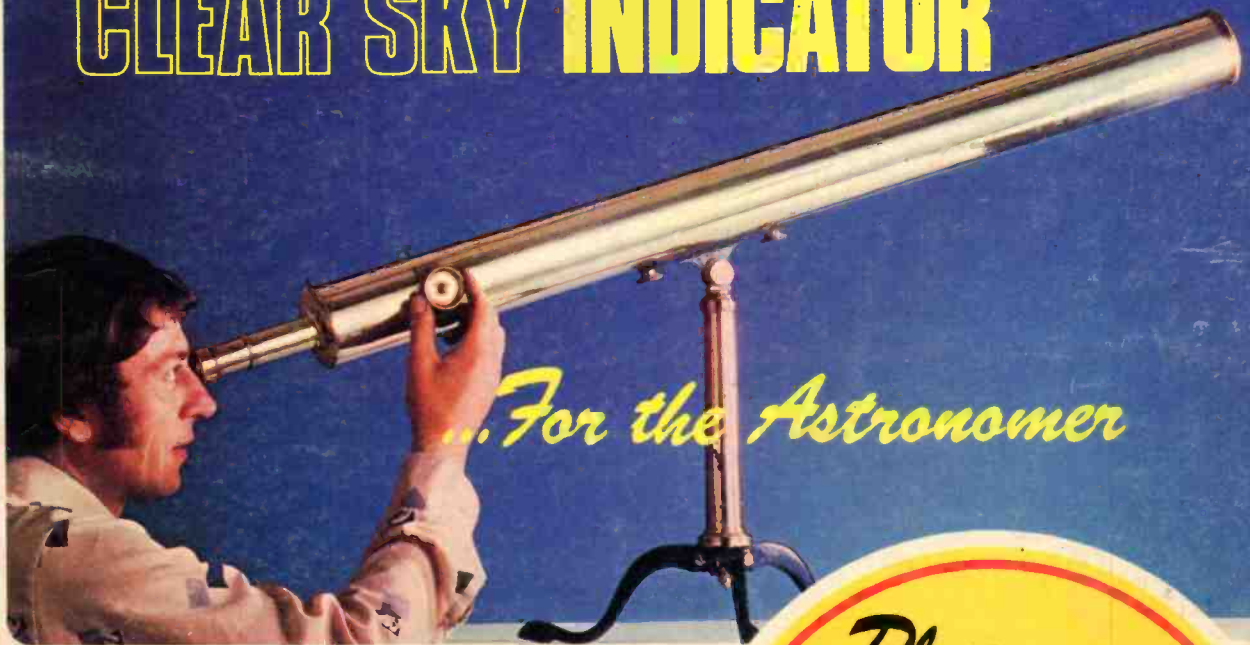


Construction and theory for everyone

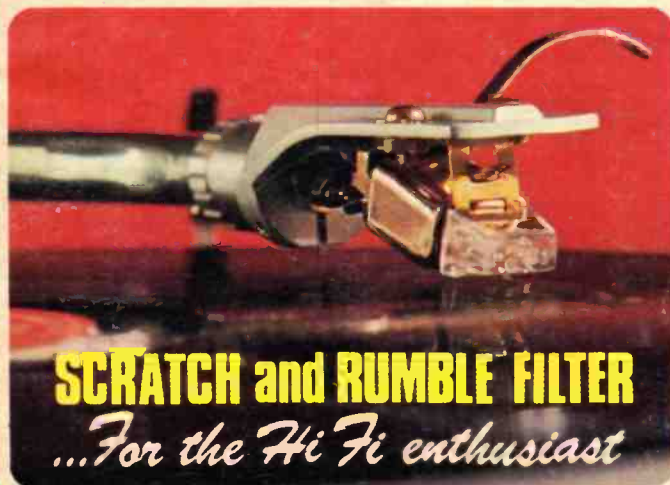
# everyday electronics

NOV. 76  
35p

## CLEAR SKY INDICATOR



*...For the Astronomer*



**SCRATCH and RUMBLE FILTER**  
*...For the Hi Fi enthusiast*

Plus...  
**ENLARGER  
EXPOSURE  
TIMER**

*...For the Photographer*

... and 2 more  
Starters!

# NOW-just when you need it most!

**BI-PRE PAK'S  
ONCE-IN-A  
LIFETIME**

# SALE

**PACK'S  
COMPONENTS  
MODULES  
SUNDRIES  
BOOKS**

**SEE  
BELOW**

**MANY ITEMS AT HALF PRICE AND LESS  
PAKS DOWN FROM 60p TO 30p EACH**

**● TESTED PAKS all at 30p each**

- Pak No. Contents**
- TP10** 2 Light dependent resistors. 400 ohms light, 1 megohm dark. 1/2" dia.
  - TP11** 10 Transistors XB102 & XB112 equiv. to AC126 AC156, OC81/2, OC72, etc.
  - TP13** 5 OC71 Light sensitive transistors.
  - TP14** 20 OC71 germanium PNP audio pre amp transistor, black glass type
  - TP15** 20 OC81 germanium PNP audio output transistor, white glass type★
  - TP17** 20 1 watt zener diodes, mixed 6-8 to 43 volts★
  - TP20** 10 Mullard OC45 transistors. I.F. amp PNP germanium
  - TP21** 30 Short lead (1/2" approx) transistors, NPN silicon planar types Ex radio manufacturer, all good but production line changes.
  - TP22** 6 Integrated circuits. 4 gates BMC962 and 2 flip flops BMC945
  - TP27** 5 Germanium PNP high frequency transistors, unmarked similar to OC170/171, AF115/6/7 3 lead TO-18.
  - TP28** 5 2N918 UHF/VHF silicon transistors. NPN 4 lead TO-18 uncodded.
  - TP35** 4 3819E transistors, N channel FETs these are 2N8819s in plastic cases★.
  - TP38** 8 Integrated circuits. DTL data supplied. Mixed types flip flops.
  - TP40** 15 Transistors, these are brand new manufacturers surplus items.

