to return to the non-conducting state. This may be accomplished by interrupting the anode current by a switch, by operating the tube from an alternating supply, or by extinguishing the tube with the aid of a second touch button (or other trigger tube) arranged in a bistable circuit. This last method is illustrated in Figs. 4.11 and 4.12.

TIME DELAY CIRCUIT

When the GKF11 assembly in Fig. 4.11 is touched, the relay will be energised and the GKF11 will glow for a predetermined time interval, after which the GR15 tube will ignite and the GKF11 will be extinguished. The relay may be used to carry out any desired operation.

When the GKF11 is touched and fired, a negative going pulse appears at its anode and is applied via C2 to the anode of the GR15 trigger tube. The latter is extinguished by the pulse. Contacts RLA1 are part of the relay and open when the relay is energised. Capacitor C1 commences to charge via the resistor chain.

After the preset time interval, the potential across this capacitor is great enough to cause the GR15 tube to fire. A negative pulse appears at the anode of this tube and is applied to the anode of the GKF11 via C2. The GKF11 is thus extinguished, the relay de-energised, and the circuit returned to its initial state. Contacts RLA1 close so that C1 discharges through R3.

The time for which the relay is energised is determined by the charging time of capacitor C1. This depends on the value of C1 and the setting of VR1. For a given value of C1, alteration of the resistor setting will change the time interval by a factor of up to ten. The time for which the relay is energised is given by the approximate formula:

$$t = 1.1(0.47 + R_v)C_1$$

where R_v is the value of the variable resistor VR1 in megohms and C_1 is in microfarads.

"ON/OFF" TOUCH CIRCUIT

The circuit in Fig. 4.12 is a bistable touch operated circuit, whereas that in Fig. 11 is a monostable one. When either of the touch button tubes in Fig. 4.12 is touched, that tube will conduct (if it is not already in the conducting state) and the other tube will be extinguished.

When the tube V1 is touched, the relay will be energised and will remain energised until the V2 is touched. The state of the circuit is shown by the glow emitted from the tube which was touched last. When one tube is switched to the conducting state, a negative pulse is developed at its anode which is passed through the anode coupling capacitor to extinguish the other tube.

OTHER DEVICES

Many other types of triggered tube are available, including those for protecting equipment from high voltage surges. However, it is felt that the types discussed above are those of direct interest to the amateur experimenter.

Next month: Decade counting tubes



BOOK REVIEWS

SOLDERING HANDBOOK

By B. M. Allen

Published by Iliffe Books Ltd.

120 pages, 8½ in × 6 in. Price 45s.

THE AUTHOR of this "practical manual for industry and laboratory" is senior works chemist at Multicore Solders Ltd., and this immediately stamps the work with authority. This most comprehensive and up-to-date book on the subject of soldering is divided into three parts. Part One is intended for the operator and deals with making a joint. All the essentials are here in word and diagram, and to hammer home the vital points, these are spelt out in capitals at the end of each section. Part Two is intended for the designer and engineer and it enlarges on methods and materials (i.e. solders and fluxes) for particular jobs. Part Three comprises a collection of data concerning materials and specifications.

Soldering is a subject generally taken much for granted. Yet, seemingly, thousands of people must be guilty of adopting undesirable methods—quite unwittingly! For example: in dealing with electronic circuit assembly, and emphatic warning is given against the use of "side-cutters" when shortening wires after soldering. We are told that the pinching action of these cutters may seriously damage the component or weaken a soldered joint. The recommendation is that if wires *must* be cut after soldering, then cutters with a shearing action like the Bib stripper should be used. Perhaps this is aimed specifically at industrial operators. No doubt in vital apparatus destined for a trip into space, this question of shock or stress on wires or components, however minute, may be a very serious matter.

This example does illustrate the thoroughgoing techniques preached by this book. It sets out to describe the perfectionist approach. If the methods given are followed, then the overall reliability of electronic equipment must be greatly enhanced.

F.E.B.

THE ELECTRONIC MUSICAL INSTRUMENT MANUAL

By Alan Douglas

Published by Sir Isaac Pitman & Sons Ltd.

372 pages, 8½ in × 5½ in. Price 55s

A PART from the theramin, no novelty instruments are contained in this handbook. It is really about electronic organs written by a man whose name is synonymous with this subject and who, of course, designed the P.E. Organ. Whilst this singularity of choice might belie the title, there is a very good reason, for it is in the electronic organ that we find the circuits of tonal synthesis of almost every instrument including the percussion family.

The first two chapters, which are short, deal appropriately enough with the physics of sound and music. From here on, the treatment is entirely electronic in the dissection and presentation of organ circuitry.

In common with most of the circuits in this handbook, practicality abounds. In the large chapter on the frequency generation, division and tone forming, there are many working examples, fully annotated, and featuring both valves and transistors as active elements. It might be added, besides the more conventional types of sine, square and sawtooth generators presented, there are the electromagnetic, electrostatic and photoelectric forms, all of which add up to a very comprehensive treatment of this fascinating subject.

In the subject of division, passive tone forming and amplification, the same liberality of example abounds, and in consequence the complete tyro will experience no qualms when attempting the copious chapter—Commercial Electronic Instruments, where complete console inset circuits, bearing such resounding pedigrees as Hammond, Wurlitzer and Baldwin are available for inspection, backed up by a very informative text.

A final chapter on experimental methods departs from the essentially commercial orientated subject matter, and presents the reader with some guidelines in experimental techniques, both in tone production and realisation.

The handbook is made complete with useful appendices, glossary and bibliography.

G.G.

QUESTIONS AND ANSWERS ON COLOUR TELEVISION

By J. A. Reddihough

Published by Newnes-Butterworths

108 pages, 6½ in × 4½ in. Price 10s

FOR THOSE about to embark on colour television servicing, or for the radio enthusiast wishing to broaden his knowledge, this pocket book is a valuable addition to the Newnes Q and A series. The contents are presented in easily understood terms with short explanations of colour derivation, separation, transmission reception, decoding and display.

It is adequately illustrated and has an index of terms, circuitry, and explanations. Difficulties in obtaining optimum colour resolution through convergence adjustments are described in a special chapter, with guidance on how one can set up the controls for best results.

A great deal of information is packed into this small book, none of which is superfluous to the knowledge required in understanding colour television.

M.A.C.

TAPE RECORDING YEAR BOOK—9th edition

Published by Tape Recording Magazine

88 pages, 9½ in × 6 in. Price 10s 6d

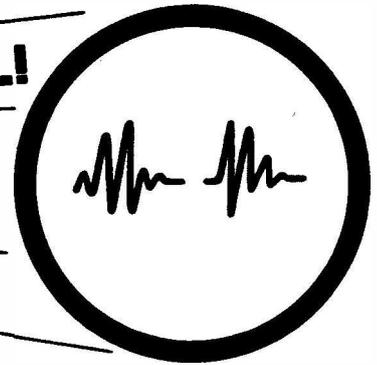
BEING limited to only one branch of electronics, this Yearbook contains 30 pages of details of tape equipments. The remainder of the space is devoted to articles written by well-known authors, the law in relation to recordings, details of competitions, table of tape playing times, glossary of terms, and lists of tape recording clubs and manufacturers.

LOOK!

PRACTICAL!

VISUAL!

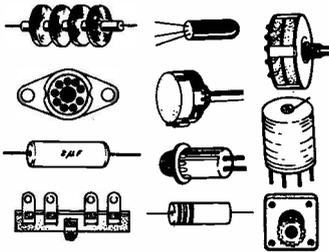
EXCITING!



a new 4-way method of mastering
ELECTRONICS
 by doing — and — seeing . . .

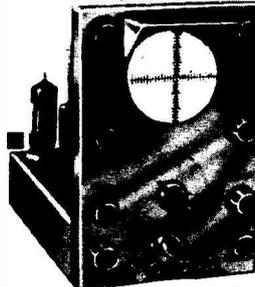
1 ▶ OWN and HANDLE a

complete range of present-day **ELECTRONIC PARTS** and **COMPONENTS**



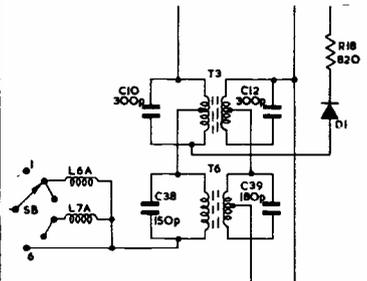
2 ▶ BUILD and USE

a modern and professional **CATHODE RAY OSCILLOSCOPE**



3 ▶ READ and DRAW and

UNDERSTAND CIRCUIT DIAGRAMS



4 ▶ CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS AND SEE HOW THEY WORK . . . INCLUDING . . .

- VALVE EXPERIMENTS
- TRANSISTOR EXPERIMENTS
- AMPLIFIERS
- OSCILLATORS
- SIGNAL TRACER
- PHOTO ELECTRIC CIRCUIT
- COMPUTER CIRCUIT
- BASIC RADIO RECEIVER
- ELECTRONIC SWITCH
- SIMPLE TRANSMITTER
- A.C. EXPERIMENTS
- D.C. EXPERIMENTS
- SIMPLE COUNTER
- TIME DELAY CIRCUIT
- SERVICING PROCEDURES

This new style course will enable anyone to really understand electronics by a modern, practical and visual method—no maths, and a minimum of theory—no previous knowledge required. It will also enable anyone to understand how to test, service and maintain all types of Electronic equipment, Radio and TV receivers, etc.

FREE POST NOW
for
BROCHURE

or write if you prefer not to cut page

To: **BRITISH NATIONAL RADIO SCHOOL, READING, BERKS.** Please send your free Brochure, without obligation, to: we do not employ representatives

NAME..... **BLOCK CAPS**

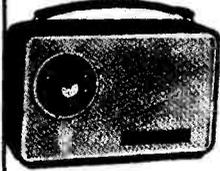
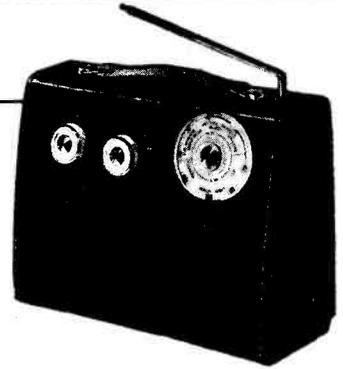
ADDRESS..... **PLEASE P.E. 9**

BUILD YOURSELF A QUALITY TRANSISTOR RADIO—FULL AFTER SALES SERVICE!

THE MARK 7 ROAMER 7

SEVEN WAVEBAND PORTABLE

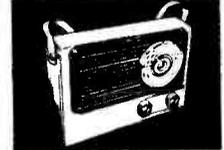
7 FULLY TUNABLE WAVE BANDS—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 x 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 x 7 x 4in approx. First grade Total building costs Parts price list and components. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. **£5.19.6 P. & P.** (FREE with parts). 7/6 (FREE with parts). Personal Earpiece with switched socket for private listening, 3/- extra.



"NEW LOOK" MELODY SIX MED. AND LONG WAVES WITH SPEAKER AND EARPIECE
6 transistors and 2 diodes. Push-pull output, tuning condenser, high "Q" ferrite rod aerial, 3in speaker, and personal earpiece with switched socket for private listening. 6 1/2 x 4 x 2in. Total Building Costs 69/6. P. & P. 4/3. Plans and parts list 2/- (free with parts).



POCKET FIVE MED. AND LONG WAVES AND TRAWLER BAND to approx. 50 metres. WITH SPEAKER AND EARPIECE. 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, moving coil speaker, etc. 5 1/2 x 1 1/2 x 3 1/2in. Total Building Costs 44/6. P. & P. 3/6. Plans and Parts list 1/6 (free with parts).



TRANSONA FIVE MED. AND LONG AND TRAWLER BAND to approx. 50 metres WITH SPEAKER AND EARPIECE. 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, moving coil speaker. 6 1/2 x 4 1/2 x 1 1/2in. Total Building Costs 47/6. P. & P. 3/6. Plans and Parts list 1/6 (free with parts).



SUPER SEVEN MED. LONG AND TRAWLER BAND. 7 transistors and 2 diodes. 3in speaker, 2 R.F. stages, push-pull output, etc. 7 1/2 x 6 1/2 x 1 1/2in. Total Building Costs 60/6. P. & P. 4/6. Plans and parts list 2/- (free with parts). Personal Earpiece with switched socket for private listening, 3/- extra.

ROAMER SIX 6 WAVEBANDS — MW1, MW2, SW1, SW2, LW AND TRAWLER BAND. 6 transistors and 2 diodes. Ferrite rod and telescopic aerials. 3in speaker. Top grade components. Size 7 1/2 x 5 1/2 x 1 1/2in. Total Building Costs 79/6. P. & P. 4/6. Plans and parts list 2/- (free with parts).

RADIO EXCHANGE LTD

DEPT. PE9, 61a HIGH STREET, BEDFORD O234 52367

Callers side entrance Stylo Shoe Shop. Open 10-1, 2.30-4.30 Monday - Friday 9-12.30 Saturday

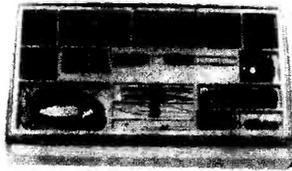
GEATRONIX LIMITED

EDUCATIONAL ELECTRONIC EQUIPMENT

MANUFACTURERS OF NORKIT

A new HOBBY for the automation age

- ★ Simple building bricks to build your own ELECTRONIC BRAINS.
- ★ Easy to understand handbooks to guide you.
- ★ Learn about LOGIC, BINARY arithmetic and BOOLEAN algebra.
- ★ Modules are rapidly assembled and dismantled to use again.
- ★ Make machines that play games, control model railways, etc. and control automatic machines of any description.

