PRACTICAL

ELECTRONICS

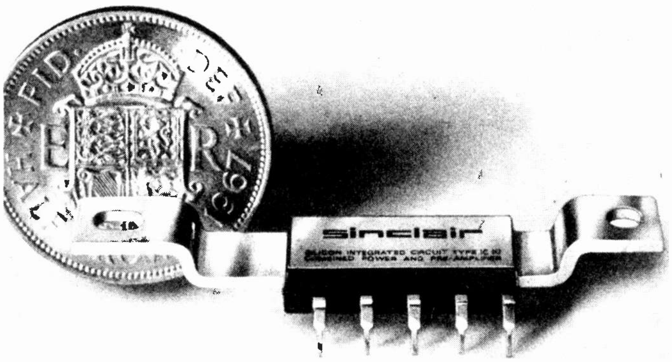
JULY 1970

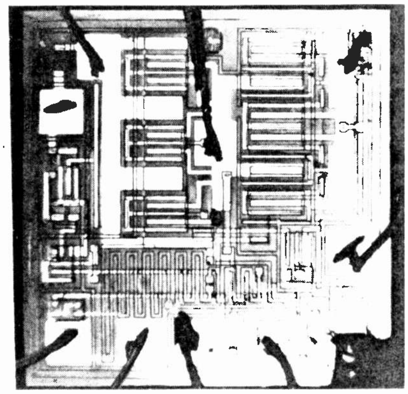
PRICE 3/6

ALSO INSIDE:

WAA-WAA UNIT........FOR GUITAR EFFECTS

MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP





the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, 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. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway 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 such components as tone and volume controls and a battery or mains power supply. However, it 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 as part of the process of producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

■ SPECIFICATIONS

Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz±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 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

■ 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. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

SINCLAIR

IC.10 *with IC-10 manual* **59/6**

POST FREE

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SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD · CAMBRIDGE
Tel. 0223-52731

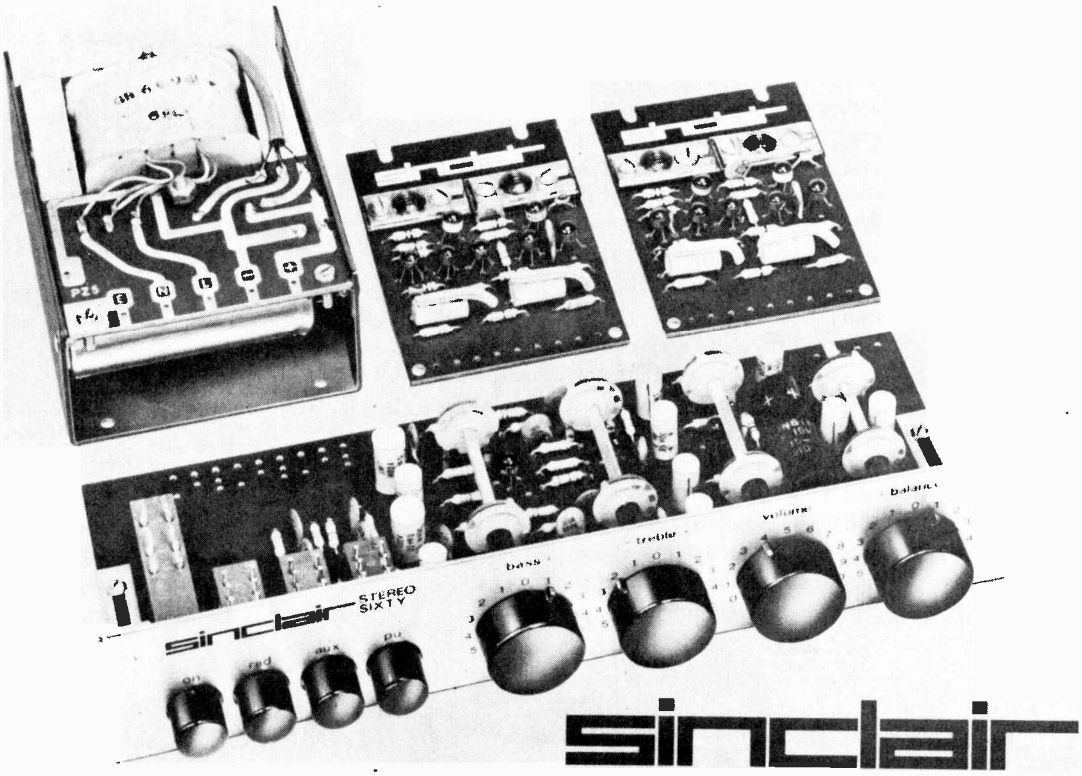
Project 60

laboratory standard modular high fidelity

Sinclair Project 60 comprises a range of modules which connect together simply to form a complete stereo amplifier with really excellent performance. So good, in fact, that only 2 or 3 amplifiers in the world can compare in overall performance. Now with the addition of three new modules to the range, the constructor has choice of assemblies with either 20 or 40 watts output per channel, with or without filter facilities.

The modules are: **1.** The Z.30 and Z.50 high gain power amplifiers, each of which is an immensely flexible unit in its own right. **2.** The Stereo 60 preamplifier and control unit. **3.** The Active Filter Unit with both high and low audio frequency cut – offs. **4.** The PZ.5 and PZ.6 power supplies. A complete system could comprise, for example, two Z.30's one Stereo-60, and 'a PZ.5. The PZ.6 is stabilised and should be used where the highest possible continuous sine wave rating is required. An A.F.U. may be added as required. In a normal domestic application, there will be no significant difference between PZ.5 or PZ.6 unless loudspeakers of very low efficiency are being used, in which case the PZ.6 will be required. For assemblies using two Z.50's there is the new PZ.8 supply unit to ensure maximum performance from these amplifiers.
All you need to assemble your Project 60 system is a screwdriver and soldering iron. No technical skill or knowledge whatsoever is required and, in the unlikely event of you hitting a problem, our customer service and advice department will put the matter right promptly and willingly. Project 60 modules have been carefully designed to fit into virtually all modern plinth or cabinets and only holes need be drilled in the wood of the plinths to mount the control unit and A.F.U. Any slight slip here will be covered by the aluminium front panels of the Stereo 60. The Project 60 manual gives all the buildings and operating instructions you can possibly want, clearly and concisely. Perhaps the greatest beauty of the system is that it is not only flexible now but will remain so in the future as the latest additions to the range show. A stereo F.M. tuner is next to come. These and all other modules we introduce will be compatible with those already available and may be added to your system at any time. And because Sinclair are the largest producers of constructor modules in Europe. Project 60 prices are remarkably low.

SINCLAIR RADIONICS LIMITED · 22 NEWMARKET ROAD · CAMBRIDGE Telephone: 0223 52731



Z.30 20 WATT R.M.S. POWER AMPLIFIER (40 WATTS PEAK)

Z.50 40 WATT R.M.S. POWER AMPLIFIER (80 WATT PEAK)

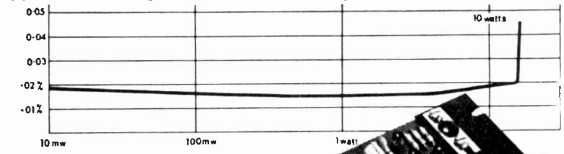
The Z.30 together with the higher powered Z.50 are both of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0·02% at full output and all lower outputs. Whether you use the Z.30 or Z.50 power amplifiers in your Project 60 system will depend on personal preference, but they are both the same physical size and may be used with other units in the Project 60 range equally well. The Z.30 is unique in that it may be used with any power source between 8 and 35 volts without need for adjustment and may thus be driven from a car battery for example. For operating from mains, for the Z.30 use PZ.5 power supply unit for most domestic requirements, or PZ.6 if you have very low efficiency loudspeakers. For Z.50, use the PZ.5, PZ.6 or the PZ.8 described below.

Power Outputs

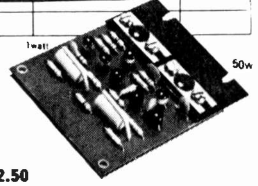
Z.30 15 watts R.M.S. into 8 ohms, using 35V/20 watts R.M.S. continuous into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms: 30 watts R.M.S. into 8 ohms, continuous, using 50V.
Frequency response 30 to 300,000Hz ± 1dB
Distortion 0·02% into 8 ohms
Signal to noise ratio better than 70dB unweighted
Input sensitivity 250mV into 100 Kohms
For speakers from 3 to 15 ohms impedance
Size 3½" × 2½" × ½"

APPLICATIONS

Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; intercom; electronic music and instruments; P.A.; laboratory work, etc. Full details for these and many other applications are given in the manual supplied with the Z.30.



Power versus distortion curve of Sinclair Z.30 amplifier.



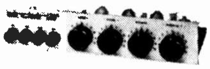
Z.30 *Built, tested and guaranteed with circuits and instructions manual* **89/6**

Z.50 *Built, tested and guaranteed with circuits and instructions manual* **109/6**

STEREO 60 Preamp/Control unit

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to obtaining a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.

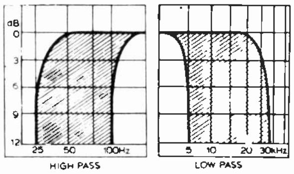
- Input sensitivities—Radio—up to 3mV Mag. p.u.—3mV: correct to R.I.A.A. curve ± 1dB; 20 to 25,000Hz. Ceramic p.u.—up to 3mV: Aux.—up to 3mV.
- Output—250mV.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone controls—TREBLE +15 to −15dB at 10KHz: BASS +15 to −15dB at 100Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8½ × 1½ × 4in.

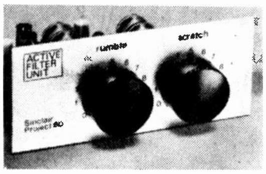


Built, tested and guaranteed **£9.19.6**

ACTIVE FILTER UNIT High Pass and Low Pass

For use between Stereo 60 unit and two Z.30s or Z.50s, the Active Filter Unit matches the Stereo 60 in styling and is as easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible by reason of the careful design and generous negative feedback employed.





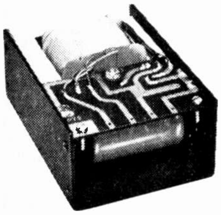
Two stages of filtering are incorporated—rumble (high pass) and scratch (low pass).
Supply voltage—15 to 35V. Current—3mA
H.F cut-off (−3dB) variable from 28kHz to 5kHz
L.F cut-off (−3dB) variable from 25Hz to 100Hz
Filterslope, both sections 12dB per octave
Distortion at 1kHz (35V supply) 0·02% at rate output

Built, tested and guaranteed **£5.19.6**

BUILDING A PROJECT 60 ASSEMBLY

The illustration here shows quite clearly how easily Project 60 can be contained in one of today's slim, modern plinths. Very little space is required to house these Sinclair units, and within the space of the motor plinth, you can install a stereo amplifier of the very highest quality. If, for example you have already put together an assembly as illustrated here, adding the Active Filter Unit would be very easy.

SINCLAIR POWER UNITS



PZ-5 *30 volts unstabilised* **£4.19.6**

PZ-6 *35 volts stabilised* **£7.19.6**

PZ-8 *45 volts stabilised (less mains transformers) for use with Z.50* **£5.19.6**

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

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

Please send ....
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for which I enclose cash/cheque money order

CRESCENT RADIO LTD.

11 & 40 MAYES RD. N.22 888-3206

MAIL ORDER DEPT. No. 11 MAYES RD. N.22

WESTON MILLIAMMETER

Modern Clear Plastic Design. 1M/A full scale calibration 0–100. 2¼in × 2¼in × 1½in.

45/- Plus 2/6 P. & P.

IMPORTED PANEL METERS

KA-38C 1¾in × 1¾in. 50μA, 100μA, 500μA, 1M/A, 5M/A. S meter 1M/A, 300V. All at **29/6** Plus 1/- P. & P.

KA-65C 3¼in × 3¼in. 300V, S meter 500μA, 1M/A. All at **39/6** Plus 1/6 P. & P.

All modern design and made to high standards.

MICROPHONE STANDS

All have standard fittings for average Mics.

Desk Stand 14in extended length	32/6
M84. 3-Section floor stand, 4ft 8in E/L	£3.10.0
MF811. 2-Section floor stand, 5ft E/L	£4.10.0
BM81. 5ft floor stand with 2ft 9in boom	£6.19.6
BM82. Super quality boom stand	£9.9.0

Plus 5/- P. & P.

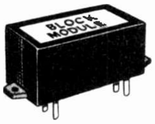
STANDARD GOOSE NECKS

(will fit our mic. stands)

8in	12/9
12in	15/9

Plus 1/6 P. & P.

SOLID STATE BLOCK MODULES



Phono pre-amp E1311: input, 100K; gain, 28db; max. out, 3-volt; max. in, 50M/V; power, 9V.
Tape pre-amp E1312, as above.
Mic. pre-amp E1313, as above.
Power amplifier E1314: input, 1,000 ohms; gain, 20db, 300M/W; power, 9-volt d.c.
Electronic organ, tone osc. E1315: tone freq., 200–1kHz; output, 80M/W; power, 9V; current, 15M/A.
Dual flasher E1318: flasher time, 1/4 secs; power, 6V; current, 150M/A; lamp, 6V 150M/A.
We also stock the morse code practice modules in this range.

ALL AT **25/-** Plus 2/- P. & P.

BATTERY ELIMINATOR

Plug your Transistor Radio, Amplifier, Cassette, etc., into the a.c. mains through this compact eliminator. 2¼in × 2in × 3in approx.

4½ volt	29/6
6 volt	29/6
9 volt	29/6

7½ volt complete with cable and plug for Philips Cassette

39/6 Plus 2/ P. & P. each

SONOTONE 9TAHC

Ceramic cartridge diamond stylus.

47/6 Plus 2/6 P. & P.

EMI LOUDSPEAKER 450

10 watts. 13in × 8in + two 2·2½in tweeters and crossover. All wired and ready for use. This ever-popular 450. In 3-8-15 ohm imp.

65/- Plus 7/6 P. & P.

EMI Loudspeaker Set 350

20 watts. 20-20 k/c. 8 and 15 ohms.

£6-19-6. Plus 7/6 P. & P.

SHELF UNIT

Two teak finish shelves on a black frame (overall size: 28in × 25in × 12in). Ideal for hi fi equipment: amplifiers, speaker cabinets etc. The perfect answer for housing unit audio and equipment. This unit is wall mounting.

50/- Plus 8/6 P. & P.

EMI SET 850

A complete speaker system **IN KIT FORM.** We supply a modern styled teak finish cabinet with black front. Overall dimensions: 14in × 9in × 9in. Made to a very high standard. A 6½in EMI woofer. A 3in tweeter. A crossover network. Acoustic wadding. Output terminals, wire and fixing hardware. Specification: Max. power, 10 watts; frequency, 65-20kHz; imp 8-15 ohms.

Kit price **9 Gns.** Plus 7/6 P. & P.

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Used! But in good working condition. These Type "F" phones are 4,000Ω imp., and a bargain at

10/- Plus 2/- P. & P. per pair

TTC G1105

High quality imported headphones.

1,000Ω per phone	15/11
2,000Ω per phone	17/6

Plus 2/- P. & P. per pair

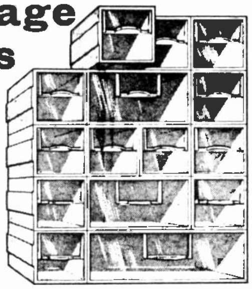
COMPONENTS CORNER

8in × 6in one sided printed circuit board	2/- each
BY100 type rectifier 800 p.i.v. 750M/A	3/3 each
4 pin transistor holders	6d each
2½in 80 ohm loudspeaker	5/6 each
2½in 25 ohm loudspeaker	5/6 each
2½in 8 ohm loudspeaker	6/6 each
U2 battery holders (blue plastic)	1/- each
Flick switches 1½in dolly mains type	3/6 each
Model motors 6–12 volt	4/6 each
10 ohm W/W pot loudspeaker control	2/6 each
OC81 double heat clips	6d each
Tape recorder rev counters	5/- each

Please include P. & P.
Send 3/- for our Component Catalogue and Flog Lists

NEW! HANDY! TIDY!

multi-drawer I-N-T-E-R-L-O-C-K-I-N-G storage units



A PLACE FOR EVERYTHING

EVERYTHING IN ITS PLACE!

Newest, neatest system ever devised for storing small parts and components: resistors, capacitors, diodes, transistors, etc. Rigid plastic units, interlock together in vertical and horizontal combinations. Transparent plastic drawers have label slots/removable space dividers. Build up any size cabinet for wall, bench or table top.

BUY AT TRADE PRICES!

SINGLE UNITS (5ins × 2¼ins × 2¼ins)
Usually 2/6 each, **OUR PRICE: 24/- DOZEN**
DOUBLE UNITS (5ins × 4½ins × 2¼ins)
Usually 4/6 each, **OUR PRICE: 40/- DOZEN**

PLUS QUANTITY DISCOUNTS!

Order £5 and over DEDUCT 1/- in the £
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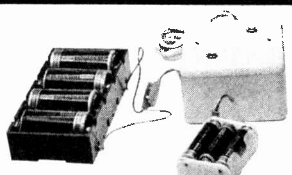
Mallory RECHARGABLE cells in U2 and Penlite U7 sizes Kestral Battery Charging Unit



Uses: Tape recorders, Portable radio and TV, Radio controlled model aircraft and boats, Cine cameras, Flashguns, Cordless shavers and other battery appliances.

Whenever you *must* have utterly dependable battery power—then these new Mallory Alkaline-Manganese rechargeable cells will provide it. The cells can be recharged many times, a simple job with the Kestrel Charging Unit which has been specially designed for these new type batteries.

PRICES
Batteries U2 equiv. 25/-
Penlite U7 equiv. 10/-
Charging unit 79/6 with one battery holder

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160V, 10%: 0·01, 0·015, 0·022, 0·033, 0·047, 5d. 0·068, 6d. 0·1, 0·15, 8d. 0·22, 9d. 0·33, 1/-. 0·47, 1/2. 0·68, 1/9. 1·0, 2/2.
400V, 10%: 0·001, 0·0015, 0·0022, 0·0033, 0·0047, 0·0068, 0·01, 0·015, 5d. 0·022, 0·033, 6d. 0·047, 0·068, 0·1, 8d. 0·15, 1/-. 0·22, 1/2. 0·33, 1/9. 0·47, 2/2.

MULLARD ELECTROLYTICS

Miniature series. Tolerance −10% to +50%. All 11d each.

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

CARBON FILM RESISTORS

High stability, very low noise, carbon film construction. E12 series 4R7 to 1M. Prices—per ohmic value

	each	10	100	1,000
0·5W 5%	1½d	1/2	10/6	97/6

SKELETON PRESET CONTROLS

Carbon construction. Linear track only available. 100, 250 and 500 ohms to 5m. Horizontal or vertical mounting on 0·1 matrix board. Miniature 0·33W 9d each.

No minimum order charge. Please add 1/- postage and packing per order. Export enquiries particularly welcome. Return of post service. No discount to trade available. Cash with order only. Send your name and address for our catalogue.

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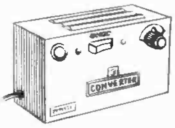
LiND-AiR AUDiO

BATTERY ELIMINATOR



Enables transistor equipment to be operated from a.c. mains. 6/9/12V output selector switch and on/off switch. Case size 4in × 2½in × 2in, complete with mains lead, connecting leads and instructions. **59/6**, P. & P. 3/6.

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BRITISH MADE TOP QUALITY

J1001	3in	L.P.	PVC	225ft	**5/6**	P. & P. 1/2
J1002	3in	T.P.	Poly	600ft	**10/6**	P. & P. 1/2
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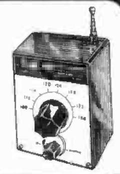
J1004	5in	D.P.	Poly	1,200ft	**15/-**	P. & P. 1/8
J1005	5¾in	L.P.	PVC	1,200ft	**12/6**	P. & P. 2/-
J1006	5¾in	D.P.	Poly	1,800ft	**22/6**	P. & P. 2/-
J1007	7in	S.P.	PVC	1,200ft	**12/6**	P. & P. 2/6
J1008	7in	L.P.	PVC	1,800ft	**17/6**	P. & P. 2/6
J1009	7in	D.P.	Poly	2,400ft	**25/-**	P. & P. 2/6
J1010	7in	T.P.	Poly	3,600ft	**50/-**	P. & P. 2/6
C60	Cassette (Library cased)				**8/6**	P. & P. 1/-
C90	Cassette (Library cased)				**13/-**	P. & P. 1/-
C120	Cassette (Library cased)				**18/-**	P. & P. 1/-

DE-LUXE STEREO HEADPHONES

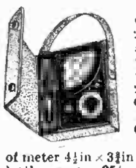
With soft rubber earpieces. Impedance 8–16ohms. Frequency response 23–13,000Hz. With lead and stereo plug. **Only 59/6**, P. & P. 3/6.

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 18¾in × 7 section telescopic aerial. Size 4 × 2¾ × 1½in. **79/6**, P. & P. 3/6.



C.1001 MULTI-TESTER



Overload protection 20,000 ohms per volt; a.c. volts 10, 50, 250, 1,000V; d.c. volts 5–25, 125; 500, 2,500V; d.c. current 0—50μA, 0—250mA; Resistance 0—60kΩ 0—6MΩ; decibels —20 to +22dB. Size of meter 4½in × 3¾in × 1in. Complete with leather case. **85/-**, P. & P. 3/6.

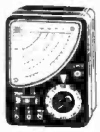
LIND-AIR LA.20

A fantastic stereo amplifier made exclusively for Lind-Air and represents considerable advance in solid state stereo amplifiers. Inputs for gram and radio tuner and provision for direct tape recording. Attractive and modern front panel with bass, treble balance and volume controls also on/off and stereo/mono switch. Output 5W per channel music power. Frequency response 40–20,000Hz 8–16 ohm speaker matching. Size 16½in × 14in × 4in.

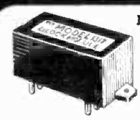
LIND-AIR PRICE £24 P. & P. 10/-

62D. MULTI-TESTER

20,000 ohms per volt; d.c. voltage 5, 25, 50, 250, 500V, 2·5kV (20,000 ohms per volt), a.c. voltage 10, 50, 100, 500, 1,000V (10,000 ohms per volt); d.c. current 0–50μA, 0–2·5mA, 0–250mA; resistance 0–6kΩ, 0–6MΩ (300 ohms and 30kΩ at centre scale); capacitance 10F to 0·001mF, 0·001μF to 0·1μF; decibels —20 to +22dB. Size 4½in × 3¾in × 1in. **71/-**, P. & P. 3/6.



TRANSISTOR MODULES

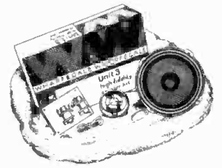


E1311. PHONO PRE-AMPLIFIER. Size 2in × 1in × ⅞in. Built-in R.I.A.A. characteristics enabling low output magnetic pick-up cartridges to be amplified up to 1V. Input 100 kΩ Gain 28dB. Max. output 3V. Max. input 50mV. Distortion 0·15% (at 1V level). Power supply 9–12V. **29/6**, P. & P. 2/-.

E1315. ELECTRONIC ORGAN TONE OSCILLATOR. Used in conjunction with an organ keyboard, variable resistances and a 9V power supply, this module acts as the oscillator unit for an electronic organ. Tone Frequency 200–1,000Hz. Output 80mW. Current 15mA. **25/-**, P. & P. 2/-.

E1316. MORSE CODE OSCILLATOR. A transistorised morse code oscillator (buzzer) to be used in conjunction with an operating key. Suitable for direct connection to a loudspeaker. Tone freq. 400Hz. Power output 80mW. Power supply 3–9V. Current 45mA, **25/-**. P. & P. 2/-.

WHARFEDALE SPEAKER KITS



Complete with all components for building into suitable cabinets.

Unit 3 Kit .... **£11.19.6** each
£21 pair
Unit 4 Kit .... **£16.0.0** each
28 Gns. pair
Unit 5 Kit .... **£23.10.0** each
39 Gns. pair
P. & P. 10/- each, 15/- pair

TELETON SAQ203 TRANSISTOR STEREO AMPLIFIER

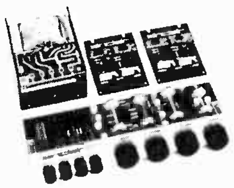
Superb quality hi-fi. 10W per channel music power. Inputs for gram (magnetic and crystal), tuner and auxiliary. Tape record output. Controls: volume, balance, bass, treble. Attractive oiled walnut cabinet with brushed aluminium front panel.

List Price £28.7.0.

Our Price 22 Gns.

P. & P. 10/-.

sinclair PROJECT 60



An attractive alternative for the enthusiast prepared to assemble these excellent modules to make a stereo assembly.

Z30 24W Power Amplifier, **89/6** (2 required).

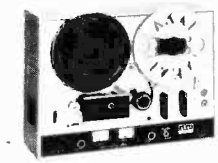
Stereo Sixty Control/Preamplifier, **£9.19.6**. PZ5 Power Supply Unit, **£4.19.6**. Project 60 is supplied complete with instruction manual and templates for plinth mounting.

SINCLAIR PROJECT 60 PACKAGE DEAL. PRICE 19 Gns. P. & P. 12/6.

SINCLAIR 1C-10 INTEGRATED CIRCUIT 10W Amplifier. Size only 1in × 0·4in × 0·2in. A true hi-fi amplifier complete with manual giving details of a wide range of applications and instructions. Guaranteed 5 years. **ONLY 59/6.** P. & P. 1/6.

SPECIAL TRANSFORMER FOR OPERATING SINCLAIR 1C-10 from a.c. mains 230/250V. Output 13V at 0·5A. **16/6.**

SAVE ON AKAI!



AKAI 4000 Stereo Tape Recorder. List Price £124.18.0.

Our Price 99 Gns.

Carr. 30/-

AKAI 4000D STEREO TAPE DECK. (As illus.) List Price £89.19.1.

Our Price 69 Gns.

Carr. 30/-

SPECIAL LIND-AIR OFFER!

ROTEL 100 AMP STEREO AMPLIFIER

Fully transistorised with all facilities for the home hi-fi system.

List price £45

Our Price £37.10.0

Carr. 10/-

Garrard HI-FI TURNTABLES

2025 T/C with stereo cartridge .. **£8.19.6**
3000 with Sonotone 9TAHCD stereo cartridge **£10.19.6**
SP25 Mk. II **£10.19.6**
SL65B **£15.19.6**
Base and cover for above **£5.19.6**
AP75 .... **£18.10.0**
SL72B **£24.19.6**
SL75B **£28.7.0**
SL95B **£39.9.0**
401 .... **£28.10.0**
Base and cover for above **£8.19.6**
P. & P. Decks, 12/6; Base and Cover, 10/-; Deck/Base/Cover, 17/6.

SPECIAL OFFERS!

SP25 Mk. II with base .... **£14.10.0** P. & P. 15/-
SP25 Mk. II with Sonotone 9TAHCD cartridge and base .... **£15.15.0** P. & P. 15/-
Sonotone 9TAHCD cartridge .... **£2.15.0** P. & P. 1/6

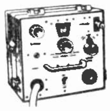
18/19, 25 & 53 TOTTENHAM CT. ROAD, LONDON W.1.
Telephone: 01-580 2255/4532/7679
Open 9-6 pm. Monday to Saturday. Thursday until 7 pm.

All Mail Orders and correspondence to Dept L4/7, Kirkman House, 54a Tottenham Court Road, London, W.1. Tel: 01-580 7041/2.

CAR LIGHT FLASHERS

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

CLASS D WAVEMETERS



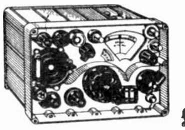
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

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/-.

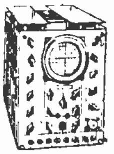
R209 MK II COMMUNICATION RECEIVER

11 valve 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 d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



£15 Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



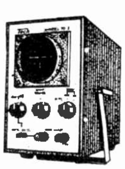
An excellent general purpose D/B oscilloscope. T.B. 2 c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 µ/watt to 6 watts. **£20.** Carr. 20/-.

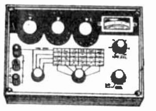
SOLARTRON CD. 71182 DOUBLE BEAM OSCILLOSCOPES. D.C. to 9Mc/s. Perfect order. **£65.** Carr. 50/-. Few available less C.R.T. **£25.** Carr. 50/-.

TO-2 PORTABLE OSCILLOSCOPE



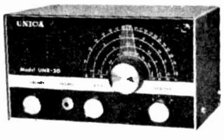
A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. **£22.10.0.** Carr. 10/-.

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.1 µH – 111 HENRYS 6 Ranges ~2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. **£20.** P. & P. 5/-.

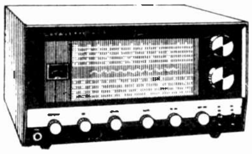
UNR-30 4-BAND COMMUNICATION RECEIVER



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.**

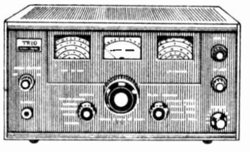
TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER. In stock. **£77.10.0.**

LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s–400 kc/s and 550 kc/s–30 Mc/s FET front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in 9¾in 8¼in. 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 bandspread 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 ● S meter ● Sep. bandspread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£42** Carriage paid.

TRIO COMMUNICATION TYPE HEADPHONES Normally **£5.19.6.** OUR PRICE **£3.15.0** if purchased with above receiver.

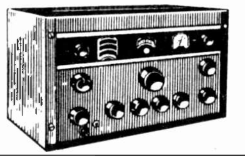
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER £65	**TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £180**

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s–30 mc/s continuous. Special features are use of FET transistors, S meter, built in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandspread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12¾" × 4½" × 7". Excellent value. ONLY **£24.** Carr. 7/6.

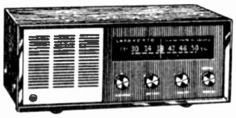
LAFAYETTE HA.800 6-BAND AMATEUR RECEIVER. £57.10.0. Carr. Paid.

RCA COMMUNICATION RECEIVER AR88D



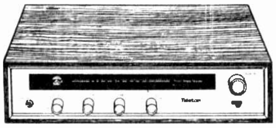
Latest release by ministry BRAND NEW in original cases. 110–250V a.c. operation. Frequency in 6 Bands. 535Kc/s–32Mc/s continuous. Output impedance 2·5–600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£65.** Carr. **£2.**

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER



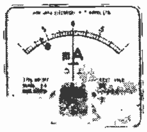
A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone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

TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4 + 4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz FM 88-108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13¾" × 3½" × 9¼" approx. Price **£34.** Carr. 7/6.

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. $1^{21}/_{32}$in square fronts.

500–0–500µA **27/6**	50mA **27/6**	150V. D.C. **27/6**
1mA **27/6**	100mA **27/6**	300V. D.C. **27/6**
1-0-1mA **27/6**	150mA **27/6**	500V. D.C. **27/6**
2mA **27/6**	200mA **27/6**	750V. D.C. **27/6**
5mA **27/6**	300mA **27/6**	15V. A.C. **27/6**
10mA **27/6**	500mA **27/6**	50V. A.C **27/6**
750mA **27/6**	3V. D.C. **27/6**	150V. A.C. **27/6**
1 amp **27/6**	10V. D.C. **27/6**	300V. A.C. **27/6**
2 amp **27/6**	20V. D.C. **27/6**	500V. A.C. **27/6**
5 amp **27/6**	100V. D.C. **27/6**	S meter 1mA **32/-**
20mA **27/6**		VU meter **42/-**

50µA	**40/-**
50-0-50µA	**37/6**
100µA	**37/6**
100-0-100µA	**35/-**
200µA	**35/-**
500µA	**40/-**

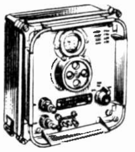
Full range of other sizes in stock. Send s.a.e. for leaflet.

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.

25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

CRYSTAL CALIBRATORS No. 10



Small portable crystal controlled wavemeter. Size 7" × 7½" × 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **89/6.** Carr. 7/6.

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 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

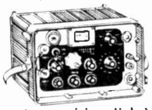
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5–1,500V. A.c. volts 1·5–1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F **35/-.** H.V. **42/6.**

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.c. coupled. 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 Airmec. Frequency coverage 20–80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1µV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

PLESSEY SL 403A

3 watt Integrated Amplifier Circuit **49/6 POST PAID**

EDDYSTONE VHF RECEIVERS MODEL 770R. 19–165 Mc/s. Excellent condition. **£150**

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. 5¼ × 5¼ × 3½. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

HOSIDEN DH-02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable headband. 8 ohm impedance. 20–12,000 cps. Complete with lead and stereo jack plug. ONLY **47/6.** P.&P. 2/6.