**● UNTESTED PAKS all at 30p each**

- Pak No. Contents**
- UT2** 150 Germanium diodes, miniature glass type★
  - UT3** 100 Silicon diodes miniature glass type, similar to 1N4148★
  - UT4** 100 Silicon diodes, miniature glass type, similar to 1N914/6.★
  - UT5** 40 Zener diodes, 250mW OAZ240 range, average 50% good★
  - UT6** 25 Zener diodes, 1 1/2 watt top hat type, mixed voltages.★
  - UT7** 30 Silicon rectifiers. 750mA BY 100 type, top hat, mixed voltages.
  - UT10** 15 Power transistors, PNP germanium and NPN silicon, mostly TO-3 but some plastic and some marked.
  - UT11** 30 OA47 gold bonded diodes, polarity marked.
  - UT12** 10 2N3819 10-channel FETs plastic case type.★
  - UT13** 15 Integrated circuits, experimenters pak, dual in line 10-5, TTL, DTL, marked and unmarked, some definitely good but old types.
  - UT14** 15 AC128 transistors PNP germanium audio output.

**● COMPONENT PAKS all at 30p each**

- CP1** 150 Capacitors, mixed bag of paper, silver mica electrolytics, etc. Approx No. counted by weight.
- CP2** 200 Resistors, mixed types and wattages, including Hi-stability Approx No. counted by weight.
- CP5** 5 Earphones, single low impedance for transistor radios, cassettes, etc. No plugs★
- CP7** 25 Heat sinks, to fit SO-2 (OC72) and TO-18 (AC128) etc.
- CP8** 500 Cable clips for G.P.O. 1/2" dia cable. Nylon with hardened steel pin (probably tungsten) sealed box of 500.
- CP12** 10 Reed relay inserts, 1" long 1/2" dia. will operate from external magnet or coil. For magnets see PAK CP13.
- CP13** 10 Magnets various sizes for operating reedswitches in PAK CP12. Ideal for burglar alarms on doors and windows, etc.
- CP16** 5 P.C. boards each containing a BF180 UHF amplifier transistor. A good basis for building a TV aerial pre-amp.
- CP17** 25 Electrolytic Capacitors, various values and voltages, many useful types, from T.V. to transistor radio & Hi-Fi.
- CP18** 1 Light activated SCR, 50 volts 1-6 A type L9F. Ready mounted on PCB with gate resistor & leads fitted. Full data & circuits for 14 projects, inc. slave photo flash unit, burglar alarm, etc.
- CP19** 3 Micro switches 1 pole change over, standard model 1 1/2" x 1/2"
- CP21** 200 Square inches copper laminate P.C. board in approx. 8 pieces.
- CP23** 4 switches, miniature, push to make, single pole.

**BUMPER I.C. PACK**

50 I.C.s at one penny each!  
50 assorted integrated circuits including many brand new marked devices.

**50p**

**FIRST EVER: QUARTZ CRYSTAL PAK**

Containing ten quartz crystals, 2-pin plug-in types. Easily dismantled from housing for re-grinding to different frequencies. Add 10p per pack to postage charge.

**50p**

## MISCELLANEOUS—Your chance to save pounds

**PRINTED CIRCUIT PANELS (Ex Equipment)**

**TYPE L4** EX cash register board. Equipped with 8 x SN7490N decode counters. 11 x SN15846N quad 2 input NAND/NOR gate. 1 x SN7413 dual schmidt trigger £1.50.

**TYPE L5.** A stabilised power supply board for I.C.s equipped with 4 x SN7413N dual schmidt triggers 1 x TVR2001 tenor I.C., 1 x 2N3738 power trans. various resistors & capacitors. 76p

**UHF TUNER UNITS**

We have sold thousands of these units brand new and made by a world famous manufacturer. Covers 625 line T.V. channels 21 to 65 Standard T.V. IF frequency output ideal for making a Hi Fi television sound receiver. £1.50

**HIGH VOLTAGE (12KV) DIODES**

Replacements for colour TV triplers, only 5 for 50p

**ON-OFF ROCKER SWITCHES**

2 pole 1 way mains push c:t 7 for hole size 1/2" x 1 1/2" each 15p

**9U.D.C. MOTORS**

Stabilised speed regulated. Ideal for portable record or cassette players. Size 1 1/2" dia. 4 x 1 1/2" plus spindle. Brand new and boxed 75p

**SUNDRY POST OFFICE (G.P.O.) ITEMS**

- EX G.P.O. telephone dials, as used in 700 and 300 type phones. Complete 35p
- EX G.P.O. telephone handsets with lead, black. (Additional P & P. 25p) 40p
- EX G.P.O. buzzers, 12/24 volt operation, clean condition 20p
- EX G.P.O. push button key switches, 2 pole change over. Brand new. 15p
- EX G.P.O. counter units 0000-9999, 10 per second (24-48v. operation) 20p

**INSTRUMENT CASES**

Beautifully finished in stove enamelled grey crackle, in heavy gauge aluminium with internal racking and heavy gauge panels (suitable as heatsinks). Ideal for P.A. systems, bench power supplies, oscilloscopes, metered instruments, etc. BRAND NEW AND BOXED.

SIZE "A" 14" x 15" x 6" deep £5.50 + additional 25p for P/P.

SIZE "B" 17" x 16" x 12" deep £6.50 + additional £1 for P/P.

**A FASCINATING & UNUSUAL OFFER VARIABLE PRE-SET VOICE DECODERS**

Brand new, but sold essentially for component value

4 stages, 7 position control knobs. On 10" x 12" P.C.B. in plastic tray

Contains 35 I.C.s. viz. 8 x 7493, 5 x 7420, 7 x 7400, 4 x 7404, 2 x 7430, 2 x 7410, 2 x 7442, 2 x 7401, 1 x 7413, 1 x 7474 and 1 x 7490 (total 35) plus 35 transistors, 4 miniature rotary switches, voltage stabilizer and various other components.

**£4.00** + additional 50p for P/P

**PUSH BUTTON SELECTOR ASSEMBLIES**

for varicap tuning systems as used in VHF/FM radio receivers of UHF/TV tuners. With indicators on each stage. 4 button assemblies. **£1.25★**

7 button assemblies with A.F.C. switch **£2.00★**

**STEREO DECODERS (FM)**

I.C. operated units for use in negative earth systems

Transistor operated unit for use in positive earth systems. L.E.D.s can be added to the above

**£1.95★**

**£1.75★**

**12 RELAYS £1 ONLY**

Ex GPO and others; various voltages and coil impedances, non-specified but extremely useful to keep for when wanted. Add 35p per pack to postage charge.

**TECHNICAL BOOKS**

Dozens and dozens of titles of NEWNES-BUTTERWORTH, BABANI PRESS, BERNARD PUBLISHERS All at **25%** OFF PUBLISHERS PRICES S.A.E. brings full list

**VAT 8%**

ON EVERYTHING EXCEPT ITEMS MARKED ★ At 12 1/2% Please add appropriate amount to total value of your order.