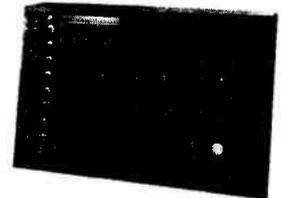


NORKIT JUNIOR £8. 16. 0
(as shown)

NORKIT SENIOR £17. 12. 0
Handbooks supplied for each kit or available separately 6/- each

LOGIC DEMONSTRATION UNIT TYPE LDU.1

A new teaching aid for rapidly setting up and demonstrating logic circuits. Stackable patching leads are used to interconnect logic symbols on a mimic diagram. The symbols are connected to appropriate components inside the unit. Switches and pushbuttons are provided to simulate input conditions and outputs are indicated by lamps and an audible alarm.



£68. 0. 0

Telephone: SOUTHEND 62521

GEATRONIX LTD., 28 REDSTOCK RD., SOUTHEND-ON-SEA, ESSEX

NEW PRICES ON NEW COMPONENTS

RESISTORS

High stability, carbon film, low noise. Capless construction, molecular termination bonding.

Dimensions (mm): Body; $\frac{1}{2}$ W: 8 x 2.8
 $\frac{1}{4}$ W: 10 x 4.3

Leads; 35

10% ranges; 10 Ohms to 10 Megohms (E12 Renard Series)

5% ranges; 4.7 Ohms to 1 Megohm (E24 Renard Series)

Prices—per Ohmic value.

$\frac{1}{2}$ W	10%	each	10 off	25 off	100 off
$\frac{1}{2}$ W	10%	2d	1/6	3/3	10/4
$\frac{1}{4}$ W	5%	2½d	1/9	3/8	11/8
$\frac{1}{4}$ W	10%	2½d	1/9	3/8	11/7
$\frac{1}{4}$ W	5%	3d	2/-	4/-	12/10

CAPACITORS

Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radial leads.

±100% tolerance.

Prices—per Capacitance value (μ F)

100 Volt Working.

	each	10 off	25 off	100 off
0-001, 0-002, 0-005, 0-01, 0-02	6d	4/3	8/4	30/-
0-05	8d	6/-	12/6	41/8
0-1	10d	7/1	15/6	51/-
0-2	1/2	10/-	20/10	68/6
0-5	2/-	17/6	37/6	125/-

Polystyrene film, Tubular, Axial leads.

±5% or ±1% tolerance.

Prices—per Capacitance value (μ F)

Unencapsulated.

160 Volt Working.

	each	10 off	25 off	100 off
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 180, 220, 270, 330, 390	5d	3/7	7/9	24/-
470, 560, 680, 820, 1,000, 1,500	6d	4/-	8/8	26/8
2,200, 3,300, 4,700, 5,600	7d	5/-	10/10	33/4
6,800, 8,200, 10,000, 15,000	8d	6/-	13/-	40/-
22,000	9d	6/9	18/-	45/4

Polystyrene film, Tubular, Axial leads.

±1% tolerance.

Prices—per Capacitance value (μ F)

Professional Grade.

100 Volt Working.

	each	10 off	25 off	100 off
100, 120, 150, 180	1/3	10/2	21/2	64/6
220, 270, 330, 390, 470, 560, 680, 820	1/3	10/8	23/1	71/-
1,000, 1,200, 1,500, 2,200, 2,700	1/6	13/10	29/11	92/-
3,300, 3,900, 4,700, 5,600	1/9	14/1	31/-	96/-
6,800, 8,200, 10,000, 12,000	1/9	15/2	32/10	101/-
15,000, 18,000	2/-	15/11	34/9	107/4
22,000, 27,000	2/3	17/3	37/10	115/-
33,000, 39,000	2/6	20/1	43/6	133/9
47,000, 56,000	2/9	22/1	47/10	147/4
68,000	3/-	24/9	53/8	165/4
82,000	3/3	26/1	56/6	173/9
0-1 μ F	3/6	27/5	59/4	182/8
0-12 μ F	3/9	30/3	65/10	202/-
0-15 μ F	4/3	34/2	73/7	228/-
0-18 μ F	5/-	37/10	81/11	252/3
0-22 μ F	6/-	47/-	101/10	313/4
0-27 μ F	6/9	53/9	116/8	358/4
0-33 μ F	7/3	58/10	126/11	390/-
0-39 μ F	7/9	65/-	140/10	433/4
0-47 μ F, 0-5 μ F	9/9	75/2	137/7	500/-

POTENTIOMETERS (Carbon)

Miniature, fully enclosed, rear tags, carbon brush wiper. Long life, low noise. Body dia. $\frac{1}{2}$ in. Spindle, $\frac{1}{16}$ in. x $\frac{1}{16}$ in. $\frac{1}{2}$ W at 70°C. ±20% \pm M, ±30% \pm M Lin. 100 Ohms to 10 Megohms, Log. 5 Kohms to 5 Megohms.

Prices—per ohmic value.

	each	10 off	25 off	100 off
	2/3	20/-	45/10	186/8

GANGED STEREO POTENTIOMETERS (Carbon)

$\frac{1}{2}$ W at 70°C. Long Spindle.

Logarithmic and Linear: 5k + 5k to 1M + 1M.

Prices per ohmic value

	each	10 off	25 off	100 off
	8/-	70/-	162/6	575/-

SKELETON PRE-SET POTENTIOMETERS (Carbon)

High quality pre-sets suitable for printed circuit boards of 0.1in. P.C.M. 100 Ohms to 5 Megohms (Linear only).

Miniature: 0-3W at 70°C. ±20% below \pm M, ±30% above \pm M. Horizontal (0-7in. x 0-4in. P.C.M.) or Vertical (0-4in. x 0-2in. P.C.M.).

Subminiature: 0-1W at 70°C. ±20% below 2.5M, ±30% above.

Prices—per ohmic value

	each	10 off	25 off	100 off
Miniature (0-3W)	1/-	8/9	18/9	46/8
Subminiature (0-1W)	10d	7/1	14/7	46/8

JACK PLUGS

$\frac{1}{2}$ in. Type P1. Standard. Screened. Heavily chromed.

$\frac{1}{2}$ in. Type SE/P1. Side-entry version of type P1.

$\frac{1}{2}$ in. Type P2. Standard. Unscreened. Unbreakable moulded cover.

$\frac{1}{2}$ in. Type P3. Tip-Ring-Sleeve Stereo version of Type P1.

$\frac{1}{2}$ in. Type P4. Tip-Ring-Sleeve Stereo version of Type P2.

3.5mm Type P5. Standard. Screened. Aluminium cover.

3.5mm Type P6. Standard. Unscreened. Unbreakable moulded cover.

Prices—

	each	10 off	25 off	100 off
P1.	3/-	26/8	62/6	233/4
SE/P1.	3/6	30/10	66/8	280/-
P2.	2/6	23/4	54/2	200/-
P3.	6/6	60/-	137/6	500/-
P4.	6/2	56/6	127/6	455/-
P5.	2/2	19/2	43/9	158/4
P6.	1/8	15/-	33/4	116/8

JACK SOCKETS

$\frac{1}{2}$ in. Type S3. Stereo version for use with P3 or P4 plugs.

$\frac{1}{2}$ in. Type S5. Standard. Moulded body. Chrome insert.

3.5mm Type S6. Standard. Moulded body. Chrome insert.

Available with make or break contacts on Tip, Ring and Sleeve.

Prices—

	each	10 off	25 off	100 off
S3	3/3	30/-	68/9	250/-
S5	2/9	25/-	56/8	216/8
S6	1/6	13/4	33/4	100/-

ELECTROLYTIC CAPACITORS (Mullard). —10% to +50%.

Subminiature (all values in μ F)

4V	8	32	64	125	250	400
6-4V	6-4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2-5	10	20	40	80	125
25V	1-6	6-4	12-5	25	50	80
40V	1	4	8	16	32	50
64V	0-64	2-5	5	10	20	32
Price	1/4	1/3	1/2	1/-	1/1	1/2

Small (all values in μ F)

4V	800	1,250	2,000	3,200
6-4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

POLYESTER CAPACITORS (Mullard)

Tubular, 10%, 160V: 0-01, 0-015, 0-022 μ F, 7d. 0-033, 0-047 μ F, 8d. 0-068, 0-1 μ F, 9d. 0-15 μ F, 11d. 0-22 μ F, 1/- 0-33 μ F, 1/3. 0-47 μ F, 1/6. 0-68 μ F, 2/3. 1 μ F, 2/8.

400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, 6d. 6,800pF, 0-01, 0-015, 0-022 μ F, 7d. 0-033 μ F, 8d. 0-047 μ F, 9d. 0-068, 0-1 μ F, 11d. 0-15 μ F, 1/2. 0-22 μ F, 1/6. 0-33 μ F, 2/3. 0-47 μ F, 2/8.

Modular, metallised. P.C. mounting, 20%, 250V: 0-01, 0-015, 0-022 μ F, 7d. 0-033, 0-047 μ F, 8d. 0-068, 0-1 μ F, 9d. 0-15 μ F, 11d. 0-22 μ F, 1/- 0-33 μ F, 1/5. 0-47 μ F, 1/8. 0-68 μ F, 2/3. 1 μ F, 2/9.

SEMICONDUCTORS: OA5, OA81, 1/9. OC44, OC45, OC71, OC81, OC81D, OC82D, 2/- OC70, OC72, 2/3. AC107, OC75, OC170, OC171, 2/6. AF115, AF116, AF117, ACY19, ACY21, 3/3. OC140, 4/3. OC200, 5/- OC139, 5/3. OC25, 7/- OC35, 8/- OC23, OC28, 8/3.

SILICON RECTIFIERS (0-5A): 170 P.I.V., 2/9. 400 P.I.V., 3/- 800 P.I.V., 3/3. 1,250 P.I.V., 3/9. 1,500 P.I.V., 4/- (0.75A): 200 P.I.V., 1/6. 400 P.I.V., 2/- 800 P.I.V., 3/3. (6A): 200 P.I.V., 3/- 400 P.I.V., 4/- 600 P.I.V., 5/- 800 P.I.V., 6/-

SWITCHES (Chrome finish, Silver contacts): 3A 250V, 6A 125V. Push Buttons: Push-on or Push-off 5/-. Toggle Switches: SP/ST, 3/6. SP/DT, 3/9. SP/DT (with centre position) 4/-. DP/ST, 4/6. DP/DT, 5/-

ROTARY SWITCHES (Wafer)

High quality. Rear tags. Long spindle, $\frac{1}{4}$ " Dia.

1p/12w, 2p/6w, 3p/4w, 4p/3w, 2p/3w. Prices—

	each	10 off	25 off	100 off
All Types	4/6	38/4	83/4	283/4

PRINTED CIRCUIT BOARD (Vero).

0-15in Matrix: 3 $\frac{1}{2}$ in x 2 $\frac{1}{2}$ in, 3/3. 5 $\frac{1}{2}$ in x 2 $\frac{1}{2}$ in, 3/11. 3 $\frac{1}{2}$ in x 3 $\frac{1}{2}$ in, 3/11. 5in x 3 $\frac{1}{2}$ in, 5/6. 0-1 Matrix: 3 $\frac{1}{2}$ in x 2 $\frac{1}{2}$ in, 4/-. 5in x 2 $\frac{1}{2}$ in, 4/6. 3 $\frac{1}{2}$ in x 3 $\frac{1}{2}$ in, 4/6. 5in x 3 $\frac{1}{2}$ in, 5/3.

Send S.A.E. for January, 1969 Catalogue

DUXFORD ELECTRONICS (PE)

97/97A MILL ROAD, CAMBRIDGE

Telephone: CAMBRIDGE (0223) 63687

(Visit us—at our new Mail Order, Wholesale & Retail Premises) MINIMUM ORDER VALUE 5/- C.W.O. Post and Packing 1/6

DIOTRAN SALES

P.O. BOX 5
WARE, HERTS
TEL.: WARE 3442

EX-COMPUTER PANELS I.B.M. Size 2in. x 4in. with TRANSISTORS, DIODES, RESISTORS, CAPACITORS, etc. Over 1 million already Sold out to the Trade. 30,000 only left at our Ridiculous Price of £3 per 100 panels or £28 per 1,000 panels. Plus carriage 6/- per 100 panels.