AUTO TRANSFORMERS

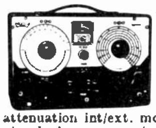
0/115/230v. Step up or step down. Fully shrouded.

150 W.	**£2.2.6,**	P. & P. 3/6
300 W.	**£2.19.6,**	P. & P. 4/6
500 W.	**£4.10.0,**	P. & P. 6/6
1,000 W.	**£6.10.0,**	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.

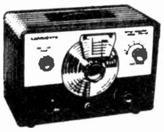
Also see oppos. page

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/P600Ω 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 AF output and % mod. on R.F 220/240 V a.c. **£32.10.0.** Carr. 7/6.

TE-20RF SIGNAL GENERATOR



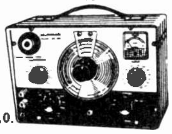
Accurate wide range signal generator covering 120 kc/s–260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£5.15.0.** P. & P. 7/6. S.A.E. for details.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20c/s to 200 kc/s on 4 bands. Square: 20c/s to 30 kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. **£16.10.0.** 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.

J1B. AUDIO SIGNAL GENERATOR. 15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. **£30.0.0.**

VM79. UHF MILLIVOLT METER. 100 Kc/s to 1,000 Mc/s. a.c. 10 mV to 3V. D.c. 10 mV to 3V. Current 0·01 µA to 0·3 mA. Resistance 1 ohm to 10 megohm. **£125.0.0.**

TT1S. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. **£37.10.0.**

Carriage 10/- per item.

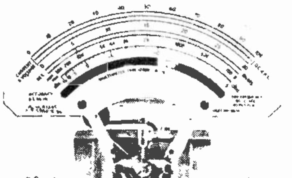
TO-3 PORTABLE OSCILLOSCOPE

3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5 cps –800 KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220/240V. A.C. Supplied brand new with handbook. **£37.10.0.** Carr. 10/-.

TE111. DECADE RESISTANCE ATTENUATOR

Variable range 0–111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω 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 600Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

AVOMETER MOVEMENTS



50µA 20 KΩ/V.

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed **69/6.** P.&P. 3/6.

Latest Catalogue

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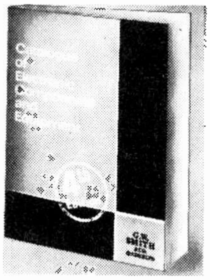

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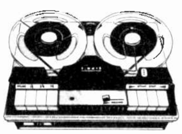

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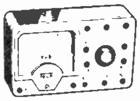

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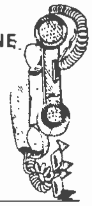

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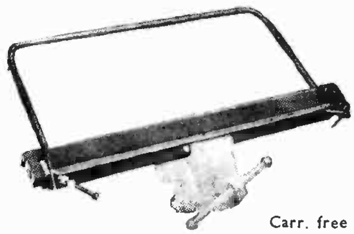

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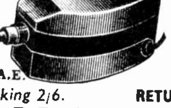

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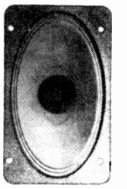

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VOL. 6 No. 7
July 1970

PRACTICAL ELECTRONICS

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THE LOGIC WAY—OR BIT BY BIT

Though oft satirised and unjustly blamed for human errors, the electronic computer is firmly entrenched as an indispensable functional part of everyday life. Nothing succeeds like success, and ever increasing demands can be expected for faster, yet smaller, more versatile machines to cope with society's expanding needs for facts and figures.

There is thus a great impetus for the electronics industry to strive to improve existing digital techniques and to develop even more advanced ideas in the field of computers and data processing. But while we can be assured of continuing (and possibly, spectacular) advancement in this area, it is well to pause and take stock of certain existing achievements which have resulted from the computer revolution.

The more obvious and significant technological "spin-off" has been the development of semiconductor integrated circuits. Only the huge quantities needed by the computer manufacturers could have made their development and production an economic proposition in the first place. But now the vast outpourings from the IC factories have become a dominant factor in the whole electronics industry. For instance, the inevitable move from analogue to digital methods for measurement and control purposes has been accelerated by the availability of logic IC's.

This fact was well demonstrated at the IEA Exhibition held at Olympia, London, last May, where a wide range of digital instruments and equipments and miniature computers formed a notable part of the display. On this evidence, the extension of automation into the smaller industrial plants is clearly becoming feasible, no doubt much to the joy of the Minister of Technology, who has been advocating this for some time now. And laboratory workers can enjoy the improved readout presentation (and often better performance) of various digital measuring instruments—though at present these are not competitive in price with the traditional analogue type instruments.

In amateur circles, to date, linear IC's have received rather more attention than logic devices. This is understandable, since the kind of projects that can be built around a linear IC (amplifiers, detectors, modulators etc.,) fall naturally into the more traditional areas of electronics—like radio and audio. But now, as we have remarked, there is a general shift of emphasis from analogue to digital techniques, with on/off switching of pulses taking precedence over amplitude variation of a.c. and d.c. signals, for many purposes.

Our new series "Making The Most of Logic I.C's" which commences in this issue points the way and indicates the prospects for the enthusiast.

F.E.B.

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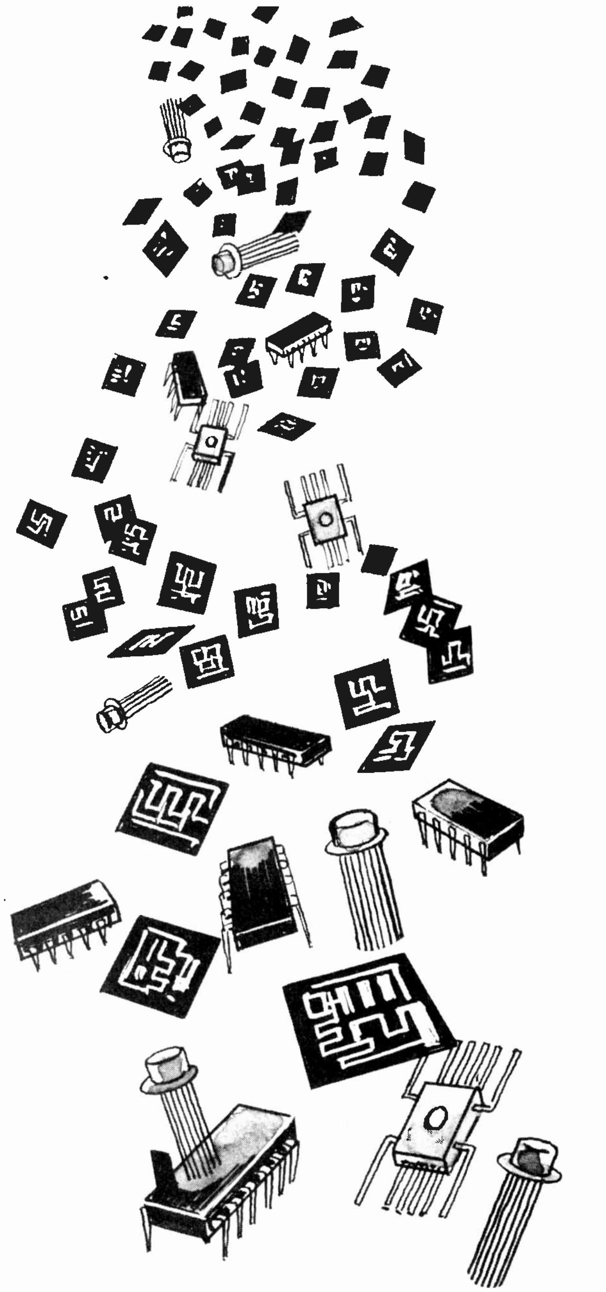


PART ONE—By R. W. COLES

MAKING THE MOST OF LOGIC IC's

SILICON monolithic integrated circuits are available at a price that makes them not only a possible alternative to discrete components, but often far cheaper. What can be done to utilise these useful building bricks? This series of articles gives a broad introduction to the various different types of logic i.c.s, explains their modes of operation, and offers some suggestions on how to use them.

THE economics of integrated circuits, as far as the manufacturer is concerned, are simple: a circuit is suitable for integration providing it can be sold in very large quantities, because setting up a production line is extremely expensive while the cost of actually producing the circuits, once the line is running, is comparatively low.

The computer industry lends itself well to this economic climate, as computers and associated data handling equipments use large quantities of a small number of different types of logic elements. These logic i.c.s then, can be produced most cheaply, and it is with the characteristics and uses of the various families of these circuits that this article will concern itself.

Many advertisers in this magazine now supply a range of circuits of this type, some are manufacturers' rejects, but these are not always as bad as they seem because each package usually contains several entirely separate functions, and the manufacturer may have rejected the whole package because one of these was down on specification.

For those who prefer to play safe, circuits are available which conform to a relaxed specification, and are usable over a restricted temperature range; these are quite suitable for amateur use. Of course the full specification ranges intended for professional use are available from their respective manufacturers. These are a little more expensive, but can be used over the temperature range of −55 to +125 degrees C.

THREE MAIN GROUPS

Logic i.c.s are available in three main groups of package outlines (Fig. 1.1); the flat pack is the smallest of these, but this very fact makes it less suitable for amateur "breadboard" layouts. The other two are both easily used; the TO-5 can conforms to the same outline as a TO-5 transistor can, and may have eight to twelve leads. Spreaders are available to enable these to be inserted in the standard 0·1in matrix perforated s.r.b.p. board, but perhaps the easiest package of all to employ, is the 14/16-lead dual in-line, whose pins conform to the above matrix as supplied. This package is also the cheapest and most versatile.

Logic i.c.s fall into several different "families" which are defined by their design philosophy. These families are usually called by their initial letters (see Table 1.1) and all have their own attendant advantages and disadvantages.

Circuits of one family are usually made by several manufacturers, and are often physically interchangeable. Apart from a brief description some of these families need not concern us here, as they are either too costly for amateur use at present, or they offer advantages which the amateur is unlikely to need, (for example, very high speed of operation).

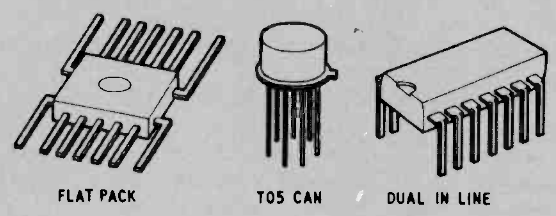
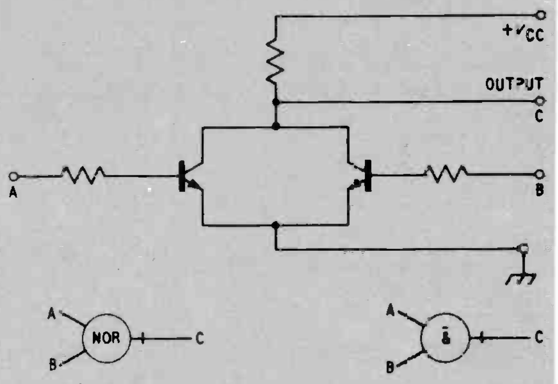


Fig. 1.1 Three basic outline forms used in making logic integrated circuits



A	B	OUTPUT C
0	0	1
1	0	0
0	1	0
1	1	0

TRUTH TABLE FOR POSITIVE LOGIC (i.e. '1'=POSITIVE)

A	B	OUTPUT C
0	0	1
1	0	1
0	1	1
1	1	0

TRUTH TABLE FOR NEGATIVE LOGIC (i.e. '1'=0V)

Fig. 1.2. Basic two-input RTL gate with truth tables for positive and negative logic

The families which may be employed in our projects with most success are:

1. Resistor Transistor Logic—**RTL**
2. Diode Transistor Logic—**DTL**
3. Transistor Transistor Logic—**TTL**

This month's article will concern itself with the first of these, the other two following later.

RESISTOR TRANSISTOR LOGIC GATES

RTL was the first family to appear on the market and is still being extensively used. The basic element of any family is the gate, and the one used in RTL is a positive logic NOR type shown in Fig. 1.2. The gate shown has two inputs A and B. If either of these is taken above the threshold voltage, its attendant transistor will saturate, taking the output of the gate down to very nearly zero volts.

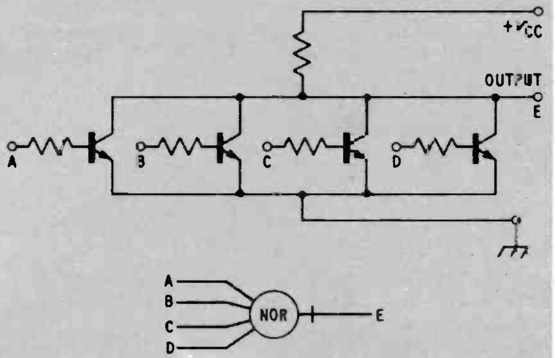
Now, if we substitute the logic notation of 1 for a positive voltage, and 0 for a zero voltage, it can be seen that, if any of the gate inputs is a 1, the output will be a 0. Similarly, if both the inputs are 0 the output will be a 1.

In this description we have assumed that a positive voltage represents a 1, but if zero volts represents a 1 and a positive voltage represents a 0 (i.e. negative logic), then from the previous analysis, two inputs (1) will give a 0 output. This gate is now operating as a NAND gate.

This dual function of gates is very important, and needs consideration when attempting to fathom out the operation of some of the more complex integrated circuits. A simple way of setting out the operation of a

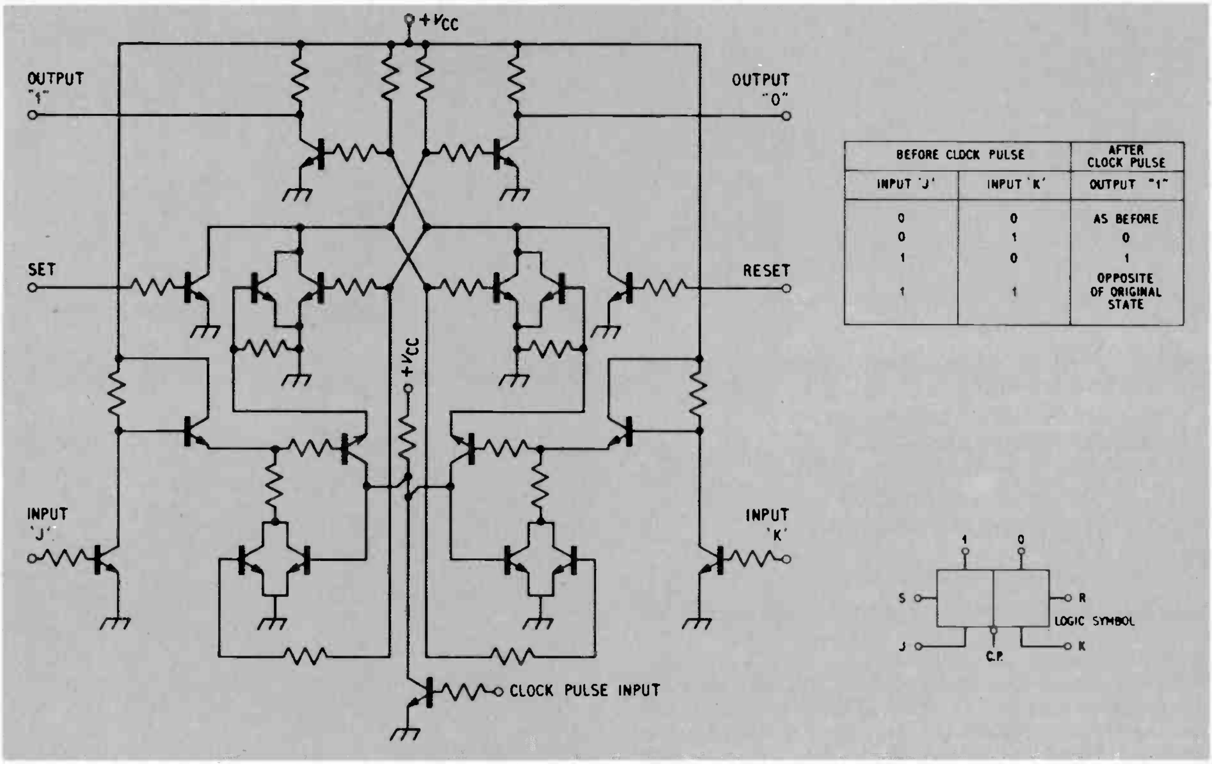
Table 1.1. LOGIC I.C. FAMILIES

Family	Characteristics
ECL	Emitter Coupled Logic, non-saturating, capable of very high speed operation, up to 300MHz
TTL	Transistor Transistor Logic, characterised by the multi-emitter input transistor; high speed of operation and high fan-out
DTL	Diode Transistor Logic, a medium speed family, using conventional circuitry
RTL	Resistor Transistor Logic, the first integrated logic family available; medium speed, low power line voltages
MOS	Metal Oxide Silicon (logic), uses f.e.t. technology; low cost, high density low speed



A	B	C	D	OUTPUT E
0	0	0	0	1
1	0	0	0	0
0	1	0	0	0
1	1	0	0	0
0	0	1	0	0
1	0	1	0	0
0	1	1	0	0
1	1	1	0	0
0	0	0	1	0
1	0	0	1	0
0	1	0	1	0
1	1	0	1	0
0	0	1	1	0
1	0	1	1	0
0	1	1	1	0
1	1	1	1	0

Fig. 1.3. Four-input RTL gate with truth table for positive logic NOR. Invert for negative logic



BEFORE CLOCK PULSE		AFTER CLOCK PULSE
INPUT 'J'	INPUT 'K'	OUTPUT "1"
0	0	AS BEFORE
0	1	0
1	0	1
1	1	OPPOSITE OF ORIGINAL STATE

Fig. 1.4. Circuit of a JK flip-flop with logic symbol. The truth table shows negative logic operation, which is best for describing JK characteristics. Note that simultaneous "1" inputs to the flip-flop cause the output state to reverse

gate is by means of a "truth table" which sets out the performance using logic terms, not, it must be remembered, voltage levels.

The truth table for our simple gate is set out beside it in both positive and negative logic notation, just as a maker's catalogue would show it.

This gate is the most simple basic element, but to increase the number of inputs merely entails adding extra transistors and resistors, as in Fig. 1.3. Manufacturers often put more than one logic function in each package, in fact the number of such elements is limited more by the number of leads available than by the physical size of the semiconductor chip.

The 8-lead Fairchild TO-5 can series of resistor transistor logic can be obtained with a 4-input gate or two 2-input gates or four 1-input (NOT) gates.

JK BISTABLE IN ONE CAN

Apart from simple gates, a logic system also requires a storage element, or bistable. Although these may be built up by interconnecting gates, it is simpler to have it in one can, because a bistable which is suitable for use in any application can become very complicated.

The storage element of the RTL family is the JK binary (Fig. 1.4). This really is the complete bistable, performing nearly all functions necessary without extra gating. It can be used in frequency dividers, counters, shift-registers, memories, and as a simple latch.

To describe the action of the JK, reference can be made to the truth table (Fig. 1.4). A bistable of this type has two main inputs, J and K, and a gating or clock pulse input, which allows the data on the J and K inputs into the bistable at the correct time.

There are also asynchronous inputs, "set" and "clear", which are overriding inputs, independent of the clock pulse, and allow the insertion of parallel data into registers. The "set" input may have been omitted, due to the number of pins available on a particular package, but the "clear" input is always available to allow resetting of counters, registers, and so on, to a state of all 0 before or after a logical operation has been performed.

The way in which the JK differs from simpler RS bistables (rarely used in integrated form) is that the JK has internal feedback to prevent simultaneous 1 inputs from producing indeterminate output states, as can be seen from the truth table.

Inputs of 1 on both J and K inputs cause the outputs to reverse, thus the JK can be made to act as a divider or counter simply by leaving the J and K inputs open circuit (this simulates 1 inputs in this logic system) and connecting the input to the clock pulse connection. The two outputs will be at half the input frequency and in antiphase.

If a further JK were to be connected to the output of the first stage in the same way, its output would be at a quarter of the original frequency and so on. The waveforms produced by three such stages are shown in Fig. 1.5; the binary digits represented by these waveforms are shown superimposed.

Those who are familiar with the binary system will be able to see that the counter has eight states, each of which corresponds to a decimal digit in natural binary. If these binary states are decoded and each output used to switch on a bulb or other indicating device, then at any point in time only one bulb would be lit. Successive input pulses would cause the next bulb in the line to light, and so on, until, on the ninth input pulse, the first bulb would be lit again.

This simple arrangement has been described to demonstrate the way in which RTL i.c.s can be employed in a workable system, and to aid the constructor in grasping the application of these useful elements.

For those interested in building such a system, the logic diagram is shown in Fig. 1.6, the logic notation is negative logic, so as to use the eight 3-input gates as NAND gates. The package count for this arrangement is seven, as three single JKs and four dual 3-input gates are required. A suitable bulb driving circuit is shown using a single *npn* transistor and a resistor; one of these is required for each of the eight outputs.

SYSTEM DESIGN

So much for the basic principles of RTL. Let us now look into the practical aspects of system design based on RTL.

The supply voltage used is usually either 3 or 3·6 volts, depending on the specified temperature range of the device selection in use. The cheap Fairchild range most readily available to use, has a restricted temperature range and uses a 3·6 volt supply. The professional ranges from all manufacturers use a 3 volt supply, which gives the same performance as the restricted range at a lower dissipation, allowing a wider range of operational temperatures.

Manufacturers' data often state a maximum supply voltage as great as 12 volts, but operating these circuits at anything other than the recommended 3 or 3·6V (plus or minus 10 per cent) is definitely not to be recommended, for a variety of reasons which need not be gone into here.

The maximum voltage that may safely be applied to any input pin is generally stated as plus or minus 4V, the positive part being limited by power dissipation considerations. The negative part is limited by the reverse voltage breakdown of the base emitter junction of the transistors used in the package.

This particular rating is unlikely to be of any concern to us if the correct supply voltage is used, unless we wish to interface our RTL logic with another system using higher voltages. In this case, a "go between" or interface circuit, that will convert the input levels to a suitable form, will have to be used.

FAN-OUT

Perhaps the most fundamental and necessary parameter to bear in mind when using RTL (or any of the other families) is the maximum "fan-out" any gate is capable of providing.

Fan-out means the number of inputs to other gates any single gate can drive, and as each input will draw a finite current from the gate output which is driving it, it is only natural that the fan-out will be limited to a certain number of inputs. Exceeding this number will cause the high level output voltage to drop to a level which is below the threshold, and malfunctions will occur.

To prevent us having to work out the possible fan-out with pen and paper, the manufacturers have fortunately worked it all out for us.

An input to the basic gate is called one load, and other inputs are scaled accordingly. The clock input of a JK element, for instance, represents two loads and, although there may be some special cases where an input represents more loads than this, these will be enough to remember for the moment, as they cover 90 per cent of the cases we are likely to encounter.

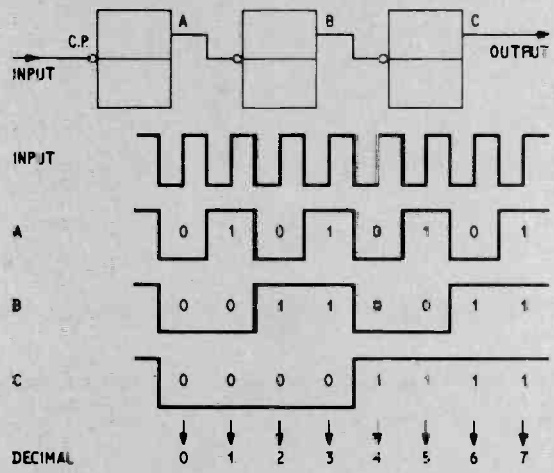


Fig. 1.5. Three cascaded flip-flops used for frequency division. Each bistable changes state on the negative edge of the input pulse. Positive logic is shown

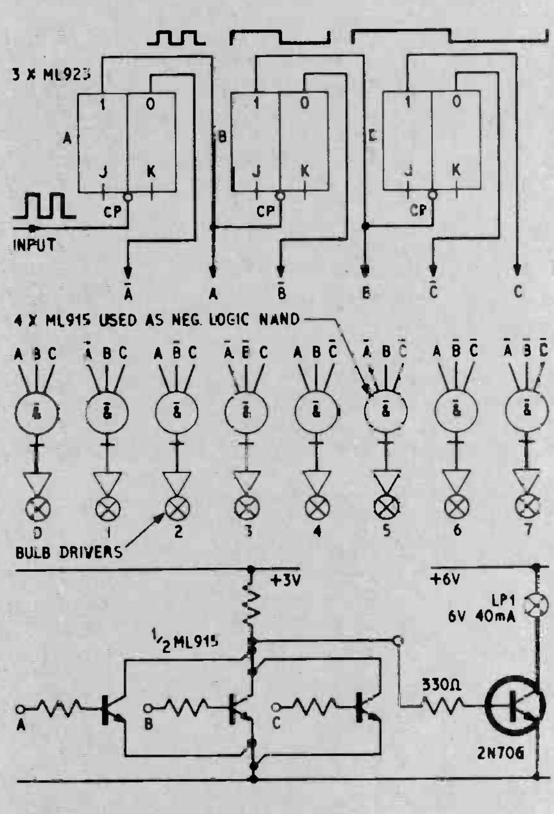


Fig. 1.6. Eight three-input NAND gates are used with the three JK flip-flops to decode the binary states and provide visual indication of these states by using bulb drivers

LOGIC TERMS

ADDER A binary adder is an arrangement of logic gates which will add two binary digits together and produce "sum" and "carry" outputs. A half-adder neither accepts a "carry in", nor produces a "carry out".

***AND* GATE** A circuit that will provide a logic 1 output only when a 1 is fed into all inputs.

ASYNCHRONOUS OPERATION of flip-flops. In this mode, entry of data into a flip-flop does not require a gating, or clock pulse.

BIT One binary digit (0 or 1), which usually forms part of a binary word.

BOOLEAN ALGEBRA The mathematical method of simplifying logic systems in which the expressions are derived from some sort of truth table

BUFFER GATE A logic gate which has a high output drive capability, or fan-out, which is used when a large number of gate inputs are to be driven by one gate function.

CLEAR INPUT This input to a flip-flop is used to set Q output to logic 0, and is an asynchronous input.

CLOCK PULSE The pulse which is used to gate information into a flip-flop when it is used in the synchronous mode. In JK connected flip-flops it will cause counting if the data inputs are both held at a logic 1.

COUNTER An arrangement of flip-flops producing a binary word, which is increased in value by one each time an input pulse is received. May also be called a divider, because successive stages of the counter divide each input frequency by two.

CURRENT SINKING LOGIC This term collectively describes both DTL and TTL and is used to indicate that the output of these gates "sink" (or earth) the current which would otherwise be holding on the input of the driven gate.

CURRENT SOURCING LOGIC This term describes, among others, RTL, and indicates that the output of this type of gate supplies current to hold on the input transistor of a driven gate.

DECODER A decoder is an arrangement of gates which will change an input word in one code, into a different type of code (for example, binary to decimal).

DIODE TRANSISTOR LOGIC (DTL) This type of logic uses diode inputs and a single transistor as an output current sinker.

EMITTER COUPLED LOGIC This type of logic is the fastest available; may be used at clock rates up to 300MHz. It is non-saturating; the basic gate circuit utilises a long-tailed pair.

EXCLUSIVE *OR* GATE This type of gate produces an output when the inputs are the same, but not when they are different, i.e. AB or $\overline{AB}$.

EXPANDER INPUTS Many logic families contain gates which have this facility, which is used to increase the number of logic performing inputs.

FAN-IN The number of inputs a single gate has.

FAN-OUT The output drive capability of any gate, and is quoted as the number of gate inputs an output will handle.

FLIP-FLOP This is the basic storage element in a binary logic system, and is used to build memories, counters and shift registers. Also called a bistable, toggle, or binary.

HIGH THRESHOLD LOGIC A modified form of DTL specially designed for use in noisy environments where its high input voltage threshold makes it insensitive to transients.

INTERFACE CIRCUIT Circuit used to link one type of logic family with another, or with analogue circuitry. In effect it translates the logic voltage swing of one into the logic swing of the other.

LARGE SCALE INTEGRATION Integrated circuits which contain very large numbers of individual gates (often many hundreds in fact). These gates are interconnected to form such things as memories which compare in size, and may be used to replace, core stores.

LINE DRIVERS AND RECEIVERS When logic signals have to be sent over many yards of cable a simple logic gate will not work properly as a driver, due to reflections and noise pick-up. Under these conditions it is necessary to use these special drivers and receivers, which use very low output impedance drive circuitry, and differential input receive circuitry.

LOAD LOGIC One load, as defined for a particular logic family, usually represents one input to a standard gate of that family. A gate output which will drive ten loads will reliably drive ten gate inputs.

LOGIC POSITIVE AND NEGATIVE Positive logic infers that the more positive voltage logic swing represents a 1, and the more negative swing represents a 0. Negative logic is the converse of this. Therefore any type of logic circuit may be treated as a positive or negative logic building brick.

MEDIUM SCALE INTEGRATION Those i.c.s which form a simple, self-contained logic system, such as a decade counter, or a five-bit shift register. These chips often contain up to 100 gates.

MONOLITHIC I.C. Integrated circuits of this type are made entirely on one very small silicon chip, as opposed to thin or thick film devices.

MONOSTABLE Type of multivibrator with one stable state. The integrated circuit version usually has input gating incorporated, and sometimes a Schmitt trigger. In i.c. parlance they are often termed single-shots, or one-shots.

M.O.S. LOGIC Logic circuits of this type are built entirely from metal oxide silicon field effect transitors, which enables a large number of gates to be built economically on a small chip, due to the small physical area needed for each active device.

***NAND* GATE** A NAND gate is an AND gate followed by an inverter. All its inputs have to be taken to a logic 1 state before the output will fall to a 0. Using the opposite logic polarity, this type of gate becomes a NOR gate.

NOISE IMMUNITY The largest noise voltage transient level on any input which the family is guaranteed to reject, i.e. not respond to.

***NOR* GATE** A NOR gate is simply an OR gate followed by an inverter. If any of its inputs are at the logic 1 level, its output will be a logic 0. Using the opposite logic polarity, this type of gate becomes a NAND gate.

***OR* GATE** A circuit that will provide a logic 1 output when any input is fed with a logic 1.

PRESET The preset input of a flip-flop is an asynchronous input which sets the Q output to a logic 1, and the $\bar{Q}$ output to a logic 0.

PROPAGATION DELAY The finite time delay, in the order of nanoseconds, between a gate receiving an input and setting up an appropriate output. For flip-flops, this delay time is often given in the form of the maximum input frequency at which the device will switch.

RESISTOR TRANSISTOR LOGIC This kind of logic uses resistors at its inputs to drive the output switching transistor directly.

SHIFT REGISTER A series connected string of flip-flops with a common clock line. On the receipt of a clock pulse the information contained by each flip-flop is shifted one place to the right or left. It is a simple type of memory.

SYNCHRONOUS OPERATION of flip-flops. Flip-flops used in this configuration require a gating, or clock pulse to enter information waiting at their inputs.

TEMPERATURE RANGE (OPERATING) There are three distinct temperature ranges for logic i.c.s. This factor determines the cost more than anything else. Circuits for military use are characterised from −55°C to +125°C, those for industrial use from 0°C to +75°C, and those for "entertainment" use from +15°C to +55°C.

TOGGLE Another word for a flip-flop, but it implies that the flip-flop will change state at the receipt of a clock pulse. It is mainly used to describe flip-flops connected as a counter, where the process of changing state is described as "toggling".

TRUTH TABLE A truth table may be used either to describe or design a simple logic element. A list of the input conditions possible is made; the output conditions which will result, or which are required, are arranged alongside. The logic expression may then be read off.

TRANSISTOR-TRANSISTOR LOGIC This logic family, usually termed TTL or T^2L, is the most versatile general purpose logic available. It utilises a multi-emitter input transistor, and a "totem-pole" output stage.

V_{CC} This symbol is used to denote the positive or negative supply voltage to an i.c. package, with respect to ground.

WORD A binary word is a collection of binary digits which together represent a complete number or command.

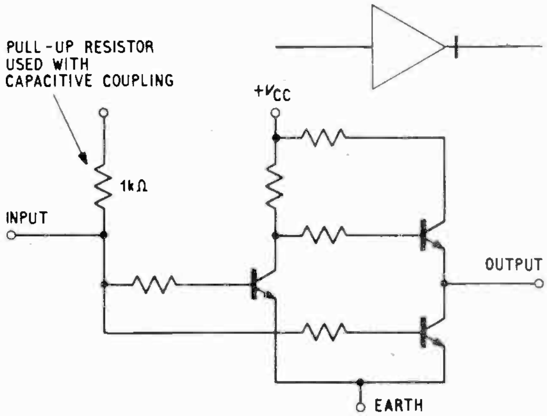


Fig. 1.7. Buffer element logic symbol and circuit

The drive capability of an output is rated as the number of loads it can successfully handle. A basic gate has an output which will drive anything up to five loads. There is one other system used by manufacturers to describe the fan-out of RTL which works in exactly the same way except that the input of the basic gate is stated to represent three loads, and the output drive capability is scaled up accordingly (i.e. 16 for the basic gate).