**MINIMUM ORDER** for items sent by post £3 excluding VAT and postage.

**POSTAGE** Please add 50p for P/P to all orders unless stated otherwise. Where additional postage and packing is quoted this is to be added to the basic 50p charge.

**CALLERS WELCOME—ORDER WITHOUT DELAY—OFFERS CANNOT BE REPEATED**

Originators of and first with component paks in U.K. and still leading

# BI-PRE-PAK

**BI-PRE-PAK LTD** Dept EF,  
220-224 WEST ROAD, WESTCLIFF-ON-SEA  
ESSEX SSO 9DF Telephone Southend (0702) 46344

# RETURN OF POST MAIL-ORDER SERVICE

JUST RELEASED

## R.C.S. 100 watt VALVE AMPLIFIER



Four inputs. Four way mixing, master volume, treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required. 5 speaker outputs. A/C mains operated. Slave output. Produced by demand for a quality valve amplifier. Send for details Suitable carrying cabinet £14. Price **£85** carr. £2-50

## ANOTHER R.S.C. BARGAIN!

ELAC 9 + 5in. HI-FI SPEAKER TYPE 59RM  
This famous unit now available, 10 watts, 8 ohm.

Price **£3.25** Post 40p



## 8" ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50-18,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts. Post 40p

10in round £4-95.

## TEAK VENEER HI-FI SPEAKER CABINETS

MODEL "A". 20 x 13 x 12in. For 12 in. dia. of £13.50 Post 10in. speaker. 69p Illustrated

MODEL "B". For 13 x 8in. of £7.50 Post 8in. speaker 75p

MODEL "O". 30 x 20 x 12in. Reflex cabinet will accept 1-12in. bass unit, 1-8in. mid range, 1-3in. tweeter. Teak finish. Grooved front. £21.50 Carr. £3



LOUDSPEAKER CABINET WADDING 18in. wide, 20p ft.

## GOODMANS CONE TWEETER

3 1/2in. diam. 18,000 C.P.S. 25 WATTS 8 Ω £3.25  
8 inch woofer 15 watts 20-75.

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt £5.20 battery operated.



STEREO VERSION OF ABOVE £8-85.

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. Mains Supply £2-85. £3.95

THE "INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER. suitable for cassettes, and all sizes of tape reels. A.C. mains 200/240V. Leaflet S.A.E. £3.95 Post 40p



## WAFER HEATING ELEMENTS

OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse, factory (available in manufacturing quantities). Approx. size 1 1/2 x 8 1/2 x 1/4 in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photocopiers and print drying equipment. Ideal for home handymen and experimenters. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos, etc., to make efficient clothes dryers, towel rails—ideal for airing cupboard. Ideal for anti-frost device for the garage—preventing frozen radiators or acting as oil pump heater. Use in greenhouse for seed raising and plant protection. Invaluable aid for bird houses, incubators, etc., etc. Can be used in series for lower heat. Or in parallel for higher heat applications.

ONLY 40p EACH (FOUR FOR £1.50)

ALL POST PAID—Discounts for quantity.

## BAKER MAJOR 12" £10.35



Post 80p  
30-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s rated 25 watts. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. £13

Please state 3 or 8 or 15 ohms. Post 50p

## BAKER SPEAKERS "BIG SOUND"

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

GROUP "25" £8-95  
12in 30 watt Post 50p  
3, 8 or 15 ohms.

GROUP "35" £10-50  
12in 40 watt Post 50p  
3, 8 or 15 ohms.

GROUP "50/12" £14-50  
12in 60 watt professional model. 8 ohms or 15 ohms. Post 80p  
With aluminium presence dome.

GROUP "50/15" £19-50  
15in 75 watt Post 90p  
8 or 15 ohms.



## BAKER 150 WATT QUALITY TRANSISTOR MIXER/AMPLIFIER



Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4 to 15 ohm. Slave output. A/C mains. Guaranteed. Details S.A.E.

Latest 50 watt Model £49 £68 Carr. £1-00

## 100 WATT DISCO AMPLIFIER CHASSIS

MADE BY JENNINGS MUSICAL INSTRUMENTS £52  
4 speaker output, vol., treble, bass controls Carr. £1  
CAN BE USED AS 100WATT SLAVE

## QUALITY LOUDSPEAKER ENCLOSURE

Teak veneered 3/4in thick wood cabinet. Size 18 1/2in x 18 1/2in x 8 1/2in. Weight 28lb. This cabinet features a wide mesh Silver Grill covering a separate compartment for mounting Tweeters or Mid-Range Horn. The fully sealed bass compartment is out for 6 1/2in Woofer. £7-80. Carr. 85p. Rosewood Version £8-60. Carr. 85p. Baffle could be cut for larger speaker.



P.W. SOUND TO LIGHT DISPLAY  
Complete kit of parts with R.O.S. printed circuit. Three channels. 600 to 1,000 watt each. As featured in Practical Wireless. Price £12-50  
Cabinet extra £3.

## 8 inch PHILIPS LOUDSPEAKER

4 ohm. 4 watt. ceramic magnet £1-95  
General purpose replacement unit.

## MAINS TRANSFORMERS Post 50p

6 VOLT 1 AMP. £1-00 3 AMP. £1-40  
12 VOLT 300 MA. £1-00 750 MA. £1-30  
20 VOLT AMP. AND 34 VOLT AMP. £2-45  
20 VOLT 1 AMP. £1-75 1 AMP. £2-00 3 AMP. £2-20  
20-0-20 VOLT 1AMP. £2 30 VOLT 1 AMP. £1-75  
0-20-40-60 VOLT 1 Amp. £8-50  
1 AMP 8, 10, 12, 18, 20, 24, 30, 35, 40, 48, 60 £4-60  
2 AMP DITTO £7-00  
3 AMP DITTO £8-70  
5 AMP DITTO £11-20

## E.M.I. TAPE MOTOR

4 pole, 240 v. Size 3 1/2 x 9 1/2in. 1200 rpm. Spindle 1/4in. diam. motor. 120v version £1. £1-85 Post 45p

## E.M.I. GRAM MOTOR

240V a.c. 3,400 rpm 2-pole. Size 2 1/2 x 2 1/2in. Collar gram motor 120v. 75p. £1-25 Post 38p