Post and Packing costs are continually rising. Please add 1/- towards same. CASH WITH ORDER PLEASE

OVERSEAS QUOTATIONS BY RETURN SHIPMENTS TO ANYWHERE IN THE WORLD

OVER 3 MILLION SILICON ALLOY & GERM. TRANSISTORS AVAILABLE FOR IMMEDIATE DELIVERY

TRANSISTORS	Qty.	Price	Qty.	Price	Qty.	Price	Qty.	Price
Type and Construction								
A 1 Germ. A.F. PNP TO-1	= AC127, NKT773, AC157, ASY86	£3.10	500	1,000	10,000			
A 2 Germ. A.F. PNP TO-5	= AC177-21, NKT237-245	£1	£3	£25	£40			
A 3 Germ. A.F. PNP TO-1	= AC128, NKT271, 2G381	£1	£3	£5	£40			
A 4 Germ. R.F. PNP TO-1	= OC44-45, NKT7125, ASY54	£1.10	£4.10	£7.10	£60			
A 5 Germ. R.F. PNP TO-5	= 2N1303, NKT164-7, 2G301-3	£1.10	£4.10	£7.10	£60			
A 6 Germ. V.H.F. PNP TO-1	= AF116-7, KNT667, 2G417	£3.10	£15	£25	£200			
A 7 Assorted Germ. A.F.-R.F. PNP mixed cans, general purpose	15s.		£2.10	£4	£32			
A 8 Germ. A.F. SO-2 PNP	= 2G371-89, ACY27-31, OC71-75	£2	£7.10	£12.10	£100			
A 9 Sil. Alloy PNP TO-5	= 2S301-5, BCY17-29, BCY30-34	£2	£7.10	£12.10	£100			
A10 Sil. Alloy PNP SO-2	= 2S321-325, OC200-205	£2	£7.10	£12.10	£100			
A11 to A7 Guaranteed 80% Good usable Transistors ideal for low cost production work and experimental use. A8 to A10 are all perfect devices, factory tested, no open or short circuit Transistors in these lots.								

TESTED TRANSISTORS

each	ONE PRICE ONLY PNP, NPN, SILICON PLANAR 1/- EACH				each
BC108	2N696	2N1132	2N2220		25733
BC109	2N697	2N1613	2N3707		2N3391
BFY50	2N706	2N1711	2N3711		T1544
BFY51	2N708	2N2904	25102		2N2906
BFX84	2N929	2N2905	25103		2N2907
BFX86	2N930	2N2924	25104		2N2696
BFX88	2N1131	2N2926	25732		2N3702
					2N3703

From Manufacturers' Over-runs—Unmarked Plastic and Metal cases. Devices similar to above Nos.

GERM. PNP AND NPN TRANSISTORS FULLY TESTED, UNMARKED SIMILAR TO 1/6 EACH

AC125	ACY22	ACY36	NKT677	OC81	2G381
AC126	ACY27	NKT141	NKT1713	OC82	2G382
AC127	ACY28	NKT142	NKT773	2G301	2G399A
AC128	ACY29	NKT212	OC44	2G302	
AC130	ACY30	NKT213	OC45	2G303	
ACY19	ACY31	NKT214	OC71	2G306	
ACY20	ACY34	NKT215	OC72	2G371	
ACY21	ACY35	NKT271	OC75	2G374	1/6 each

POWER TRANSISTORS

OC25	OC35	NKT403	ASZ17		
OC26	AD130	NKT404	T13027		
OC28	AD140	NKT405	T13028		
OC29	AD149	NKT452	T13029		

Manufacturers' Surplus Germ. A.F. All similar to above.

TRANSISTOR EQVT. BOOK

2,500 cross references of transistors—British, European, American and Japanese. A must for every transistor user. Exclusively distributed by DIOTRAN SALES. 15/- EACH.

Sub-Min. Plastic 1 Amp Sil. Rect.		Vast mixed lot of subminiature glass diodes, Comprising of Silicon, Germ., Point Contact and Gold Bonded types plus some Zeners, 500,000 available at Lowest of Low Price.	
Type No.	PIV Each	Type No.	PIV Each
IN4001	50	1,000	1/3
IN4002	100	1,000	1/6
IN4003	200	2,000	2/-
IN4004	400	2,000	2/9
IN4005	600	3,000	3/-
IN4006	800	3,000	3/9
IN4007	1,000	4,000	4/9

1,000 pieces £3.0.0, 5,000 pieces £13.10.0, 10,000 pieces £23.

BRAND NEW FULLY TESTED EPOXY CASE UNIJUNCTION TRANSISTORS. Type T1543 and BEN 3000 and replacement for 2N2646. Full data available. LOWEST PRICE AVAILABLE ANYWHERE. 100 off 4/- each = £20; 500 off 3/6 each = £87.10; 1,000 off 3/- each = £150. Sample devices 7/- each on request.

HIGH QUALITY SILICON PLANAR DIODES. SUB-MINIATURE DO-7 Glass Type, suitable replacements for OA200, OA202, BAY38, 15130, 15940. 200,000 to clear at £4 per 1,000 pieces. GUARANTEED 80% GOOD.

SILICON PLANAR PLASTIC TRANSISTORS. 2N3708A Vc830 Hfe 20-60. All marked fully tested and guaranteed. 1 off 1/6 each; 100 off 10d, each; 500 off 9d, each; 1,000 off 7½d, each.

TO-5 METAL CAN SILICON PLANAR TRANSISTORS. VERY HIGH QUALITY 99% good type. 2N697, BFY51, 2N1893, £8 per 500 pieces. £13 0/0 for 1,000 pieces.

FULLY TESTED DEVICES AND QUALITY GUARANTEED—SURPLUS TO REQUIREMENTS

OA202 Silicon Diode. Fully Coded. 150 PIV 250mA Qty. Price £30 per 1,000 pieces.

ORP12 Cadmium Sulphide Cell. 1-24 9/- each; 25-99 7/- each; 100-999 6/- each; 1,000 up 5/6 each. Made in Holland.

BY100 SIL. RECT'S 800 PIV 550mA. 1-49 2/6 each; 50-99 2/3 each; 100-999 2/- each; 1,000 up 1/10 Coded. Fully Coded. 1st Qty.

THYRISTORS (S.C.R.'s) TESTED, BRAND NEW AND CODED: TO-5 CASE

Type No.	PIV Amp	Each
2N1595	50	7/6
2N1596	100	9/-
2N1597	200	10/6
2N1598	300	14/-
2N1599	400	15/-
BTX30-580	500	22/6
BTX30-600	600	23/-

TO-48 CASE (STUD)

Type No.	PIV Amp	Each
2N682	50	12/-
2N683	100	15/-
2N685	200	19/6
2N687	300	25/6
2N688	400	32/6
2N689	500	47/6
2N690	600	30/-
2N691	700	56/-
2N692	800	62/-

TO-46 CASE (STUD)

Type No.	PIV Amp	Each
2N1771	50	4/7
2N1772	100	4/7
2N1774	200	4/7
2N1776	300	4/7
2N1777	400	4/7
2N1778	500	4/7
2N2619	600	4/7

YOUR CORTINA CAN DELIVER 144 B.H.P.!

Enough power to reach 60 m.p.h. in under ten seconds! How can she do it? Easy... when she's been fitted with a 3-litre V6 Ford Zodiac engine. And that simple conversion could cost you as little as one third of the price of a new big-engined baby.

Profit from our experience at PRACTICAL MOTORIST. After only a few minor body modifications, we successfully shoehorned this large-capacity power unit in with safety. Now she really knows her way about on our traffic-packed highways, and she's ready any time to get herself adapted for racing, rallying, hill climbing and sprints.

Read the two-part case-history of our compact "extra-delivery" V6 Cortina, starting in the September issue.



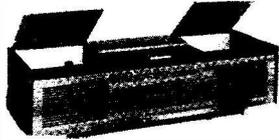
PRACTICAL motorist

September issue OUT NOW! 2/6

STEREOGRAM CABINET \$19

An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel

BLACK LEATHERETTE SIDE PANELS
Dimensions: 52" x 17 1/2" x 12". Speaker positions for Twin 10" x 5" Speakers



SPEAKERS 6/6

2" — 75Ω. 2 1/2" — 35Ω. P. & P. 2/6.

ACOS MICS. 35/- STANDARD

STICK MIC. 2gns. P. & P. 3/6.

ASSORTED CONDENSERS

10/- for 50. P. & P. 7/6.

ASSORTED RESISTORS

10/- for 50. P. & P. 4/6.

ASSORTED CONTROLS

10/- for 25. P. & P. 7/6.

TRANSISTORS

MULLARD MATCHED

OUTPUT KIT

9/- OC81D—2 OC81's.
P. & P. FREE.

FERRITE RODS 3/6

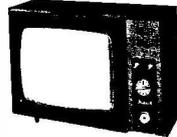
6", 8" x 3/8" complete with
LW/MW COILS. P. & P. FREE.

17in.—£11.10.0 Carr. 30/-

19in. SLIM-LINE FERGUSON 24 gns.

TWO-YEAR GUARANTEE
EX-RENTAL TELEVISIONS

FREE ILLUSTRATED
LIST OF TELEVISIONS
17"—19"—21"—23"



WIDE RANGE OF MODELS
SIZES AND PRICES
DEMONSTRATIONS DAILY

RECORD PLAYER CABINET 49/6.

Cloth covered. Size 16 1/2" x 14 1/2" x 8"
Takes any modern autochanger.
P. & P. 7/6.

SINGLE PLAYER CABINETS 15/6. P. & P. 7/6.

TRANSISTOR CASES 19/6.
Cloth covered, many colours.
Size 9 1/2" x 6 1/2" x 3 1/4". P. & P. 3/6.
Similar cases in plastic 7/6.

TWO-YEAR GUARANTEED REGUNNED TUBES

70" & 90" 14in.—69/6, 17in.—
89/6, 21in.—99/6, 110" 17in.—
19in. & 21in.—99/6, 23" (not
bonded)—119/6. Exchanged
Bowls. Carr. 10/6.

DUKE & CO. (LONDON) LTD.
621/3 Romford Road, Manor Park, E.12
Phone 01-478 6001-2-3 Stamp for Free List.

ELECTROVALUE

EVERYTHING BRAND NEW AND TO SPEC. NO SURPLUS

SPECIALIST SUPPLIERS OF TRANSISTORS

IN TYPES TO SUIT ALMOST ALL APPLICATIONS

- COMPETITIVE PRICES
- HIGH QUALITY COMPONENTS FOR TRANSISTOR CIRCUITS
- PEAK SOUND AS ADVERTISED
- CATALOGUE Our latest 1969 catalogue is packed with up-to-the-minute items and invaluable information. Send 1/6 for your copy now.
- DISCOUNTS 10% on orders for components for £3 or more. 15% on orders for components for £10 or more.
- POSTAGE on orders for £1, add 1/-. FREE on orders for £1 or over. Overseas orders welcome—Carriage charged at cost.

ELECTROVALUE
(DEPT. PE), 32a ST. JUDES RD., ENGLEFIELD GREEN, EGHAM, SURREY
Telephone: Egham 5533 (STD 0784-3)



Become a RADIO TECHNICIAN

and work at
the nerve centres
of civil aviation

The National Air Traffic Control Service, a Department of the Board of Trade, needs Radio Technicians to install and maintain the very latest electronic aids at Civil Airports such as Heathrow, Gatwick and Stansted, Air Traffic Control Centres, Radar Stations and specialist establishments.

This is responsible demanding work (for which you will get familiarisation training) involving communications, computers, radar and data extraction, automatic landing systems and closed-circuit television and it offers excellent prospects with ample opportunities to study for higher qualifications in this fast-expanding field.

If you are 19 or over, with practical experience in at least one of the main branches of telecommunications, fill in the coupon now.

Starting salary is £915 at (19) to £1,189 (at 25 or over): scale maximum £1,372 (higher rates at Heathrow), and some posts attract shift-duty payments. From January 1970 these rates will be increased to £985, £1,295, £1,500 respectively. The annual leave allowance is good and there is a non-contributory pension scheme for established staff.

Complete this coupon for full details and application form:
To: A. J. Edwards, C. Eng., M.I.E.E., M.I.E.R.E., Room 705, The Adelphi,
John Adam Street, London WC2, marking your envelope 'Recruitment'.

Name.....
Address.....

Not applicable to residents outside the United Kingdom. PE/81

NATCS National Air Traffic Control Service

Practical Electronics Classified Advertisements

MISCELLANEOUS

GLASS FIBRE OPTIC LIGHT GUIDES
0.031" DIA. TOTAL FIBRE BUNDLE HELD WITHIN P.V.C. SLEEVING

5'	10'	15'	25'	50'	STRICTLY CWO
19/6	34/6	47/6	72/3	132/3	

FIBRELIGHT, Dept. PE4
31 STOKE ROAD, GUILDFORD, SURREY

PROJECT BUILDERS note—Having trouble obtaining special components? We will endeavour to supply ALL parts for your project, specials, e.g., coils, p.c. boards, etc., as well as standard items. **SRV ELECTRONICS**, 11 Rosedene Ave., Croydon, CRO 3DN. 01-684 0402.

WANTED. Somebody to construct about three metal detectors. Possibility of further orders. Terms to be negotiated. Contact—**CHAIT**, Flat 6, 170 Highgate Rd., London, N.W.5. Gulliver 8395.

ROBOTS

Synthetic Animals with "BRAINS" of their own. The NEW range of projects include: an electronic 'animal' which "LEARNS", an Electro Chemical device capable of "REPRODUCING" itself! Other projects **SURE TO INTRIGUE YOU** are an audio transmitter/receiver which has quite an amazing range and requires **NO LICENCE**; also a machine which "recognizes" itself, and an electronic dog whistle, etc., etc. **HOSTS OF EASY-TO-CONSTRUCT** projects, for anyone with a basic knowledge of Electronics.

SEND 2/6 for your list—NOW!

To: 'BOFFIN PROJECTS'

incorporating
BIONIC DESIGNS, 4 CUNLIFFE RD.
STONELEIGH, EWELL, SURREY
Designed by **GERRY BROWN** and
JOHN SALMON and presented
on T.V.