The obvious question now crops up, what happens when we need to drive more inputs than the gate fan-out allows us to? The answer is that we use a separate RTL package called a "buffer" to provide current amplification of the gate output. This enables us to drive up to 25 input loads, which will be necessary when driving the long "clock" lines of shift registers or certain kinds of counter.

BUFFER

The circuit of the buffer element is shown in Fig. 1.7, and a cursory glance will show us that it differs considerably from the basic RTL circuit from which all the gate and bistable elements are assembled. In fact, it bears a resemblance to the "totem-pole" quasi-complementary output stage much used in audio power amplifiers these days. The circuit operation is very similar, the aim being to provide a very low output impedance in both the high and low logic states.

This element is also very useful for constructing astable and monostable multivibrators, because although these can be made using a dual 2-input gate, the capacitance drive capability is poor due to the relatively high impedances associated with the basic RTL circuit; also the output wave shape will not be very square.

ASTABLE

A circuit for an astable is shown in Fig. 1.8; two buffer elements are required. The only discrete components needed are two capacitors, which set the frequency and mark-space ratio. Note that the "pull-up" resistors R1 and R2 are provided inside the package, and have a value of 1 kilohm.

The astable is a very useful circuit as it can be used as the "clock" of a digital system; it also has a large fan-out and complementary outputs.

Having drifted slightly from discussing system design pointers, let us continue by bringing up another

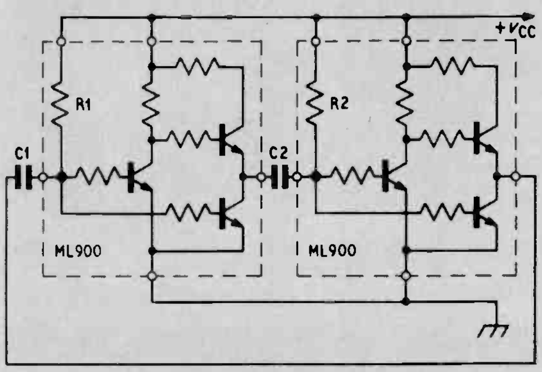


Fig. 1.8. Astable multivibrator made up from two buffer elements. The frequency of operation is defined by the capacitor values and the pull-up resistors R1 and R2. $f_0 = 1/(1{\cdot}4 \times R_1 \times C_1)$

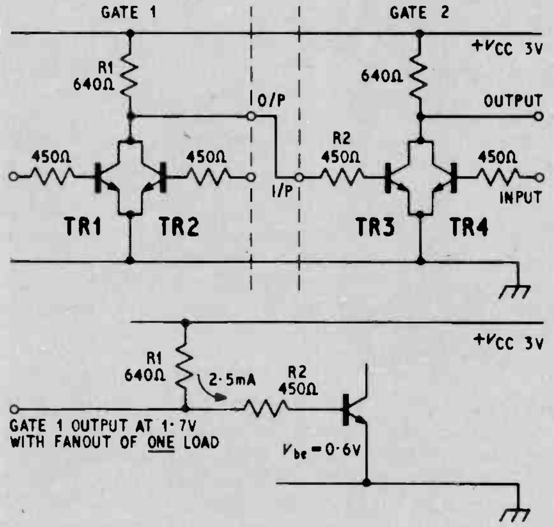


Fig. 1.9. Loaded basic gate circuit with fan-out of one

important point; the voltages or logic levels we can expect to find in a practical system in operation.

SATURATED LOGIC

RTL employs "saturated logic", that is, the output transistor of the basic gate is either fully turned on (saturated) or completely cut-off. The output voltages are therefore either just above earth, or at the full supply potential, for an unloaded gate. The output low voltage will not vary much with loading, but the output high voltage most certainly will, and to see why, let us consider the loaded basic gate circuit (Fig. 1.9).

When TR1 and TR2 are both turned off, TR3 of gate G1 will see a positive potential through R1 and R2 and will turn on. Now the output terminal of G1 is a point somewhere along the potential divider made up from R1, R2, and the base-emitter junction of TR3. The voltage across this junction V_{be} is essentially the same as that across a forward biased silicon diode; this is usually 0·6V and is independent of the current through it.

Therefore the current through the divider is found from

$$\frac{V_{CC} - V_{be}}{R_1 + R_2} = \frac{3 - 0{\cdot}6}{640 + 450} \simeq 2{\cdot}2\text{mA}$$

The voltage at the output terminal of G1 is

$$\begin{aligned} V_0 &= V_{CC} - (R_1 \times 2{\cdot}2 \times 10^{-3}) \\ &= 3 - (640 \times 2{\cdot}2 \times 10^{-3}) \\ &= 3 - 1{\cdot}408 \\ &\simeq 1{\cdot}6 \text{ volts} \end{aligned}$$

This lengthy explanation has been given to show that, even with a fan-out of only one, the logic levels will be quite low, and also to show what actually occurs when gates are interconnected, a point easily forgotten in arranging systems. The minimum output high voltage which will always operate another RTL gate, is in the region of 800mV at room temperature, and the maximum output low voltage is in the region of 250mV.

NOISE IMMUNITY

In any electronic circuit there is always present a certain amount of spurious noise, which can be due to anything from mains ripple to switching transients within the circuit itself. In a digital system this noise can cause gates to turn on when they are not intended to, and bistables to change state, if the noise is of sufficient amplitude and duration.

The noise immunity of a logic family is basically defined as the voltage necessary to raise or lower the quiescent input voltage to a gate sufficiently for it to change state. As RTL is associated with very low voltages, it follows that it will have a poor noise immunity, and this is in fact how it turns out in practice.

The manufacturers guarantee only a 300mV minimum noise rejection under worst case conditions, so any system we may design using this family will have to have due consideration paid to supply line decoupling and perhaps screening if it is essential to avoid malfunction.

A feature of any family, which industrial or professional users would be most interested in, but which is unlikely to concern us as amateurs, is the speed of operation or propagation delay, which is the frequency at which a bistable will change state, or the delay between a gate receiving an input, and setting up a relative output.

Although RTL is quite a slow family, its minimum frequency capability is 8MHz, and its maximum propagation delay is in the region of 30ns, which should prove more than adequate for our use.

This concludes the design considerations of RTL and it is hoped that readers now have some idea of the uses and limitations of this, the cheapest family.

Next month's article will show an example of how the RTL family can be put together in a practical project. Later articles will deal with the DTL and TTL families.

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2N1304	4/6	2N3904	7/6	AD142	14/3	BC169	2/6	NKT403	15/6
2N1305	4/6	2N3906	7/6	AD149	17/6	BC177	6/3	NKT405	15/6
2N1306	6/9	2N4058	5/3	AD161/AD162		BC178	5/8	OA47	1/9
2N1307	6/9	2N4059	4/-	(matched)	16/- pr.	BC179	6/-	OA90	1/3
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2N1711	7/-	2N4284	3/3	AF117	6/6	BC186	8/6	OA200	1/11
2N2147	18/9	2N4286	3/3	AF124	7/6	BC212L	5/-	OA202	2/-
2N2218	9/3	2N4289	3/3	AF127	7/-	BC213L	5/-	OC71	5/6
2N2270	12/9	2N4291	3/3	AF139	9/6	BC214L	5/3	TIP31A	17/6
2N2484	13/6	2N4292	3/3	AF180	18/6	BCY70	5/6	TIP32A	23/9
2N2646	10/9	2N4410	4/9	AF239	9/9	BD121	18/-	TI843	10/6
2N2904	11/-	2N5062	12/3	ASY26	6/6	BD123	24/3	ZTX300	3/6
2N2924	4/-	2N5163	5/-	ASY27	8/3	BD124	16/-	ZTX301	3/6
2N2925	4/6	2N5192	25/-	ASY28	6/6	BF167	5/6	ZTX302	4/6
2N2926	2/3	2N5195	28/3	B5041	15/-	BF178	10/6	ZTX303	4/6
2N3053	5/6	2N5457	9/9	BA102	9/-	BF180	12/-	ZTX304	6/9
2N3054	14/3	2N5458	9/9	BA115	4/-	BF194	7/-	ZTX500	5/-
2N3055	16/-	2N5459	9/9	BA130	4/6	BF195	7/6	ZTX501	5/-
2N3325	10/9	40250	14/3	BA145	5/6	BFX29	10/9	ZTX502	6/-
2N3663	11/6	40361	12/6	BC107	2/9	BFX84	7/5	ZTX503	5/-
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C	1/8W	5%	4·7Ω–330kΩ	E24	2·5d	2d	1·75d
C	1/4W	10%	4·7Ω–10MΩ	E12	2·5d	2d	1·75d
C	1/4W	5%	4·7Ω–10MΩ	E24	3d	2·5d	2·25d
C	1W	10%	4·7Ω–10MΩ	E12	6d	5d	4·5d
MO	1/2W	2%	10Ω–1MΩ	E24	9d	8d	7d
WW	1W	10% ± 1/20Ω	0·22Ω–3·9Ω	E12	15d all quantities		
WW	3W	5%	12Ω–10kΩ	E12	15d all quantities		
WW	7W	5%	12Ω–10kΩ	E12	18d all quantities		

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

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

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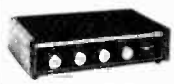

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Dual antilog	10K only	8/6

Any type with ½A D.P. mains switch, extra **2/6**. Please note: only decades of 10, 22 and 47 are available within ranges quoted.

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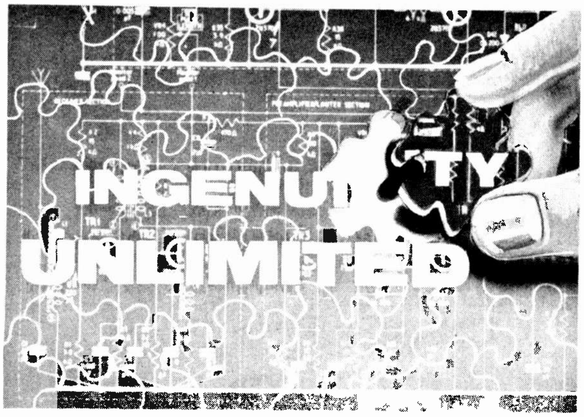


A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

CAR ANTI-THEFT ALARM

A SIMPLE car anti-theft alarm using three miniature relays is shown in Fig. 1. When triggered, the alarm prevents the engine from being started, sounds the horn continuously, and switches on the interior light. The alarm is normally controlled by a dashboard switch and push-button. Once the alarm is triggered the dashboard controls are rendered inoperative. The alarm can then only be released by the master switch which is mounted on the relay unit. For maximum security the relay unit should be situated in the locked bonnet or boot of the car.

OPERATION

The thief gets no warning that an anti-theft device is fitted to the car until having made his entry he closes the the door behind him. The alarm then triggers.

When the owner returns to his car he avoids triggering the alarm by moving the dashboard switch to the "OFF" position before closing the door.

CIRCUIT DESCRIPTION

The complete circuit diagram of the alarm unit fitted to a car is shown in Fig. 1. All relays are shown released and switches S1 and S3 closed. This is the "alarm set" state. Switches S1 and S2 are mounted on the dashboard, the master switch S3 is mounted on the relay unit.

When a thief opens the car door the switch S4 closes and provides a path for relay RLA to operate via RLC1 contact. As the relay operates its contact RLA1 on changing over causes relay RLB to operate. Contact RLB1 provides a holding path for relay RLB independent of contact RLA1. Contact RLB3 short circuits the ignition contact breaker to earth thus preventing the engine from being started. On opening the door, relays RLA and RLB operate and hold in. When the door is closed, relay RLA releases as its holding path via the door switch S4 is interrupted. As the relay releases, contact RLA1 provides a path for relay RLC to operate, via contacts RLB1 and RLB2 which are still made.

The horn is switched on via contacts RLC3, RLA1, and RLB1. The interior light is switched on via contacts RLC1, RLB2, RLA1, and RLB1. Contact RLB3 still disables the ignition circuit. The only possible method of releasing the alarm is by opening the master switch S3 which allows all three relays to release.

SETTING-UP

With the door closed, move S1 to "on". Push button switch S2 is pressed and held in whilst the door is opened. Switch S2 may now be released, and closing the door leaves the alarm set.

The circuit operation for setting the alarm is as follows. Operating S2 causes relay RLC to operate. Opening the door provides a holding path for relay RLC independent of S2, i.e. via RLC1 contact and door switch S4. Closing the door breaks the holding path allowing it to release. Hence when the alarm is set, all three relays are released.

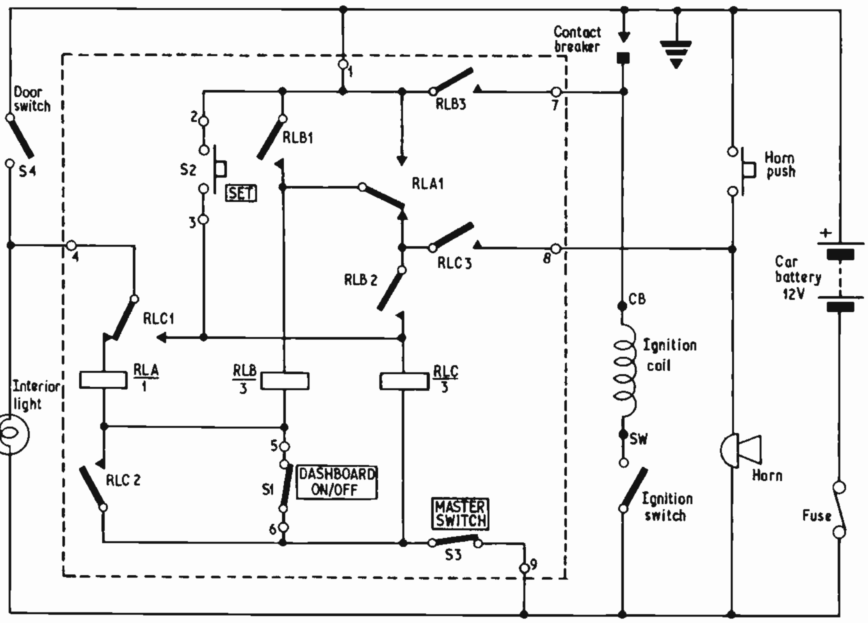


Fig. 1. Circuit diagram of the car anti-theft alarm

CONSTRUCTION

Any type of 12V relays having the required number of contacts may be used, see Fig. 1. Miniature sealed relays are most suitable as they will prevent the entry of dirt and moisture to the contacts. However, it is important that the contacts are heavy duty types and capable of carrying the horn current, which could be as much as 7 amps at switch on. The relays can be mounted on a piece of s.r.b.p. board and then mounted in a metal diecast box. The master switch S3 and a 9-way terminal block should be mounted on the sides of the box.

WIRING

Care should be taken to ensure that connections are made to the correct points on the car wiring. (Refer to Fig. 1.) Terminal 8 is connected to the horn-push side of the horn. Terminal 7 is connected to the terminal marked CB on the ignition coil.

The alarm may be fitted on cars using either positive or negative earth systems. Terminal 1 must be connected to the earth (chassis) side of the battery and terminal 9 to the other side of the battery via the fuse.

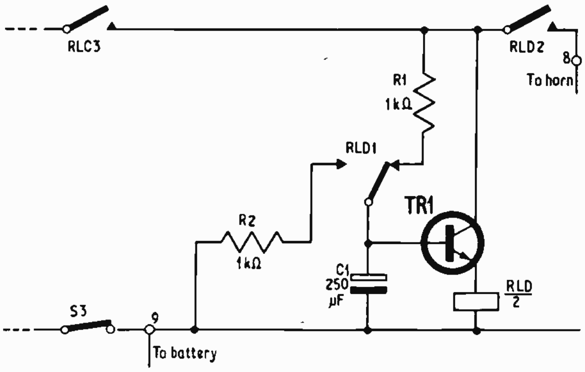


Fig. 2. Additional circuitry for adding an interrupted alarm note to the car anti-theft alarm

MODIFICATIONS

If an interrupted note from the horn is preferred, another relay must be added, see Fig. 2.

The component values may be adjusted to find the preferred interruption rate and on/off ratio. The circuit is a simple charge-discharge system with the coil of relay RLD forming the emitter load of the transistor. The relay coil resistance should be greater than 150 ohms, and the transistor chosen to suit the power requirement of the relay.

The circuit Fig. 2 is drawn for use on cars with positive earth. For negative earth systems a *pnp* transistor should be used and capacitor C1 reversed.

It may be preferred by some motorists to dispense with the ignition cut-out and hooter alert, and to arrange that the alarm condition merely disconnects the petrol pump. This is easily done by omitting RLC3 and RLB3 contacts, and providing a "break" contact on RLC relay connected in series with the petrol pump.

K. L. Spence,
London,
N.W.7.

TEMPERATURE ALARM

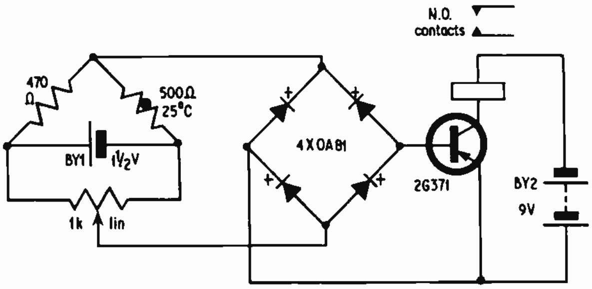


Fig. 1. Simple temperature alarm circuit

I WONDER if the temperature alarm circuit shown in Fig. 1 is of interest to your readers. When the temperature of a liquid or solid, etc. must be kept constant the thermistor is inserted into the liquid and the potentiometer set so that there is no voltage applied to the transistor, the relay will not operate.

When there is a temperature change, approximately ±1 degree depending on the transistor and components used, the relay will operate, ringing a bell or any other suitable alarm.

David G. Warner,
Birmingham, 34.

I.C. HOLDER

SOME time ago I bought a Fairchild μL914 integrated circuit with the idea of carrying out various simple experiments. As soon as the device arrived it was obvious that constantly soldering and unsoldering would soon ruin it. However, a B9A valve base plug was to hand and the i.c. was soldered to it as in Fig. 1.

The numbers indicate the i.c. terminal numbers. Note that lead 8 is singled out by the flat or spot on the i.c. case. All i.c. leads are wired to the plug following the standard B9A pin numbering, i.e. 1 to 1 . . . 8 to 8. The result is very robust and has stood up to a great deal of wear and tear.

N. Harrison,
Stafford.

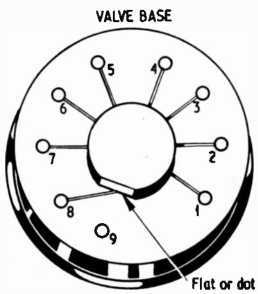
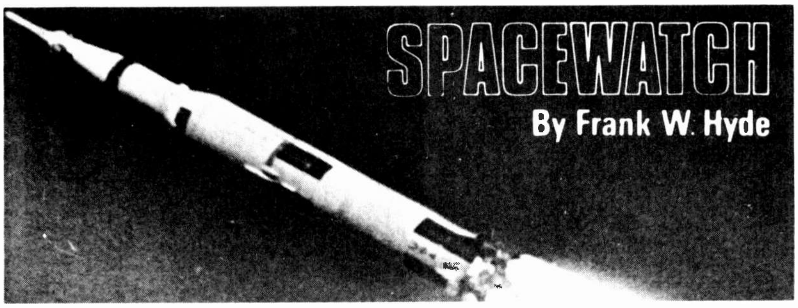


Fig. 1. Wiring details for the B9A valve base plug i.c. holder



NEW RADIO TELESCOPE

India's new radio telescope is in operation and the first results have been released. During the first 14 days of observations the telescope was directed at the southern part of the sky and five new radio sources are reported to have been discovered.

The design of the telescope is based on the cylindrical paraboloid. There are 24 towers of equidistant spacing over a distance of 530 metres. Each tower supports a parabolic arm of 30 metres in length and the 24 arms support the wire reflectors and the aerials. The whole aerial can be steered through 140 degrees elevation.

Sited at Ootacmund in Southern India and being near the equator, it is one of the largest telescopes that is able to track sources for more than two hours a day, and in an east west direction for more than nine hours per day. The operating frequency is 324 to 329MHz and a further system of dipoles is being designed for use at 100MHz.

The new tracking station, under the direction of Dr D. Swarup, who had his training in America, puts India on the map in radioastronomy and will add another observatory to chart the sources from the southern hemisphere with great precision.

It is planned to set up two dishes 13·5 metres in diameter at a point 3·5km to the west of the present site in order to provide interferometer facilities.

There is one unusual task that the observatory will carry out and that is to measure minute changes in the almost non-existent atmosphere of the moon caused by the dumping of terrestrial materials on the surface of the moon.

CARBON MONOXIDE IN SPACE

Hydrogen, water, ammonia, formaldehyde and the hydroxil radical have already been found in galactic clouds. Using the 35ft microwave telescope, the National Radio Observatory in West Virginia have discovered carbon monoxide at a frequency of 115GHz.

Five main sources have been recorded but the most important are in the sources of Sagitarius A and Orion A. Sagitarius A is in the direction of the nucleous of the galaxy and Orion A is in a region of star formation. The width of the line is 2MHz in the Orion source and the total extent of the CO is 1 degree in diameter which is larger than the source itself.

The Sagitarius source is a complicated one having several doppler shifted lines over a total bandwidth of 100MHz.

ECHO 1 AND ECHO 2

The two passive satellites *Echo 1* and *Echo 2* both died within a short time of each other and have left the geodesists in a little difficulty. Having magnitudes of 2·5 × they were easily recorded by small cameras. These cameras were able to photograph the satellites against the background of stars as part of the triangulation programme of Western Europe.

Having now to use much fainter satellites the International Association of Geodesy is pressing for another *Echo* satellite. Those being used at the moment, *Explorers 19* and *39*, are often too faint for European cameras. The present accuracy of location is about 30 metres and it is hoped to bring this to 3 metres with standard photographic methods. When the laser methods come into use in 1972 the accuracy will improve to less than 1 metre.

UK-5

In 1973 satellite *UK-5*, which when in orbit will have its name changed to *Ariel 5*, will have a number of interesting experiments to undertake. There will be six experiments altogether and they will all be concerned with cosmic X-rays or X-ray astronomy, and for the second time a British satellite will carry an American experiment.

In the GEC-Marconi design of the *UK-5* satellite, all the sky surveys and precision measurements of point sources can be made from the same vehicle. Two survey instruments are mounted in the cylindrical walls of the spinning satellite and look out sideways. The four measuring instruments which deal with the components of the individual sources, look along the satellite's axis of spin. Fine gas jets are provided so that the axis can be pointed in any direction.

The United States experiment is being prepared by the Goddard Spaceflight Center and together with Leicester University's experiment will carry out the survey of sources. An experiment of the University College, London, will fix the positions of the sources with an accuracy of one minute of arc.

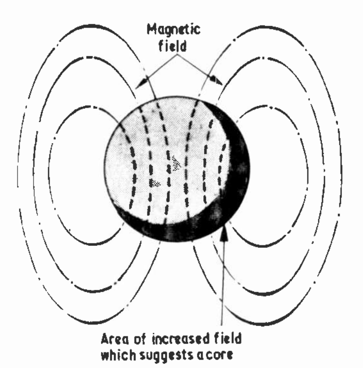
APOLLO 12

The *Apollo 12* has provided one of the most worth while scientific experiments in the moon programme. The magnetometer which the *Apollo 12* crew set up on the moon for the Ames Research Centre, has shown some remarkable results reported Dr C. P. Sonett of Ames, whose group have some considerable experience in this field, when he spoke at a special conference held in Newcastle by the Nato advanced study institute.

In 1967 the magnetometer on board *Explorer 35* which orbited the moon provided some detailed information about the solar wind. This showed that like the earth a "shadow" existed on the side away from the sun. The magnetometer with three sensors showed that there was a relatively large field on the surface of about 350 microgauss.

It is thought that this arises from a large mass of magnetised material at a distance of some 200km from the *Apollo 12* site. It is not possible that this is part of an overall field because it would have been registered on *Explorer 35*. It must therefore be a localised field. This idea fits in with the discovery by *Apollo 12* of "fossil" magnetised material on the moon.

This must mean that at some time the moon was in a much larger magnetic field than at present. Sudden variations which have been noted by *Explorer 35* in the area of the *Apollo 12* magnetometer are due to fluctuations in the solar field and are up to five times as large than elsewhere. From this it follows that there must be a conducting core surrounded by a much less conductive shell. Calculation shows that this shell has a depth of something of the order of a few hundred kilometres. Perhaps here is another important clue to the composition of the moon.



Has the moon a core

P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST

PART TEN CONCLUDING ARTICLE: DIAL CALIBRATION, A.G.C. MODULE, OPERATION SEQUENCE

Construction details of the receiver and local oscillator were completed last month. The local oscillator tuning dial must now be calibrated and the operational sequence learned before the receiver can be used. This final article also gives details of an automatic gain control module which can be easily added to the receiver chassis if required.

DIAL CALIBRATION

The dial specified in the components list last month is calibrated 0 to 500 by the manufacturer and dial calibration is carried out with reference to these markings—using the vernier dial. Table 10.1 shows the received frequencies, corresponding to dial readings in steps of 50. Five frequencies are given for each dial position corresponding to the five ranges selected by the range switch. The dial can be calibrated in MHz, using Letraset numerals for each range.

A.G.C. MODULE

The a.g.c. unit is provided as an additional item and is used in conjunction with the carrier control; the only difference to the operator is that once the carrier level has been set by the carrier control, the gain of the receiver will automatically compensate for any change in the *received* carrier level. The unit works in the following manner.

CIRCUIT DESCRIPTION

The sideband and the carrier signal is picked up from SK6 on the i.f. unit and fed to SK1 of the a.g.c. module (Fig. 10.1). Capacitors C2, C3, C4 and crystals X1 and X2 act as a sharp sided filter at 2MHz exactly, the bandwidth being approximately 100Hz, equally displaced about 2MHz. As a result of this filter action, the 2MHz carrier signal is accepted and the sideband information rejected. Transistors TR1 and TR2 amplify the 2MHz carrier signal selectively due to the filter action of L1 and C7 (tuned to 2MHz). Maximum gain is achieved in this two stage amplifier as the feedback, via R2 and R3, is fully decoupled by C8.

All the voltage gain is developed in TR1, TR2 reduces the output impedance to match the following common base amplifier TR3. Transistor TR3 has a similarly tuned collector load, in the shape of L2 and C13, and further voltage gain, at 2MHz, is developed

Table 10.1. DIAL CALIBRATION

Range	A	B	C	D	E
Dial reading	Frequency in MHz				
0	1·8	3·0	5·0	8·5	16·0
50	1·85	3·18	5·04	8·75	16·7
100	1·87	3·25	5·1	8·9	17·0
150	2·07	3·47	5·6	9·5	18·05
200	2·2	3·66	5·9	10·0	18·5
250	2·36	3·88	6·21	11·0	20·3
300	2·53	4·2	7·0	11·91	22·5
350	2·8	4·5	8·01	12·8	24·8
400	3·02	4·9	8·42	13·85	26·0
450	3·38	5·55	9·61	16·0	30·5
500	4·0	6·8	11·8	18·2	35·2

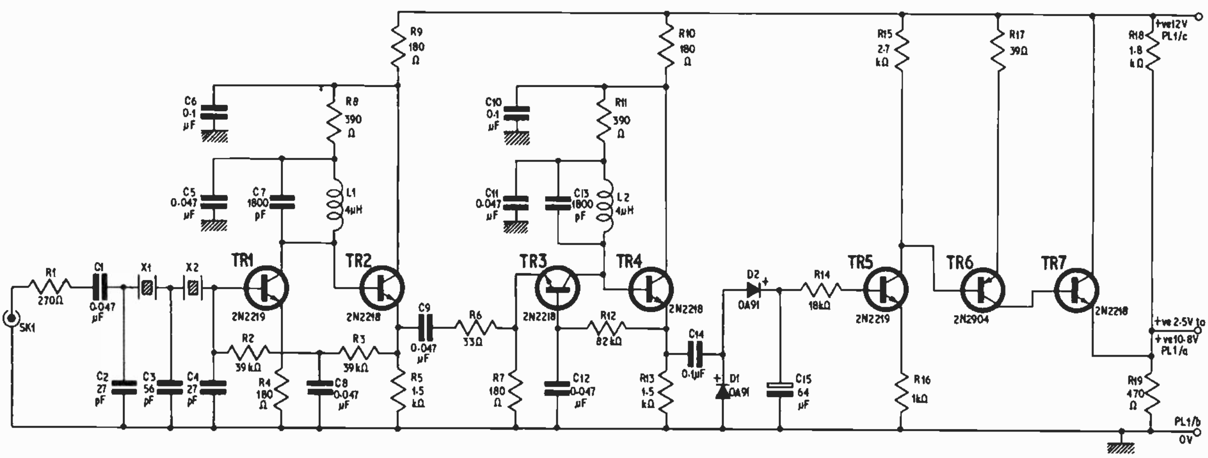


Fig. 10.1. A.G.C. module circuit diagram

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BCY42	4/-
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2N914	4/6
2N918	7/6
2N929	5/6
2N930	7/6
2N1090	6/6
2N1091	6/6
2N1131	6/6
2N1132	8/-
2N1302	4/-
2N1303	4/-
2N1304	5/-
2N1305	5/-
2N1306	5/-
2N1307	5/-
2N1308	7/-
2N1309	7/-
2N1496	34/-
2N1507	4/8
2N1613	5/6
2N1671,A	29/6
2N1711	6/6
2N1893	10/-
2N2147	17/-
2N2152	27/6
2N2148	12/6
2N2160	14/9
2N2243	26/-
2N2368	5/-
2N2369	5/-
2N2369A	5/6
2N2432	67/-
2N2484	8/-
2N2613	7/6
2N2614	4/-
2N2646	10/-
2N2711	6/-
2N2712	6/-
2N2713	5/6
2N2904	8/6
2N2904A	8/-
2N2905	10/-
2N2905A	8/-
2N2923	4/-
2N2924	4/-
2N2925	3/6
2N2926 Green	2/-
2N2926 Yellow	2/-
2N2926 Orange	2/-
2N2926 Brown	2/-
2N3011	12/6
2N3036	39/-
2N3053	5/-
2N3054	12/6
2N3055	15/-
2N3133	6/-
2N3135	6/-
2N3136	6/-
2N3235	28/6
2N3234	27/6
2N3391A	6/-
2N3392	5/-
2N3393	5/-
2N3394	4/9
2N3402	5/6
2N3403	5/6
2N3404	7/6
2N3414	5/6
2N3415	6/-

2N3416	7/6
2N3436	15/-
2N3525	21/9
2N3528	19/-
2N3606	5/6
2N3607	4/6
2N3702	3/3
2N3703	3/-
2N3704	3/3
2N3705	3/-
2N3706	2/9
2N3707	3/-
2N3708	2/-
2N3709	3/-
2N3710	3/-
2N3711	3/-
2N3819	8/-
2N3820	18/9
2N3826	6/-
2N3854	5/6
2N3854A	5/6
2N3855	5/6
2N3855A	6/-
2N3856	6/-
2N3856A	6/-
2N3858	5/-
2N3858A	6/-
2N3859	5/6
2N3859A	6/3
2N3860	6/-
2N3866	25/-
2N3877	9/-
2N3877A	9/6
2N3900	10/6
2N3900A	11/6
2N3903	7/-
2N3904	7/-
2N3905	7/6
2N3906	7/6
2N4037	15/-
2N4058	4/6
2N4059	5/-
2N4060	5/-
2N4061	4/-
2N4062	4/6
2N4284	3/-
2N4285	3/-
2N4286	3/-
2N4287	3/-
2N4288	3/-
2N4289	3/-
2N4290	3/-
2N4291	3/-
2N4292	3/-
2N4871	6/9
2N5027	10/6
2N5028	11/6
2N5029	9/6
2N5030	8/6
2N5172	3/-
2N5174	10/6
2N5175	10/6
2N5176	9/-
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2N5249	13/6
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2N5306	8/-
2N5309	12/6
2N5354	5/6
2N5355	5/6
2N5356	10/6
3N84	26/-
3N128	18/6
3N140	19/6
3N141	21/6
3N142	16/6
3N143	19/6
3N152	24/-
2S001	10/-
2S002	12/6
2S003	12/6
2S004	15/-
2S005	15/-
2S006	15/-
2S012	25/-
2S012A	22/6
2S017	15/-
2S018	17/6
2S019	19/6
2S024	25/-
2S104	12/6
2S301	8/6
2S302	7/6
2S303	10/-
2S304	12/6

2S306	15/-
2S320	9/-
2S321	6/-
2S323	10/-
2S701	8/6
2S703	12/6
2S720	25/-
2S732	8/6
2S1002	10/-

DIODES & RECTIFIERS

AA119	2/-
AAY11	2/-
AAZ12	6/-
AAZ13	2/6
BA100	6/-
BA110	6/-
BA111	6/-
BA112	18/-
BA115	1/6
BA130	3/-
BAY31	2/6
BAY38	3/-
BY100	5/-
BY125	3/6
BY127	4/-
BY234	2/3
BYX10	3/-
BYX36/150	2/6
BYX36/300	2/10
BYX36/600	3/9
BYY21	25/-
BYY23	26/3
BYY25	31/9
BYY142	3/9
BYZ10	9/-
BYZ12	6/-
BYZ13	5/-
CG6E	4/-
CG63	2/-
CG64	2/6
CG61	2/6
CG62	2/6
EA403	3/6
EC401	5/-
EC402	4/8
EB383	3/6
GEX45/1	4/-
GJ3M	4/-
OA5	3/8
OA10	6/-
OA47	1/6
OA70	1/6
OA73	1/6
OA79	1/6
OA81	1/6
OA85	1/6
OA90	1/6
OA91	1/6
OA95	1/6
OA200	2/-
OA202	2/-
SD19	7d
TD716	12/-
IN34A	4/-
IN60	4/-
IN64	4/-
IN82A	9/6
IN87A	4/6
IN191	5/-
IN914	1/9
IN4001	2/-
IN4005	4/-
IN4007	5/-
IN4148	1/9
IS113	4/6
IS44	1/9
IS130	2/-
IS131	2/6
IS132	3/-

LOWEST I.C. PRICES YET!