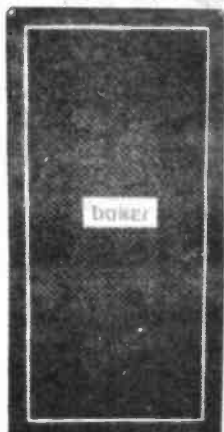
## BAKER DISCO SPEAKERS HIGH QUALITY—BRITISH MADE 2 x 12" CABINETS

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

50 WATT R.M.S. £43 Carr. £3

70 WATT R.M.S. £46 Carr. £3

100 WATT R.M.S. £59 Carr. £4

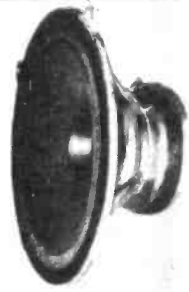


1 x 15" + 1 x 12" 100 WATT CABINET Size 36" x 24" x 15" £65-00. Carr. £5  
Ideal for Disco, Ogran or PA work. High quality. Full range.

## SUPERB HI-FI

### 12in 25 watts

A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and constrictive tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register. Bass Resonance 25cps  
Flux Density 18,500 gauss  
Useful response 20-17,000cps 8 or 15 ohms models.

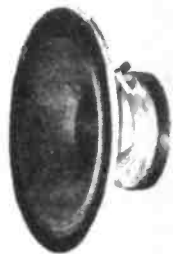


£16-30 Post 80p

## AUDITORIUM

### 12in. 35 watts

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

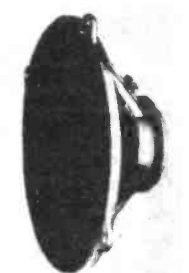


£15-50 Post 80p

## AUDITORIUM

### 15in. 45 watts

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



£19-50 Post 90p

Hi-Fi Enclosure Manual containing plans, designs, crossover data and cubic tables, 68p

# RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, CROYDON

Minimum post 30p. Components Lists 10p. Cash price includes VAT Access & Barclay cards welcome. Rail Selhurst. Tel. 01-684 1665

# Sparkrite mk2

Capacitive discharge  
electronic ignition kit

VOTED BEST  
OF 8 SYSTEMS  
TESTED BY  
'POPULAR  
MOTORING'  
MAGAZINE



- \* Smoother running
- \* Instant all-weather starting
- \* Continual peak performance
- \* Longer coil/battery/plug life
- \* Improved acceleration/top speeds
- \* Up to 20% better fuel consumption

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.

Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). All kits fit vehicles with coil/distributor ignition and up to 8 cylinders.

#### THE KIT COMPRISES EVERYTHING NEEDED

Ready drilled pressed steel case coated in matt black epoxy resin, ready drilled base and heat-sink, top quality 5 year guaranteed transformer and components, cables, coil connectors, printed circuit board, nuts, bolts, silicon grease, full instructions to make the kit negative or positive earth, and 10 page installation instructions.

#### OPTIONAL EXTRAS

Electronic/conventional ignition switch. Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device. Includes switch connectors, mounting bracket and instructions. Cables excluded. Also available: RPM limiting control for dashboard mounting (fitted in case on ready built unit).

**CALLERS WELCOME.** For Crypton tuning and fitting service — phone (0922) 33008.

**PRICES INCLUDE VAT, POST AND PACKING.**

Improve performance & economy NOW

**POST TODAY!**

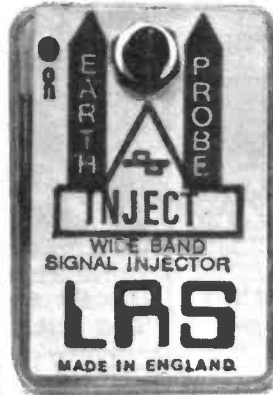
**Quick installation**  
No engine modification  
required

Electronics Design Associates, DEPT EE 11  
82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 33652

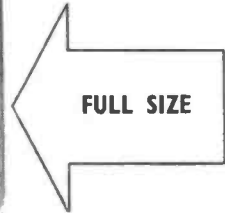
Name .....

Address .....

Mk. 2 DIY Ass. Kit @ £11.80	QUANTITY REQD.	I enclose cheque/PO's for <b>£</b>
Mk. 2 Ready Built Negative Earth @ £14.97		
Mk. 2 Ready Built Positive Earth @ £14.97		Cheque No.
Ignition Changeover switches @ £4.30		Send SAE if brochure only required.
R.P.M. Limit systems in above units @ £2.42		



£1.65\*  
BUYS THIS



FULL SIZE

OUR HANDY LITTLE POCKET SIGNAL INJECTOR, RADIATES OVER MOST OF THE AUDIO/RADIO SPECTRUM WITH A 'RICH IN HARMONIC' SIGNAL. LOOK AT THE SPEC.

- \* I.C. Design with LED 'on' Indicator
- \* Complete with Probe, Earth Lead and Instructions.
- \* Also Batteries and 1 Year Guarantee.
- \* 10-Day Money-back Offer.

★ All for only £1.65 + p&p at 15p to:

### LRS Electronics

3, CLIVESWAY, HINCKLEY, LEICESTERSHIRE  
Mail order only — Trade enquiries welcome.



## Become a radio amateur.

Learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence.

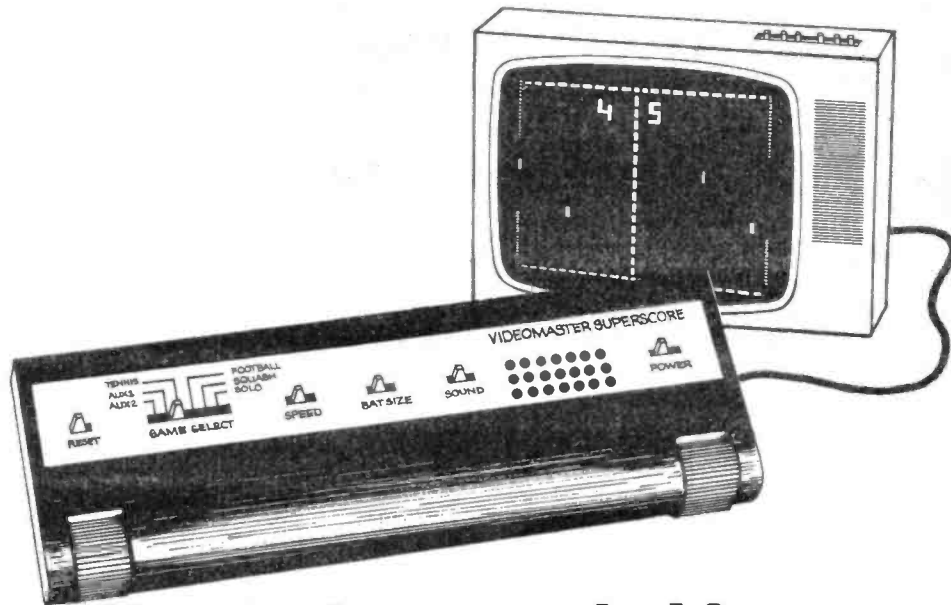
Free!