Send 1/- for

STATE OF THE ARTISTS LIST OF

Comps and full data, applications on latest dcl/uhf low noise N/FET, 2N5245, 10/- ea. also Sprague 'UNICIRCUIT' ULN2111A, d.i.l. for FM/SSB det, 60db wdbnd amp/lm, etc. £1.10.6 ea. C.W.O. 5d. p.p. per order to: **T. ADVISER**
2 Crown Acre, Brockenhurst, Hants

PROFESSIONALLY MADE CONTROL PANELS from 48 sq. in. 16/18 gauge aluminium, cut, drilled, spray painted and legend. Send full size drawing for quotation. **C. S. CONDUIT, 7 Millbrook, Salisbury, Wilts.**

6 OR 12 VOLT FLUORESCENT LIGHTS

12 ins. 8 Watt tube ample light for caravan, tent, etc. Fully transistorised, low battery drain. Unbeatable at **£2.19.6** post paid.

or in kit form **50/-**

SALOP ELECTRONICS
83 Wyle Cop, Shrewsbury, S.A.E. for lists

HI-FI loudspeaker systems for the home constructor, cabinet kits, the new range of Peerless speakers, speaker kit systems and cross-over networks. BAF wadding, speaker fabric (samples on request) and all other necessary components. Send 5d in stamps to: **AUDIOSCAN, Dept. PE, 4 Princes Square, Harrogate, Yorks.**

RATES: 1/3 per word (minimum 12 words). Box No. 1/6 extra.

Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Electronics"
IPC MAGAZINES LTD.,
Fleetway House, Farringdon Street,
London, E.C.4

MISCELLANEOUS (continued)

BRAND NEW. Sangamo Weston Domestic Time Switches, Model S.302, in maker's boxes. Normally **£4.14**. Special offer, without plug, **£3 +5/-** p. & p. Hurry, only 40 available. E.P.H. Co., 17 Cambridge Road, Ellesmere Port, Wirral, Cheshire.

BUILD IT in a DEWBOX quality cabinet 2in x 2 1/2in x any length. **DEW LTD.,** Ringwood Road, Ferndown, Dorset. S.A.E. for leaflet. Write now—right now.

ETCHED PRINTED CIRCUIT BOARD KITS. Full instructions. 19/6, c.w.o. **CIRCUITETCH, 12 Cambridge Rd., St. Albans, Herts.**

MUSICAL MIRACLES. Send S.A.E. for details of Rhythm Modules, Versatile Bass-pedal unit, self-contained with unique effects, kits for waa-waa pedals. Also new 50uA meters **25/-** post paid. **HURRY! D.E.W. LTD.** 254 Ringwood Road, Ferndown, Dorset.

UFO DETECTOR CIRCUITS, data. 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts.

ELECTRONIC SOLITAIRE. Build this game from complete kit. Over 32,000 combinations. Hours of intrigue, relaxing, challenging! Full kit and instructions **55/-**. Educates in binary logic. **D.E.W. LTD.,** 254 Ringwood Road, Ferndown, Dorset.

ONE OFF PRINTED CIRCUIT BOARDS. Cheaply made to customers' requirements. Send s.a.e. for details: **D. R. MANN, 12 Randolph St., Nottm.**

CLEARING LABORATORY, scopes, V.T.V.M.'s, V.O.M.'s, H.S. recorders, transcription turntables, electronic testmeters, calibration units, P.S.U.'s, pulse generators, D.C. null-potentiometers, bridges, spectrum analysers, voltage regulators, sig-gens, M/C relays, components, etc. Lower Beeding 236.

SERVICE SHEETS

LARGE SUPPLIER OF SERVICE SHEETS

T.V., RADIO, TRANSISTORS, TAPES, CAR RADIOS
Only 5/- each, plus LARGE S.A.E.
(Uncrossed P.O.'s please, returned if service sheets not available.)
FREE TV FAULT TRACING CHART OR TV LIST ON REQUEST

C. CARANNA
71 BEAUFORT PARK, LONDON, N.W.11
MAIL ORDER ONLY

SERVICE SHEETS (continued)

SERVICE SHEETS (1925-69) for televisions, radios, transistors, tape recorders, record players, etc., by return post, with free fault-finding guide. Prices from 1/-. Over 8,000 models available. Please send S.A.E. with all orders/enquiries. **HAMILTON RADIO, 54 London Road, Bexhill, Sussex.**

SERVICE SHEETS, Radio, TV, 5,000 models. List 1/6. S.A.E. enquiries. **TELBAY, 11 Maudland Bank, Preston.**

RADIO TELEVISION, over 8,000 Models. **JOHN GILBERT TELEVISION, 1b Shepherds Bush Rd., London, W.6. SHE 8441.**

FOR SALE

£6,000 IN VOUCHERS GIVEN AWAY. See free Cat. for details. Tools, Materials, Mechanical, Electrical, thousands of interesting items. **WHISTON, Dept. PVE, New Mills, Stockport SK12 4HL.**

MORSE MADE EASY !!

FACT NOT FICTION. If you start **RIGHT** you will be reading amateur and commercial Morse within a month (normal progress to be expected).

Using scientifically prepared 3-speed records you automatically learn to recognise the code **RYTHM** without translating. You can't help it, it's as easy as learning a tune. 18 W.P.M. in 4 weeks guaranteed.

For details and course C.O.D. ring S.T.D. 01-660 2896 or send 8d. stamp for explanatory booklet to:

GSHC (Box 19), 45 GREEN LANE, FURLEY, SURREY

WANTED ALL COPIES PRACTICAL ELECTRONICS, any condition. List quantity, and price wanted. Box 21.

"**PRACTICAL ELECTRONICS**", first to latest—**£9.** **McGILL, 48 Shannon Rd., Hull, Yorkshire.**

E.M.T. RECTIFIERS, K8/30 5/-, K8/50 7/6, K3/100 12/8. Oluf 6KV 4/8. Power Rheostat L25W 5 ohms 10/- Vtb. pack 6V-220V. 30/- P. & P. 1/6. S.A.E. for list **BOURDON, CAMPS, 41 Higher Compton Road, Plymouth, Devon. Tel. 0752 77974.**

BOOKS AND PUBLICATIONS

SURPLUS HANDBOOKS

19 set Circuit and Notes 6/6 P.P. 6d
1155 set Circuit and Notes 6/6 P.P. 6d
H.R.O. Technical Instructions 5/6 P.P. 6d
38 set Technical Instructions 5/6 P.P. 6d
46 set Working Instructions 5/6 P.P. 6d
88 set Technical Instructions 7/- P.P. 6d
BC. 221 Circuit and Notes 5/6 P.P. 6d
Wavemeter Class D Tech. Instr. 5/6 P.P. 6d
18 set Circuit and Notes 5/6 P.P. 6d
BC.1000 (31 set) Circuit & Notes 5/6 P.P. 6d
CR.100/B.28 Circuit and Notes 10/- P.P. 9d
R.107 Circuit and Notes 7/- P.P. 6d
A.R.88D. Instruction Manual 18/- P.P. 6d
42 set Circuit and Notes 6/6 P.P. 6d
52 set Sender & Receiver Circuits 7/6. post free.
Circuit Diagrams 5/- each post free.
R.1116/A, R.1224/A, R.1355, R.F. 24, 25, & 26.
A.1134, T.1154, CR.300, BC.342, BC.312, BC.348, J.E.M.P. BC.624, 22 set.
Resistor Colour Code Indicator... 2/6 P.P. 6d

S.A.E. with all enquiries please.
Postage rates apply to U.K. only.

Mail order only to:
Instructional Handbook Supplies
Dept. P.E., Talbot House, 28 Talbot Gardens
Leeds 8

EDUCATIONAL

GET INTO ELECTRONICS—big opportunities for trained men. Learn the practical way with low-cost Postal Training, complete with equipment. A.M.I.E.R.E., R.T.E.B., City & Guilds, Radio, T.V., Telecoms., etc. For FREE 100-page book, write Dept. 856K, CHAMBERS COLLEGE, 148 Holborn, London, E.C.1.

CITY & GUILDS AND R.T.E.B. EXAMS. Specialised ICS home-study course will ensure success. For details of wide range of exam, and diploma courses in Radio, T.V. and Electronics, also new practical courses with kits, write to ICS (Dept. 577), Intertext House, Stewarts Road, London, S.W.8.



RADIO & TELEVISION SERVICING RADAR THEORY & MAINTENANCE TELECOMMUNICATIONS

This private College provides efficient theoretical and practical training in the above subjects. One-year day courses are available for beginners and shortened courses for men who have had previous training. Write for details to:—
The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. Tel. 01-373 8721

TECHNICAL TRAINING in Radio, TV & Electronics thro' world-famous ICS. For details of proven home-study courses write: ICS, Dept. 561, Intertext House, Stewarts Road, London, S.W.8.

SITUATIONS VACANT

A.M.I.E.R.E., A.M.S.E. (Elec.), City & Guilds, G.C.E., etc., on "Satisfaction or Refund of Fee" terms. Wide range of Home Study Courses in Electronics, Computers, Radio, T.V., etc. 132-page Guide—FREE. Please state subject of interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 124K), Aldermaston Court, Aldermaston, Berks.

ENGINEERS. A technical certificate or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C.Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B. and G.C.E. exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts., Building, etc. For full details write for FREE 132-page guide. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 125K), Aldermaston Court, Aldermaston, Berks.

TAPE RECORDERS

TAPES TO DISC—using finest professional equipment—45 r.p.m. 22/-. S.A.E. leaflet, DERBY, High Bank, Hawk Street, Carnforth, Lancs.

RECEIVERS AND COMPONENTS

RECEIVER PANELS MW/LW. Size 8 x 3in. Six transistors, OC44, OC45 (2 off), OC81D, OC81 (2 off), ½ watt output, contains all resistors, capacitors, I.F. transformers, osc. coil and transistors but will require ferrite aerial, tuning capacitor, wavechange switch, and volume control, supplied with connecting data, as brand new, made by famous British manufacturer, ONLY 32/6 post paid.

TUNING CAPACITORS (Brand new and boxed). 345pF + 165pF with two 20pF sections for F.M. tuner, size 2½ x 2 x 1½in. ONLY 4/6 each or 8/- for two. 325pF + 375pF with two 20pF sections for F.M. tuner, size 2½ x 1½ x 1½in. ONLY 4/6 each or 8/- for two.

VOLUME CONTROLS. 5k log. with S.P. switch, ½in dia. spindle. 2/- each (new).

DISC CERAMIC CAPACITORS. 0.02mF 500v.w. wire ended, 1,800pF 1,000v.w. wire ended, 0.047mF 30v.w. P.C. type, all 3/- doz.

Thyristors. 400 P.I.V. at 5 amp. ideal for drill speed controls. 12/6 each.

TRANSISTORS. GT45B equiv. to OC45, OC71, etc. (BRAND NEW marked). 1/8 each, 12/- doz.

TRANSFORMERS. 250V a.c. input, 22 volts at 1 amp. output. 11/- post paid.

TAG STRIPS. 4½in long with 9 insulated tags and 2 earth tags. 4d. each, 3/- doz.

MIXED BAG. Silver mica and ceramic capacitors, approx. 150 items 10/- bag. Approx. 250 for 16/-.

5X33 SILICON DIODES. Unmarked 300 P.I.V. at ½ amp. tested 8d. each, 5/- doz.

ELECTROLYTICS. 32 + 32mF 250 v.w. 2/- each.

TRANSISTOR. Single tuned 470Kc/s I.F. transformers, 1/6 each, 4 for 5/-.

VALVE. 465Kc/s I.F. transformers ½sq., 1½in high, some 2in high, 2/- each.

HUNTS. 25mF, 350v.w. ½ x 1½in, brand new, wire ended, 6d. each, 4/- doz.

TELEVISION mains dropper resistors—send for list. 12.7 Mc/s and 13.125 Mc/s HC6/U xtals. tested, ex-equipment, 4/6 each.

ALL ITEMS PLUS 1/6 POSTAGE UNLESS STATED. MAIL ORDER ONLY
S.A.E. FOR LISTS

A. J. H. ELECTRONICS
59 WAYERLEY ROAD, THE KENT
RUGBY, WARWICKSHIRE
RUGBY 71066

RADIO TECHNICIANS

A number of suitably qualified candidates are required for unestablished posts, leading to permanent and pensionable employment (in Cheltenham and other parts of the UK, including London). There are also opportunities for service abroad.

Applicants must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to such candidates who can also offer "O" Level GCE passes in English Language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications. A knowledge of electro-mechanical equipment will be an advantage.

Salary. Scale is from £915 at 19 to £1,189 at 25 (highest pay on entry) rising to £1,372. (These scales are being further increased at I.I.70). Posts are unestablished, but opportunities exist for establishment and also advancement to higher grades up to £2,145 with a few posts carrying still higher salaries.

Annual Leave allowance of 3 weeks 3 days rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:

Recruitment Officer (RT/54)
Government Communications Headquarters
Oakley, Priors Road
Cheltenham, Glos. GL52 5AJ

TECHNICAL TRAINING by ICS IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the ICS trained man. Let ICS train YOU for a well-paid post in this expanding field.

ICS courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

- * C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.
- * C. & G. ELECTRONIC SERVICING.
- * R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.
- * RADIO AMATEURS' EXAMINATION.
- * P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.

Examination Students Coached until Successful.