IC10	59/6	Sinclair IC amp.
PA230	20/-	IC Preamplifier
PA234	20/-	1 watt audio amp
PA237	32/6	2 watt audio amp.
PA246	52/6	5 watt audio amp.
PA424	43/-	Zero voltage switch
SL403A	42/6	3 watt Plessey amp.
SL702C	29/6	Plessey linear amplifier
TAA263	15/-	Mullard linear amp.
TAD100	45/-	IC receiver
TAA293	20/-	Mullard gen. purp. amp.
TAA310	30/-	Record/Playback preamp.
TAA320	13/-	MOS LF amplifier
3N84	26/-	Silicon controlled switch

Data sheets available on request—1/- per copy.

PLEASE NOTE: Only new—full specification integrated circuits, no below-specification types.

FAIRCHILD MICRO-LOGIC

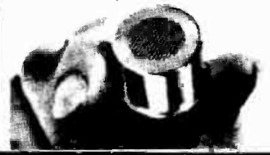
	1–6	7–11	12+
ul 900	9/9	9/-	8/-
ul 914	9/9	9/-	8/-
ul 923	12/6	11/9	11/-

Prices for 100+ and 1000+ on application

5 page data and circuits article—2/6
Plastic spreaders—1/6 each

ULTRASONIC TRANSDUCERS

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



ZENER DIODES

400mW 10% GLASS CASE. TEXAS Mfr.

1S2036	3·6 volt
1S2039	3·9 volt
1S2043	4·3 volt
1S2047	4·7 volt
1S2056	5·6 volt
1S2062	6·2 volt
1S2068	6·8 volt
1S2075	7·5 volt
1S2082	8·2 volt
1S2100	10 volt
1S2110	11 volt
1S2120	12 volt
1S2160	16 volt
1S2180	18 volt
1S2270	27 volt
1S2300	30 volt

PRICES: 1–24 3/6
25–99 2/9
100+ 2/3

2N3819 7/-

Texas FET
25 + 6/- 100 + 5/3

2N4871 6/9

Motorola unijunction
25 + 5/9 100 + 4/9

2N3055 15/-

115 watt silicon power transistor
25 + 13/- 100 + 11/-

BC107/8/9 2/9

NPN Planar transistors
BC107 & 9
25 + 2/5 100 + 2/2
BC108 25 + 2/3 100 + 2/-

BY 127 4/-

Mullard Plastic HV rectifier 800 piv. 1 amp. (similar BY100, etc.)
25 + 3/3 100 + 3/-

2N2926 2/-

NPN Planar transistors
25 + 1/8 100 + 1/6

INFRA-RED DEVICES

56 CAY 29/6
Gallium arsenide emitter

MGA 100 35/-
Gallium arsenide emitter

31F2 28/6
Infra-red detector diode

AD161/2 10/-

Siemens/Telefunken NPN/PNP output pair
25 + 9/- 100 + 8/-

OCP 71 19/6

Mullard phototransistor
25 + 17/3 100 + 14/9

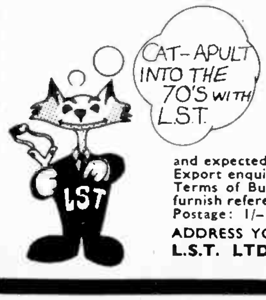


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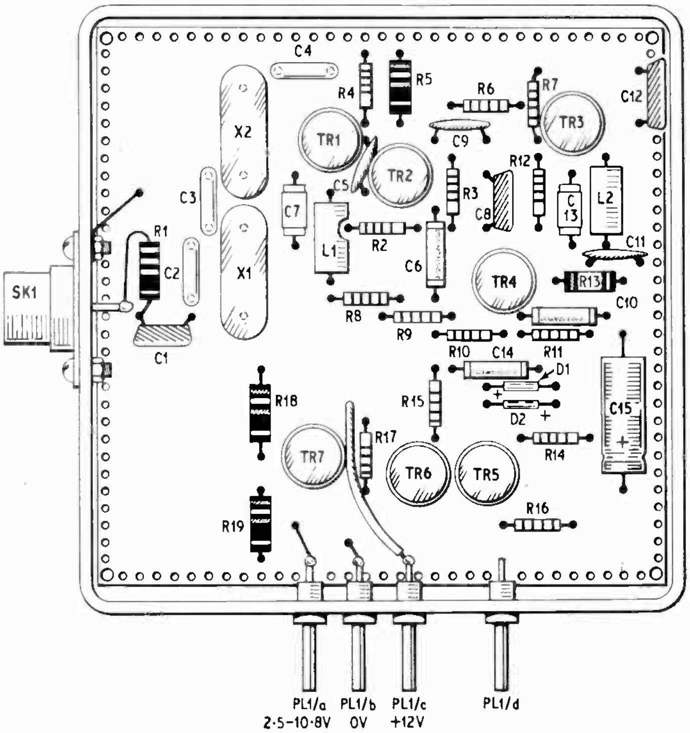
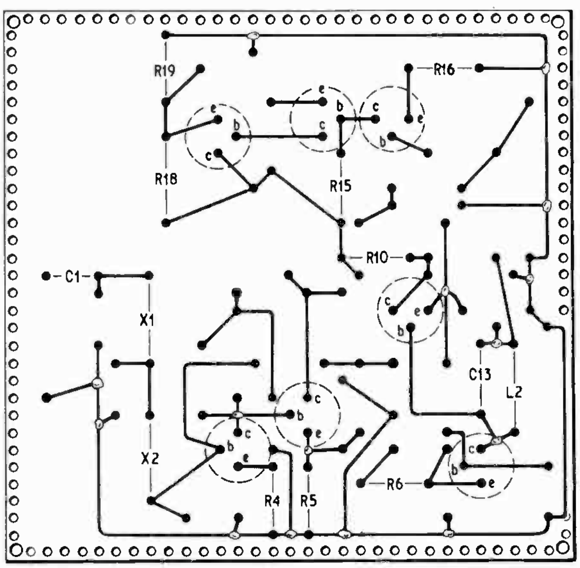
FIG. 10.2. A.G.C. MODULE



Component layout of a.g.c. module



Underside wiring of a.g.c. module

COMPONENTS . . .

A.G.C. MODULE

Resistors
R1 270Ω
R2 39kΩ
R3 39kΩ
R4 180Ω
R5 1·5kΩ
R6 33Ω
R7 180Ω
R8 390Ω
R9 180Ω
R10 180Ω
R11 390Ω
R12 82kΩ
R13 1·5kΩ
R14 18kΩ
R15 2·7kΩ
R16 1kΩ
R17 39Ω
R18 1·8kΩ
R19 470Ω
R20 560Ω
All $\frac{1}{3}$W, ±5% high stab

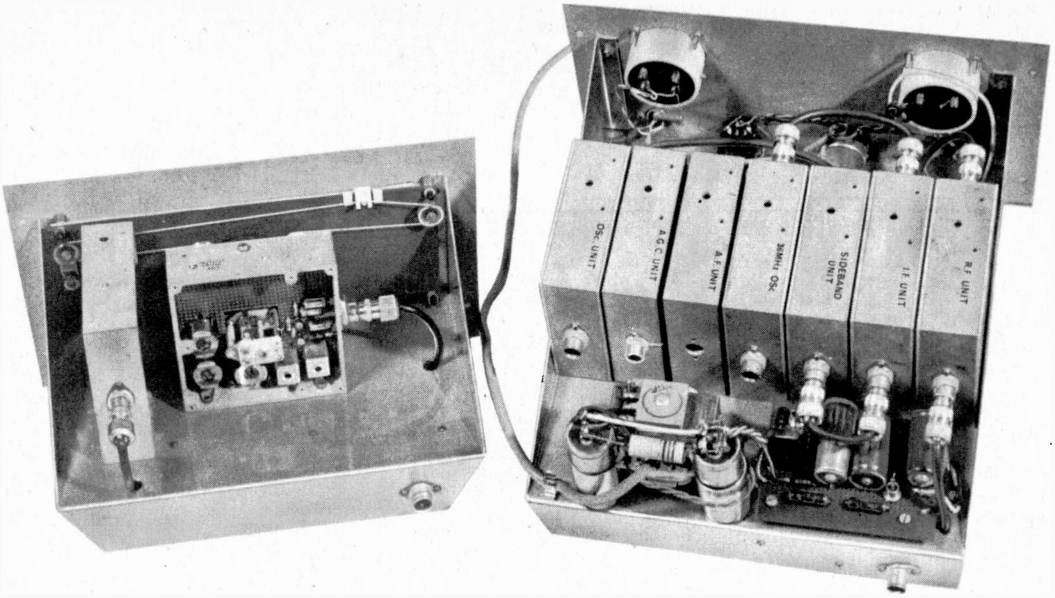
Capacitors
C1 0·047μF ceramic
C2 27pF } mica ±5%
C3 56pF } mica ±5%
C4 27pF } mica ±5%
C5 0·047μF ceramic
C6 0·1μF polyester
C7 1,800pF polystyrene ±5%
C8 0·047 ceramic
C9 0·047μF ceramic
C10 0·1μF polyester
C11 0·047μF } ceramic
C12 0·047μF } ceramic
C13 1,800pF polystyrene ±5%
C14 0·1μF polyester
C15 64μF elect. 10V

Semiconductors
TR1 2N2219
TR2, 3, 4 2N2218 (3 off)
TR5 2N2219
TR6 2N2904
TR7 2N2218
D1, 2 OA91 (2 off)

Inductors
L1 4μH choke ±5%
L2 4μH choke ±5%

Crystals
X1, 2 2MHz (1·999900 to 2·000010MHz, 2 off)

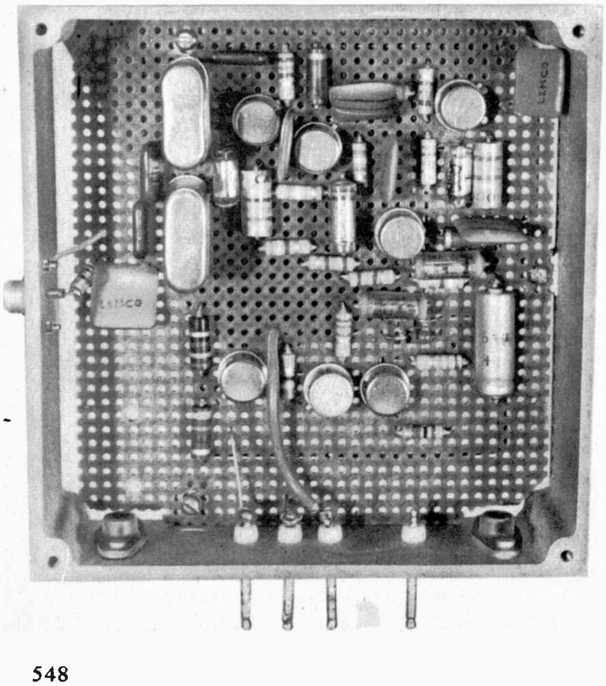
Miscellaneous
SK1 coaxial output socket
PL1/a–d lead through connectors (4 off)
Veroboard 3½in × 3½in, 0·1in grid



in this stage. Transistor TR4, acting as an emitter follower, presents a high impedance to the collector load of TR3, thus sustaining the high impedance load required for voltage gain to take place, and presents a low impedance to the diodes D1 and D2.

Diodes D1 and D2 rectify the positive going portion of the signal and the resultant positive d.c. voltage is fed, via R14, to the base of TR5. As the voltage at the base of TR5 becomes more positive and the collector of TR6 is connected to the base of TR7, the emitter of TR7 follows the change in TR5 base voltage and the quiescent 2 to 5 volts at the junction of R18 and R19 starts to go more positive due to the extra current being drawn through R19. When this voltage becomes more positive the gain of the receiver is reduced, due to the fact that this point is connected back to the r.f. and i.f. units.

A point of equilibrium is reached, and C15 ensures that the overall loop does not oscillate. The charging time of C15 is relatively quick, due to the low source resistance of D1 and D2, and the output impedance of the emitter follower, while the discharge time is a matter of some seconds as a result of the high resistance discharge path via R14 and the input impedance of TR5—in the order of 50 kilohms.



A.G.C. MODULE CONSTRUCTION

The a.g.c. module is constructed in a case similar to those used for other modules in the main receiver chassis, as shown in Fig. 2.1. All components are mounted on plain perforated Veroboard and wired up on the underside using component leads wherever possible. Component layout and wiring are shown in Fig. 10.2.

Once constructed and tested—as detailed later—the a.g.c. module is fitted in the main receiver chassis in the vacant module position. The module is wired up with reference to the circuits given in Fig. 10.3. It can be

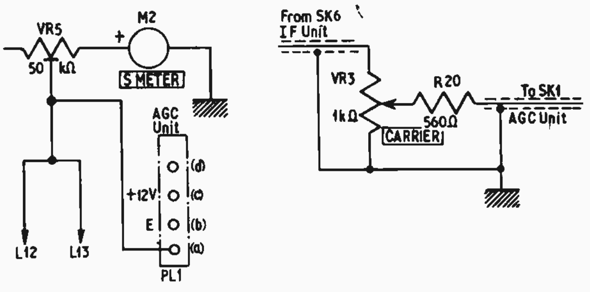


Fig. 10.3. Modified chassis wiring circuit for the a.g.c. module

seen that wiring already connected around M2 and VR3 ("carrier") will have to be modified to incorporate the a.g.c. module.

SETTING UP INSTRUCTIONS

Equipment required

(a) **Power Supply** 12V, 100mA.
(b) **Multimeter.**
(c) **Signal Generator** 2MHz (Crystal controlled) giving an output of up to 10mV.

PROCEDURE

Apply the supply voltage, in the correct polarity, to the correct terminals and check the d.c. potentials to see that they correspond to those indicated in Table 10.2. Having established that the d.c. conditions are correct, apply a 2MHz signal, ±20Hz, to SK1 at a level of 0·25mV. Connect a multimeter between pins PL1/a and PL1/b with the positive lead to PL1/a. The voltage at this point should be 2·5 volts ±0·3 volts. Increase the input signal level to 1mV and the voltage at PL1/a should increase to approximately 10·8 volts. The voltage at PL1/a should start to increase positively as the 2MHz input signal level reaches approximately 0·5mV. If the voltage at PL1/a has not increased to 10·8 volts when the input signal is 1mV at 2MHz reduce the value of R16 until the correct voltage has been established (R16 must not be less than 270 ohms).

If the voltage is more than 4 volts at PL1/a, when the input signal at 2MHz is 0·25 volts, then insert a resistor in series with C8 until the voltage is reduced to approximately 3 volts.

OPERATIONAL SEQUENCE

The sequence for setting the controls, when searching for a station and finally setting the receiver when the required station has been located, would appear, at first sight, to be somewhat complicated. However, this is not the case. For the operation to be simply understood it must be remembered that in single side-band transmission a carrier tone is transmitted at some level below the sideband information. The carrier tone is the information that indicates to the receiver what gain setting it should take up. In the case of automatic gain control (described earlier in this article) the carrier signal is sensed and the r.f. and i.f. gain of the receiver is automatically set. This leaves only the audio output level and the "R.F. Gain" to be individually adjusted.

OPERATION WITHOUT A.G.C.

First of all the "Audio Gain" is set to position 6 (the total sweep of VR1 and VR2 is divided equally into 10 divisions) and the "R.F. Gain" advanced to it's maximum gain condition (i.e. fully clockwise). The "Carrier" control is now advanced until the V.U. meter (M1) reads the noise of the receiver fluctuating around −10dB. The local oscillator is set to the required frequency and when the signal is located the "Carrier" control is adjusted until the V.U. meter reads 0 V.U. If the signal strength (S) meter (M2) reads less than 9dB the "R.F. Gain" control is left at it's maximum setting. However, if the Signal Strength Meter reads in excess of 9dB the "R.F. Gain" should be reduced and the "Carrier" increased until the signal strength meter reads 9dB and the V.U. Meter reads 0 V.U. It is this final adjustment that may prove to be a little awkward until some experience has been obtained in operating the receiver when it will be found that it only takes two or three seconds to make the necessary adjustment.

Table 10.2. A.G.C. UNIT D.C. VOLTAGES

Stage	Vc	Ve	Vb
TR1	7	1·2	1·9
TR2	10	6·3	7
TR3	7	1·2	1·9
TR4	10	6·3	7
TR5	12	0	0
TR6	0	0	12
TR7	12	2·5 (10·8V max with full input signal—see text)	0

TR5, 6 and 7 voltages are taken with no input to SK1

CONCLUSION

It was stated in part one of the receiver articles that a b.f.o. unit would be included in the local oscillator. A separate b.f.o. unit has not been described as the "offset A1" system of c.w. reception has been used. To receive keyed c.w., the receiver is tuned to the required frequency and then offset approximately 1kHz by the fine tune control thus giving a 1kHz tone.

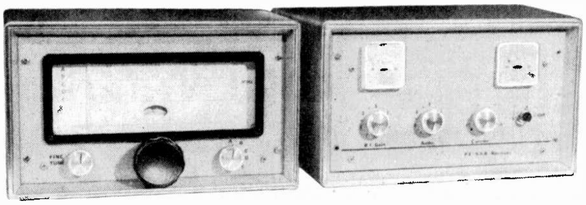
There are various other small alterations from the original description of the receiver, in particular the fitting of the power supply in the receiver main chassis and not in the local oscillator chassis as originally described. This has been altered to provide a self-contained receiver unit that can be used with any signal generator. The power supply can, of course, be fitted in the local oscillator unit to provide a complete signal generator if required. It should be noted that the output frequency of the local oscillator is 34MHz higher than the frequencies indicated on the tuning dial. ★

Note: a kit of Neosid coil parts for the local oscillator unit is now available from Neosid Ltd., Stonehills House, Howardsgate, Welwyn Garden City, Herts. The kit to be called "Wideband Local Oscillator Kit" contains the following parts:

Former 722/1 Bakelite	5 off
Base plate 5027/6PLD	5 off
Aluminium screening can 7100	5 off
Screw core 4 × 0·5 × 10/900	5 off

The "Wideband Local Oscillator Kit" is for the local oscillator only and is in addition to the "Wideband Kit" which is for the main receiver only. The above kit is available from Neosid at the above address on receipt of a 25s postal order—no cheques.

Correction: chassis type numbers given last month should have been—1690C and BC510



AUDIO TRENDS

By F.C. JUDD

THE introduction and development of two-channel stereo recording and radio has brought about a pleasing and very acceptable new dimension to high fidelity sound reproduction in the home. The latest innovation, and one which is claimed to be an improvement on the two-channel system, is four-channel stereo which has been designed to reproduce the "ambience" as well as the spatial effect of the concern hall.

The latter technique requires a four track tape recording with four separate replay amplifiers and loudspeakers. Two loudspeakers are placed in front of the listener in the normal way and two are placed at the rear to produce the reverberant effect that would normally be experienced in a large hall.

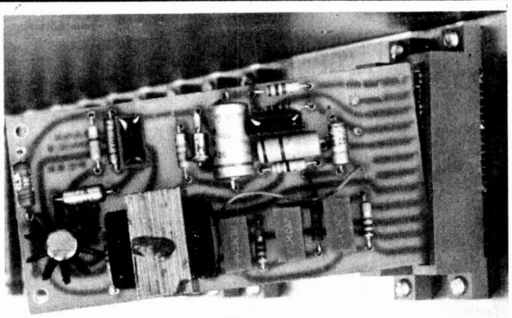
As four separate tracks are required for reproduction, recordings are at present only made on magnetic tape. Whether the system might be extended to disc and even radio, remains to be seen as it would necessitate either four separate recordings in one groove or the use of a parallel groove for the two extra channels. Four-channel stereo radio would involve more complexity.

FOUR-CHANNEL STEREO AT SONEX '70

Demonstrations of four-channel stereo by the American company Acoustic Research, and sponsored by their U.K. agents Bell and Howell Ltd. at the recent "Sonex '70" exhibition, tended to show that in an average size living room, the sound from the loudspeakers at the rear became too confused with sound from those at the front, especially to a listener positioned midway between the speaker systems. The more or less double expenditure for four channels merely to obtain a reverberation effect from the rear hardly seems to be worthwhile.

Four-channel stereo and the extra cost involved might be better used to improve the overall stereo effect from the front. Reverberation could always be added to a small degree by feeding the channel signals into a reverberation unit and taking the output from this to a rear (of the listener) loudspeaker.

Over 160,000 tickets were issued for the Sonex '70 audio exhibition at the Skyway Hotel, Heathrow, the first of its kind to be staged by the industry's own trade association, the Federation of British Audio.



A Millbank Electronics audio module

Rank-Wharfedale 100·1 tuner amplifier

"Twin Assembly" loudspeaker kit by Richard Allan

The exhibitors' original policy of "strictly hi fi equipment only" seems to have been ignored for there was a good deal of equipment on show that could only be rated as "capable of good but otherwise pleasing quality".

LOUDSPEAKER KITS

A loudspeaker can be a fairly expensive item and, for stereo, the cost is doubled, but for those who can successfully carry out the cabinet work at home there are some new loudspeaker kits to choose from.

Richard Allan Limited, a well-known name for loudspeakers, have just brought out three kits which include their "Triple Assembly", a three-unit system for 15 watts at 8 or 15 ohms, and the "Super Triple" assembly (three units) for power up to 20 watts. The smallest kit is a twin speaker system for 10 watts called the "Twin Assembly".

Each kit contains the appropriate bass, mid-range and treble units and crossover network, details for building a suitable enclosure, and there is a choice of Vynair speaker aperture covering materials. Further details from Richard Allan Limited, Bradford Road, Gomersal, Cleckheaton, Yorks.

TUNER AMPLIFIER

A completely new product, featuring integrated circuits, ceramic filters and f.e.t.'s in the v.h.f. tuner section, is the Rank-Wharfedale tuner amplifier called the 100.1 Multiplex Receiver and has an output power rating of 35 watts r.m.s. per channel combining f.m. stereo and medium and long wave a.m. radio channels.

It has inputs for tape recorder replay and magnetic and ceramic pick-up cartridges with outputs for up to four loudspeakers and stereo headphones. The makers claim the very low distortion factor of 0·1 per cent at full power, a weighted signal-to-noise ratio of 90dB at 35 watts from the output stages and 75dB at 35 watts from the pick-up inputs.

Control features include a low pass (whistle) filter, v.h.f. muting and local and remote speaker switching. Further details and the recommended retail price are available from Rank-Wharfedale Limited, Idle, Bradford, Yorkshire, who have incidentally just introduced three loudspeaker unit kits for constructors and will send details on request.

AUDIO AMPLIFIER MODULES

Readers interested in professional fields of recording and public address, and who need to build their own equipment for special requirements, may find the Millbank Electronics' range of audio modules very useful. These modules include microphone pre-amplifiers, equalising amplifiers for tape head and pick-up inputs, a high signal level amplifier for passive mixer networks, a VU meter amplifier, a line-up tone oscillator and many others.

Each unit is pre-assembled on a plug-in printed circuit board and many different combinations can be used to build up complete items of equipment. Suggestions include signal mixers with, say, two low impedance microphone inputs, one magnetic pick-up input, two high level signal inputs, a VU meter and a 600 ohm line output.

The modules are designed for high quality professional equipment and prices range between about £7 10s for a microphone pre-amplifier to £11 for a 600 ohm line amplifier. Suitable power supplies and other accessories are also available. Details from Millbank Electronics, The Square, Forest Row, Sussex.

MONO TAPE RECORDER

Recently introduced at the "Sonex" exhibition, the new Brenell 6M series now includes a complete mono tape record/replay unit known as the MK6 type M. The deck has a three-motor tape transport system and will take up to 8in diameter spools. It runs at 15, 7½ and 3¾ and 1⅞in/second and has a half-track mono three-head system which allows for off-tape monitoring.

The MK6 Type M unit includes separate recording and replay amplifiers and has a 15 watt output stage. Inputs are provided for microphone and magnetic or ceramic pick-up cartridges and high level signals. Other features are bass and treble controls, a built-in loudspeaker and signal mixing facilities. Further details from Brenell Engineering Company Limited, 231/5, Liverpool Road, London, N.1.

A COMPLICATED electronic circuit is usually little more than a collection of familiar sub-circuits or stages, each consisting of just one or two transistors arranged in a special way. With experience these stages, or "building bricks", can be easily recognised at a glance and thus enables a whole circuit diagram to be "read" with ease.

There now follows a short compendium of the more commonly used sub-circuits.

SINGLE TRANSISTOR PHASE-SPLITTER

The "phase-splitter" is widely used in audio amplifier circuits to convert an input signal into two forms of output signal. In Fig. 4.1 these outputs are shown at the collector and emitter. Output 1 from the emitter is an "in-phase" replica of the input signal, i.e. when the

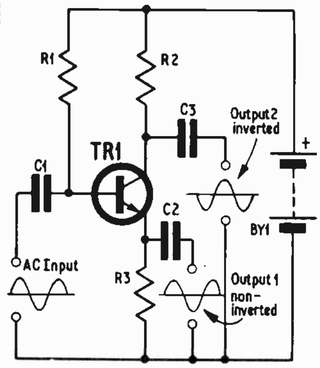


Fig. 4.1. Single transistor phase splitter, two outputs for one input

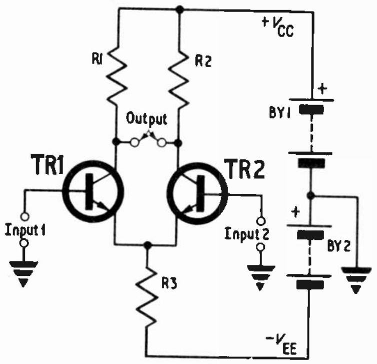
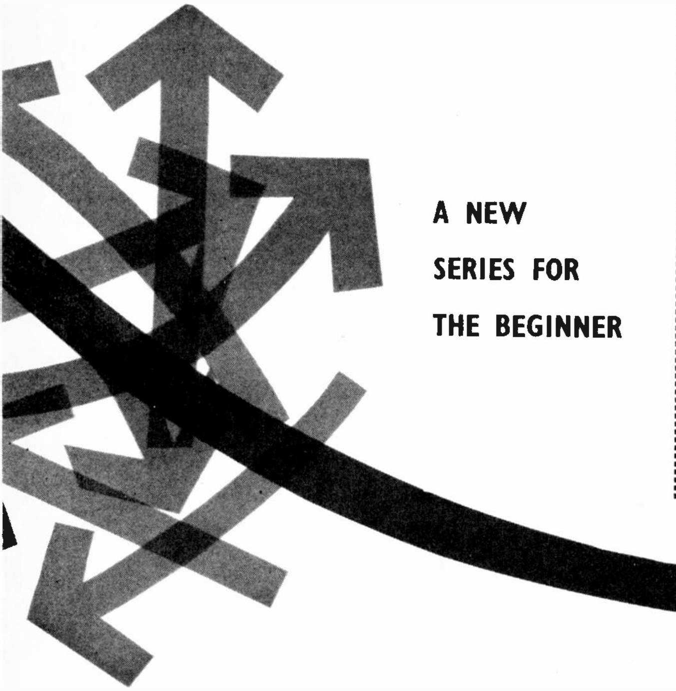
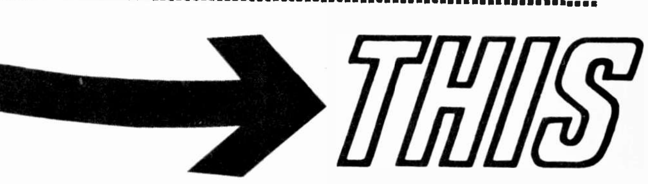


Fig. 4.2. Long-tailed pair, one output for two inputs





input signal voltage goes positive, so does the output voltage from the emitter. Output 2 from the collector is phase inverted. (Phase inversion was explained in Part 3.)

The two outputs are of almost equal amplitude if $R_2 = R_3$ but they move in opposite polarity directions. The phase splitter can be regarded as a common-collector combined with a common-emitter configuration in a single transistor stage.

LONG-TAILED PAIR

Fig. 4.2 shows the circuit of the "long-tailed pair", so called because its common emitter resistor R_3 projects downwards like a tail. It is also known as a "differential amplifier".

The action of the long-tailed pair is fairly complicated, with inputs fed into the two bases. Looking at TR1 first in Fig. 4.2, an input signal at the base is amplified and appears in phase-inverted form at the collector of TR1. At the same time, a second in-phase output is fed directly from the emitter of TR1 to the emitter of TR2. Now if a signal is fed to the base of TR2, there will be an output at TR2 emitter combining with that from TR1, and a phase inverted output at TR2 collector.

Fig. 4.3. Compound connected transistors

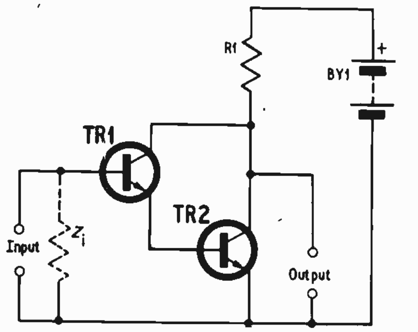


Fig. 4.3a. Super-alpha pair, common emitter mode. Overall gain is equal to the product of the two transistor gains (h_{FE})

If the two inputs are in phase there will be no output at the collectors. An output will only be obtained between the collectors when the two inputs are in opposite phase.

In the form shown in Fig. 4.2 (there are several variants of this circuit) the pair act as a "differential" or "difference" amplifier, producing an output signal which is directly proportional to the difference between the two independent input signals. Notice how the battery centre-tap in Fig. 4.2 is earthed, and forms the common input terminal for both signals; this automatically provides self-bias and allows the circuit to accept a.c. as well as d.c. signals without the need for bias resistors.

One of the main advantages of the long-tail pair is that it is insensitive to changes of temperature, which makes it particularly useful for amplifying small d.c. signals. An increase of TR1 collector current with a rise in temperature is accompanied by a similar increase of TR2 collector current, thus the circuit tends to remain in balance and does not "drift".

DARLINGTON AND COMPOUND PAIRS

Transistors can be coupled together to yield a very large current gain and a high value of input impedance. The "super-alpha pair" shown in Fig. 4.3a is a modified common-collector amplifier TR1 feeding a common-emitter amplifier TR2. Overall current gain is approximately equal to the product of the individual gains of each transistor, typically 2,500.

The input impedance of an amplifier usually falls with increasing frequency of the a.c. signal, due to small amounts of stray capacitance within the circuit. Input impedance Z_i of the super-alpha pair can be more than 50 kilohms below about 5 kilohertz, and voltage gain is around 100. The output is taken from TR2 collector.

Next, the Darlington pair circuit of Fig. 4.3b is made up of two common-collector amplifiers, and offers an input impedance Z_i which can be several megohms under ideal conditions. Current gain is about the same as for the circuit of Fig. 4.3a, but voltage gain will be slightly less than unity. The output is taken from the emitter of TR2.

Some interesting compound circuits can be devised with complementary arrangements of *npn* and *pnp* transistors. Fig. 4.3c shows one form of complementary compound pair, with TR1 acting as a modified *pnp* common-collector amplifier which drives an *npn* common-emitter amplifier. Because the d.c. collector voltage of TR1 is very low, the overall current gain of the circuit is no more than approximately 1,000, but the input impedance Z_i is high.