WAA  
Brechure, without obligation to: EEK116  
BRITISH NATIONAL RADIO  
& ELECTRONICS SCHOOL,  
P.O.Box 156, Jersey, Channel Islands.

NAME .....

ADDRESS .....

(Block caps please)



# Here's the remarkable new **VIDEOMASTER<sup>TM</sup>** Superscore Home TV Game Get it together for only £24.95

Available to you in kit form at the same moment as its national launch, the brilliant new Videomaster Superscore contains the latest product of MOS technology: a TV game chip.

The logic contained in it had previously to be generated by 100 TTL devices. Now it is condensed into one 28-pin chip.

This all-new Videomaster plugs into your 625-line UHF TV set (for overseas customers having VHF sets we can supply the necessary VHF modulator) to give you four exciting games (including tennis and football) and two future game options. It features on-screen digital scoring, realistic hit sounds, two bat sizes, two

ball speeds, automatic serving and much more. It runs on six 1½ volt SP11 type batteries (not supplied).

The Videomaster Superscore kit costs only £24.95 including VAT (recommended retail price of the ready built model is over £40.00) and comes complete with ready-tuned UHF or VHF modulator, circuit board with printed legend, all resistors, transistors and diodes, built-in loudspeaker, socket for mains adaptor, and, of course, the TV game chip itself.

Easy to put together the Superscore has full assembly instructions, circuit diagram and circuit description. Don't miss this chance to own the newest electronic game at such low cost.

## POST TODAY TO:

**Videomaster Ltd** 14/20 Headfort Place, London SW1X 7HN



Please send me (insert No. requ'd).....Videomaster Superscore Kits at £24.95 (inc. VAT & P&P in UK) or £23.10+£4.00 for P&P overseas)

I enclose my cheque/money order\* for £.....

VHF modulator required YES/NO\*

EE72

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

ALLOW 21 DAYS FOR DELIVERY

\* delete as necessary

An exciting **NEW** series from ...



## Newnes Technical Books

Each of the books in this series is written by an expert in his own particular field. The books are authoritative yet easily understood by those with no technical knowledge whatsoever, and the texts are supplemented by many highly informative illustrations.

### MASTER ELECTRONICS IN MUSIC

T. D. Towers

**Contents:** Creating Musical Sounds by Electricity – Making Musical Instruments Louder – Musical Special Effects by Electronics – Electronic Keyboard Instruments – Electric Guitars – Magnetic Tape Music – The Robot Drummer – Music Synthesisers – Music by Computer – Index.

130 pages 0 408 00262 X £2.50

### MASTER HI-FI INSTALLATION

Gordon J. King

**Contents:** How it Works – The Amplifier – Programme Signal Sources – Importance of a Good F.M. Signal – The Loudspeaker – Mono, Stereo and Quadrophonic Sound – Four-channel Techniques – Room Effects – Best Use of Controls – Terminology – Index.

150 pages 0 408 00237 9 £2.50

### MASTER STEREO CASSETTE RECORDING

I. R. Sinclair

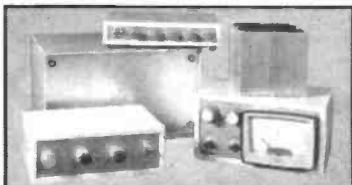
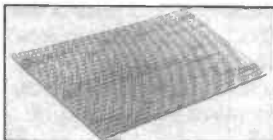
**Contents:** Stereo Systems – Signal Sources – Controls and Facilities – Making the Recording – Replaying and Monitoring – Essential Maintenance – Aids to Better Recording – Noise Reduction Systems – Cassette Recorder and Hi-Fi.

140 pages 0 408 00238 7 £2.50

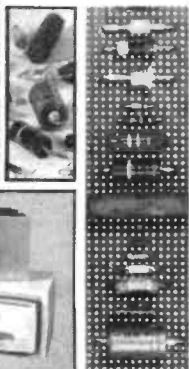


NEWNES TECHNICAL BOOKS, Newnes-Butterworths, Borough Green, Sevenoaks, Kent

Veroboard, D.I.P. board, pins, tools, plastic boxes, Veropak metal case, Veroboxes, D.I.P. and transistor sockets, etc. New catalogue available (price 10p + S.A.E. 7" x 9")



# vero



## TO START AND FINISH

Verob Electronics Ltd. have products to suit your requirements.

Verob Electronics Limited, Retail Dept., Industrial Estate, Chandler's Ford, Hants., SO5 3ZR Telephone: Chandler's Ford 2956 (STD 04215)

## QUALITY STEREO SOUND

ALMOST  $\frac{1}{2}$  PRICE OFFER! SOLENT AUDIO SYSTEM

£5-00  
down

MADE TO SELL AT  
DOUBLE THE PRICE  
IN CABINET FORM  
OUR PRICE £69.95



Solent Mark II Stereo Tuner Amplifier chassis with AM/FM radio covering long medium short and Stereo FM wavebands. Separate Bass and Treble controls. 30 watts total power output (frequency response 25-20,000 Hz) AFC Switching Tape record and playback facilities. Dimensions 18½" x 9" x 3½". The very latest BSR automatic record deck with cue and pause control. Two matching elliptical speaker units.

Order early limited stocks available cash price £69.95. Credit Sale £5.00 deposit 9 monthly payments of £8.30 (Total Credit price £79.70). P. & P. £4.00. Send £9.00 today.

Chassis only available for cash at £49.00 + p. & p. £3.00.

Full 12 months Guarantee.

CALLERS WELCOME.

Access and Barclaycard Orders Accepted by Telephone

FREE! Stereo headphones supplied with every complete order

LEWIS radio EE 11/76 100 CHASE SIDE SOUTHGATE LONDON N14 5PL Telephones: 01-882-1644

## ROOM THERMOSTAT

Famous Satchwell elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month £2.90, post and VAT paid.



## NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-Low X111 Price £1.25 each. Post and VAT paid.

## RADIO STETHOSCOPE

Easiest way to fault find, traces signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Complete kit comprises two special transistors and all parts including probe tube and crystal ear-piece. £2.95, twin stereo-set instead of ear-piece £1.00 extra. VAT and postage incl.



## MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12v volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: main transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1.90 including post and VAT.

## MOTORIZED DISCO SWITCHES

With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 2000w's can be controlled and this would provide a magnificent display. For mains operating £4.25 post & VAT Paid. Ditto 9 switch £4.95 Post & VAT Paid. DITTO BUT 12 SWITCH £5.75 POST AND VAT PAID.



## MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fans, blower, heaters, etc. New and perfect. Snip at 95p + VAT & Postage 35p. 1" stack motor £1.50 + VAT & postage 35p. 1 1/2" stack motor. £2 + VAT and Postage 40p.

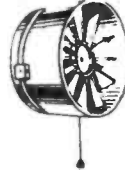
## WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make. £2.75 post and VAT paid.



## EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic feet per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc. It's so quiet it can hardly be heard. Compact. 7 1/2" casing comprises motor, fan blades, sheet steel casing, pull switch, mains connector and fixing brackets. £5.25 INCLUDING POST & VAT Monthly list available free; send long stamped envelope.



## 28 RPM GEARED MAINS MOTOR

This is a substantial motor (1" stack induction type) quite powerful definitely large enough to drive a rotating display or a tumbler for polishing stone etc. Approximate overall size 4" x 3 1/2" x 2 1/2" these are ex-unused equipments, carrying our normal ex-equipment guarantees. PRICE £2.95 POST AND VAT PAID.

## SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450w). Unit in box all ready to work. £7.95 plus 95p VAT and postage.



## TELESCOPIC AERIALS

for portable car radio or transmitter. Chrome plated—six sections, extending from 7 1/2 to 47in. 60p + 10p. Post & VAT. KNUCKLED MODEL FOR F.M. 80p + 17p Post and VAT.

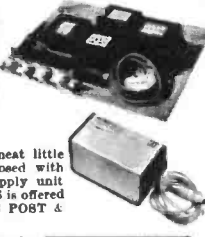
## NEED A SPECIAL SWITCH

Double lead contact. Very slight pressure closes both contacts 18p each. Plastic pushrod suitable for operating. 10p each, 10 for 60p.



## MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Goodmans speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £14.00 including VAT and postage.



## PP3/PP9 BATTERY ELIMINATOR

Made in Japan for Bush Radio. This is very neat little transformer driven full wave unit totally enclosed with input mains and output leads. This power supply unit which was originally marketed by Bush at over £6 is offered as this month's snip. PRICE £2.80 INCLUDING POST & VAT.

## THIS MONTH'S SNIP

This is a Satchwell thermostat. It is highly sensitive and can be set to control temperature within 1°C. Like most other very sensitive thermostats it is of low current rating so if you require it to switch heaters or similar then you will have to use a thermostat to switch a relay, the relay will of course operate one radio/tape cassette/calculator, in fact any battery appliance, and will save their cost in a few months). Specs: Full wave rectification, double insulated mains transformer—total enclosed in a hard P.V.C. case—three core mains lead terminal output—when ordering please state output voltage 4 1/2v, 6v, 7 1/2v, 9v, 12v, or 24v. Price £3.95. Post and VAT included.

## TWIN OUTPUT POWER PACKS

These have two separate R.C. smoothed outputs so can operate two battery radios or a stereo amp without cross modulation (they will of course operate one radio/tape cassette/calculator, in fact any battery appliance, and will save their cost in a few months). Specs: Full wave rectification, double insulated mains transformer—total enclosed in a hard P.V.C. case—three core mains lead terminal output—when ordering please state output voltage 4 1/2v, 6v, 7 1/2v, 9v, 12v, or 24v. Price £3.95. Post and VAT included.



## INFRA RED BINOCULARS

Made for military purpose during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (6KV approx.) and providing the objects are in the rays of an infra-red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra-red cell, technical data on which is available. The binoculars are unused, believed to be in good working order, in fact they were never issued and are still in original cases, but since they were made a long time ago they can hardly be called new. Sold without guarantee. Price £17.50 per set + £1 carriage.



## CLEAR SKY INDICATOR SCRATCH AND RUMBLE FILTER ENLARGER TIMER

To receive parts for the projects featured this month, send the estimated price + 40p post. Any cash adjustment can be made later.

## MICRO SWITCH BARGAINS

Rated at 5 amps 250 volts, ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for £1.00 VAT AND POST PAID.

## HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH

1-2-3-Bank, each bank consisting of the changeover micro switch rated at 10 amps 250 volts. Through panel fixing by 2 lock nuts complete with black 1" diameter knob. Prices:—1 bank 40p—2 bank 55p—3 bank 70p.

## SMITHS CENTRAL HEATING CONTROLLER

Push button gives 10 variations as follows: (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for two periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off. A handsome looking unit with 24 hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over £18. We offer these while stocks last at £7.50 each INCLUDING VAT and Postage.

## SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands—K1L contains chassis front panel and all the parts £1.50—Crystal ear-phones 55p including VAT and Postage.

## ONLY £1.50 FOR SEVEN ELECTRIC MOTORS

7 powerful batt. motors as used in racing cars and power models. Output and types vary for use in hundreds of projects—Tools, toys, models, etc. All brand new reversible and for 1 1/2-12v batts. Wiring diag. inc. VAT, POST PAID.



TERMS: Where order is under £5 please add 40p surcharge to offset peaking expenses

**J. BULL (ELECTRICAL) LTD.**  
(Dept. E.E.), 103 TAMWORTH ROAD,  
CROYDON CR9 1SG.

## ITS FREE!

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

Remember 7.029P (again available). Electricians of the old school most certainly will, and most will agree how much better this is than its modern replacement 2.5mm. It has greater current carrying capacity (20 amps against 13 amps) and being stranded it will not break so easily and being larger it is easier to use. A fortunate buyer enable us to offer 3 core 7.029 cheaper than we could offer 3 core 2.5mm, namely £9.50 against £11.50. If you are contemplating installing a ring main, an immersion heater, storage heaters or fires, then you should definitely buy some of this cable. It is P.V.C. covered, correctly colour coded and up to all British standards; in fact, we made by one of our most famous cable companies. Price £9.50 + 76p per 100 metre coil. Carriage £2.50 + 20p.