NEW SELF-BUILD RADIO AND ELECTRONIC COURSES

Build your own 5-valve receiver, transistor portable, signal generator, multi-meter and valve volt meter—all under expert guidance.

POST THIS COUPON TODAY and find out how ICS can help YOU in your career. Full details of ICS courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES

**INTERNATIONAL
CORRESPONDENCE
SCHOOLS**

**A WHOLE WORLD
OF KNOWLEDGE
AWAITS YOU !**

International Correspondence Schools
(Dept. 152), Intertext House, Stewart Road,
London, S.W.8.

NAME
Block Capitals Please

ADDRESS

8/69

RECEIVERS AND COMPONENTS
(continued)

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

VALVES BOXED, TESTED & GUARANTEED

BF80	3/-	PCC84	3/-	PY81	3/6
EBF89	3/6	PCF80	5/-	PY82	3/-
ECC82	3/-	PCF82	3/6	UI91	4/6
ECL80	3/-	PCL82	4/-	6F23	5/-
EF80	1/6	PCL83	4/-	30F5	2/6
EF85	3/-	PL36	5/-	30L15	5/-
EY86	4/-	PL81	4/-	30P12	4/6
EZ40	4/6	PL83	4/-	30C15	5/-
EB41	4/6	PY33	5/-	50CD6G	7/6

Transistor Audio Pack, 2G339A, 2G381A, 2G371B
10/- each post 6d.

POST, ONE VALVE 9d. TWO TO SIX 6d.
OVER SIX POST PAID.

TRANSISTORISED REVERBERATION

Six transistor circuit, all components £7.10.0, post free. (Case 34/- extra, P. & P. 2/6). Circuit and construction details 1/- (free with kit).

TRANSISTORISED SIGNAL INJECTOR 19/6 P. & P. 1/6. Catalogue of components etc. 1/- Wilsc Electronics Ltd, 6 Copley Road, Doncaster, Yorks.

TRANSISTOR PANELS

INTEGRATED CCT'S TAKEN FROM PANELS
A - Quad 2 I/P Gate 5/- With Circuit
B - Dual 4 I/P Gate 5/- and Pin
C - Dual 2 Level Gate 5/- Connections
D - Dual "D" Flip Flop 5/-
F - Single I/P Gate 5/- Post Paid

EX GOVMT. RECEIVER R.209 covering 1-20 mcs 12V D.C. Input £12.10.0 Post Paid (Tested).

50 VARIOUS TRANSISTORS on Panels 15/- Post Paid.

20-OC45	£1
20-OC76	£1
40-TK28c	£1

COMPUTER PANELS with 40 sil. pnp or npn transistors, Diodes and res., 22/6 Post Paid.

COMPUTER PANELS WITH SEMI-CONDUCTORS. Postage 6d per panel

8-OC42 or GET875 + 24-OA81	7/6
24-A1678 (V405A) 550 mcs PNP + 22 Diodes	15/-
4-OC170 + 2-OC139 + 2-OC42	7/6
9-ASZ20 + 1-T2040 + 27 Diodes	7/6
4-OC42 + 6-GET875 + Diodes	7/6
2-OC170 + 1-T20306 + OC42	4/-
5-OC23 + 15-OA10	25/-
10-2N388 + 2-OC403 + 2-T2040	8/6
8-ASZ20 + 80 Diodes	7/6
6-ASZ21 + 15-OA91	6/-
9-5B240 + 18-OA47	10/-
12-2G106 + 24 Diodes	9/6
8-OC72 + 8-OA10	10/-
6-2N388	7/6
8-OC76 + 8-OA10	7/6
12-2N388	10/-
12-A1678 (V405A) 550 mcs PNP + 22 Diodes	10/-
36-OA5	6/-
6-GET872 + 8-OA10	5/-
4-OC42	3/-
12-ASZ20 + 80 Diodes	9/6
4-GET872 + 8-OA10	3 for 12/-
4-2G106 + 1-2N2410	4/-
2-OC42 + 8-OA47	3/-
2-GET872 + 4-OA10 + RF Chokes 3 for 10/-	
24-Sil. h.f. Transistors	15/-
3-GET871 + 3-GET841, ETC.	22/6
3-OC23 + 6-OA10 + 2-OA5	10/-

TEST CARDS. 6 transistors 20 for 20/-
ELECTROLYTICS 25,000 @ 12V, 16,000 @ 12V, 15,000 @ 10V, 10,000 @ 30V, 4,000 @ 60V, 3,000 @ 80V, 2,000 @ 50V, 1,200 @ 180V, 8/6 Post Paid.

ZENER DIODES -2,4, 2.7, 3.6, 4.75, 5.25, 5.75, 6.2, 6.8, 7.5, 13, 15, 16, 18, 20, 27, 30, 33 volts. 3/6 each, mostly 1 watt

POLYSTYRENE CAPACITORS. 125V, 18, 22, 120, 220, 270, 330, 390, 560, 820, 1,000, 1,200, 1,800, 2,200, 2,700, 3,300, 3,900, 4,700, 5,600, 6,800, 8,200, 0.01, 0.012, 0.015, 2/6 doz. Post/Packing, 1/-.

BRAND NEW BOXED CHASSIS containing 2-OC35, 2-OC29 12 WW resistors 23/-, Postage 1/6

NEW CROSS RADIO
6 OLDHAM ROAD, MANCHESTER 4

RECEIVERS AND COMPONENTS
(continued)

TAPE HEADS

BSR BRAD. 39/6 pair	REUSER - COLLARO ERASE	15/-
2-TRACK	4-TRACK	15/-
BSR MARR. 39/6 pair	BOGEN ERASE	27/6
4-TRACK	UL218/6	27/6
MICHIGAN REC./PLAY	HOWEORD ERASE	15/-
MED. IMP. 37/6	T.E. 2/3	15/-
4-TRACK	4-TRACK	15/-

TRANSISTORISED FM TUNER
6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in x 4in x 2in 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108Mc/s. Ready built ready for £6.7.0 use. Fantastic value for money

SUB-MIN. TRANSISTOR LWMW/FM TUNER
Similar to above. Complete with aerial, tuners, dial and instructions £14

TUNER DULCI FM7S STEREO £23

COMPACT TRANSISTOR FM TUNER
Oiled Walnut cabinet, brushed gold front panel, vertical styling, internal batteries £9.19.6

FM MULTIPLEX STEREO ADAPTOR
Printed circuit biscuit, 4 trans. 6 diodes 9V with full instructions £4.19.6

LOUDSPEAKERS

12" TWIN COME 10 watt PEAK 15 ohm	12" 25 watt, 15 ohm, GUITAR SPEAKER	35/-
10" 10 watt, 15 ohm, CERAMIC	2" 40 ohm	6/6
MAGNET	21" 80 ohm	6/6
CABINET Teak 23 1/2 x 13 1/2 x 9 1/2, contemp. 12" legs for Tape Recorder and Tuner or Amplifier, etc.		99/6

RELAYS 14 x 11 x 7, 700 ohm 9-24V, 185 ohm 6-12V, 430 ohm 6-18V 10/-

TWEETER 3" 16 ohm, 10W CR.0.3kΩ, Horn type Hi-Fi 18,000 c/s 25/-

CROSSOVER NETWORK 3kcs, 16 or 3 ohm 14/-

MULTIMETERS from 32/-

CHARGER TRANSFORMER 21/6
4 Atmp. 3/- P/P
2/6/12 volt

SUPER SILICON RECT. T.V., etc., 1,200 PIV 800mA, 5/-; or complete with instr. resistor, condenser, 6/6; 400 PIV HW 6A, 6/-; 200 PIV HW 6A, 6/- BY100 type, 6 for 10/-.

Jumper lead 6". Croc clips to Phono plug and Std. Jack Adaptor 7/6

TRANSISTORS
2N3638A 5/-, 2N3643 5/6, AC138 5/-, AC141 5/-, ACY20 3/8, ACY21 4/-, AD140 5/-, AF178 11/8, AF186 10/-, BC108 3/-, BC109 3/-, BCY63 4/6, BF181 7/-, NK1213 5/6, NKY226 5/6, OA91 1/8, OAZ270 3/6, OC35 5/-, OC45 2/-, OC81D 2/8, OC82 4/-, OC200 3/8, GET103-113-118-119-887-889-890-896-7-8 3/-

CHANGER DECKS
UA25 BSR with template, Mono. List £6.19.6
UA25 BSR with template, Stereo. List £7.9.6
1025 Garrard with template, Mono. List £7.7.6
1025 Garrard with template, Stereo. List £7.7.6

PLINTH in simulated teak. Complete with Clearview rigid perspex cover for 1025. P/P on Decks or Plinth and Cover 7/6

SWITCH ROTARY RECIPROCATING 4 Position, 15amp. Single hole fixing, with instructions. List 14/7 5/6
C60 CASSETTE 10/2, C90 14/3. 3 Post free

Stamped envelope for full selection and bargain offers in MULTIMETERS, RADIOS, BABY ALARMS, INTERCOMS, WALKIE-TALKIES, RECTIFIERS, SINCLAIR, DULCI AND EAGLE Lints. UNDER 21-P. P. 6d., £1 to £3-1/6, over £3-2/6. C.O.D. 3/6. MAIL ORDER ONLY.

DURHAM SUPPLIES
367 KENSINGTON STREET
BRADFORD 8, YORKSHIRE

INTEGRATED CIRCUITS at lowest price. GE Type PA234 1 Watt Audio Amplifier. Few only at 17/8 each inc. data P. & P. C.W.O. JEF ELECTRONICS, 12 York Drive, Grappenhall, Warrington, Lancs. Mail order only.

COMPONENTS

Samples from our catalogue:— Gearing motors 300rpm-1r/24H from 7/6, 15V, 300mW. Zeners 3/-, 10K + 10K 2% 3' ganged pots 20/-, 220 ohm 200 watt resistors 7/6, 6d. stamp for catalogue.

F. HOLFORD & CO.
6 Imperial Square, Cheltenham

RECEIVERS AND COMPONENTS
(continued)

BRAND NEW MINIATURE ELECTROLYTICS, 15/16 volt, 0.5-200mfds. 8/- dozen, 1/2 watt 5% carbon film resistors, 10 ohms-1 megohm 1/6 dozen. Minimum order 7/6 postage 1/- The C.R. SUPPLY CO., 127 Chesterfield Rd., Sheffield, S8 0RN.

NEW VHF KIT

Receives Television Sound, Ambulances, Aircraft, Radio 2, 3 and 4 on VHF, etc.

This novel little set will give you endless hours of pleasure and can be built in one evening. The Kit comes with easy to follow instructions and circuit. Powered by 9v Battery. Complete with built in Jack Plug Socket for use with Earphones or Amplifier.

ONLY 57/- P. & P. FREE U.K. ONLY

Postal Orders, Cheques to Dept. P.E.1

Galleon Trading Co., 298A Lodge Lane, Romford, Essex

WE ARE BREAKING UP COMPUTERS

EX COMPUTER PRINTED CIRCUIT PANELS 2in x 4in packed with semi-conductors and top quality resistors, capacitors, diodes, etc. Our price, 10 boards 10/- P. & P. 2/-. With a guaranteed minimum of 35 transistors.

SPECIAL BARGAIN PACK. 25 boards for £1. P. & P. 3/6. With a guaranteed minimum of 85 transistors, 100 boards 65/- P. & P. 7/6. With a guaranteed minimum of 350 transistors.

GIANT PANELS. 5in x 4in, min. 20 transistors, 9 x 56 µH inductors, resistors, diodes, etc. 3 for £1. P. & P. 2/.

PANELS with 2 power transistors sim. to OC28 on each board + components. 2 boards (4 x OC28) 10/- P. & P. 2/.

TRIM POTS. On 2in x 4in boards + Ta caps and other components. 100Ω, 500Ω, 15K, 20K. State requirements. 5 boards 10/- P. & P. 2/-.

NPN GERMANIUM TO5 1 WATT POWER TRANSISTORS. On small heat sink, on 2in x 4in panel. 5 for 10/- P. & P. 2/-.

POWER TRANSISTORS. Sim. to 2N174 ex-eqpt. On Finned Heat Sink (10D). 4 for £1 P. & P. 5/-.

DIODES. Ex eqpt. Silicon, 150 PIV, 10 amp. 4 for 10/- 150 PIV, 20 amp. 4 for £1. Post free.

OVERLOAD CUT OUTS. Panel mounting in the following values... 5/- each. 2, 3, 4, 10 amp. P. & P. 1/-.

MINIATURE GLASS NEONS, 12/6 doz. P. & P. 1/-.

PAPST FANS. Powerful Extractor/Blower fans. 230/250V. 100 c.f.m., 2,800 r.p.m. 35/- + 5/6 P. & P. each.

MICRO SWITCHES. Miniature button type. 10/- doz. P. & P. 1/6.

TOGGLE SWITCHES LONG ARM. Ex-eqpt. SPST 13/6 doz., DPST 15/- doz., DPDT 22/6 doz. P. & P. all types 2/- doz.

NEW SPRAGUE. 0.22µF 250V small capacitors. 5/- doz. P. & P. 1/-.

NEW SPRAGUE ELECTROLYTICS. 4µF 150V. 5/- doz. P. & P. 1/-.

LARGE CAPACITY ELECTROLYTICS. 4in, 2in diam. 5screw terminals. 7/6 post free.
4,000mF 72V d.c. wkg.
10,000mF 25V d.c. wkg.
25,000mF 12V d.c. wkg.