When base bias resistors are added to the circuits of Fig. 4.3 they tend to reduce or shunt the input impedance, and this creates problems.

BOOTSTRAPPING

Bootstrapping is a technique used to boost amplifier input impedance to high values, while avoiding the shunting effect of bias resistors. Such a circuit appears to pull up its input impedance "by its bootstraps" so to speak.

In the common-collector circuit of Fig. 4.4, a resistance R3 is inserted between the transistor base and the bias resistors R1 and R2. An input signal is fed via C1 straight to the base of TR1, and reappears as an output signal across the emitter resistor R4 without a change of phase. This output signal is then fed-back through C2 to the other end of R3 so that almost equal in-phase voltages are present at both ends of R3. If the voltages at each end of R3 are equal and in phase there will be no flow of current through R3, and this resistor therefore behaves like a very high impedance, typically several megohms at low frequencies.

WAY TO ELECTRONICS 4

for high input impedance and large current gain

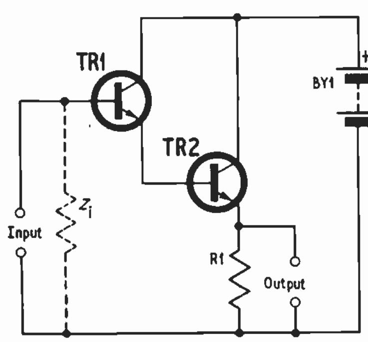


Fig. 4.3b. Darlington pair, common collector mode. Very high input impedance, low output impedance

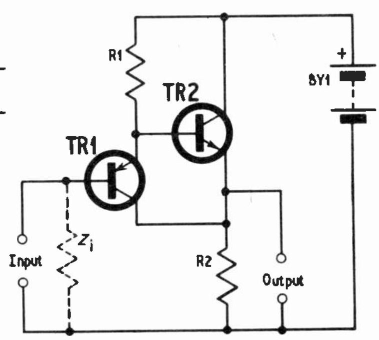


Fig. 4.3c. Complementary pair, pnp and npn, gives current gain of about 1,000 and high input impedance

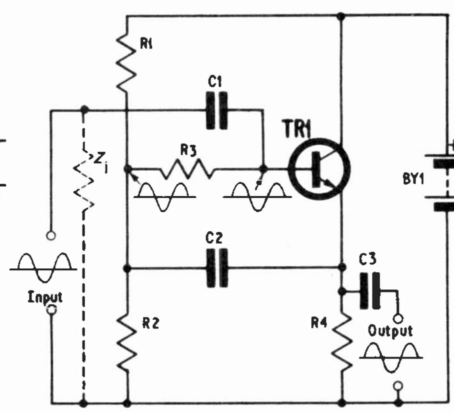
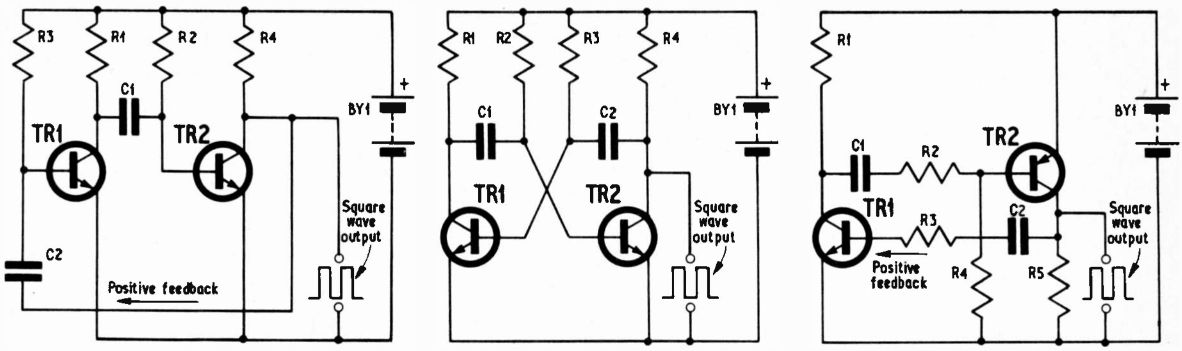


Fig. 4.4. High input impedance can be achieved by using "bootstrap" circuit. R3 is made to appear as a very high impedance to the signal fed into TR1 base

WAVEFORM GENERATORS



(a) Collector coupled astable multivibrator. Frequency is approximately $1/0{\cdot}7\,(C_2R_2 + C_1R_3)$

(b) Alternative arrangement of collector coupled astable shown in (a)

(c) Complementary pair astable

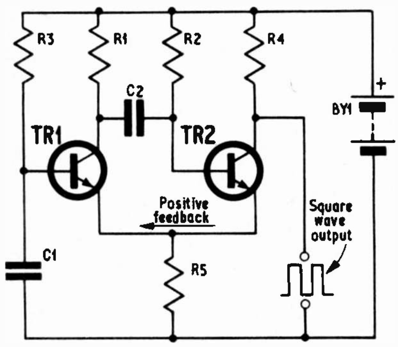


Fig. 4.5. Square wave generators

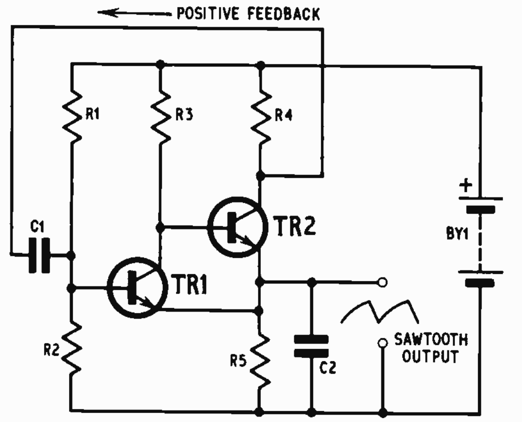


Fig. 4.6. One form of sawtooth waveform oscillator. Positive feedback is applied through C1

SQUARE WAVE OSCILLATOR

The circuits considered so far are frequently used for amplifying or producing signals which vary smoothly with time. Much of electronics, however, is concerned with abrupt transitions of signal level, and the handling of steep-sided pulses of different duration and shape. A square wave oscillator, for example, yields an output consisting of a train of rectangular shaped pulses which can be used to trigger other circuits.

In Fig. 4.5a, two common-emitter amplifiers are coupled together with capacitors. TR1 collector output is coupled via C1 to the base input of TR2, and the collector of TR2 is coupled back to the base of TR1 by capacitor C2, making a closed loop. The result is unrestrained positive (in-phase) feedback which causes the circuit to oscillate vigorously, with each transistor switching on and off alternately. A transistor is said to be "on" when it is passing maximum collector current and its collector is at almost the same voltage as its emitter.

At the start of a pulse, one transistor will be hard on while the other transistor is off or non-conducting. After a time, dependent on the values of R3, R2, C1 and C2, there is a rapid transition when the transistors reverse their roles, i.e. the "on" transistor goes off and vice versa.

The square wave oscillator of Fig. 4.5a is called an "astable multivibrator" (i.e. non-stable), and it belongs to an important trio of pulse circuits. An alternative (and more common) way of drawing the astable is given in Fig. 4.5b.

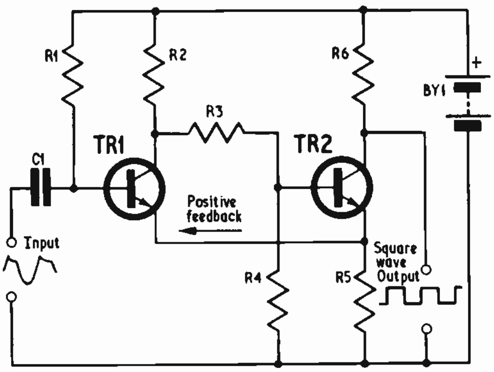
An *npn* and a *pnp* can be used as a complementary pair as shown in Fig. 4.5c, both transistors conduct at the same time, and turn off simultaneously. However, if the transistors both switch off completely, they will cease to amplify and the circuit will not oscillate. Therefore, TR2 is held slightly on by a high value of base bias resistor R4.

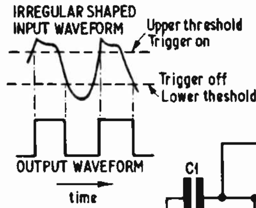
Fig. 4.5d shows an emitter coupled astable. The base of TR1 is held "steady" by C1 decoupling capacitor, and TR1 therefore acts as a common-base amplifier, with an emitter input and a collector output which feeds phase-splitter TR2 via C2. Direct coupling between the two emitters provides a positive feedback path, and a square wave output is taken from R4.

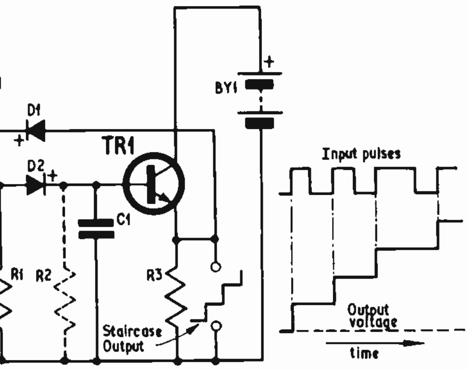
SAWTOOTH OSCILLATOR

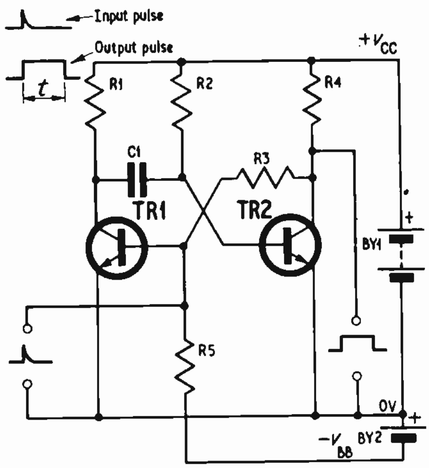
Another waveform shape is the "sawtooth"; a train of triangular pulses obtained by alternately charging and discharging a capacitor. The sawtooth oscillator provides a ramp or rising voltage output which is almost directly proportional to time, and is therefore utilised in timing circuits and for the X axis sweep in oscilloscopes.

In the circuit of Fig. 4.6 the feedback from the collector of TR2 to the base of TR1 is positive (in-







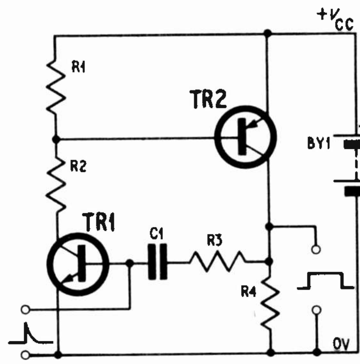


(a) Collector coupled monostable

Fig. 4.7 (above left). Schmitt trigger circuit. Square wave output is derived from approximate sine wave input, based on upper and lower threshold voltages that are set by choice of component values

Fig. 4.8 (above right). Staircase generator. Used as a memory store or counter. It registers each input pulse and steps up the output voltage

Fig. 4.9 (left and right). Monostable multivibrators. A short pulse at the input becomes a long pulse or square wave at the output



(b) Complementary pair monostable

phase), and would give a square wave oscillation if the capacitor C2 was disconnected. This is a form of multivibrator, positive feedback being applied via C1.

When TR2 conducts, C2 is connected to the positive supply rail via TR2 and R4. The capacitor C2 charges up relatively slowly, and the voltage across it increases almost linearly with time. When the circuit switches, TR2 goes off and C2 discharges through R5, giving a downward sloping ramp. So, the output taken from across C2 is a sawtooth waveform.

The working of this circuit depends on critical choice of component values, since the regenerative action depends on the working voltages set by R3 and R5.

SCHMITT TRIGGER

The "Schmitt trigger" fulfills the role of a fast acting switch which is controlled by a change of input voltage.

When the input exceeds a set value (upper threshold), the circuit triggers on, and turns off when the input drops to slightly less than another set value called the lower threshold. The circuit in Fig. 4.7 closely resembles that of a long-tailed pair and has a similar action, except that the bias resistor R3 is connected to the collector of TR1 instead of to the positive battery rail. This arrangement supplies d.c. positive feedback, and causes the circuit to "change state" very rapidly, typically in less than one microsecond.

Among the many applications of the Schmitt is that of converting a sine wave—or any irregular shaped waveform, into a square wave of the same frequency; see the waveforms of Fig. 4.7 which show the trigger levels.

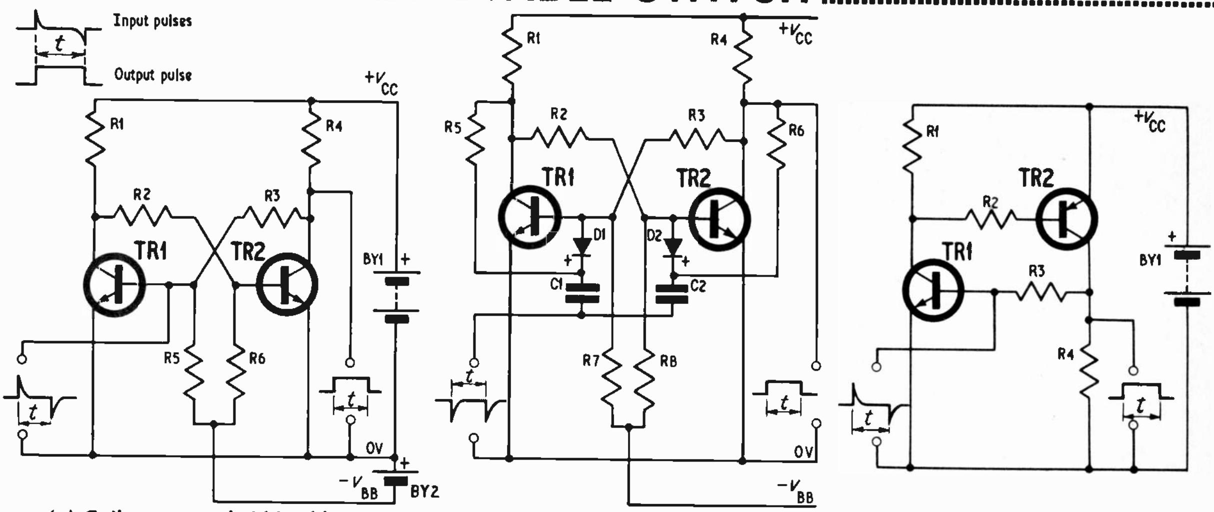
STAIRCASE GENERATOR

From a pulse input, the "staircase generator" or "pump circuit" of Fig. 4.8 supplies an output which rises in steps, one step per input pulse. The circuit actually "remembers" each input pulse and adds the next to it.

The mode of operation is as follows. A positive input pulse is passed by C1 and D2 to place a positive charge on capacitor C2. Because of D2, the only discharge path for C2 is via the base of TR1. However, TR1 is a common-collector amplifier, and presents a high resistance to C2 which will discharge this capacitor relatively slowly. If the input pulses are not widely spaced in time, the voltage across C2 will remain almost constant between pulses, giving a flat top to each step of the staircase. The purpose of D1 is to keep the height of each step constant by feedback from the emitter of TR1.

If a d.c. voltmeter is placed across the staircase generator output, it will give an indication of the number of input pulses received. The circuit can also be used as a frequency meter if a resistor R2 (shown dotted in Fig. 4.8) is added to discharge C2 quickly. Yet another application is that of frequency divider, if

BISTABLE SWITCH



(a) Collector coupled bistable

(b) Steering diodes used to trigger at the base or collector

(c) Complementary pair

Fig. 4.10. Bistable multivibrators. Two input pulses are required to switch the output on, then off. Outputs can be taken from either collector

some means of discharging C2 is devised, which operates when the output voltage reaches a pre-arranged level.

MONOSTABLE MULTIVIBRATOR

A feature of many pulse circuits is that they have two "states". For example, the "monostable multivibrator" has a stable and a quasi-stable state. When triggered by an input pulse of short or indeterminate duration, the circuit of Fig. 4.9a switches from its stable state (TR1 off, TR2 on) to its quasi-stable state (TR1 on, TR2 off), where it remains for a time dependent on the values of capacitor C1 and resistor R2, thus furnishing an output pulse of precise length or duration. At the end of the timed period, the monostable reverts to its stable condition and is then ready to accept the next input pulse.

The complementary version of the monostable draws hardly any current from the battery when stable, but an input pulse causes both transistors to turn on during the timed period, see circuit Fig. 4.9b.

The monostable can provide a delaying action if the trailing edge of its output pulse is used to trigger a following circuit, and it will also act as a frequency divider.

BISTABLE MULTIVIBRATOR

The third member of the multivibrator family is the "bistable". With its two stable states, the action of this circuit is similar to that of a self-latching toggle switch.

Looking at the basic bistable circuit of Fig. 4.10a, a positive input pulse will turn TR1 on, overcoming the potential $-V_{BB}$. TR2 is held hard off by this action and by $-V_{BB}$. The voltage at TR2 collector will be almost $+V_{CC}$ volts. Further positive input pulses will not change the state, but a negative pulse will reset the circuit to its former condition, by pulling TR1 into a state of cut-off, and turning TR2 on. The voltage at TR2 collector will then drop to near zero volts.

For most purposes it is preferable to use the bistable with input pulses of one polarity, and here diodes can be added to the circuit to "steer" the pulses to the appropriate transistor base, as shown in Fig. 4.10b. Diodes D1 and D2 alternately steer only negative input pulses to whichever transistor happens to be on at the time, bringing the base of that transistor down to its emitter potential and turning it off. Meanwhile the other transistor turns on and is then ready to receive the next input pulse.

Digital computers depend on the bistable for counting and other mathematical operations. The computer version of the bistable, similar to the circuit of Fig. 4.10b, is usually called a "flip-flop" or "binary stage".

A complementary bistable is given in Fig. 4.10c. A positive input pulse will turn on both transistors at the same time.

Part 5 next month will look at a range of electronic devices, including transducers which are used to translate mechanical and other phenomena into electrical signals.

Gerry Brown . . .

ON THE FRINGE

EMOTIONAL TOMATO

Few would think seriously about the likelihood of a tomato plant owning any kind of emotion, much less consider the possibility of botanical specimens demonstrating a form of telepathy. Nevertheless, Cleve Backster, a research psychologist with the Backster Foundation

in New York, has very strong reasons for believing so. Backster made his discovery some little while ago when he connected a polygraph (sophisticated lie-detector) across one of the leaves of a tomato plant.

His idea at the time was to try and gain some evidence for a co-relationship between sap movement, after watering the plant, and changes in the plant's tissue resistance at such times.

During his experiments he decided, apparently "for the hell of it", to concentrate his attention on the particular leaf connected to the equipment and make a strong mental impression of his definite intention to burn the plant with a lighted match. Imagine his utter amazement when the polygraph pen took a steep downward swing over the recording paper! Like all sensible experimenters he of course checked the repeatability of the effect. Surprisingly the same down-going trace appeared on the chart on almost every occasion.

Since the early experiments Backster has speculated on what the effects might be for related traumatic experiences of other plant and animal species in the environment of a specimen undergoing test. For example, killing off quantities of brine shrimp by dumping them in boiling water containers resulted in "wild" movements of the pen.

Backster wonders whether there is some kind of signal generated by cell life when it dies that might be sensed by other cells still living. He found

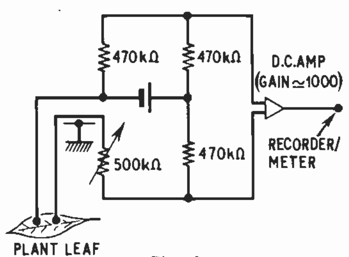


Fig. 1

too that violence of virtually any form could produce a reaction. Pricking his finger or even breaking an egg in the vicinity of the test specimen could apparently cause quite remarkable reactions on the machine.

Backster maintains that there were times when if he had haressed the test plants enough he could be several miles away and on the instant of his intention to return to the laboratory there would be recorded a strong movement on the chart.

Obviously I can only report on Cleve Backster's findings so far but, just for the record, I have performed some simple experiments along the same lines and really the results can be quite staggering! In my short experience of the Backster effect a response was obtained 70 per cent of the time.

Setting equipment up for observation of the effect can be very tricky, since the application required in order to see a response must be high, see Fig. 1. This, if one does not meticulously null out offset voltages and carefully balance the input to the amplifier, can cause such havoc that it may be impossible to obtain any worthwhile results at all. It is not therefore recommended that beginners to electronics should try out such a set-up; the results could be ambiguous at best!

LIT-UP BUGS

The time was when miners had to carry canaries around with them in order to remain in circulation. Since

then things have changed a bit and among the many methods that have come along since the early days is this extremely bright new way of detecting firedamp. The idea is a British patent which, according to the specification, utilises a transparent cell containing a micro-organism called *Photobacterium fischeri.*

This culture has the peculiar property of glowing quite brightly when exposed to air. However, it seems that if air contaminated with some toxic material is passed over the cell the organism's light output drops dramatically until a point is reached when the light from it fails completely. Following an exposure of this kind the culture rapidly regains its previous abilities to emit light when the air is purer.

In its entirety the detector uses a sensitive photocell and amplifier to monitor any changes in the intensity of the emission from the bacteria. This may then be used to signal, either locally or at some distant station, any imminent threat to the lives of those in the hazardous environment.

Over the normal working life of the culture its ability to recover from toxic agents diminishes and so it is necessary to incorporate within the electronics compensatory circuitry which can adjust the sensitivity of the amplifier at a corresponding rate.

Since the "bugs" appear to be sensitive to other materials in addition to firedamp one can speculate that they may well prove invaluable to researchers connected with atmosphere pollution due to traffic exhaust.

PLATED LEAVES

Although I can recall doing it in the school physics lab' some years back, there are a great number of people who have now joined the craze for electroplating various forms of flora. In fact, it seems, just about anything from leaves

to chrysanthemums have an appeal in this direction!

The technique is fairly simple as you will see. Having obtained your specimen (not, I hope, from Kew Gardens) it must be dunked in warmed petroleum jelly (Vaseline) and any surplus liquid shaken off. When cooler, a thin piece of insulated wire is firmly wrapped round the steam of the leaf.

Powdered graphite must then be carefully sprinkled all over and, assuming the specimen has been completely, covered it is now ready for the plating bath. The electrolyte of course depends entirely on what you intend plating your leaf with; the old favourite copper is a fairly inexpensive beginner and so copper sulphate would be the correct electrolyte to use. Details of the required set-up are shown in Fig. 2.

The plating process needs to be carried on for a fair period of time; over-night is likely to prove sufficient. Following this the plated material must be lifted from the bath with care to avoid removing the coating. After leaving it to dry out during the day it should then have a coating of lacquer applied to protect it.

The number of things that can be plated seems to be pretty well limitless and I have it on very good authority that someone has already electroplated a cabbage! I think this must have been done for posterity, since this particular genus of edible flora will probably cease to exist on the table when we go over to swallowing the Sunday roast in tablet form!

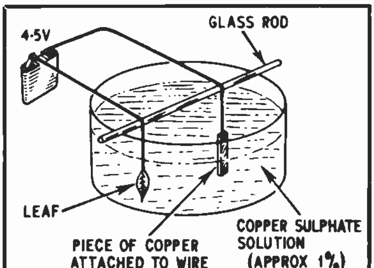


Fig. 2

- REALISTIC
- PHOTO ELECTRIC
- HIT AND SCORE TARGETS
- COMPLETELY SAFE FOR CHILDREN

By G. W. JONES

P.E.

THE P.E. Marksman introduces the skills of real target practice into the home in complete safety. It provides instantaneous "hit" and scoring indications whereupon the system automatically reverts to its initial state. Construction is comparatively simple and the system is flexible since it may be expanded into sophisticated target assemblies which, for example, include sound, physical and flare effects.

The principles of operation may be applied to other projects, however, in order to provide suitable reference whereby such projects may be undertaken, the system to be described is embodied in a miniature rifle range. This range is comprised of an electronic rifle and target assembly, each battery operated and self contained so that interconnections between rifle and target are not needed.

The rifle "shot" is the timed flash of a torch and a unique target arrangement enables light emitted from a standard torch to be accurately evaluated for scoring purposes. This greatly simplifies the construction of the rifle, the necessity for lenses and a projection system being eliminated. A simple adjustment enables ranges of up to 30 feet to be accommodated and the same control satisfies ambient light conditions.

GUN OPERATION

There are many cheap plastics toy guns on the market and one must be selected which will accommodate a small torch at or directly underneath the muzzle. Space must be available for two switches (one to serve as the trigger and the other as the bolt action or "reload" switch), and a miniature electronic circuit.

The circuit of the rifle shown in Fig. 1 is such that when the spring loaded "trigger" switch S1 is operated, a flash of light is emitted from the torch and irrespective of the time the switch contacts are made, the duration of the flash is constant. Correct trigger pressure and operation relative to firing a rifle may thus be practiced.

Since the target is a phototransistor, the time period of the flash is also important with respect to range and scoring assessment and providing competitive firing is carried out at the same range, accurate score assessing by the phototransistor is obtained. In practice a time period of approximately 0·25 seconds enables sufficient light to be emitted from the torch but prevents the firer from dwelling on the aim to obtain a false assessment of the original shot.

GUN CIRCUIT

The rifle circuit (Fig. 1) is based on a standard 3 volt torch with the lamp (LP1) electrically isolated from the normal switch and batteries.

Switch S2 is the reload switch and is of the double pole, change over type. In the reload position C1 is charged to the battery potential and since virtually no current is dissipated with the switch in this position, the

MARKSMAN

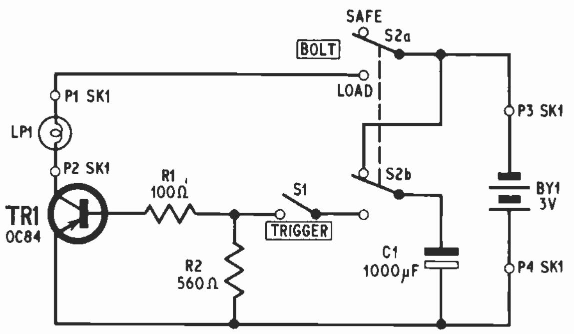


Fig. 1. Circuit diagram of the "Gun"

rifle system may be considered to be switched off for storage purposes (the prototype has stood for months in this condition and is still serviceable).

When the switch is changed to the load position the capacitor charge is ready at S1 for discharge into the base of TR1, hence the term "reload switch". Switch S1 is a single pole spring loaded switch and serves as the trigger; when it is operated the capacitor discharges into the resistor network (R1 and R2) and the base of the transistor TR1 which is switched on for a period of time determined by the *CR* network. Since lamp LP1 is the collector load of the transistor, the lamp flashes for the time period determined by the network and then switches off to await the next reload operation carried out by S2. Resistors R1 and R2 in conjunction with capacitor C1 determine the flash time and typical values are given.

When S2 (the reload switch) is positioned at the right-hand side of the rifle in the approximate location of the rifle bolt, the firing action of the rifle becomes realistic since a physical bolt action is necessary in conjunction with a correct trigger pressure. A reasonable simulation of firing a rifle is thus obtained.

COMPONENTS . . .

GUN

Resistors
R1 100Ω ¼W carbon ±10%
R2 560Ω ¼W carbon ±10%

Capacitor
C1 1,000pF elect. 6V

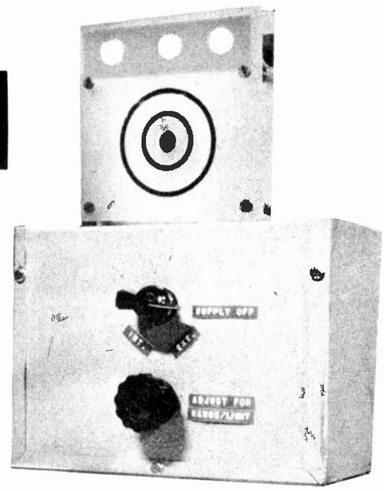
Transistor
TR1 OC84

Switches
S1 s.p.s.t. biassed off toggle
S2 d.p.d.t. toggle

Miscellaneous
LP1 } small 3V spot torch (used as gun barrel)
BY1 }
SK1 miniature four way connector
Gun—plastics toy gun (see text)
Veroboard 2¼in × 1⅛in, 0·15in matrix

GUN CONSTRUCTION

The flash circuit is constructed on a small piece of Veroboard, as shown in Fig. 2. The circuit is connected to S1 and S2 by insulated flexible leads so that S1 and S2 can be fixed in the gun, as described earlier,



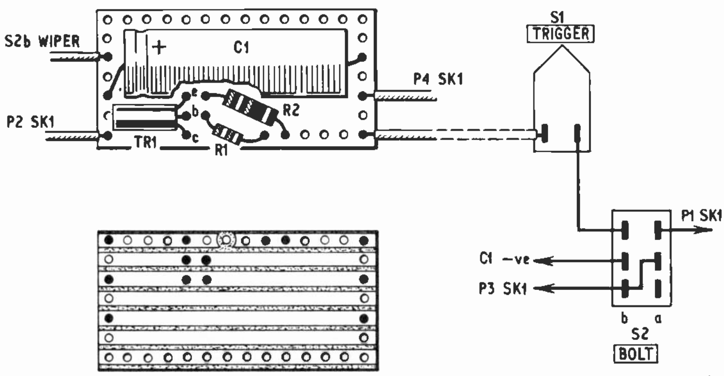
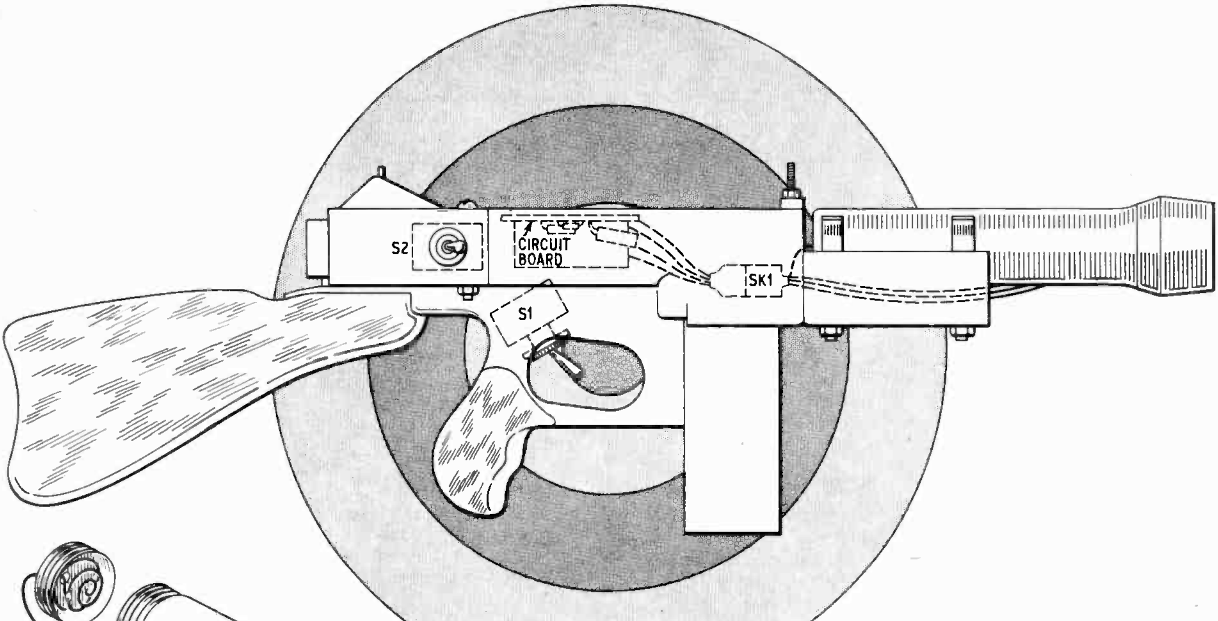


Fig. 2. "Gun" circuit layout and wiring



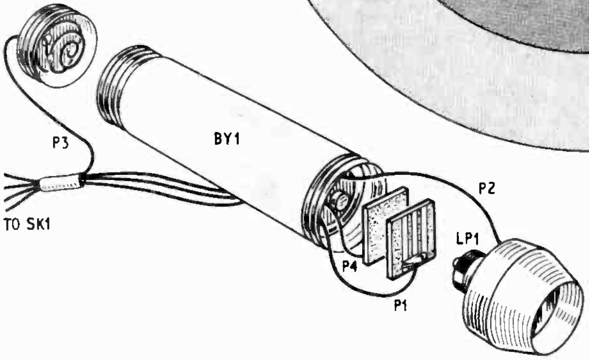
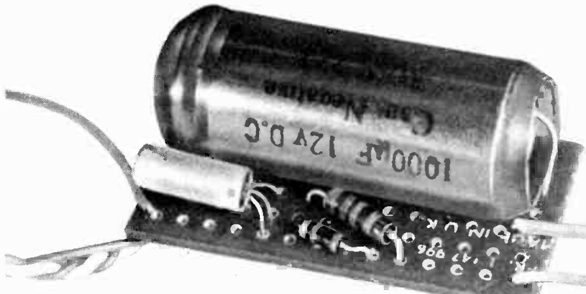


Fig. 3. Electronic installation in a plastics toy gun and alteration and wiring of the torch used as the gun barrel



before the component panel is positioned in the body or handle of the rifle. The board is connected to BY1 and LP1 via flexible insulated leads and a four way miniature connector (SK1).