Remember 3.029P. This would not be much good today as most installations call for a trailing earth wire as well as L & N., however a special offer this month is 3 core 1.5mm at only £5.60 + 44p per 100 metres. Post £1.50p + 12p.

NER Accounting Computer. This we understand was in working order immediately before being dismantled and delivered to us but as we have no means of testing it and as also we don't have any spares for it, we cannot give any guarantee. If you buy it then you will have to take a chance. The computer is American made, it weighs over 1 ton, has an alphabetical numerical keyboard. We cannot see any type number on it but the numbers that do appear are as follows: Class 390-590-1. It comprises three main units with interconnecting leads, the first unit is a 10kw isolating same as the 416 amp described below. This is a very heavy transformer and new would cost at least £700. The second major unit is the computer control panel, this weighs nearly a ton and is full of components and hardware. The third unit is the desk with the alphabetical and numerical keyboards. The price we are asking for this computer is £375 and we feel certain that even if it could not be got going again it would realise a lot more than this if broken down and sold for its component parts. Important Note: Owing to its size this computer is not at our Croydon address. If you wish to view this please be prepared to travel into Sussex just off the Brighton Road and telephone us in the rays of an infra-red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra-red cell, technical data on which is available. The binoculars are unused, believed to be in good working order, in fact they were never issued and are still in original cases, but since they were made a long time ago they can hardly be called new. Sold without guarantee. Price £17.50 per set + £1 carriage.

7kv EHT Transformer. This is made by Parmeko, this is a "c" core construction totally enclosed in black enamelled steel sheet case. The primary consists of two separate windings each 125 volts tapped with two 10 volt steps so it could be used on 110 volts or 250/240 volts. The secondary is centre tapped and has further tappings to give voltages as follows: 2.5kv-0.2.5kv, 3kv-0.3kv, 3.5kv-0.3.5kv. The current rating of the secondary is 245 ma r.m.s. Price £30 + £2.40p. Carriage £2 + 16p.

Isolation Transformer. Very high current 416 amps, primary 0.250 volts, last 60 volts in 10 volt steps so this transformer can be used to step up voltages for instance at the end of a long cable run. Secondary, centre tapped 120v-0.120v so this transformer will isolate and step down or will isolate at normal mains in and normal mains out or finally it will isolate and step up. A big transformer completely enclosed in sheet steel box weighing about 300 lbs. Price £100 + £8. Carriage at cost but we would prefer you to collect this. (This is at Croydon).

5 Bank Switch Panel. This is a Government Surplus item so it is very well made and contains switches which will break 15 amps DC. The 5 switches are completely separate so may be used to control separate circuits or they may be ganged together to bring in 5 heaters in parallel suitable for mains or battery work. Size of the switch is approximately 5 1/2 x 1 1/2 x 1 1/2 and operation is by nickel plated toggles. Price 75p each + 6p. Post 20p + 2p.

Cooling Thermostat. The thermostat switches off as the temperature in the room rises. It is, therefore, suitable for controlling electric room heating. We have a similar model but with contacts which switch on as the temperature rises. These are for air conditioning or cooling circuits. Contacts again rated at 20 amps and these have changeable contacts so they can be used for cooling or heating or both but as their original function was intended for cooling they are set and calibrated for 12-40°F. Price £3.50p + 26p.

Simmerstat. Often confused with thermostats the function of simmerstat is to pulse the supply into a heater or cooker. The longer the pulse is the greater will be the amount of heat dissipated and vice versa. The length of the pulse is determined by a control knob which in the case of a cooker is usually engraved—simmer, stir, but we have cooker as well as industrial heaters. Current rating is 15 amps 200/250 volts AC. Price £1.75p + 14p. Post 20p + 2p.

Flash Ernie is the name we have given to our latest disco light display because it is a random flasher and is very effective especially with coloured bulbs. Kit consists of motorised stud switch, master control switch, anti-spark caps, 9 lamp holders, connecting wire and wiring diagram. Price £5 + 40p. Post 60p + 6p.

# Technical Training in Radio, Television and Electronics

ICS have helped thousands of ambitious people to move up into higher paid, more secure jobs in the field of electronics - now it can be your turn. Whether you are a newcomer to the field or are already working in the industry, ICS can provide you with the specialised training so essential to success.

## Personal Tuition and Guaranteed Success

The expert and personal guidance by fully qualified tutors, backed by the ICS guarantee of tuition until successful is the key to our outstanding record in the technical training field. You study at the time and pace that suits you best and in your own home. In the words of one of our many successful students: "Since starting my course, my salary has trebled and I am expecting a further increase when my course is completed."

## City and Guilds Certificates

Excellent job prospects await those who hold one of these recognised certificates. ICS can coach you for:

- Telecommunications Technicians
- Radio, TV Electronics Technicians
- Technical Communications
- Radio Servicing Theory
- Radio Amateurs
- Electrical Installation Work
- Also MPT Radio Communications Certificate

## Diploma Courses

Colour TV Servicing  
Electronic Engineering and Maintenance  
Computer Engineering and Programming  
Radio, TV and Audio, Engineering and Servicing  
Electrical Engineering, Installations and Contracting

## Qualify for a New Career

Home study courses for leading professional examinations and diploma courses for business and technical subjects:—

G.C.E.	Engineering	Purchasing
60 subjects	Farming	Sales
at "O" &	Heating	Storekeeping
"A" levels	Industrial	Work Study
Accountancy	Management	
Air	Mechanical	
Conditioning		
Building		

POST OR PHONE TODAY FOR FREE BOOKLET.

## ICS To: International Correspondence Schools

SINCE 1890  
Dept 7117 Intertext House, London  
SW8 4UJ or telephone 622 9911

Subject of Interest \_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

Telephone Number \_\_\_\_\_

YES SIR 1st class post TONIGHT!  
We specialise in high spec components  
with express service for phone customers



## HIGH SPEC components FAST!

Agents for VERO - ANTEX -

BIB MULTICORE SOLDER

- OPEN 9am-5pm, 6 days—Phone orders 9am-4pm.
- S.A.E. for stock list including pots, presets, I.C.'s 7400 & CMOS.
- capacitors, plugs, sockets, switches, cable, etc.
- Post free envelope included for your next order.
- SUPER EXPRESS phone service—ask for details.
- Shop at keen prices 6 days per week. Late night—Fri. 7-10pm.