KEYTRONICS, 52 Earls Court Road London, W.8. Mail order only

ORGAN BUILDERS: 282, 2-2k-1-2d, 28/-; 170, 18k-1-2d, 17/-; 92, 100k-1-2d, 9/-; 253 4700pf. encap. polystyrene-11d, 232/-; 72, 0.1uf polyester-5-5d, 33/-; 12 Vinkors (LA2300)-7/-, 84/- Available separately or 390/- lot. All Mullard. L.E.C., 304 Avery Hill Road, London, S.E.9. Postage, Packing 2/6.

ELECTRICAL

**GRAND CLEARANCE SALE
EVERYTHING MUST GO**

PRECISION METERS. Brand new and boxed, size 3 1/2 in sq. Type 1, 0-500V FSD. Type 2, 0-150mA. Fully guaranteed. Moving coil movement. List £3.5. Our price 30/- each, p.p. 2/6. Two for 55/-, post free.

TANK AERIALS. Fully interlocking copper plated, one foot sections. Ideal for scooter aerials or for TX/RX work. Six sections 4/6, p.p. 1/6. 12 sections for 10/-, post free.

RADIATION METERS. Pocket type. Brand new in maker's cartons. Only 9/6 each, p.p. 1/6. Two for 17/6, post free.

STANDARD DESK TELEPHONES. Not new but working. Only 19/6 each, p.p. 5/-. Two for 35/-, carr. 5/-.

TELEPHONE DIALS. Only 6/- each. Four for £1, post free.

TELEPHONE EXCHANGES. PMBX TYPE. Ex-GPO, in good condition and ready to use. Cord type, £12.10, carr. 50/-. Cordless type £15, carr. 15/-.

SMOOTHING UNITS. Excellently made pieces of equipment. 12V or 24V d.c. input gives a fully smoothed, fully regulated d.c. output. Robust metal case. Brand new in maker's cartons. Price 55/-, p.p. 5/-.

MINIATURE 1 1/2 in moving coil speakers. Only 3/6 each, p.p. 1/- 36/- per doz., post free.

HEAVY DUTY POWER SUPPLY UNITS. Famous manufacture. Input 200/250V 50 cycles a.c. Output 250V d.c. at 175mA, 6-3V/12V at 4 amps. Robust rack mounting cabinet. List £42, brand new and boxed, 59/6, carr. 10/-.

TANNOY MIKES (heavy duty). Ideal for P.A. work. Complete with high quality moving coil headphones. Only 19/6 each, p.p. 5/-.

MONSTER CONSTRUCTORS' PARCEL. Two 1 1/2 in dia. moving coil speakers. One 12V heavy duty DPDT switching relay. Up to 20 amp switching plus many low current contacts. Twelve wire wound resistors. One brand new parachute complete with full cords. Over 100 sq. ft of silky material. One 5ft whip aerial. Twelve electrolytic condensers. Twelve small plastic boxes suitable for containing your transistorised units. One telephone dial. One miniature 10 henry 60mA smoothing choke. All for 35/-, carr. 5/-.

PRINTED CIRCUIT TOP BAND SUPERHET CHASSIS. Uses standard components. Complete with circuit. Only 15/-, post free.

0-3-30V TRANSFORMERS. Mains input. Output at 4 amps. Only 9/6 each, p.p. 2/6. Two for £1, post free. Fully guaranteed.

MINIATURISED TRANSISTORISED BFO UNIT. A miniature tunable B.F.O. unit that will enable your set to receive CW or SSB. Compact single hole fixing. This unit will fit anywhere. Ideal for all Ex-Govt. Communication and Commercial Receivers. Complete with fitting instructions. Only 30/6, p.p. 2/6.

GLOBE SCIENTIFIC LTD
DEPT. P.E.36, BRIDGEND, MERES 1

**240 VOLT
ELECTRICITY
ANYWHERE**



BEST EVER 200/240 VOLT "MAINS" SUPPLY FROM 12VOLT CAR BATTERY
Exclusive World Scoop Purchase. The fabulous Mk.2D American Heavy Duty Dynamotor Unit with a Massive 210 watt output and giving the most Brilliant 200/240 volt performance of all time. Marvellous for Television, Drills, Power Tools, Mains Lighting, AC Fluorescent Lighting and all 200/240 volt Universal AC/DC mains equipment. Made at tremendous cost for U.S.A. Govt. by Delco-Remy. This magnificent machine is unobtainable elsewhere. Brand New and Fully Tested. Only £4.19.6 + 10/6 postage. C.O.D. with pleasure, refund guarantee. Please send S.A.E. for illustrated details.
Dept. PE, STANFORD ELECTRONICS
Rear Derby Road, North Promenade
BLACKPOOL, Lancashire

BATTERY ELIMINATORS

The ideal way of running your TRANSISTOR RADIO RECORD PLAYER, TAPE RECORDER, AMPLIFIER, etc. Types available: 6v, 9v, 12v, 18v (single output) 39/6 each. P. & P. 2/9. 9v + 9v; 6v + 6v; or 4 1/2v + 4 1/2v (two separate outputs) 42/6 each. P. & P. 2/9. (Please state output required. All the above units are completely isolated from mains by double wound transformer ensuring 100% safety.)
R.C.S. PRODUCTS (RADIO) LTD.
(Dept. P.E.), 31 Oliver Road, London, E.17

GLASS FIBRE OPTIC

FLEXIBLE LIGHT FIBRE now available in any length. 150 + glass fibres in 0.080 in. diam. P.V.C. sheath with 3 times lower loss than plastic fibre.
Used like wire but to convey light to remote or inaccessible positions for inspection, panel indicators, photo-electric and other applications. Prices per ft. (Post free) 1-9, 5/-; 10-49, 4/-; 50-249, 3/-.
Enquiries S.A.E.

SYSTEM 696 & CO.
15 BELL RD., EAST MOLESEY, SURREY

**Buy with confidence and get results.
Refund if not delighted.**

RHYTHM GENERATOR. 29 silicon transistors and 119 diodes. Finger tip selection of seven instruments in nine basic rhythms in any sequence. Self contained in an attractive case 14 x 13 x 7 1/2 in. Retail at over £74. Our price only £44.9.6. + 10/6 P. & P. + Ins. S.A.E. for illustrated leaflet.

REVERBERATION AMPLIFIER. Self contained transistorised battery operated. An entirely different approach to sound reproduction. Normally sound reproduction from a single course has a flat one dimensional effect. With this, proper sound delay through reverberation, tones are created with a truly third dimension for concert hall originality. Two controls adjust volume and reverberation. Simply plug microphone, guitar, etc. in and the output into your amplifier. Supplied in a beautiful walnut cabinet 7 1/2 x 3 x 4 1/2 in. £10.4.0. P. & P. + Ins. 6/-.

POWER CONTROLLER. Power at your finger tips. Not just half wave control but full wave. One variable control gives zero to full power. Uses latest 15amp 3kw triac and special triggering device. Complete with box, power socket, etc. Ideal for flood lights, fires motors, etc. In kit form £6.9.6., ready built £9.4.6. + 5/6 P. & P.

VOX SWITCH KIT. This sound operated switch is ideal for mobile T.X. work tape recorder switching, etc. etc. you speak it switches. High & med. imp. inputs. A.F. take off point. Drives your 12 volt relay. 42/6, P. & P. 2/6.

METRONOME KIT. Variable beat, listen whilst you play and keep in the groove. Easy to build, pocket size with personal mini earphone. 25/- P. & P. 2/6.

MORSE OSCILLATOR KIT. P.C. board, transistors, high stab. components battery carrier, ear piece. Adj. tone. Just attach your key. Drives phones or speaker. 15/6. P. & P. 2/-.

Free lists with every order. For lists only send 1/- P.O. (deductable from first order).

AUDIO EFFECTS
5 SHAW LANE, HALIFAX

NEW RANGE BBC 2 AERIALS

All U.H.F. aerials now fitted with tilting bracket and 4 element grid reflectors.

Loft Mounting Arrays, 7 element, 37/6. 11 element, 45/-. 14 element, 52/6. 18 element, 60/-. Wall Mounting with Cranked Arm, 7 element, 60/-. 11 element, 67/-. 14 element, 75/-. 18 element, 82/6. Mast Mounting with 2in. clamp, 7 element, 42/6; 11 element, 53/-. 14 element, 62/-. 18 element, 70/-. Chimney Mounting Arrays, Complete, 7 element, 72/6; 11 element, 80/-. 14 element, 87/6; 18 element, 95/-. Complete assembly instructions with every unit. Low Loss Cable, 1 1/8 in. U.H.F. Pre-amps from 75/-. State clearly channel number required on all orders.

BBC · ITV AERIALS



BBC (Band 1). Telescopic loft, 25/-. External S/D, 30/-. "H", 22-15.8.

ITV (Band 2). 3 element loft array, 30/-. 5 element, 40/-. 7 element, 50/-. Wall mounting, 3 element, 47/6. 5 element, 52/6.

Combined BBC/ITV. Loft 1+3, 40/-; 1+5, 50/-; 1-7, 60/-; Wall mounting 1+3, 57/6; 1+5, 67/6; Chimney 1+3, 67/6; 1+5, 75/-.
VHF transistor pre-amps, 75/-.

COMBINED BBC1-ITV-BBC2 AERIALS
1+3+9, 70/-; 1+5+9, 80/-; 1+5+14, 90/-; 1+7+14, 100/-. Loft mounting only. Special leaflet available.

F.M. (Band 2). Loft S/D, 15/-; "H", 22/6. 3 element, 55/- External units available. Co-ax cable, 8d. yd. Co-ax plugs, 1/4. Outlet boxes, 5/-; Diplexer Crossover Boxes, 18/6. C.W.O. or C.O.D. P. & P. 6/-. Send 6d. stamps for illustrated lists.

CALLERS WELCOME

OPEN ALL DAY SATURDAY

K.V.A. ELECTRONICS (Dept. P.E.)
40-41 Monarch Parade
London Road, Mitcham, Surrey
01-648 4884

CRESCENT RADIO LTD.

(electronic component specialists)

For all regular components try
40 Mayes Road, Wood Green, N.22
For surplus components and equipment try
11 Mayes Road, Wood Green, N.22

COMPONENT BARGAINS

500K Ω Log Pots with Good Spindles	1/6 each
10MFD 6 volt Miniature Type	8/- per doz
68 Ω W/W 5 watt Resistors	9/- per doz
Carpenter Polarized Relay No. 4H4(z)MK2	10/- each
5K Ω D.P. Transistor Pot	2/6 each
8MFD 3 volt Miniature Type	4/6 per doz
047MFD 160 volt Mullard Type	4/6 per doz
Varley Relay VP/2 700 Ω	6/- each
OC19 Power Transistor	5/- each
Pack of 50 Unmarked, Untested Transistors	10/6 per pack
16MFD 275V Small Type Capacitors	1/- each
500MFD 6 volt Transistor Capacitors	10d each
1 inch Spun Aluminium Standard Spindle Knob	2/6 each
2 1/2 inch 25 Ω Loudspeaker	5/6 each
2 1/2 inch 80 Ω Loudspeaker	5/6 each
100MFD 6 volt Miniature Type	9d each
4 Way Standard Connecting Blocks	6d. each
047 750 volt Capacitors	3/6 per doz

MODEL MOTORS
Small Motors for the Model Maker, etc.
12 volt 9,000 RPM ... 2/1 each
3 volt 4,900 RPM ... 2/1 each

BARGAIN COMPUTER BOARDS
Assorted Components mounted on boards all with long tags. Ideal for breaking down and experimenting with. Take advantage of bulk purchase
1 Board ... 2/- each
20 Boards ... 20/-

PRINTED CIRCUIT BOARD
8 x 6 inch One Sided Board ... 2/- each
CASSETTES
All B.A.S.F. Types: C60 ... 13/6 each
C90 ... 19/6 each
C120 ... 25/- each

With our new premises in Mayes Road we can now offer an even wider selection of components for the home constructor and enthusiast.
POSTAGE WITH ORDER PLEASE; P.S.
Our new catalogue is now available at 1/6 per copy

S.E.S. YOUR COMPLETE SUPPLIER

196 Regent Road, SALFORD 5, Lancashire

TELEPHONE 061-872 5187

(Member of the Harrop Industrial Group)

C.W.O. please 1/- p. & p. for orders of components under £1
Orders of Lektrokkit: 2/- handling charge on orders under £1
5/- handling charge on orders under £5

RESISTORS: All brand new, Hi-Stab, low noise, 5% tol. carbon film. $\frac{1}{2}W$ E12 series 4-7 ohm to 10M, 2d. each or 15/- per 100 of one value. $\frac{1}{4}W$ E24 series 4-7 ohm to 10M, 2d. each or 15/- per 100 of one value. $\frac{1}{2}W$ E12 series 2-2 ohm to 3-9 ohm, 6d. each. $1W$ E12 series 10 ohm to 10M. (10% tol.), 3d. each. $3W$ —wirewound—0.5 ohm to 12 ohm, 1/6 each. $5W$ —wirewound—15 ohm to 82kohm, 1/9 each. **PRE-PACK** gives you 5 off each, 5% resistors from 4-7 ohm to 1M either $\frac{1}{2}$ or $\frac{1}{4}$ watt. 65 different values (E12)—**ONLY £12s. 6d.** ***NOW— $\frac{1}{2}W$ carbon film 5%, E12 series 10 ohm to 100kohm, 2d. each.