The torch can be removed from the gun to change batteries and LP1 when necessary and, in the prototype, was affixed in place of the gun barrel by two spring clips. Details of the prototype gun are shown in Fig. 3.

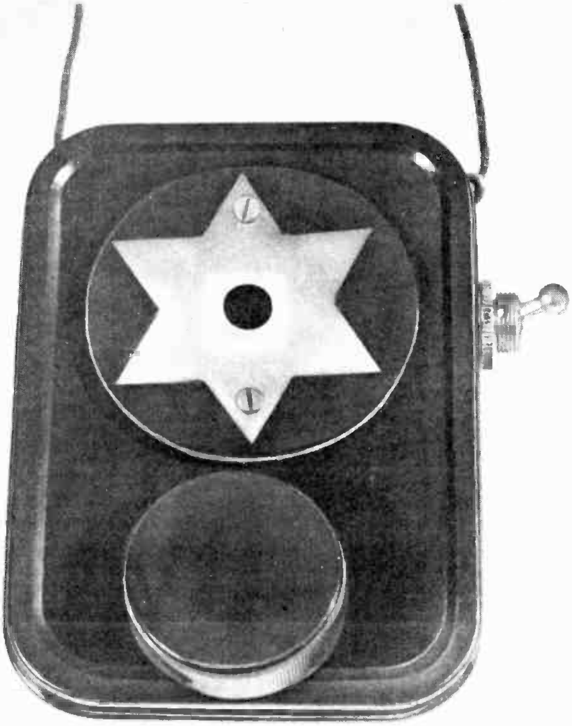
FUNDAMENTAL TARGET

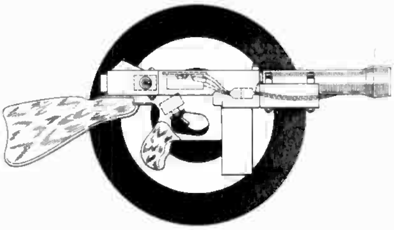
The manufacture of suitable targets largely depends on individual approach and imagination. The simplest form of target that may be made and, if required, expanded into more sophisticated systems, is shown in Fig. 4. It will automatically register a "hit" at ranges up to 30ft and then revert to its initial state thus requiring no physical readjustments.

This target can be built into a small space, therefore a cluster may be built if evaluation of aim is required using this method. However, since a phototransistor for each circuit is required, a more economical circuit is detailed for score evaluation at a later stage in this article.

The circuit shown in Fig. 4 will sense an infinitely small change in ambient light and is ideally suited to register and indicate the flash of a torch at ranges dependent upon the power of the light. Ranges of 30 feet can be obtained from small, cheap "spot torches" and far greater ranges are obtainable using more powerful torch beams.

A flash of light from a remote source falling on the phototransistor TR2 will produce a pulse at C2 which switches off TR3 and consequently switches on TR4.





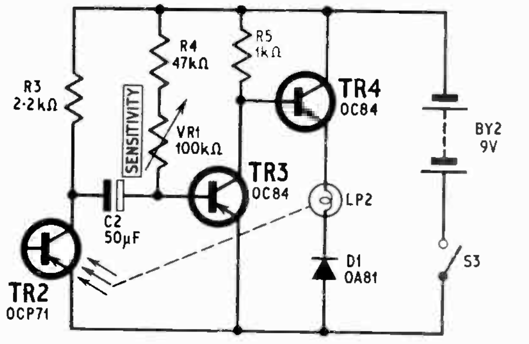


Fig. 4. Fundamental target circuit diagram

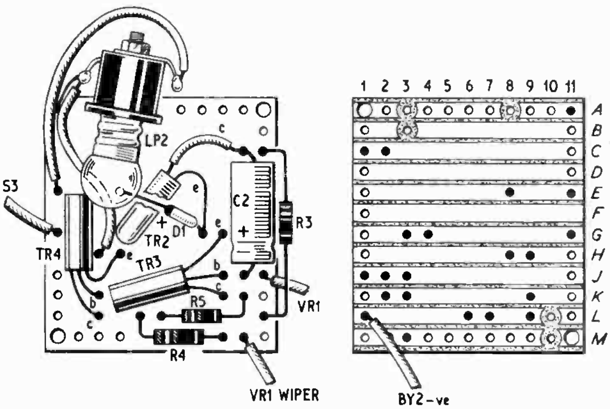


Fig. 5. Layout and wiring of fundamental target

Since LP2 is in the emitter line of TR4, a flash of light is emitted from LP2. Lamp LP2 is fitted adjacent to TR2 and hence capacitor C2 receives a further and stronger pulse when TR2 senses the adjacent flash of light, in consequence the lamp remains on. However, since the capacitor C2 discharges at a higher rate than the rate maintained by the now constant light, the filament switches off after a time period determined by the *CR* network. The filament thus serves as a visual indication of a "hit" on the phototransistor and automatically switches off after a few seconds.

The potentiometer VR1 enables the target to be set up to operate relative to ambient light conditions which includes virtually any light normally experienced indoors. Maximum sensitivity (range) is obtained by rotating the potentiometer knob until the circuit hunts (the lamp operates in a continuous on off sequence) and then retarded slightly so that the lamp is off. A flash from the torch in the rifle assembly accurately aimed at the phototransistor will operate the lamp in the target assembly for several seconds.

It should be noted that the above circuit operates from a "rate of change" of light, and a shadow intercepting light received by the photocell could operate the filament under certain conditions; it is therefore advisable to position the target where the level of light is likely to be reasonably constant.

FUNDAMENTAL TARGET CONSTRUCTION

Layout and wiring of the components, mounted on a Veroboard panel, for the fundamental target is shown in Fig. 5. The target is constructed in a tobacco tin (Fig. 6) and is completely self contained. Holes are cut in the lid of the tin for the potentiometer and "target area" above TR2. A 9V PP4 battery is used as shown in Fig. 6.

This target, although simple, has a variety of applications; as previously stated it can be used, in conjunction with others, to give evaluation of aim; it can also be used as a moving target and affixed to any moving object—including a person.

COMPONENTS . . .

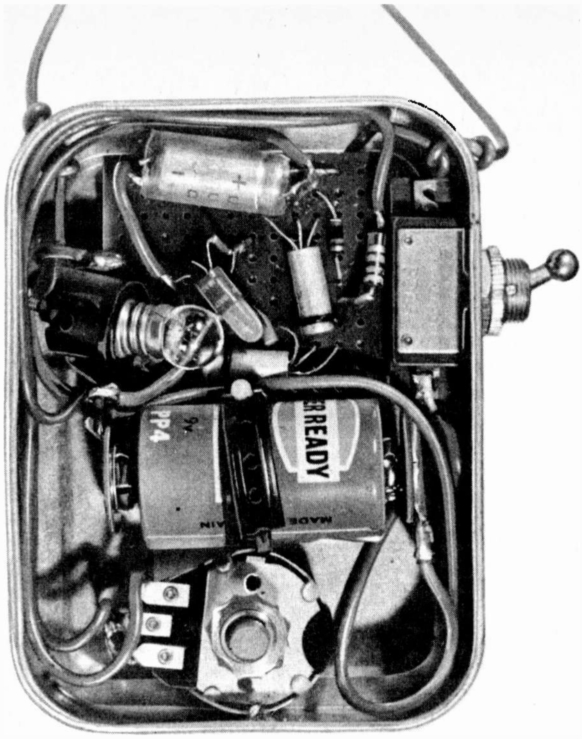
FUNDAMENTAL TARGET

Resistors
R3 2·2kΩ
R4 47kΩ
R5 1kΩ
All $\frac{1}{4}$W ±10% carbon

Capacitor
C2 50μF elect. 12V

Semiconductors
TR2 OCP71 (phototransistor)
TR3 OC84
TR4 OC84
D1 OA81

Miscellaneous
VR1 100kΩ potentiometer
LP2 6V 0·04A bulb and holder
BY2 9V PP4 battery
S3 s.p.s.t. toggle switch
Case, small oblong tobacco tin
Knob for VR1
Veroboard 2in × 1$\frac{3}{4}$in, 0·15in matrix



The latter application opens up a new range of ideas for childrens' games and, with small modifications to prevent alteration of controls during use, the target can provide "hit" indication for childrens' "war" or "cowboys" games.

AUTOMATIC SCORE TARGET

In order to provide a target system for competitive scoring, additional circuits are necessary and invariably one must look for the most economic approach with the greatest entertainment potential. The circuit described is designed to obtain maximum facilities with the minimum number of components. The facilities available may be divided into two sections:

(a) A digital evaluation of the "shot" with respect to an aiming mark on the target

(b) A flare or cascade of lights which may be adapted to provide dramatic visual effects.

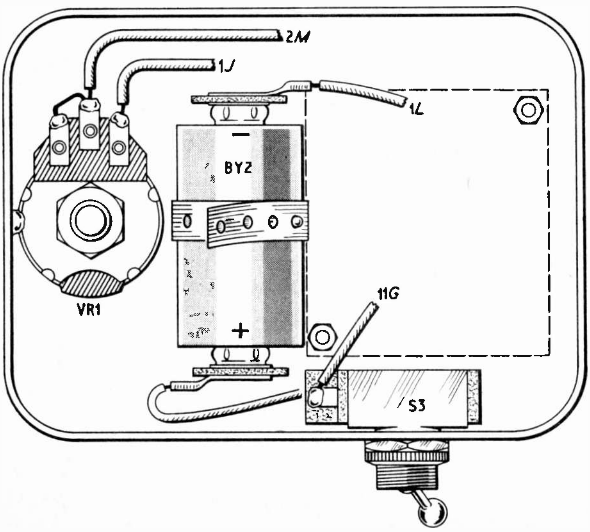


Fig. 6. Complete fundamental target wiring and installation

In either case, sound effects may be included to augment the overall effect.

This particular target consists of a phototransistor and three lamps fitted in line and fairly close together. The three lamps light in sequence or cascade according to the value of light received by the phototransistor and may therefore serve for both digital or flare effect indications relative to aim accuracy. A potentiometer adjusts the threshold of lamp operation so that range or degree of accuracy required is variable.

Digital indication is available when the lamps are identified 1, 2, 3, in left to right sequence, so that a direct hit will light all lamps and a near miss might light only one or two. The flare effect of the filaments may also be adapted to illuminate silhouettes such as the outlines of a tank or an aeroplane; considerable scope is available for similar innovations.

In order to make a fair assessment of each shot the position of the light image obtained from the gun must be evaluated relative to a fixed point at the target. A phototransistor serves as this aiming mark but since the shape and intensity of the image varies when light is emitted from a standard torch, there is every likelihood that when a photocell is used as the aiming mark of the target the same image will probably produce two or three bright spots over its area, each capable of obtaining the direct hit indication from the three lamps. So that this characteristic is largely eliminated a unique target arrangement is constructed.

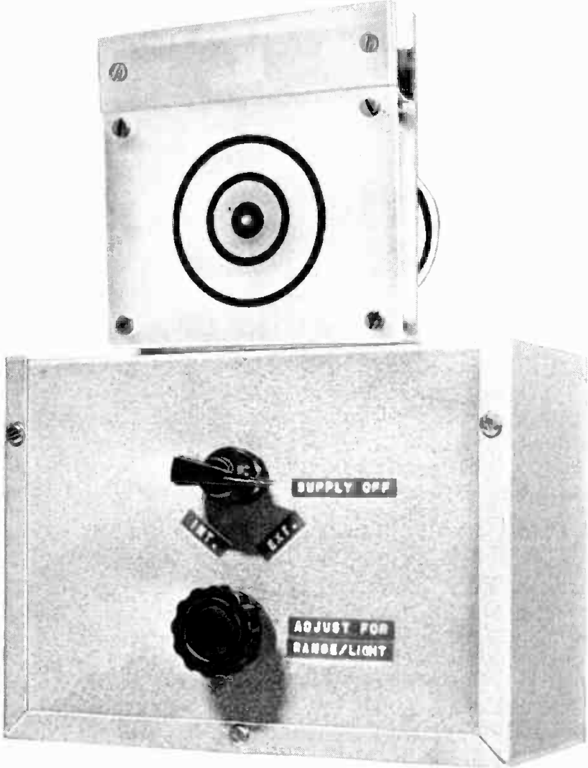
TARGET ARRANGEMENT

Assuming the rifle range is used in a room where ranges in the region of 10 to 20 feet are required, an area of misted perspex is used as the target surface. It will be found that the image produced by a cheap torch is approximately 4 to 6 inches across at its brightest area when shone on to a wall at a range of 10 feet. By cutting the perspex to a similar size (which may be square or circular) the area of the image and target surface will be roughly the same at operational range.

A phototransistor is fitted into a hole in the centre of the perspex to accommodate the dome of the transistor so that direct light from the torch will not fall on the sensing element. When the torch is shone on to the perspex, some of the light penetrating the target surface travels at right angles to the beam of light and illuminates the edges of the hole in which the photocell is fitted. If the full image from the torch covers the target area, the phototransistor will register maximum light from the torch and any inaccuracy of alignment will reduce the signal derived from the phototransistor. This still leaves a certain margin for error but when it is realised that a control is available to set the threshold of lamp operation, the degree of measurement variation becomes surprisingly consistent as the prototype target has proved. A means for evaluating the accuracy of the beam of a standard torch relative to a fixed point is thus achieved. Fig. 7 illustrates the circuit for such a target and when an oscillator is driven by the last transistor, an effective whine can be obtained from a miniature headphone.

AUTOMATIC SCORE CIRCUIT

The flash from the torch in the gun assembly is sensed by the phototransistor TR5 and amplified by TR6 and 7. Capacitor C3 and resistor R7 provide an initial delay into the circuit which is highly desirable at the next stage. The variable potentiometer VR2 and resistor R6 serve to obtain a threshold to relate the sensitivity of the phototransistor to the ambient light



COMPONENTS . . .

SCORE EVALUATION TARGET

Resistors

R6	1kΩ	R10	220Ω
R7	330Ω	R11	560Ω
R8	4·7kΩ	R12	2·7kΩ
R9	150Ω	R13	68kΩ

Capacitors

C3 6·4μF elect. 12V
C4 1,000μF elect. 12V
C5 0·01μF

Semiconductors

TR5 OCP71 (phototransistor)
TR6, 7 OC84 (2 off)
TR8, 9, 10 2N697 (3 off)
TR11 OC139
TR12 OC84
D2, 3 OA81 (2 off)

Miscellaneous

BY3 9V PP9 battery
SK2 2 way connector
SK3 6 way connector
VR2 25kΩ potentiometer
S4 2 pole 6 way wafer switch
LP3, 4, 5 6V 0·04A bulbs and holders (3 off)
X1 2,000Ω magnetic earphone
Veroboard 4in × 3¾in, 0·15in matrix
Misted perspex (see text)
Aluminium for case and chassis 17in × 10½in, 18 s.w.g.
Feed through terminals (2 off)
Knobs (2 off, one pointer)

level. Diode D2 minimises drift in the initial amplifying stage (TR6 and 7) and the output of the amplifier is applied to the delaying *CR* network consisting of D3, C4 and resistors R9, R10 and R11. These resistors are stepped in value so that a low output from the amplifying stage will only switch on TR8 and consequently lamp LP3. An increased output will operate the second transistor TR9 so that two lamps are energised and when the maximum signal is sensed by the phototransistor, all three lamps are energised since all three transistors are switched on.

The delaying effect obtained from C4 and resistors R9, 10 and 11 tends to produce a cascade effect with respect to the amount of light falling on the phototransistor TR5.

Since VR2 determines the threshold for lamp operation relative to ambient light, it will be appreciated that this control can also determine, to a certain extent, the degree of accuracy required at a specific range.

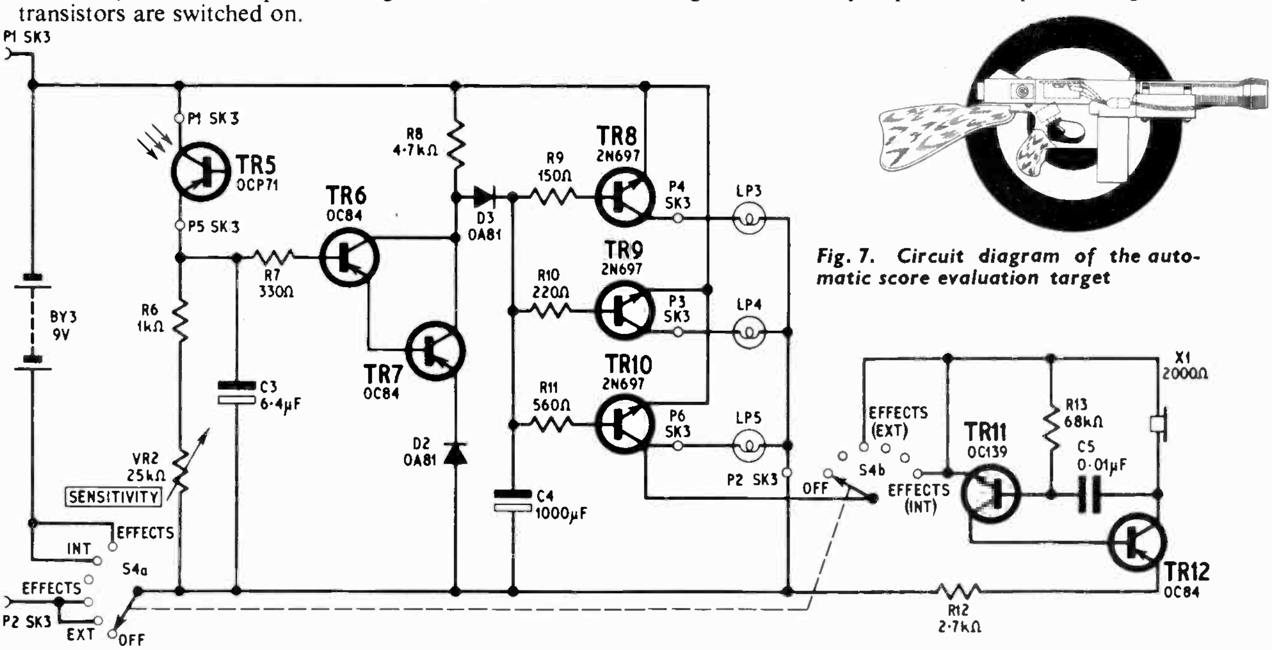


Fig. 7. Circuit diagram of the automatic score evaluation target

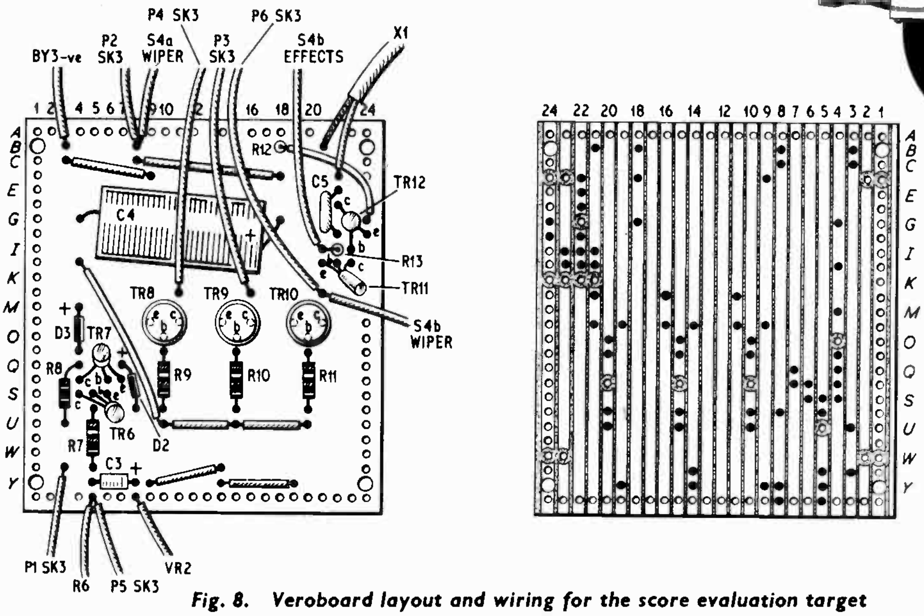


Fig. 8. Veroboard layout and wiring for the score evaluation target

Quite an effective and economical sound effect is obtained when an oscillator is arranged to be driven in parallel with lamp LP5. When a signal reaches this section of the circuit (LP5) it is virtually varying in strength continuously and the result is that a plaintive whine is emitted from the earpiece. The oscillator consists of a *npn* transistor, TR11 and a *pnp* transistor TR12, operating in conjunction with a 0·01μF capacitor, C5. A 2,000 ohm earpiece (X1) is used for sound effects and provides audible whines which are apparent in comparatively quiet conditions; amplification may be added as required.

AUTOMATIC SCORE TARGET CONSTRUCTION

Most of the circuitry for the automatic score evaluation target is mounted on a piece of Veroboard as shown in Fig. 8. Veropins are inserted in the board to provide anchor points for the connecting leads.

The two sockets SK2 and SK3, VR2, S4, X1 and BY3 are mounted on a "U" shaped aluminium chassis and wired to the Veroboard as shown in Fig. 8. The chassis used measures 7 × 5 × 3 inches and is made of two "U" shaped interlocking sections.

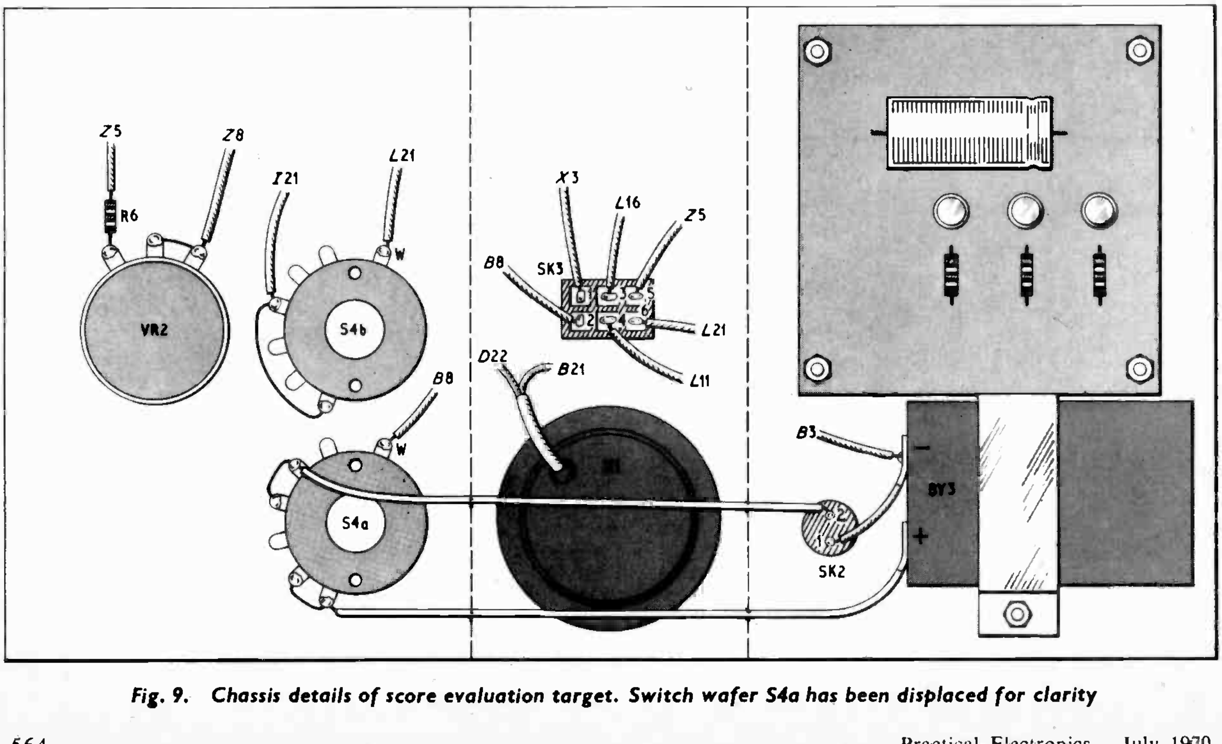


Fig. 9. Chassis details of score evaluation target. Switch wafer S4a has been displaced for clarity

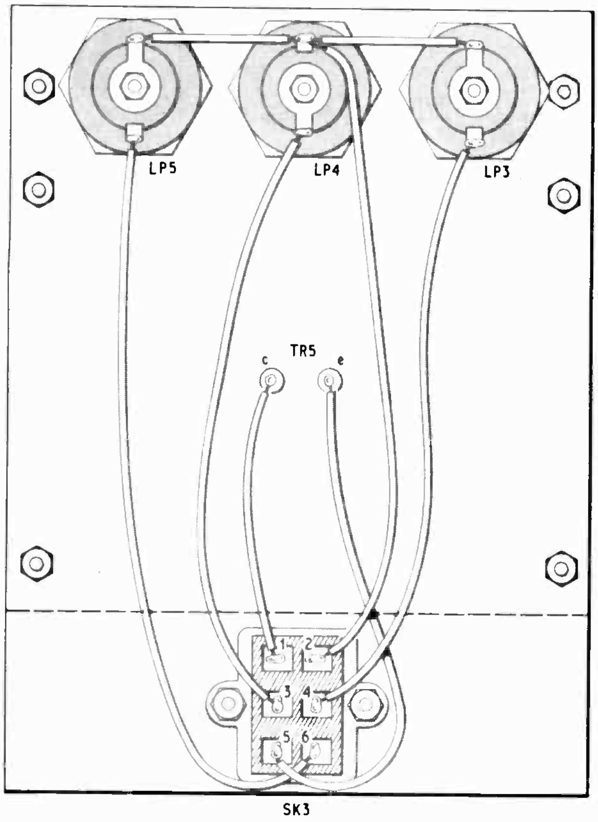


Fig. 10. Target wiring details

The actual target and score indicator assembly is mounted on top of the aluminium chassis and is positioned and held by SK3. Misted perspex sheet that forms the target is fixed to the aluminium mounting by four screws and spacers. Phototransistor TR5 is fitted in a small hole drilled in the perspex so that the junction is covered by the surrounding perspex.

Two feed-through terminals affixed to the aluminium serve to connect the phototransistor leads to the circuit. All target wiring is shown in Fig. 10 and construction details are shown in Fig. 11. The target size will depend on the light image size as indicated earlier.

The misted perspex target area must not be extended to cover the indicator lamps as this will cause the first lamp to trigger the second and third lamps as the light will be transmitted through the perspex. If a covering is required for the lamps a second piece of perspex can be mounted in front of the lamps and the edges of the two pieces painted black to prevent light transmission. A screen should also be placed below the lamps to prevent any stray light from reaching the phototransistor, see Fig. 11

VISUAL EFFECTS

In the prototype, transparent silhouettes are arranged to fit over the three indicators. One is divided into three holes which fit over the three lamps and digital information is obtained when each hole is identified with a number. Another outlines the side section of a fighter aircraft with the nose of the fuselage over the first indicator. The effect of a hit tends to make the aircraft appear to catch fire from the nose rearwards and flames appear to rapidly sweep along the fuselage.

The silhouettes are made from cardboard and may take shapes which may be associated with the sound effect. For example, the eyes of a ghoulish figure may be made to light up when "shot" and this effect may be accompanied by an agonising wail.

The basic circuit could be extended to provide mechanical movements when the target is "hit" and no doubt some readers will add this facility. ★

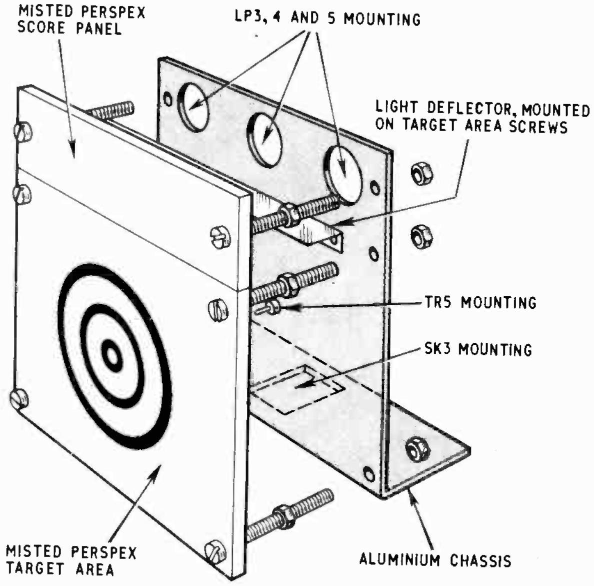


Fig. 11. Target construction details

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.

EDUCATIONAL KITS

Each month the range of educational construction kits available on the market seems to multiply. This month there are two new ranges from **Geatronix** and **Limrose Electronics.**

Known as the Mark II Norkit, the Geatronix range of transistor/resistor logic modules consist of *NAND, AND, NOR* and *OR* gates together with bistable units and lamp and relay drivers.

These modules have solderless connections and the assembly system allows for grouping together of up to 18 modules. There are three busbars which pass through eyelets in the printed circuit boards and serve the dual purpose of holding the assembly rigid and distributing power supplies.

Interconnections are made with patching leads which push into slots in the printed circuit board. Rearrangement of the logic circuit is achieved by removal and reconnection of the patching leads.

Prices of the Norkit Mark II range of kits is obtainable from Geatronix Ltd., 28 Redstock Road, Southend-on-Sea, Essex.

The Compukit 1 is an educational aid to learning and teaching elements of logic, Boolean algebra and fundamentals of digital computers now being marketed by Limrose Electronics.

Logic circuits are constructed by making soldered, or solderless connections to the terminal pins mounted on the special printed circuit board. Logic states are indicated by miniature wire-ended 4½V bulbs mounted on the board.

Assembly is fairly simple and a 16-page illustrated instruction book is included with the kit. The kit contains: 18 silicon transistors; 18 germanium diodes; 42 carbon film resistors; 2 lamps and plastics clips; a 9¾in × 5¼in printed circuit board; battery; 2 microswitch push-buttons; terminal pins; wire; solder; wire cutter and stripper.

The kit is aimed at the serious amateur, apprentices, students, and teachers interested in understanding the basic working principles of digital computers and logic operations.

The basic Compukit 1 costs £7 7s and can be supplied ready assembled for an extra 27s 6d from Limrose Electronics, Lymm, Cheshire.

BUILDING BRICKS

A range of encapsulated modules have been received from **Newbury Sound Equipment.** Having uniform dimensions and occupying less than two cubic inches of space, these units are: a general purpose 500mW power amplifier suitable for 3–15 ohm loudspeakers. A pre-amplifier with a gain maximum of 40dB and suitable for use in combination with the power amplifier. A square wave generator with a frequency range of 30Hz–6kHz. A tachometer module which will provide a linear indication of engine r.p.m. in 4- or 6-cylinder vehicles whether 6 or 12V. Finally, a pre-amplifier suitable for line voltages of 9–24V or 200–500V, the gain being 26dB.

Bench testing of these various units bore out the specifications given, in fact the power amplifier and pre-amplifier modules have found a permanent place as test gear adjuncts in the workshop.

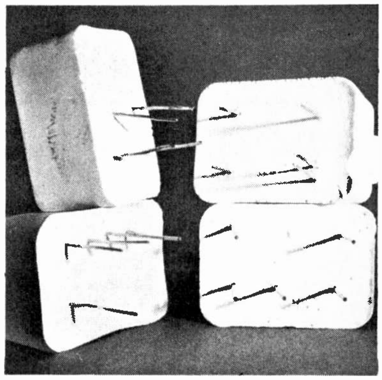
Control and input and output connections on the encapsulations are made via 20 s.w.g. wire leads.

Experiment with these modules proved than any reversal of supply polarity would result in irreparable damage. This problem could have been eliminated by the simple inclusion of a diode in the module supply line.

Further information on these modules may be obtained by writing to Newbury Sound Equipment, 21, Lancaster Court, Lancaster Avenue, London, S.E.27.

AUDIO

First introduced at the Sonex 70 exhibition two new products from **Sinclair Radionics** may be of interest to readers.