PRE-SETS: Min. skeleton carbon track, low noise with good stability; Values—Lin: 1k, 2.5k, 5k, etc., to 5M; Log: 5k, 10k, 25k, etc., to 1Mohm, only 10d. each. Sub-Min skeleton Lin. track: 1k, 2.5k, 5k, etc., to 5M, only 9d. each. Slider pre-sets wirewound $\frac{1}{2}W$ rating Lin: 10 ohm to 5k, 2/3 each. $3W$ wirewound fully enclosed Lin. tracks. 10 ohm to 30k, 3/9.

POTENTIOMETERS: Min. enclosed, carbon track and wiper contact only 2/6; Values—Lin: 1k, 2.5k, 5k, etc., to 10M; Log: 5k, 10k, 25k, etc., to 5Mohm. Min. with double-pole switch, insulated spindles only 5/6. Values—Lin: 25k, 50k, 100k; Log: 3k, 5k, 10k, 250k, 500k, 1M, 2M. $3W$ wirewound Lin. tracks 50 ohm to 100kohm 7/4 each.

CAPACITORS: New genuine Mullard Electrolytics

		(Min.)				(Small)				
6-4V	6-4	25	50	100	200	320	640	1,000	1,500	2,500
10V	4	16	32	64	125	200	400	640	1,000	1,600
16V	2.5	10	20	40	80	125	250	400	640	1,000
25V	1.6	6.4	12.5	24	50	80	160	250	400	640
40V	1	4	8	16	32	50	100	160	250	400
64V	0.64	2.5	5	10	20	32	64	100	160	250
Prices: 1/-					10d. each	1/3	1/4	1/6	1/9	2/6

		(Large)				(Multi-plates)				
25V	800	1,250	2,000	4,000	6,400	500V	8-8 μ F	6/6		
40V	500	800	1,250	2,500	4,000	500V	16-16 μ F	7/6		
64V	320	500	800	1,600	2,500	350V	32-32 μ F	7/3		
Prices:										
			6/6	8/-	12/6	15/-	35V	50-50 μ F	9/-	

(all values in Microfarads)

Mullard Miniature Metallised Polyester 250V. 0-01, 0-015, 0-022, 0-033, 0-047, 0-068 μ F, 6d. each. 0-1, 0-15, 0-22 μ F, 7d. each.
Mullard Polyester Film and Foil 400V. 0-001, 0-0015, 0-0022, 0-0033, 0-0047, 0-0068, etc., to 0-033 μ F, 6d. each. 0-047 to 0-1 μ F, 8d. each. 0-15 μ F, 10d. 0-22 μ F, 1/-, 0-33 μ F, 1/6, 0-47 μ F, 1/9.
Disc Ceramics (Erie) 500V, 1,000, 4,700pF, 5d. each. Silver Micas 1% tol. 500V, 2-2pF to 620pF, 1/- each. Polystyrene 160V, 100-1,000pF, 5d. each. ***NOW—Best Tantalum (polarised) 35V, 0-47, 0-68, 1 μ F, 2/6 each. 2-2, 3-3, 4-7, 6-8 μ F, 3/4 each. 20V 10 μ F, 15V 22 μ F, 10V 33 μ F, 6V 47 μ F, 3/9 each. Low Voltage Disc Ceramics 20V—0-01, 0-022, 0-047 μ F, 10d. each. 0-1, 0-22, 1/3 each. Midget Tubular Ceramics—0-002, 0-003 μ F, 10d. each.

SEMICONDUCTORS: All New and Unused
Mullard: OAS 4/6; OAB1 3/4; OA202 2/3; OCT1 4/-; OCT2 4/6; OC4 7/9; OC45 4/-; BC107, 109 3/9 each; BC108 3/6; BFY51 4/6; MPE 105 9/6; Silicon Rectifiers—(0-5A) 400piv 2/9; 800piv 3/-; 1,500 piv 3/6; (1-2A) 400piv 6/-; 800piv 7/-; 1,500piv 7/6; (2-5A) 400piv 6/6; 800piv 7/6; 1,500piv 10/6; (1-2A and 2-5A types are sized mounted—Anodes). ***NOW—2N2924 1/6; 2N2926 (brown or Red) 2/6, (Orange) 2/9, (Yellow) 3/-, (Green) 3/3; 2N3643 8/6; 2N379, 2N4289 4/- each; 1N4148 1/6.

SWITCHES: 100 series—SPST 3/8; SPDT 3/11; DPST 4/6; DPDT 4/8. 400 series SPST 3/2; SPDT 3/6; DPST (with center position) 3/8. Series 500—push-to-make or push-to-break 3/11 each (push buttons available in white, red, black, green). Slide Switch 3/4; Wave Change switches 5/9 each. Miniature "Maka-Switch" also available—Shafts 5/-; Wafers 5/4 each.

PLUGS AND SOCKETS: Min. Plugs (black or red) 6d. Min. Sockets to fit 7d. Banana Plugs (black or red) 9d. 4mm Sockets to fit (black, red, green) 9d. Co-Ax Plugs 1/2. Co-Ax Sockets 1/4. Sub-Min Jack Plugs and Sockets 2/- each. Min. Jack Plugs and Sockets 3/- each. Recorder Plugs 3-way 2/7 5-way 3/-, Recorder Sockets 3-way 1/2, 5-way 1/4.

WIRE: Min. Stranded (available in 10 colours) 3d. yd. Solid Core 3d. yd. 14/0-0076in. Stranded 4d. yd. Min. Mains Lead 1/3 yd. Min. Microphone cable 1/6 yd. Co-Ax cable 1/3 yd.

LAMPS: Min. Wire Ended Neons 2/-; Panel Neon Indicator 6/4; Pilot Light + 12V bulb 8/-; Min. Flange Light + 12V bulb 11/-.

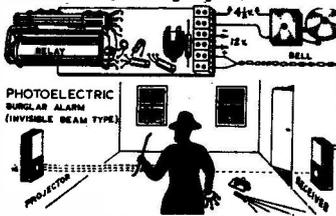
SOLDERING IRONS: A.N.T.E.X. CN240 ISW mains operated, small, 32/6. E240 20W mains operated, specially shaped handle, 35/-. Spare bits and elements available. Also stands for above irons, 11/6 each. ***NOW—SOLDER by Multicore—at Reduced Prices to Everyone! Size A—Approx. 20ft coil 60/40 Alloy 22 s.w.g. in dispenser. Recommended retail price 3/-. **OUR PRICE 2/9.** Size B—Approx. 200ft reel 60/40 Alloy 22 s.w.g. individually packed. Recommended retail price 15/-. **OUR PRICE 12/6.** B1B Wire Strippers: strips insulation without nicking wire. Recommended retail price 4/6, **OUR PRICE 4/-.**

LEKTROKIT: Chassis construction system—the professional look to a home construction. Parts to build a chassis 8 $\frac{1}{2}$ x 4 $\frac{1}{2}$ in.—2 chassis rails 1/10 each. 2 side plates 4/4 each. Front panel (covered in crack-proof paint) 8/3. Perforated cover 5/5. 2 plain covers 4/5 each. 4 rubber feet 9d. 7 boards available each 4 $\frac{1}{2}$ x 4in.—Thus 2 boards fit above chassis. Plain perforated aluminium board 2/2. Aluminium board drilled for 6 valveholders 8/7G. B8A, B9A, 3/6. Aluminium board drilled for 2 valveholders international octal, UX4, etc., 2/4. 0-1in. perforated grid SRBP board, 2/9. Veroboard 0-1in. and 0-2in. 6/6 each. Cloverleaf aluminium board 6/- (Cloverleaf lead throughs 6d. each. Pins for SRBP board 4/6 100).

For full details of all our stocks send 3/6 for our bright explanatory 120 page catalogue, or 6d. stamp for Data Sheets.

PHOTOELECTRIC KIT

CONTENTS: 2 P.C. Chassis Boards, Chemicals, Etching Manual, Infra-Red Photo-transistor, Latching Relay, 3 Transistors, Condensers, Resistors, Gain Control, Terminal Block, Wiegand Case, Screws, etc. In fact everything you need to build a Steady-Light Photo-Switch/Counter/Burglar Alarm, etc. (Project No. 1) which can be modified for modulated-light operation.



PHOTOELECTRIC KIT 39/6

Postage and Pack. 2/6 (UK)
Commonwealth:
SURFACE MAIL 2/6
AIR MAIL £1.0.0
Australia, New Zealand
S. Africa, Canada and U.S.A.
Also Essential Data Circuits
and Plans for Building
10 Advanced Designs

INVISIBLE BEAM OPTICAL KIT

Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photoelectric Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.
CONTENTS: 3 lenses, 2 mirrors, 2 45-degree wooden blocks, Infra-red filter, projector lamp holder, building plans, performance data, etc. Price 19/8. Postage and Pack. 1/6 (U.K.). Commonwealth: Surface Mail 2/-; Air Mail 8/-.

LONG RANGE INVISIBLE BEAM OPTICAL KIT

CONTENTS: As above. Twice the range of standard kit. Larger Lenses, Filter, etc. Price 29/8. Postage and Pack. 1/6 (U.K.). Commonwealth: Surface Mail 2/6. Air Mail 10/-.

JUNIOR PHOTOELECTRIC KIT

Versatile Invisible-beam, Relay-less, Steady-light Photo-Switch, Burglar Alarm, Door Opener, Counter, etc., for the Experimenter.
CONTENTS: Infra-Red Sensitive Phototransistor, 3 Transistors, Chassis, Plastic Case, Resistors, Screws, etc. Full Size Plans, Instructions, Data Sheet "10 Advanced Photoelectric Designs".
Price 19/8. Postage and Pack. 1/6 (U.K.). Commonwealth 2/-; Air Mail 4/-.

JUNIOR OPTICAL KIT

CONTENTS: 2 Lenses, Infra-red Filter, Lampholder, Bracket, Plans, etc. Everything (except plywood) to build a miniature invisible beam projector and photocell receiver for use with Junior Photoelectric Kit.
Price 19/8. Post and Pack. 1/6 (U.K.). Commonwealth: Surface Mail 2/-; Air Mail 4/-.

YORK ELECTRICS

333 YORK ROAD, LONDON, S.W.11

Send a S.A.E. for full details, a brief description and Photographs of all Kits and all 52 Radio, Electronic and Photoelectric Projects Assembled.

YUKAN SO PROFESSIONAL THE SELF-SPRAY YUKAN AEROSOL WAY—

Get these air drying GREY HAMMER NOW! OR BLACK WRINKLE (CRACKLE) finishes

Yukan Aerosol spraykit contains 16 ozs. fine quality, durable easy instant spray. No stove baking required. Hammers available in grey, blue, gold, bronze. Modern Eggshell Black Wrinkle (Crackle) all at 15/11 at our counter or 18/11, carriage paid, per push-button self-spray can. Also Durable, heat and water resistant Black Matt finish (12 ozs. self-spray cans only) 13/11 carriage paid.
SPECIAL OFFER: I can plus optional transferable snap-on trigger handle (value 5/-) for 18/11, carriage paid. Choice of 13 self-spray plain colours and primer (Motor car quality) also available.

Other Yukan Air Drying Aerosols. 16 ozs. at 16/11 corr. paid include: Zinc Chromate Clear Lacquer. Metallics: Grey, Blue, Bronze and Gold.

Please enclose cheque or crossed P.O. for total amount direct to.

DEPT: K/5 YUKAN, 307A, EDGWARE ROAD, LONDON, W.2.

We supply many Government Departments, Municipal Authorities, Institutes and Leading Industrial Organisations—We can supply you too.

Open all day Saturday. Closed Thursday afternoons.

12in. "SUPERB" £15

The exceptional quality and performance of the "Superb" brings truly exceptional sound from a single loudspeaker, recreating the musical spectrum virtually flat \pm 5db. 20 to 17,000 c.p.s. The unit consists of the latest double cone, woofer and tweeter cone together with massive Baker "FERROBA" magnet assembly having a flux density of 16,500 gauss and a total flux of 176,000 Maxwells. Bass resonance 22-26 c.p.s. Rated 20 watts. Voice coils available 8 or 15 ohms. Suitable for all High Fidelity Systems. A high quality loudspeaker providing clear reproduction of the deepest bass and highest treble.



Further details and 48 page Enclosure Manual 5/9 post paid. Baker Reproducers Ltd. Bensham Manor Road Passage, Thornton Heath, Surrey. 01-684-1665

VALUABLE NEW HANDBOOK FREE TO AMBITIOUS ENGINEERS

Have you had your copy of "Engineering Opportunities"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

On 'SATISFACTION OR REFUND OF FEE' terms

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

WHICH OF THESE IS YOUR PET SUBJECT?

ELECTRONIC ENG.

Advanced Electronic Eng.—
Gen. Electronic Eng.—
Applied Electronics—
Practical Electronics—
Radar Tech.—
Frequency Modulation—
Transistors.

ELECTRICAL ENG.

Advanced Electrical Eng.—
General Electrical Eng.—
Installations—
Draughtsmanship—
Illuminating Eng.—
Refrigeration—
Elem. Elec. Science—
Elec. Supply—
Mining Elec. Eng.

CIVIL ENG.