Newbury Sound Equipment encapsulated modules

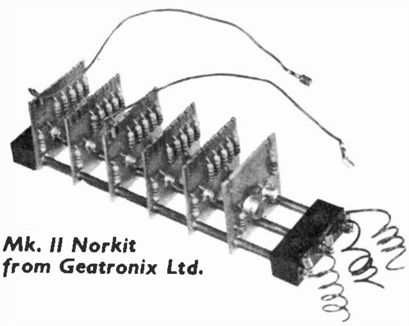
The first is the Sinclair Active Filter Unit which is an addition to their Project 60 range of high fidelity modules. The purpose of a filter unit is to reject frequencies above (scratch) or below (rumble) specific cut-off frequency when these frequencies are likely to contain interference. This unit contains continuously variable cut-off frequency controls for both the scratch and rumble filter circuits.

Designed specifically to complement the other modules in the Project 60 range the active filter can easily be added to other amplifier systems.

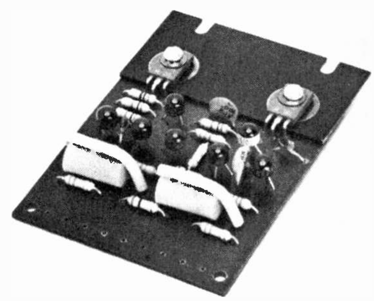
The cost of the Sinclair Active Filter Unit is £5 19s 6d.

The Z.50 power amplifier is the other new product from Sinclair. This amplifier is similar in design to the Z.30 but, by using higher current power transistors, the output is increased to 40W continuous r.m.s. into 3 or 4 ohms or 30W r.m.s. into 8 ohms. Also, the maximum supply voltage is raised to 50V.

The Z.50 amplifier costs £5 9s 6d built and tested.

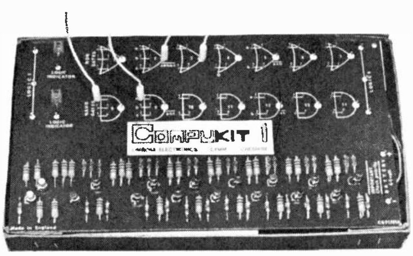


Mk. II Norkit from Geatronix Ltd.



Sinclair Z.50 amplifier and active filter unit

Compukit I marketed by Limrose



Audio Tronics 70

The 1970 edition of Lasky's famous Audio-Tronics catalogue is available FREE on request. The 28 tabloid pages—many in full colour are packed with 1000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast, Electronics Hobbyist, Servicemen and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio accessories plus **Lasky's amazing money saving vouchers worth over £25.**

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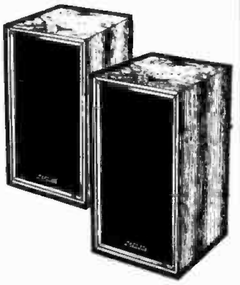
EXCLUSIVE

FOSTER "Criterion" MkII

HIGH FIDELITY 2 SPEAKER TWO WAY BOOKSHELF SPEAKER SYSTEM

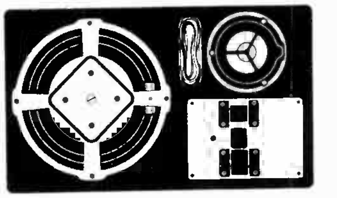


Another high quality bookshelf system from Foster. The "Criterion" Mk. II is a sealed infinite baffle type encolsure using 5½in. bass/mid-range woofer with rolled cloth edge and a 2½in HF cone type tweeter. The compact cabinet is constructed of ¾in laminate with handsome oiled walnut veneer finish and black woven acoustic gauze—front panel with satin chrome edge insert. SPEC: Frequency range 90–20,000Hz. Power Handling 10 watts. Impedance 8 ohms. HF crossover. Screw Tag connections at rear. Size 12¼ × 7¾ × 6¾in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

LASKY'S PRICE **£9.10.0** or 2 for **£17.10.0** Post 1—7/6 2—10/-

WHARFEDALE

UNIT 3 SPEAKER KIT



3in tweeter uses new Wharfedale "Acoustiprene" dome diaphragm. Crossover unit crossover freq. 1,750Hz. ALL accessories, acoustic wadding, mounting bolts, wire, etc., are supplied, you provide the cabinet to suit your needs. 8in Bass/Mid. range speaker employing a powerful magnet assembly with diecast chassis and Flexiprene roll surround. The Wharfedale Unit 3 speaker kit can be constructed by anybody and with a suitable cabinet will provide a highly sophisticated system giving true Hi-Fi reproduction from 40–17,000Hz. Impedance 4/8 ohms. Max. power handling 15W.

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UNIT 4 SPEAKER KIT

2 speakers (12in Bass and 3in Treble) to give full range, balanced reproduction Frequency response of 45–17,000Hz when housed in suitable cabinet. Superior 4-element crossover unit ensures optimum performance from each speaker.

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3 speakers (12in Bass, 5in M.-R. unit, 3in Treble) give clean, smooth performance. Frequency response of 40–20,000Hz when housed in suitable cabinet. Unique mechanical/electrical 6 element crossover unit.

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TTC HEADPHONES

MODEL G-IIII

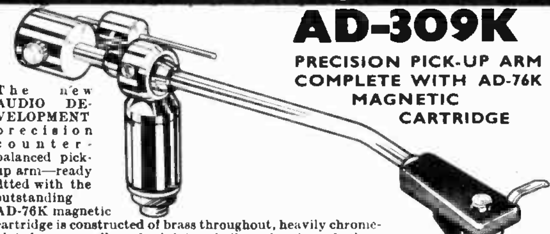
Yet another outstanding TTC product which gives you exceptional value plus super quality. These stereo phones use two 3in low imp. high flux density dynamic reproducers. Freq. Res. 25–15,000Hz. Fitted with foam cushioned adjustable earpads for super listening comfort, imp. 8 ohms, matching 16 ohms. Max. Input 0·5W. Complete with 36in shielded grey cable. Pearl grey finish with double spring headband.

ONLY **63/-** Post 3/6

AUDIO DEVELOPMENT

AD-309K

PRECISION PICK-UP ARM COMPLETE WITH AD-76K MAGNETIC CARTRIDGE



The new AUDIO DEVELOPMENT precision counter-balanced pick-up arm—ready fitted with the outstanding AD-76K magnetic cartridge is constructed of brass throughout, heavily chrome-plated; uses needle and miniature ballrace bearings; both coarse and fine balance adjustment is provided. The fixed head has standard ½in mounting centres and is finished in black enamel with chrome lifting spur. Completely wired, with all fixing nuts and washers. Arm rest also supplied. Tech. details: Overall length 285mm; needle to pivot length 223mm; offset angle 24°; overhang 10mm. Requires single 7/16in dia. mounting hole.

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AUDIO DEVELOPMENT AD-76K

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WAA-WAA UNIT
......FOR GUITAR EFFECTS

By D.C.HAMILL

THE "Waa-Waa" effect, much used in pop music, is produced by passing the output from a guitar or organ, etc. through a band-pass filter, the resonant frequency of which can be altered. The rapid changing of this formant, as it is called, produces the Waa-Waa effect.

The unit described in this article obtains this shifting formant by switching different values of capacitance across an inductor, thus changing the resonant frequency of the tuned circuit. This must not be done by mechanical switches, as clicks will be produced; these are objectionable, especially if the tuned circuit rings at all when it is energised by the switching transients.

In this design, the switching is done by transistors controlled by time delay networks, so that the capacitors are switched slowly in and out of circuit.

SWITCHED CAPACITORS

The circuit diagram of the unit is given in Fig. 1. Here the input signal is fed to SK1, the input to the pre-amplifier TR1. Capacitor coupled to the collector is the band-pass filter L1, C3.

To alter the resonant frequency of this filter the capacitors C5 and C8 can be switched in by biasing on the transistors TR2 and TR3.

There are two modes of switching: automatic, which applies negative-going square waves via the footswitch S1, and single-shot, which applies the line voltage to the transistor bases for as long as S2 is depressed.

The automatic pulses are derived from the multi-vibrator comprising TR5 and TR6. These can be varied in their mark/space ratio by adjustment of VR1.

TIME DELAY

With the depression of either of the footswitches there is a small delay before the capacitors C5 and C8 are switched. This is achieved by connecting the resistor-capacitor networks R4, C6 and R5, C7 at the bases of TR2 and TR3 respectively. The time constants are arranged so that TR2 switches on before TR3, so there is a gradual transition of the resonant frequency.

As the formant circuit attenuates the signal, an additional amplifier TR4 is used.

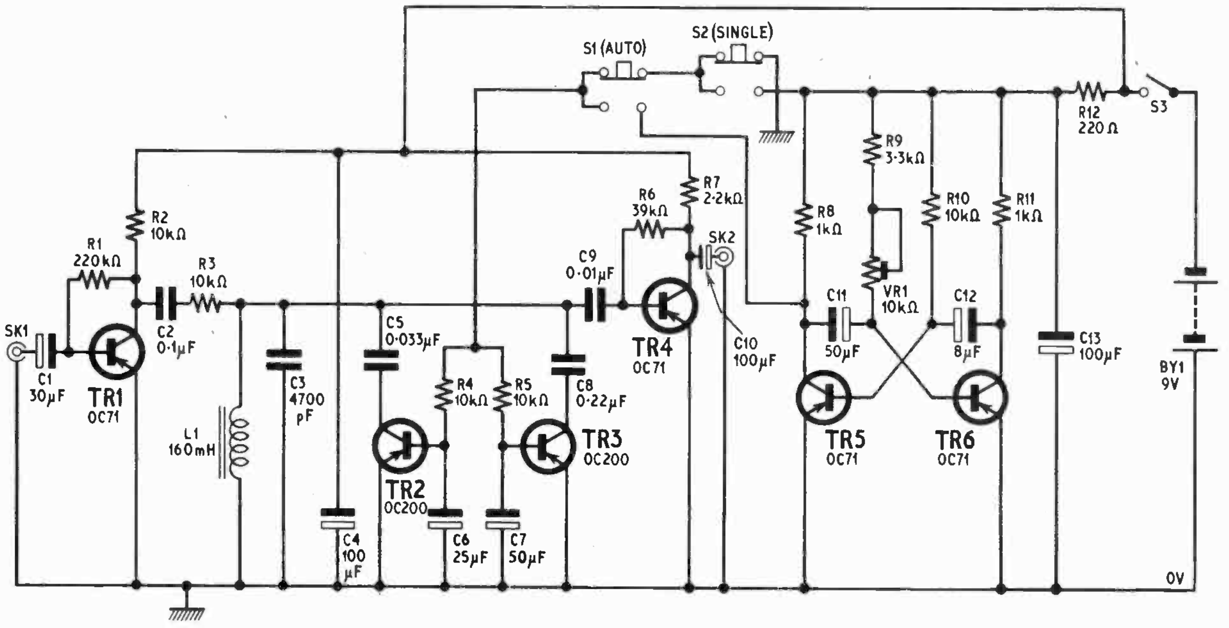
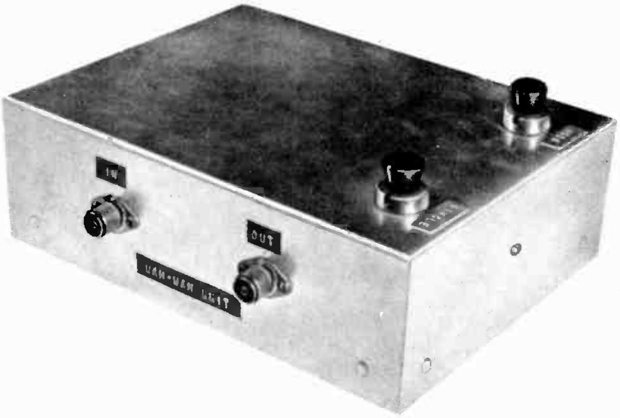


Fig. 1. Complete circuit diagram of the waa-waa unit



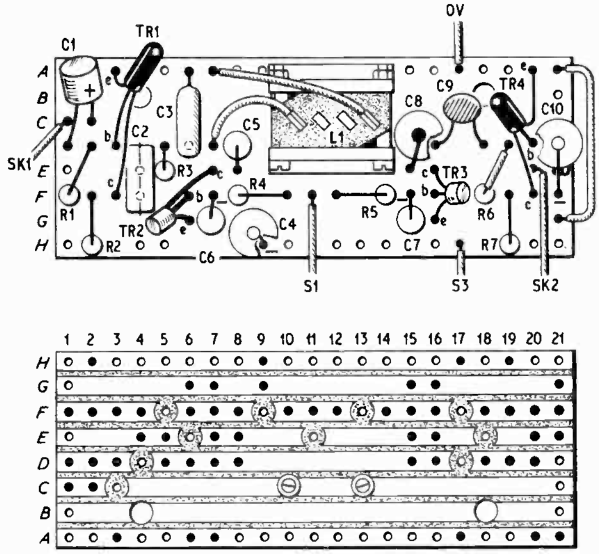


Fig. 2. Waa-waa module layout and wiring

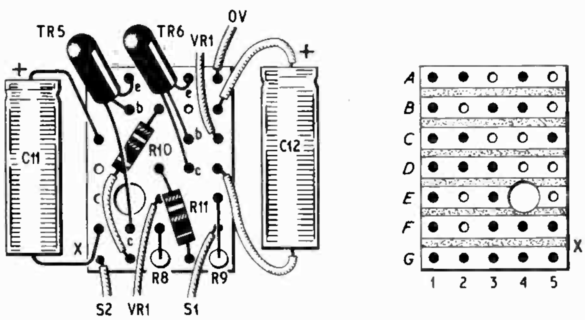


Fig. 3. Multivibrator module layout and wiring

COMPONENTS . . .

Resistors

R1	220kΩ	R7	2·2kΩ
R2	10kΩ	R8	1kΩ
R3	10kΩ	R9	3·3kΩ
R4	10kΩ	R10	10kΩ
R5	10kΩ	R11	1kΩ
R6	39kΩ	R12	220Ω

All ±10%, ¼ watt carbon

Capacitors

C1 30μF elect. 6V
C2 0·1μF polyester
C3 4,700pF polystyrene
C4 100μF elect. 25V
C5 0·033μF polyester
C6 25μF elect. 12V
C7 50μF elect. 12V
C8 0·22μF polyester
C9 0·01μF polyester
C10 100μF elect. 12V
C11 50μF elect. 12V
C12 8μF elect. 12V
C13 100μF elect. 12V

Inductor

L1 660 turns of 38 s.w.g. enamelled copper wire wound on bobbin of Ferroxcube pot core type LA1

Potentiometer

VR1 10kΩ linear wirewound preset

Transistors

TR1, TR4, TR5, TR6 OC71 (4 off)
TR2, TR3 OC200 (2 off)

Switches

S1, S2 Single pole, changeover press switches (Bulgin S.M.357) (2 off)
S3 On/off toggle switch

Sockets

SK1, SK2 Coaxial sockets (2 off)

Battery

BY1 9V, type PP3 or similar

Miscellaneous

8in × 6in × 2½in aluminium chassis, Veroboard, battery clips, 6B.A. nuts, bolts and spacers

CONSTRUCTION

In the prototype unit two circuit modules are constructed. These consist of the basic Waa-Waa module and the multivibrator module, details of which are given in Fig. 2 and Fig. 3.

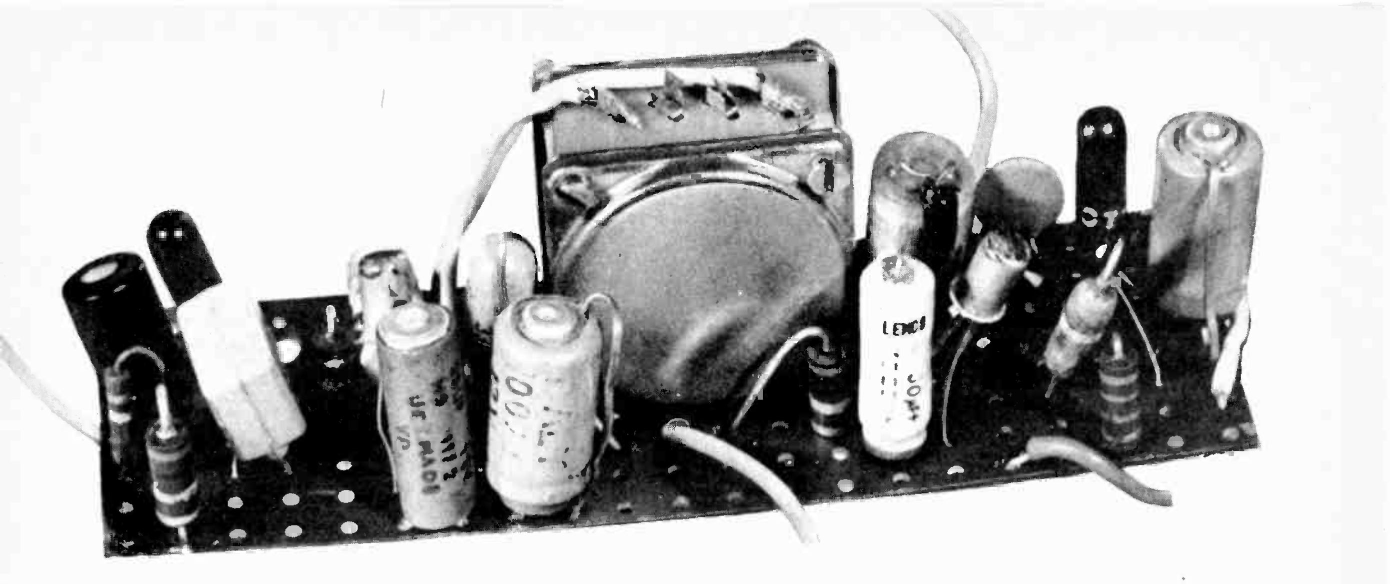
If only the single Waa-Waa function is required, both the multivibrator and S1 can be omitted in the construction.

The inductor L1 is made up by pile winding 660 turns of 38 s.w.g. enamelled copper wire on a Ferroxcube pot core bobbin. When assembled the pot core is mounted on the Veroboard by two ¼in 6B.A. screws. In tightening these up, be careful not to crack the ferrite core.

With the modules completed they should be wired and mounted with their associated components in an 18 s.w.g. aluminium chassis, as shown in Fig. 4. The boards should be spaced away from the chassis to prevent short circuits.

USING THE WAA-WAA

The unit may be used with any guitar amplifier as the output impedance is about 600 ohms. When switched on with no footswitches depressed, the unit acts as a treble booster, accentuating the harmonics of the guitar.



Waa-Waa unit circuit board

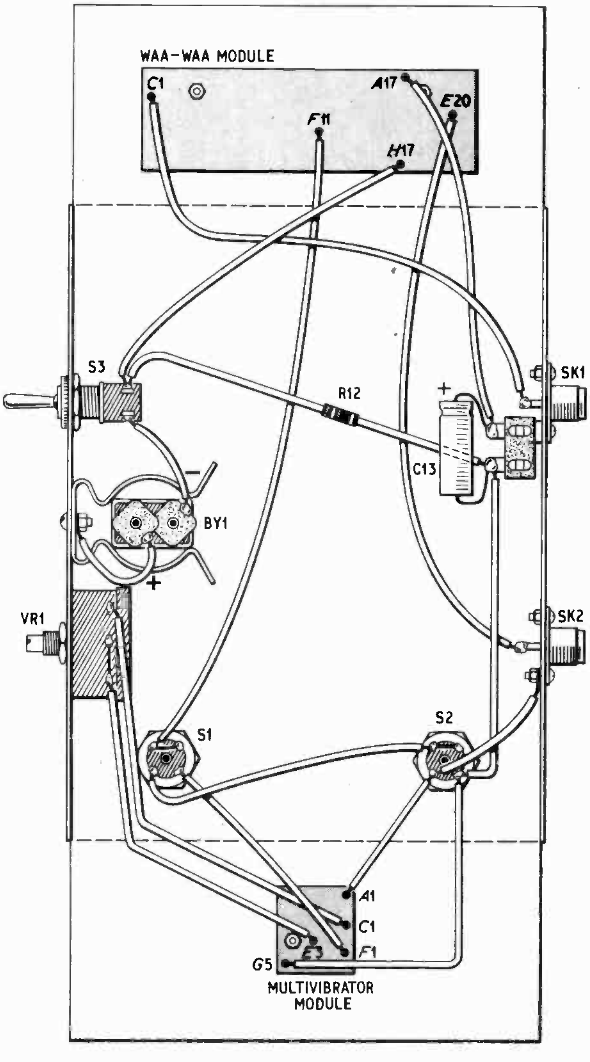


Fig. 4. Layout and wiring of the complete waa-waa unit in an aluminium chassis. The end flanges are shown folded flat for clarity

Depressing the SINGLE footswitch (S2) produces a single "Waa". With a little practice it is easy to add this effect to single notes or chords, then quickly releasing the switch to produce a second "Waa".

If the AUTO switch (S1) is used, the effect can be produced continuously at a frequency determined by the setting of the potentiometer VR1. This is very effective on rhythm guitars as the Waa-Waa will not always coincide with the beat of the music.

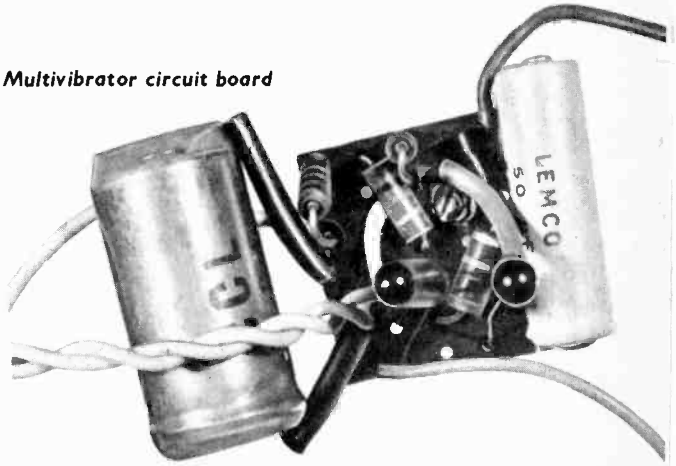
MODIFICATIONS

If the Waa-Waa is used with an electronic organ, where the pitch is generally higher and harmonics more prominent, it would be better to reduce the values of C5 and C8.

If the effect is still too heavy, a resistor can be wired in parallel with L1 to reduce its *Q*-factor. The actual value would depend on experiment and personal requirement.

Again, with other instruments it is necessary to ensure that the first stage is not overloaded. In the prototype, a 16mV signal proved the maximum for the least distortion. If this figure is in fact exceeded a 1 kilohm potentiometer should be interposed between SK1 and C1 to provide signal attenuation. ★

Multivibrator circuit board



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SIGNAL/NOISE RATIO —70 db at full output.
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Specification

INPUTS VOL. 1 8 mV at 50K OHMS (mic).
VOL. 2 8 mV at 50K OHMS (mic).
VOL. 3 50 mV at 500K OHMS (aux).
VOL. 4 50 mV at 500K OHMS (aux).
50 OHM and 600 OHM Mic inputs may be ordered at £2.0.0. extra per Input.
1 or 2 meg OHM aux inputs may be ordered at no extra cost.
FREQUENCY RESPONSE 30–20,000 HZ ±3 db.
SIGNAL/NOISE RATIO Better than –65 db.
HARMONIC DISTORTION Less than 0·5% at 1 volt.
BASS Continuously variable 20 db at 100 HZ.
TREBLE Continuously variable 30 db at 10 KHZ.
SIZE 12½" × 6" × 4¼".
CUT OUT REQUIRED 11½" × 5".
FUSE 60 ma internally mounted.

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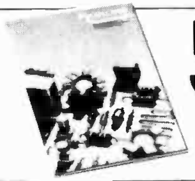

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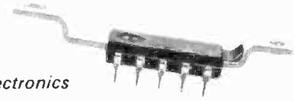

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TRANSISTOR D.C. MULTIMETER

By W. CLELAND

BASIC amplifier design, amplifier construction and stabiliser construction were detailed last month. We now move on to describe the remainder of the circuitry and give further construction details.

OVERLOAD PROTECTION

At the amplifier input, steps are taken to reject spurious signals, and also to protect the amplifier against excessive inputs. The high resistances in series with the input (Fig. 2) give some protection against overloads, since the base-emitter junctions of the transistors are able to pass a current of milliamps—sufficient to drop a high voltage across the resistors.

To maintain conduction when one base-emitter junction is reverse biased, the diodes D1 and D2 are added. Under normal conditions, both diodes are reverse biased, and do not affect the working of the circuit. When an excessive voltage is applied, either D1 or D2 will conduct, according to the polarity.

INTERFERING SIGNALS

No connection is made between the amplifier circuit and the earthed metal case in which the meter is housed, but there will still be some leakage resistance and capacitance; common mode inputs are therefore possible, although greatly attenuated. A common mode interfering voltage acts equally on both input terminals, displacing the differential signal asymmetrically relative to zero signal potential.

The high impedance of TR11 (Fig. 2) in the emitter circuit of the input stage, causes any common mode input to be reproduced in the emitter circuit, and not to appear elsewhere in the amplifier. The emitter circuit must be able to cope with the largest common mode signal encountered.

Mains frequency interfering signals could upset the action of the amplifier and cause severe pointer vibration, especially on the more sensitive ranges. This is overcome by restricting the bandwidth of the amplifier; in other words, by lengthening the time constant. Two 0·1μF feedback capacitors (C1 and C2) from the emitters of the output transistors, provide a time-constant of 0·13 second, increasing to 0·85 second on the more sensitive ranges. The risk of inaccuracy due to leakage through the capacitors, is decreased with modern humidity resistant dielectrics. A dielectric resistance of 10,000 megohms can be maintained by certain types of capacitor.

RANGE EXTENSION

Various methods of range extension are outlined in Fig. 5. Independent variation of R_L is the simplest method, as it involves only one resistance. As R_L is reduced, the voltage amplification increases. The higher values of R_L provide improved zero stability.

It is convenient to have the milliammeter in series with the load resistance R_L, instead of forming part of it. The resistance of the copper wire of the moving coil increases with temperature, and putting the milliammeter outside R_L avoids temperature errors. To make the arrangement symmetrical, a 75 ohm resistor is connected on the other side of R_L.

The number of ranges that can be provided by varying R_L is limited, but as a complement to other methods, it has an independent multiplicative effect, giving rise to an expanded series of ranges. For complete coverage, another method of range extension is necessary. This is to vary the two series resistances at the input, switching in values of 100 kilohms, 1 megohm, and 10 megohms. Resistances much higher than this are not practicable, so the higher voltage ranges are obtained by switching in a shunt element to produce the attenuation required. This will tend to reduce the accuracy on the upper ranges.

Currents are measured by means of a number of shunt resistances that can be switched across the input terminals. Advantage is taken of the sensitivity of the instrument to provide low potential drops on the current ranges of between 2 millivolts and 50 millivolts—less than the 75 millivolt potential difference of the milliammeter itself. Two pole switching is necessary to avoid switching surges, and double connections are required for the 1 ohm (R15) and 0·1 ohm (R27) resistors to exclude the resistance of the leads.

Some of the higher shunt resistors have to be adjusted in value to allow for the input impedance of the instrument in parallel. These small adjustments are made by means of other resistors in series.

RESISTOR TOLERANCES

Overall accuracy of the multimeter will depend upon resistor tolerances together with the accuracy of the moving coil meter (M1), which is within 2 per cent. When resistors of a particular tolerance are connected in series or parallel, the combined tolerance remains the same. However, when the resistors are used in obtaining ratios or products, the tolerances become additive. Range resistors of $\pm$0·5 per cent tolerance, used as input, feedback, and load resistors will add 1·5 per cent to the 2 per cent tolerance of the meter, making the overall figure $\pm$3·5 per cent.

On the higher voltage ranges, the need to introduce an attenuator arrangement will bring this up to $\pm$4·5 per cent. On the current ranges, the added 0·5 per cent for the shunt resistors, will make the overall tolerance $\pm$4 per cent.

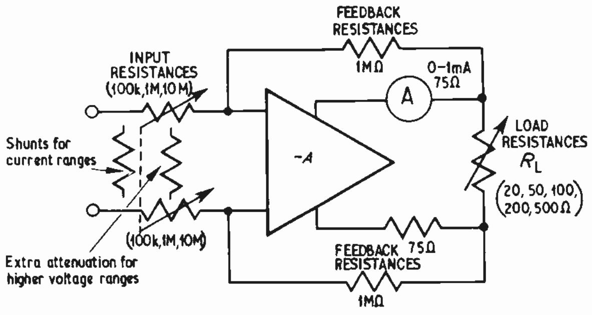

Fig. 5. Methods of range extension used in the d.c. multimeter

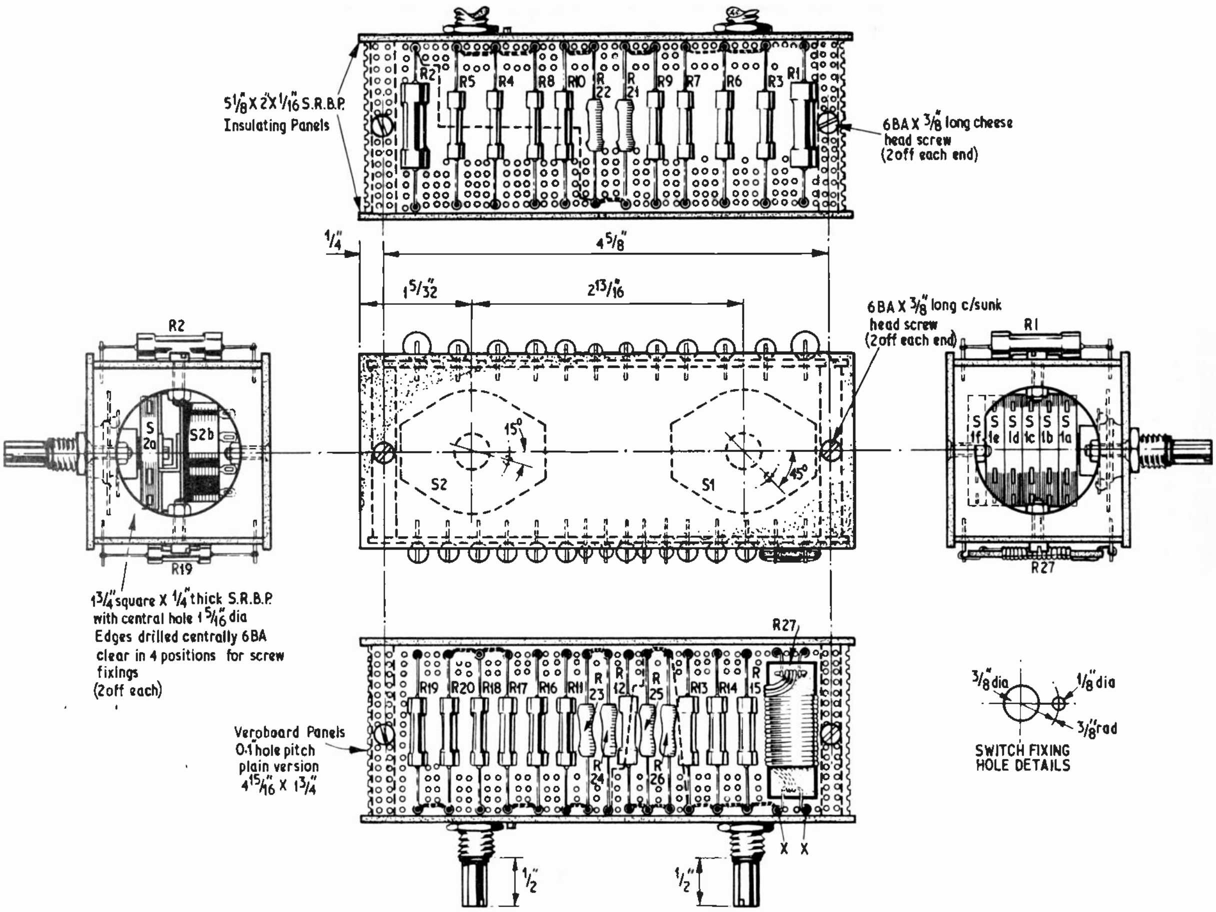

Fig. 6. Range switching assembly and layout details

It can be seen that a close tolerance on range resistors is necessary, and metal film resistors are the obvious choice. These have the best stability of any resistors available, and withstand soldering better than other types of resistors.

LOW VALUE RESISTOR

The 0·1 ohm shunt (R27) has to be specially made; construction is as shown in Fig. 6. The resistor is wound on a rectangle of s.r.b.p., measuring $1\frac{3}{8}$ inches × $\frac{1}{2}$ inch. At each end of the former twin connections are formed of doubled 20 s.w.g. tinned copper wire passed through a pair of holes drilled at each end of the strip. The resistance consists of three strands of 23 s.w.g. double cotton covered Constantan wire, each 8 inches long. These are bared at one end, twisted round one of the tinned copper wires where it is doubled, and soldered.