Advanced Civil Eng.—
General Civil Eng.—
Municipal Eng.—
Structural Eng.—
Sanitary Eng.—
Road Eng.—
Hydraulics—
Mining—
Water Supply—
Petrol Tech.

RADIO & T.V. ENG.

Advanced Radio—
General Radio—
Radio & TV Servicing—
TV Engineering—
Telecommunications—
Sound Recording—
Automation—
Practical Radio—
Radio Amateurs' Examination.

MECHANICAL ENG.

Advanced Mechanical Eng.—
Gen. Mech. Eng.—
Maintenance Eng.—
Diesel Eng.—
Press Tool Design—
Sheet Metal Work—
Welding Eng.—
Pattern Making—
Inspection—
Draughtsmanship—
Metallurgy—
Production Eng.

AUTOMOBILE ENG.

Advanced Automobile Eng.—
General Auto. Eng.—
Auto. Maintenance—
Repair—
Auto. Diesel Maintenance—
Auto. Electrical Equipment—
Garage Management.

WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT, INSTRUMENT TECHNOLOGY, WORKS STUDY, MATHEMATICS, ETC.

Which qualification would increase your earning power?
A.M.I.E.R.E., B.Sc.(Eng.), A.M.S.E., A.M.I.P.E., A.M.I.M.I., A.R.I.B.A.,
A.I.O.B., A.M.I.Ex., A.R.I.C.S., M.R.S.H., A.M.I.E.D., A.M.I.Mun.E., C.ENG.,
CITY & GUILDS, GEN. CERT. OF EDUCATION, ETC.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
316A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE

THIS BOOK TELLS YOU

- ★ HOW to get a better paid, more interesting job.
- ★ HOW to qualify for rapid promotion.
- ★ HOW to put some letters after your name and become a key man . . . quickly and easily.
- ★ HOW to benefit from our free Advisory and Appointments Depts.
- ★ HOW you can take advantage of the chances you are now missing.
- ★ HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.

164 PAGES OF EXPERT
CAREER - GUIDANCE

PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Electronics, Radio, T.V., Etc., A.M.I.E.R.E. City & Guilds Radio Amateurs' Exam. R.T.E.B. Certificate P.M.G. Certificate Practical Electronics Engineering Practical Radio Radio & Television Servicing Automation

INCLUDING TOOLS

The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.

B.I.E.T.

You are bound to benefit from reading "ENGINEERING OPPORTUNITIES"—send for your copy now—FREE and without obligation.



POST COUPON NOW!

TO B.I.E.T., 316A ALDERMASTON COURT,
ALDERMASTON, BERKSHIRE.

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).

NAME

ADDRESS

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD

ENGLANDS LEADING COMPONENT & EQUIPMENT CENTRES

SOLID STATE—HIGH FIDELITY AUDIO EQUIPMENT

Mono or Stereo Audio, Equipment developed from Dinsdale Mk.II—each unit or system will compare favourably with other professional equipment selling at much higher prices.

COMPLETE SYSTEMS FROM £15.5.0

THE FINEST VALUE IN HIGH FIDELITY—CHOOSE A SYSTEM TO SUIT YOUR NEEDS AND SAVE POUNDS

All units available separately

SEND FOR FREE BROCHURE (No. 21) TODAY! DEMONSTRATIONS DAILY AT '303' EDGWARE ROAD



ELECTRONIC ORGANS KITS TO BUILD YOURSELF AND COMPLETE UNITS

The MAYFAIR Acclaimed by everyone

A completely new development in portable electronic musical instruments and a new field for the home constructor. The 'MAYFAIR' produces a multitude of the most pleasing sounds with a wide range of tone colours suitable for classic or popular music. The organ is fully polyphonic, that is full chords can be played over the entire keyboard. Supplied as a kit of parts which includes 185 transistors, printed circuit panels, special fully sprung and depth of touch adjusted keyboard, attractive vinyl covered cabinet with carry handle.

Delayed terms available COMPLETE KIT Depot £20.19.8 12 monthly payments of £1.70. £121.8.8 BUILT AND TESTED Depot £28.8.8 12 monthly payments of £2.40. £121.8.8



THE MAYFAIR 99 GNS BROCHURE 9

A complete detailed and illustrated construction manual is provided with circuits and full parts list. All items may be purchased separately. All parts supplied are fully guaranteed. Full after sales service.

★ The GROSVENOR

The Grosvenor is designed for the more ambitious musician and has a much wider range than most commercial organs. It comprises two four-octave (48 note) keyboards and a thirteen-note pedal board. It has four pitches (i.e., 8th, 4th, 2nd, 1st) on the upper or solo keyboard, three pitches (i.e., 10th, 8th, 4th) on the lower or accompaniment keyboard, two pitches (i.e., 10th, 8th) on the pedal board. Variable sustain on the solo keyboard and variable vibrato on both keyboards. It has 16 voices in the solo tone-forming unit, 10 voices in accompaniment tone-forming unit and 4 voices in the pedal tone-forming unit. All components and kit sections are available separately including the Oak Console at £85.18.8.



THE GROSVENOR KITS FROM £220 terms available BROCHURE 98

A complete detailed and illustrated construction manual is provided with circuits and full parts list. All parts supplied are fully guaranteed. Full after sales service and advice freely available. One built the 'MAYFAIR' or 'GROSVENOR' will then provide years of enjoyable entertainment. Call in—See them for yourself.

PRACTICAL ELECTRONICS—ELECTRONIC ORGAN KIT

We are able to supply Parts as described in this series. Details on request

ORGAN COMPONENTS: COMPLETE RANGE IN STOCK + 40 AND 81 NOTE KEYBOARDS + 2 TO 5 PAIR STOP TAPS + CHANGES + REGENERATION SPRINGS AND UNITS + STOP TABS AND ASSEMBLY + PEDAL BOARDS + RHODIUM AND GOLD CLAD WIRE. ALSO PRINTED CIRCUITS ETC. COMPLETE RANGES FOR TRANSISTORISED ORGANS. ASK FOR NEW PRICE LISTS WITH DETAILS LEAFLET 95

INTEGRATED TRANSISTOR AMPLIFIERS

MAM 8 WATTS MONO OR 12 WATTS STEREO

We are pleased to offer two new designs with the choice of either mono or stereo systems. These BRITISH DESIGNED UNITS favour the user in so many ways—with fantastic power and quality with far greater adaptability, with freedom for battery or mains operation.



for complete listening satisfaction choose either the—

MAT MONO OR STEREO MAM OPTIONAL POST PACKING MAINS UNIT EITHER MODEL. £8.10.0 P900 80/40 40 4

Illustrated leaflets 12 and 14 FREE on request



DO IT YOURSELF MW/LW PORTABLE

New printed circuit design with full power output. Fully tunable on both MW/LW bands. 7 transistors plus diode, push-pull circuit. Fitted 5 inch speaker, large ferrite aerial and Mullard transistors. Easy to build with terrific results. All local and Continental stations.

TOTAL COST £6.19.6. P.P. 4/6 TO BUILD Send for Brochure 1



NEW MODELS NOMBREX TRANSISTORISED Test Equipment

MODEL	PRICE Leaflet
29a R.F. Generator	21 8 0
29b Xial R.F. Generator	29 10 0 35
30 Audio Generator	19 10 0 24
31 R.F. Generator	12 10 0 25
32 C.R. Bridge	10 10 0 26
33 Inductance Bridge	28 8 0 29



QUALITY CAR RADIOS

A precision engineered car radio that's perfect company for long hours on the road. It has built-in push-button operation for immediate station selection and choice of Medium or Long wave frequency. Two sets of wave meters. Includes full accessories and instructions.

POSITIVELY NEGATIVE EARTH PRICE £12.12.6 plus 4/- MANUAL as above £28.18.8. but with single MW/LW Push Button.



'SCOOP' STARR RECORD PLAYER

Deck. Plays 33, 45, 78 records 9 volt operated. With mono cartridge. Brand new. As illustrated. 59/6 post 3/6

*MULLARD 1 WATT AMPLIFIER 9 volt, 5 transistor unit complete with volume control. Output to 3 ohms. Ideal for use with Starr Record Deck. 45/- post 3/6. Send for leaflet 2

BUILD A QUALITY TAPE RECORDER

To get the best out of your MAGNAVOX DECK, you need a MARTIN RECORDKIT. This comprises a special high quality 6 valve amplifier and pre-amplifier which comes to you assembled on the printed circuit board—in fact everything needed down to the last screw FOR MAKING A SUPERS TAPE RECORDER, which, when built, will compare favourably with instruments costing twice as much, yet you need no experience or technical skill to bring this about. THE INSTRUCTIONS-MANUAL MAKES BUILDING EASY AND SUCCESS ASSURED.



4 Track 39 gns. P.P. 2/6 Kit comprises: Deck, Amplifier, Cabinet and speaker, with MICROPHONE 7 in 1,200 Ft. tape, spare 3000. ALL UNITS AVAILABLE SEPARATELY. Today's Value £28. ASK FOR BROCHURE 8

VHF FM SUPERHET TUNER MKII

5-MULLARD TRANSISTORS & 4 DIODES - 300 Kc/s BANDWIDTH - PRINTED CIRCUIT CONSTRUCTION - HIGH FIDELITY REPRODUCTION MONO AND STEREO. A popular VHF FM Tuner now used throughout the country for quality reception of mono-ephoric and with the decoder stereophonic broadcasts. There is no doubt about it—VHF FM gives the real sound. Excellent stability, economically priced. PARTS TOTAL COST £8.19.6. DECODER £5.19.6. (CABINET 20/-) ASK FOR LEAFLET 3



TRANSISTORS MANUFACTURERS—DISTRIBUTORS. We publish a QUANTITY, SEMI-CONDUCTOR BULLETIN listing over 500 different devices available FROM STOCK in medium to large quantities at KEEN PRICES coupled with PROMPT DELIVERIES. TO OBTAIN YOUR COPY, WRITE TO US (on Company Headed Note-paper please) requesting our SEMI-CONDUCTOR BULLETIN. For TELEPHONE QUOTATIONS, PHONE (01) 723 1008 Extn. 4 (01) 723 0401 Extn. 4. We purchase medium to large quantities of Transistors and Devices excess to Manufacturers and Distributors' requirements. Write or Phone Extn 4.

NEW—MALLORY LONG LIFE MERCURY BATTERIES 50% OFF LIST PRICES

RM12 1.35 volts 3600 mAh OUR PRICE 5/- each size 2" x 1" dia. RM25 1.35 volts 3600 mAh OUR PRICE 5/- each Pack of 3. Size 2 1/2" x 1" dia. OUR PRICE 10/- each. Easy split into eight 1.35v cells. These cells are ideal for any application where SMALL SIZE HIGH CAPACITY and LONG LIFE are required. QUANTITIES AVAILABLE.



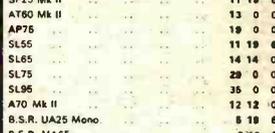
COMPLETELY NEW 1969 LIST OF 1000 types. Send for your FREE COPY TODAY. (list 36) S.C.R.'s from 5/- Field Effect Transistors from 7/6 Power Transistors from 5/- Diodes and Rectifiers from 1/-

GARRARD RECORD DECKS

ALL BRAND NEW at huge savings

Model	Price
2025 Mono/Stereo GKS 25	8 8 0
3000 LM Mono/Stereo 8 TAHC	9 19 8
SP25 Mk II	11 19 6
AT60 Mk II	13 0 0
AP75	19 0 0
SL55	11 19 8
SL65	14 14 0
SL75	29 0 0
SL85	35 0 0
A70 Mk II	12 12 0
B.S.R. UA25 Mono	5 19 8
B.S.R. MA65	9 19 8
B.S.R. MA70	12 12 0
B.S.R. MA75	16 0 0
401 Garrard	28 10 0

Carriage/Packing 7/6d. all models. Complete range of accessories available. Send for New 8 page brochures 16 17



HI-FI equipment to suit EVERY POCKET

VISIT OUR NEW HI-FI CENTRE at 309 EDGWARE ROAD AND SAVE UP TO £300 SEPARATE UNITS OR THE SYSTEM OF YOUR CHOICE for all leading makes

- AMPLIFIERS
- TUNERS
- DECKS
- SPEAKERS
- MICROPHONES
- TEST EQUIPMENT
- HEADPHONES
- CARTRIDGES, etc.

All with Terrific Savings It will PAY YOU to pay us a VISIT!

COMPLETE SYSTEMS from £46—£200! SEND FOR NEW 8-PAGE ILLUSTRATED HI-FI LIST 16/17

Fully Illustrated CATALOGUE

COMPLETELY NEW 9th EDITION (1969)

The most COMPREHENSIVE—CONCISE—CLEAR COMPONENTS CATALOGUE

- Complete with 10/- worth discount vouchers FREE WITH EVERY COPY
- 32 pages of transistors and semi-conductor devices, valves and crystals.
- 210 pages of components and equipment.
- 70 pages of microphones, decks and HI-FI equipment.

6,500 ITEMS 320 BIG PAGES Send today 7/6 Post etc 2/



HENRY'S RADIO LTD

OPEN MON.—SAT. 9 a.m.—6 p.m. THURS. 9 a.m.—1 p.m.

303 Edgware Road, London, W.2. Mail Order Dept. all types of Components, Organ Dept. (01) 723-1008/9 309 Edgware Road, London, W.2. High Fidelity Sales, P.A. and Test Equipment, Record Decks (01) 723-6963