Temporary connection is established at the other end, and successive adjustments are made in a bridge circuit until the value is very close to 0·1 ohm. The testmeter can be used on the 2 millivolt range as a null detector, but will only function with the 0·1 ohm resistor omitted if the lower pair of terminal pins (marked XX) are connected together. The bridge circuit, Fig. 7, requires a precision 10 ohm resistor, precision 100 to 1 ratio arms, and a means of varying the current up to about 100mA. Some difficulties are produced by thermo-e.m.f.s and by heating of the resistances, and may result in a lower accuracy than the ±0·5 per cent aimed at.

Final adjustment is made after winding the three strands of Constantan wire on to the strip of s.r.b.p. and soldering the ends. One turn of three strands can be separated and scraped very carefully to increase the resistance; assuming that the value is only very slightly less than 0·1 ohm. Once the correct value has been reached the resistance can be varnished.

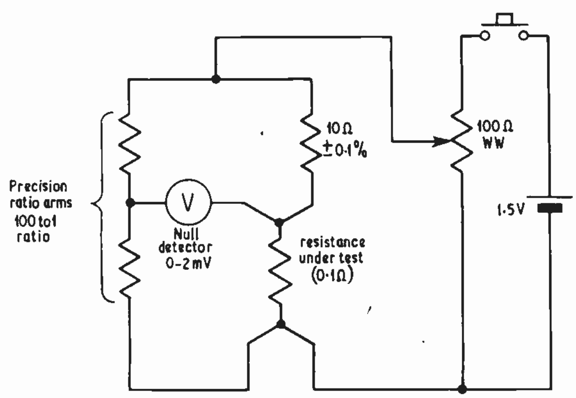

Fig. 7. Bridge circuit for measuring the value of R27

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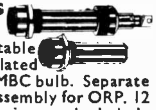

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700	16–24	4 c/o	I.B.	15/6
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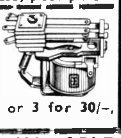

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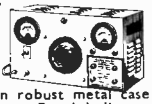

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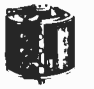
Price: RT 100VA 3·18 turns per volt, £2.5.0 plus 3/6, P. & P. RT 300VA 2·27 turns per volt, £4.4.0 plus 5/6 P. & P. RT 1kVA 1·82 turns per volt, £6.10.0 plus 6/6 P. & P. RT 2kVA 1·5 turns per volt, £10.10.0 plus 9/6 P. & P. RT 3kVA 1·5 turns per volt, £14.0.0 plus 9/6 P. & P.

INPUT 230/240v. A.C. 50/60— OUTPUT VARIABLE 0-260v.

BRAND NEW
Keenest prices in the country. All Types (and Spares) from ½ 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. 12 amps, £21. 0. 0. 15 amps, £25. 0. 0. 20 amps, £37. 0. 0. 37.5 amps, £72. 0. 0. 50 amps, £92. 0. 0.



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Carriage extra on open types.

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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
Speed adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £5.5.0 plus 5/- P. & P.

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Ideally suited for above Strobe kits. Price 10/6. P. & P. 2/6 or Post Paid with kits.

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 Kohm, 280 mA; 1·5 Kohm, 230 mA; 2·5 Kohm, .2 a.; 5 Kohm, 140 mA. Diameter 3½in. Shaft length ⅝in., dia. ¼in. All at 27/6 each. P. & P. 1/6.

50 WATT. 1/5/10/25/50/100/250/500/1/1·5/2·5/5 Kohm All at 21/- each. P. & P. 1/6.
25 WATT. 10/25/50/100/250/500/1/1·5/2·5 Kohm. All at 14/6 each. P. & P. 1/6.

VEEDER ROOT, 230V a.c. 50 cycle, 5-figure counter (non-resettable). 18/6, P. & P. 1/6.

NICKEL CAD. BATTERY OUTFIT (Ex. W.D.)
Two metal carrying cases each containing 10×1·2V 7AH (12V) Batteries, also 10 × 1·2V 22AH (12V) Batteries (40 batteries in all). One dual voltage, dual meter thyristor controlled charging unit. Designed for charging the 7AH and 22AH batteries simultaneously. Input voltage can be adjusted between 100 and 250V a.c. Built to Ministry specification. Ideal power supply for field work. Offered at fraction of makers' price. Two sets of batteries, 1 charging unit. The set £45 P. & P. 30/-.

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10 in makers' carton 35/- post paid.

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24-30V D.C. operation. Stabilised unijunction Timer and S.C.R. (30V 1 amp.), encapsulated in metal core. Timing interval adjustable from a fraction of a second to several minutes by means of external resistor or pot. By adding a 24V Relay many other complex timing Functions are possible. Price: 16/6 incl. circuit. P. & P. 2/6. Suitable relay 10/- post paid.

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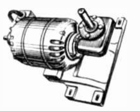

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20 SOLID STATE PROJECTS FOR THE HOME by R. M. Marston. 18/-. Postage 1/-.
THE HI-FI AND TAPE RECORDER HANDBOOK by Gordon J. King. 40/-. Postage 2/6.
BEGINNER'S GUIDE TO TRANSISTORS by J. A. Reddihough. 15/-. Postage 1/-.
SCR MANUAL by General Electric Company 25/-. Postage 1/6.
RADIO COMMUNICATION HANDBOOK by Radio Society of Great Britain. 63/-. Postage 4/6.

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DIMMASWITCH

This is a dimmer of standard size in ivory and chrome to replace modern light switches without wiring change—controls 40-600 watts, 200/250 volts at 50Hz of all lights except fluorescents.

Two models are available with on/off switch to control from maximum to zero.

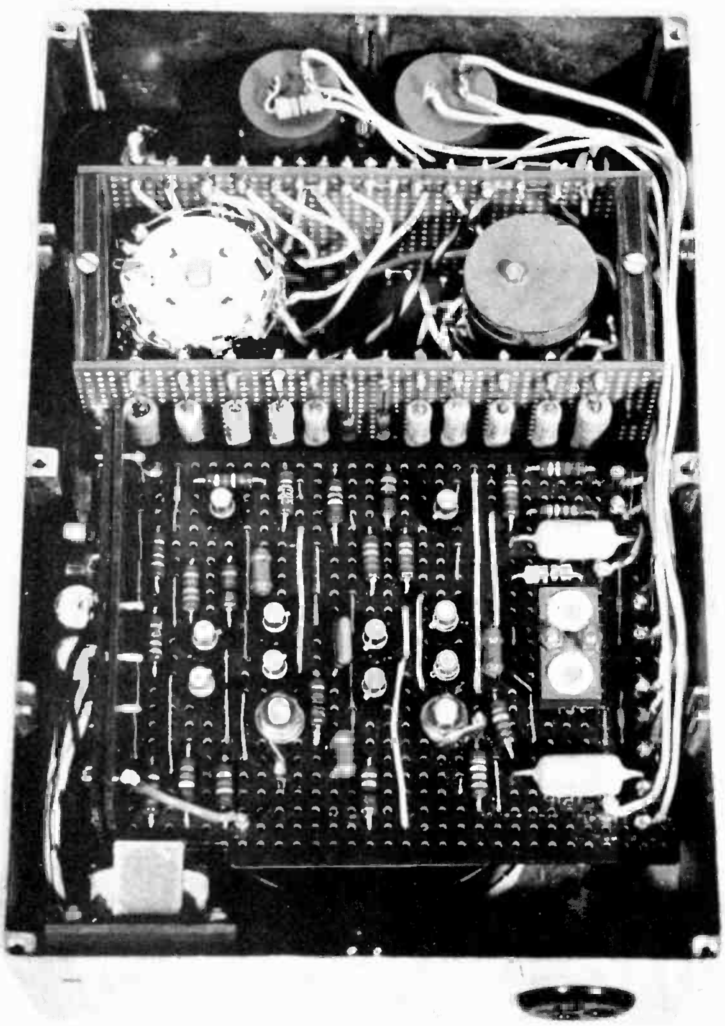
DS500/2 at £3 12s. 6d. with clockwise or reverse dimming, with the switch at full reverse rotation.

DS500/2/P at £3 18s. uses a patented switch giving on/off control at any position of dimming.

Both are available in D.I.Y. kit form at 10/- less. Fuse protection is available at 2/6 extra.

Please send C.W.O. to:
DEXTER & COMPANY
ULVER HOUSE, 19 KING STREET
CHESTER CH1 2AH
Tel.: Chester 25883

As supplied to H.M. Government Departments, Hospitals, Local Authorities, etc.



COMPONENTS . . .

RANGE SWITCHING

Resistors

R1	10MΩ	R15	1Ω
R2	10MΩ	R16	30Ω
R3	1MΩ	R17	20Ω
R4	1MΩ	R18	100Ω
R5	1MΩ	R19	300Ω
R6	1MΩ	R20	200Ω
R7	100kΩ	R21	220Ω
R8	100kΩ	R22	4·7kΩ
R9	20kΩ	R23	470Ω
R10	220kΩ	R24	56Ω
R11	10kΩ	R25	10Ω
R12	1kΩ	R26	10Ω
R13	100Ω	R27	0·1Ω ±0·5% (see text)
R14	10Ω		

R1 to R20 ±0·5% metal film type 4015D (10MΩ type 4016D—Welwyn) available from The Radio Resistor Co., 9–11 Palmerston Road, Harrow, Middlesex

R21 to R26 ±2% metal oxide (Electrosil type TR5)

Switches

S1 Maka switch assembly and four 12-way single pole wafers

S2 Maka switch assembly, one 12-way single pole wafer and d.p.s.t. mains switch

Miscellaneous

Veroboard plain perforated 5in × 1¾in, 0·1in matrix (2 off)

S.R.B.P. board 5⅛in × 2in × $\frac{1}{16}$in (2 off) and 1¾in × 1¾in × ¼in (2 off)

23 s.w.g. d.c.c. Constantan wire (24in)
6B.A. fixings

RESISTOR CONNECTIONS

In Fig. 6, R27 is shown soldered to the two pairs of terminal pins. The separate input and output connections must be preserved so that no part of the connections becomes part of the shunt resistance, and there must be two separate connecting leads to the switch; these can be of flexible p.v.c. covered wire. A somewhat similar arrangement is used for R15, although the resistor itself has single axial leads.

When the testmeter is completed, it is possible to compare the 0·1 ohm resistance with the 1 ohm resistance, by comparing a reading on the 100 × 0·5mA range with the corresponding reading on the 10 × 5mA range. It is not a highly accurate check, because, even if the current is kept exactly the same on both readings, there is a tolerance of 2 per cent involved. Used instead of the bridge method, it could make possible a tolerance of 5 per cent on the 100mA range.

RANGE SELECTION

Range selection is by means of two rotary switches, S1 and S2, forming part of an integrated section that can be wired up before final installation. The range-switching assembly combines the switches and range resistors in a compact unit (Fig. 6) constructed from insulating material. A circular aperture in each end enables the connecting leads to be brought out. The ends are ¼ inch thick to take the 6 B.A.bolts holding the assembly together, and can be made, if necessary, by sandwiching a piece of ⅛ inch thick material between two pieces $\frac{1}{16}$ inch thick. It is convenient to fix the 6B.A. nuts temporarily in position on the inside of the circular aperture by applying some adhesive around them.

The sides of the assembly are formed by the boards on which the range resistors are mounted, consisting of 0·1 inch matrix plain perforated Veroboard.

The range resistors are soldered to rows of terminal pins along the edges of the group boards. The spacing is arranged as in Fig. 6 to accommodate the different sizes of the resistors. Wiring behind the boards is also indicated. Further wiring, shown diagrammatically in Fig. 8 consists of flexible p.v.c. covered leads to the switches, and external leads to the amplifier board, etc.

WAFER SWITCHES

When the range switching assembly is fitted in the testmeter, it is secured in position by the nuts on the

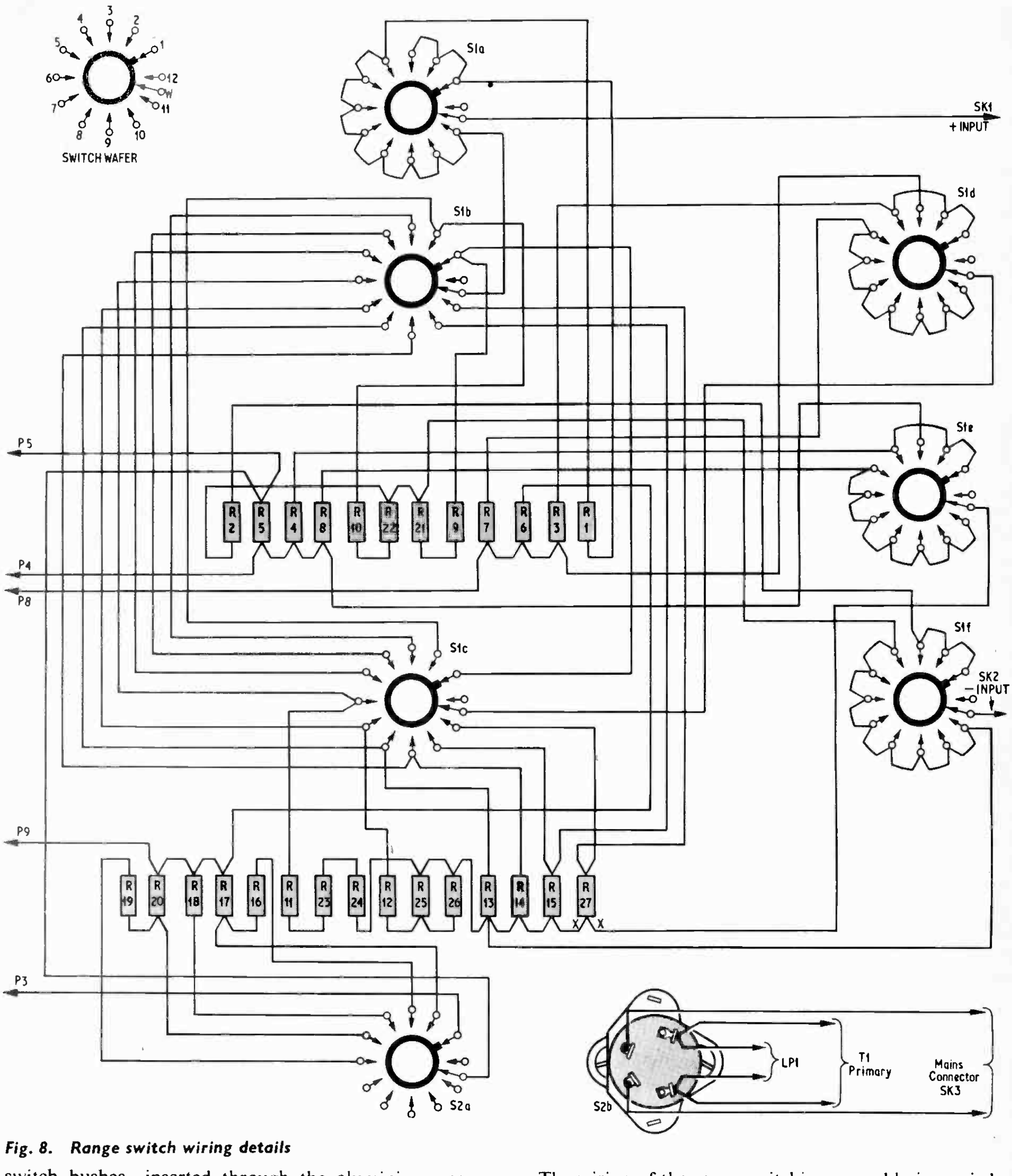


Fig. 8. Range switch wiring details

switch bushes—inserted through the aluminium case. The top and bottom of the range switching assembly are panels of $\frac{1}{16}$ inch insulating material, measuring $5\frac{1}{8}$ inches by 2 inches. The panel that is fixed to the case has $\frac{3}{8}$ inch diameter holes for the switch bushes.

Each switch has to be keyed in position to prevent turning. As shown in Fig. 6, holes of $\frac{1}{8}$ inch diameter are drilled in the insulating panel at the required positions for the spigots that are fitted on the switch bushes. The spigot rings combine limit stops for the switches, and a check should be made to ensure that the switch rotates a total of six positions for S2, and 11 positions for S1.

The wiring of the range switching assembly is carried out with reference to Fig. 8. The circuit diagram of the entire testmeter appeared last month and can be used to check the wiring; all pin numbers were shown on the circuit diagram. A different colour of p.v.c. covered flexible wire can be used for each switch wafer. The external leads to the amplifier pins should also be in different colours. Wires should not be pushed down to the bottom of the switch assembly where they could become jammed in the switch mechanisms.

Next month: final construction and setting up

Readout—

A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

Nematic Crystals

Sir—Perhaps the following background comment, on the above subject, may prove of interest to readers G. E. Dunning and L. P. E. Light (P.E. "Readout", January 1970).

The nematic mesophase is a phenomena exhibited by some 0·5 per cent of organic crystals as they are heated through their freezing points to their melting points.

Crystals T_1
↓
Smectic Mesophase T_2
↓
Nematic Mesophase T_3
↓
Isotropic Liquid

where T_1, T_2 and T_3 are reversible transition temperatures.

Nematic comes from the Greek "Nematos" meaning threadlike. Smectic also comes from the Greek "smectos" meaning soaplike. These intermediate phases, or mesophases, occur within definite temperature ranges, specific for each compound and mostly above ambient temperatures. The threaded texture of the nematic mesophase is clearly visible between crossed polaroids. Only the nematic mesophase is affected by magnetic or electric fields.

The phenomena was first noted in the literature in 1888 (Reinitzer) and there have been sporadic bursts of interest in it to the present day. A good deal of the published work has been carried out with p-Azoxyanisole using conductive glass by the Corning Glass Co. Voltages used were of the order of 1–3kV/cm with frequencies mainly between d.c. and 1kHz (although frequencies up to microwave are recorded). In practice, only thin films of about 50 microns, sandwiched between layers of conductive glass, were used. Excitation was supplied by low frequency oscillators having outputs of 10–20 volts. It is generally accepted that magnetic fields are more effective in lining up the thread-like "swarms" of molecules, than electric fields. Also of interest is the fact that under the conditions outlined above, the nematic mesophase exhibits properties similar to those shown by ferroelectric materials, namely that it has a "domain" structure and also displays hysteresis effects. It is thought that impurities may affect the alignment direction.

Current interest in these compounds is not confined to their electrical properties. Research is at present being carried out using them in nuclear magnetic resonance techniques where they have proved useful as solvents.

They are also currently being used in the field of gas chromatography as liquid phases, mainly in the separation of meta and para isomers.

The compounds used in the above work can be considered as organic research chemicals. Most have been synthesised by the chemists carrying out the research, but a few of them are marketed by specialised chemical companies to chemical laboratories:—

(1) 4-n-Butoxybenzoic Acid
Ralph Emmanuel
Cat. No. 12,420-6
Cost 100g = 69/-
Also by:—
Kodak Ltd., Kirkby, Liverpool.

(2) p—Azoxyanisole
British Drug Houses
Cat. No. 27888
Cost 10g = 23/-

(3) Methyl Red (o-Carboxybenzene—azo—dimethylaniline) is a very common indicator. No supply difficulties should be encountered.

In conclusion, may I point out a typographical error in F. J. Stone's reply to G. E. Dunning:—

P-N Butoxy Benzoic Acid should, of course, read:—
p-n-Butoxy Benzoic Acid *or* alternatively
4-n Butoxybenzoic Acid.

In chemical nomenclature -N- means that two chemical groups are linked through a nitrogen atom, while -n- means that the Butyl group is straight chained.

I. MacKinnon,
Glasgow.

Best investment

Sir—After teaching for forty-one years at the lower end of the education spectrum, I feel I can add something to your Editorial about the Electronics Industry's best investment—aid to school leavers.

This is indeed a good idea, but it needs more than an unlimited supply of transistors and resistors to make it work.

In the school staff room, Technology is a forbidden subject, and only woodwork, metalwork and technical drawing are respectable.

The much boasted Nuffield Physics, with its "find out for yourself" doctrine and "Worcester Circuit Board" are not good enough, in fact I would say this kind of approach to electrical science is definitely harmful, remembering that electricity is a good servant but a bad master, and hit and miss methods, especially with beginners, can lead to very bad habits.

Many schools are carrying out worthwhile projects in physics, chemistry and scientific thinking, but these are usually led by enthusiasts who know where they are going, and more often than not at a high level in the school strata, where we find the future scientists; so that the shortage of skilled manpower will still persist.

What is needed is a careful programme of practical teaching, beginning with the ten year olds, not based upon hook-ups and make shift apparatus, and with a status at least equal to the more established subjects.

Then all those enthusiasts and interested youngsters will indeed be ready when they are needed.

G. A. Cozens,
Southampton.

P.E. Organ on television

Sir—I have constructed the P.E. Electronic Organ and the results have been excellent except in so far as I am told that a neighbouring television set picks up my playing! I have reduced this interference by earthing the mains chassis. Could you or any reader please suggest any further modification to lessen the interference?

C. Young,
London, N.8.

Good reception!

Sir—May I congratulate you on the series of articles for the holiday motorist and suggest a further article on constructing a unit to enable an extra car battery to be charged to provide power for camp lighting, and even electric soldering for the enthusiast who cannot leave his hobby at home.

In addition, could someone please suggest how to stop the guitar pick-up featured in April "Ingenuity Unlimited" from acting like a radio receiver?

D. B. Bloomfield.
Lambley,
Nottingham.

Readout—

A SELECTION FROM OUR POSTBAG

continued

Mobile rally

Sir—I wonder if it would be possible for you to publish some of the following information in the July issue of your magazine.

On Sunday, June 21 at 1 p.m., Swansea University Radio Society will be holding its mobile rally, the venue being the University grounds at Singleton Park (on the A4067 road).

There will be talk-in on topband and two meters for those unfamiliar with the area. The usual type of events are being organised, including a mobile/pedestrian d.f. hunt.

This will be an outing suitable for "all the family" as there are many local amenities. Refreshments will, of course, be provided. Further details may be obtained from me at the address below.

Philip Regan (P.R.O.),
Union House,
University College,
Swansea SA2 8PP.

Quod erat corrigendum

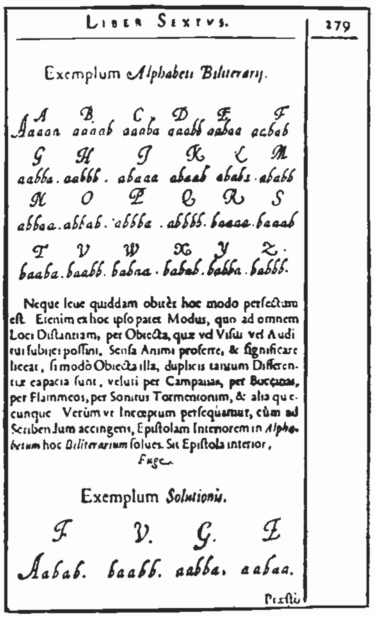
Sir—I read your interesting article on your *Chessboard Computer*, where you mention Napier. The enclosed copy is taken from one of my First Editions printed in 1623—Francis Bacon's "De Augmentis Scientioerum", written when he was Lord Chancellor and printed later in 1623. Bacon actually corrected Napier's logarithms and instigated the publication of them; the actual book with his annotations is in the Folger Library in America.

I am no mathematician, but is this not the binary scale expressed in terms of A and B. The context of this page of the book is part of his illustration of the "Bilateral Cypher" he invented in the 1570's while in France.

If you substitute 0 and 1 for A and B do you not have binary, or am I wrong?

Ewin MacDuff,
Shoreham-by-Sea,
Sussex.

Plate 1.



LIBER SEXTUS. 279

Exemplum *Alphabeti Biliterarij*.

A aaaaa. B aaaab. C aaaba. D aaabb. E aabaa. F aabab.
G aabba. H aabbb. I abaaa. K abaab. L ababa. M ababb.
N abbaa. O abbab. P abbba. Q abbbb. R baaaa. S baaab.
T baaba. V baabb. W babaa. X babab. Y babba. Z babbb.

Neque leue quiddam obiter hoc modo perfectum est. Etenim ex hoc ipso patet Modus, quo ad omnem Loci Distantiam, per Obiecta, quæ vel Visui vel Auditui subijci possint, Sensa Animi proferre, & significare liceat, si modò Obiecta illa, duplicis tantum Differentiæ capacia sint, veluti per Campanas, per Buccinas, per Flammeos, per Sonitus Tormentorum, & alia quæcunque. Verùm vt Inceptum persequamur, cùm ad Scribendum accingeris, Epistolam Interiorem in *Alphabetum* hoc *Biliterarium* solues. Sit Epistola interior,

Fuge.

Exemplum *Solutionis*.

F. aabab. V. baabb. G. aabba. E. aabaa.

Præstò

A truly practical man

I have been a reader of PRACTICAL ELECTRONICS for a considerable period of time and derive a great deal of pleasure from studying and building various circuits. However, I find the greatest pleasure in "making do" with transistors and components that are the results of gleaning from various sources.

Making a transformer or coil which actually produces sound or operates a reed switch is very satisfying especially when the wire has been taken off an old choke that was once doing sterling service in dad's first superhet!

In other words, to build a chrome encrusted, mahogany housed, hi-fi amplifier, and to spend twenty or thirty pounds on sophisticated crystals, special non-noise, non-scratch, non-itch transistors, just does not appeal.

I would like to see more articles on the typical sizes, turns, wire data of coils, transformers, relays, etc. etc.

Some considerable time ago, one reader wanted to know where to *obtain* square copper wire, the idea of making the stuff not appearing to have occurred to him. Why, the old-timers would have softened an old file, drilled it, filed it, hardened and tempered it, and pulled the wire through the die in the time it took to write the letter.

Which reminds me, I must get back to my snuff box. I'm soldering it up to make a transducer for a home-made barometer—I wonder how I can suck some of the air out?

Anybody got a long-winded circuit to replace these new-fangled Zener diodes?

B. Grainger,
Birmingham.

NEWS BRIEFS

Queen's Award to Industry 1970

THE FIFTH list of The Queen's Award To Industry was announced recently. This year there are 104 recipients, 25 of whom are receiving the award for technological innovation. The award has been given to the following 19 firms for technological innovation or exports concerned with electronics:

For technological innovation—

British European Airways Corporation—automatic landing of aircraft
Computer Technology—production of a modular computing system
William Cotton Ltd.—electronic control of knitting machines
Elliott Flight Automation Ltd.—digital cathode ray tube displays
Hawker Siddely Aviation Ltd.—automatic landing of aircraft by the Hatfield Division
Imperial Chemical Industries Ltd.—computerised control of an olefine chemical plant by the Heavy Organic Chemicals Division, Billingham
Radyne Ltd.—semiconductor manufacturing equipment
Saunders-Roe Developments Ltd.—self-powered light sources (Betalight)

For Export—

Brush Clevite Company Ltd.—Electronic components
Cambridge Scientific Instruments Ltd.—X-ray micro-analysers and scanning electron microscopes
Coulter Electronics Ltd.—Electronic particle sizing equipment
Elliot Flight Automation Ltd.—Aviation electronic equipment
Garrard Engineering Ltd.—Record playing equipment
G.K.N. Floform Ltd.—Precision components for the electronics industry
Honeywell Ltd.—Computers, controls and automation systems
Johnson, Matthey and Co. Ltd.—Refined base and precious metals (Engineering metals)
K.E.F. Electronics Ltd.—Loudspeakers
Racal-Mobilcal Ltd.—Radio telephone equipment
Redifon Ltd.—Electronic equipment
Short Brothers and Harland Ltd.—Guided weapon systems

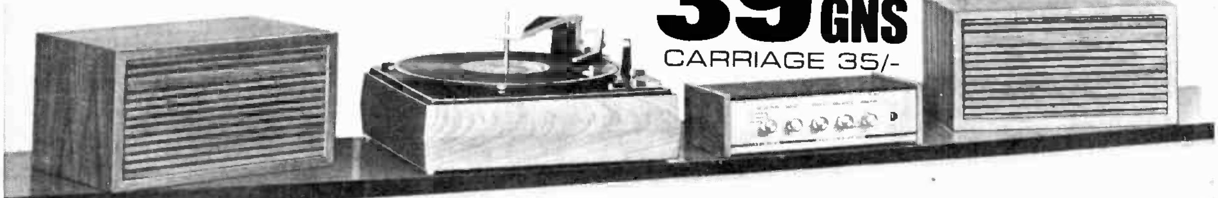
Two of the above firms are of particular interest, these are: Imperial Chemical Industries Ltd., and K.E.F. Electronics Ltd. I.C.I. are one of two firms—the other being Rolls-Royce—who have won the award in all five years.- K.E.F. Electronics, a company which was formed only eight and a half years ago, have increased exports by 250 per cent in the last three years.

It is interesting to note that out of 104 companies receiving the award almost one-fifth have received it due to innovations or exports allied to electronics.

COMPLETE STEREO SYSTEM

FOR ONLY 39 GNS

CARRIAGE 35/-



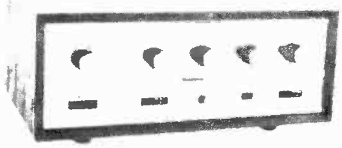
PREMIER STEREO SYSTEM "ONE" Consists of an all transistor stereo amplifier. Garrard 2025 T/C auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12 × 5½ × 3½in. high (Amplifier available separately if required **£14.19.6.** Carr. 7/6).

PREMIER STEREO SYSTEM "TWO"

As system "ONE" above but with Garrard SP25.

PREMIER PRICE **45 Gns.** Carr. 35/-

TELETON SAQ203E STEREO AMPLIFIER



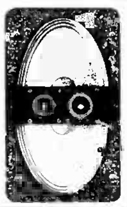
A small but powerful amplifier designed for stereo hi-fi reproduction. 10 watts per channel music power. Inputs for Gram (Magnetic and Crystal), Tuner and Auxiliary. Tape Record output. Controls: Volume, Balance, Bass, Treble, Stereo/Mono slide switch. Stereo headphone socket. Attractive oiled walnut cabinet with brushed aluminium front panel. List Price £28.7.0.

PREMIER PRICE **22 Gns.** P. & P. 10/-

WIDE RANGE OF HI-FI STEREO EQUIPMENT ON DEMONSTRATION

All leading makes available including Rogers, Armstrong, Dulci, Wharfedale, Goodmans, Goldring, Shure, etc., etc.

E.M.I. 13 × 8in. HI-FI SPEAKERS



Fitted two 2½in. tweeters and crossover network. Impedance 15 ohms. Handling capacity 10W. Brand new.

79/6 P. & P. 7/6.

"NOVA" 505 STEREO AMPLIFIER

A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 5 watts per channel. Frequency response 40-20,000 Hz ± 3dB. Inputs for radio, P.U. Ceramic, P.U. Magnetic Tape. Separate bass and treble controls, Volume and Balance controls, Mono Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14¼ × 9½ × 3½in. A.C. 200/250V.

PREMIER PRICE **18 Gns.** Carr. 10/-

PREMIER STEREO SYSTEM "FOUR"

Teleton SAQ203E Amplifier (as above)	£23.2.0
Garrard SP25	£11.19.6
Shure M3D	£6.19.6
Teak base and cover	£5.10.0
Pair of Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
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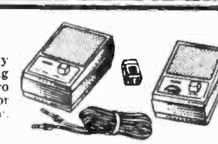

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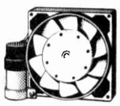

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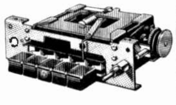

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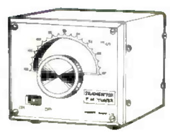

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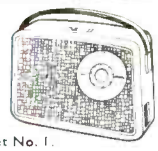

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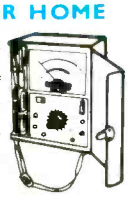

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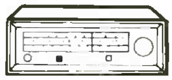

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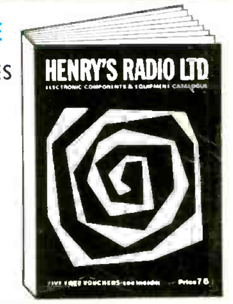

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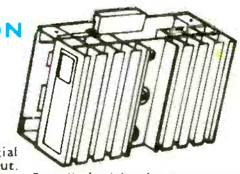

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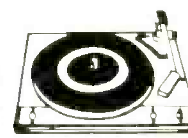

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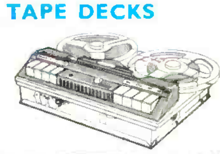

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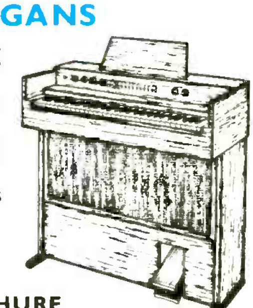

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