### TRANSISTORS + 200 OTHER TYPES IN STOCK

AC125 20p	BC109 11p	BC262A 15p	BFX29 25p	TIP41A 67p
126 20p	109B 12p	287 20p	84 22p	42A 80p
127 20p	109C 13p	300 27p	88 22p	TIS43 35p
128 20p	117 18p	301 26p	BFY50 17p	ZTX300 13p
151 35p	142 22p	303 30p	81 18p	302 18p
153 35p	143 24p	338 16p	52 18p	500 15p
176 20p	147A 9p	557 9p	BY164 40p	502 18p
187 20p	147B 10p	BCY71 18p	ME0401 18p	1N914 5p
158 20p	148 9p	72 14p	0411 18p	1N4001 5p
AD149 80p	148B 10p	BD123 80p	ME4001 10p	4002 9p
161 42p	149B 11p	124 68p	4101 11p	4005 9p
162 42p	149C 11p	131 36p	MPF102 32p	4006 10p
MCH/PR	154 18p	132 38p	OA47 8p	4148 5p
1-04	157B 12p	139 54p	90 5p	2N2219 20p
AF116 24p	177 17p	155 75p	91 4p	2646 40p
117 24p	178B 18p	BF158 20p	200 8p	2926O 13p
124 30p	179B 19p	184 25p	OC28 90p	2926G 15p
239 37p	184B 12p	185 28p	29 58p	3053 18p
AU113 1-50p	184L 11p	194 10p	35 80p	3055 60p
BC107 11p	187 26p	196 12p	44 30p	3702 11p
107A 15p	212A 13p	197 12p	71 25p	3703 10p
108 10p	212L 15p	199 15p	ORP12 65p	3704 13p
CIL108 8p	213B 12p	200 38p	TIP29A 47p	3705 10p
BC108B 11p	214 15p	338 34p	30A 56p	3707 12p
108C 12p	214L 17p	BFW11 68p	31A 57p	3819E 25p

<b>DIODES</b>	<b>BRIDGES</b>	<b>RESISTORS 1p each</b>	<b>LINEAR I/C's</b>
50V 3A 13p	100V 1A 24p	WATT E12 (8%)	LM330 33p
100V 3A 15p	200V 1A 25p	1 ohm - 10m ohm	LM380 SL67451-28
200V 3A 18p	400V 1A 28p	ZENERS (400mw) BZX 83	LM3900N 69p
400V 3A 21p		3V, 3V3, 5V1, 5V6, 7V5,	NE555 60p
		9V1, 10V, 12V, 18V, 22V,	SN7613ND 1-60p
		30V. All at 12p each.	SN7613N 1-75p
<b>THYRISTORS</b>		<b>LED T11 209/0-125 0-2"</b>	SN76223N 1-75p
60V 1A 20p		Red 20p	TBA800 1-35p
600V 1A 80p	TAG 1 600	Grn 20p	TBA810S 1-48p
700V 1A 1-20	BT106	CLips for above 1p.	TBA820 1-20p
400V 4A 58p	CT106D1		ZN414 1-35p
500V 6A 1-25	BT109		

Post & Packing 25p per order. VAT please add to total \* 12½%, rest 8%

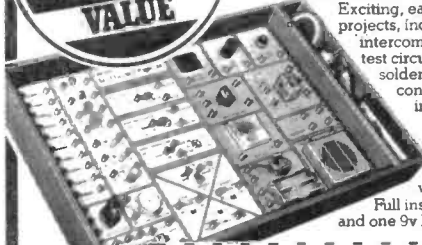
## ORCHARD ELECTRONICS

FLINT HOUSE, HIGH STREET, WALLINGFORD, OXON, OX10 0DE  
Telephone 0491 35529.

# TANDY



**\* Safe Battery Power**  
**\* No Tools or Soldering**  
**\* With SCR, Zener Diode**



Exciting, easy-to-use. Build 65 projects, incl. alarms, radios, intercoms, computer and test circuits, etc. Safe, solderless spring clip connection. Parts incl. solar battery, transformer, code key photo cell, meter, earphone, speaker. Attractive wooden case. Full instructions. Two AA and one 9v battery required.

28-250

65-in-1 Electronic Project Kit (as advertised)

Fill in your name and address and take this voucher to any Tandy store. It's worth £2.50 OFF a 65-in-1 Electronic Project Kit. 1 per customer. Offer ends 30.11.76

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

FOR TANDY  
*Bob Paul*



# TANDY

Available from any of our 150 stores  
**Nationwide supermarket of sound!**



# FABULOUS

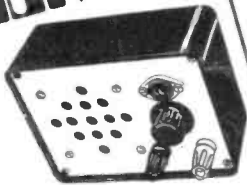
# NEW KITS

## EASY TO CONSTRUCT

DORAM  
KITS  
CONTAIN  
EVERYTHING  
DOWN TO  
THE LAST  
NUT!



### TEST BENCH AMP



Compact 1W output  
unit with built in  
loudspeaker. Input  
sensitivity 35mV

£4.59  
+S

### De-luxe FM TUNER BY LARSHOLT



£89.95  
+H

- ★ Illum. tuning scale and sig. meter.
- ★ Mute control and MPX
- ★ 5 pre-set tune and scan tune
- ★ no alignment req.
- ★ Mono/afc controls

### DWELL METER FOR MOTORISTS



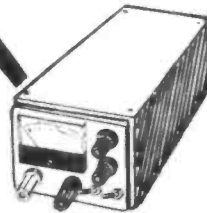
£5.70  
+S

Designed to facilitate contact breaker  
adjustments without the use of a feeler  
gauge. Worn contact breaker points may  
be adjusted accurately, a task otherwise  
almost impossible.

## Available NOW!

### POWER SUPPLY

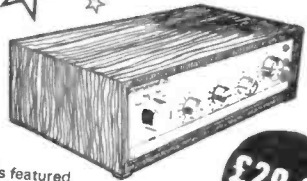
0-30V and 0-1A  
with a variable  
current limit



£19.95  
+S

### 'INTERNATIONAL 25'

Build yourself a  
**BIG SOUND** amp  
at a budget price



£29.95  
+H

As featured  
in 'ETI' Oct. 75 edition

#### FEATURES

- ★ Triple Op-amp pre-amplifier
- ★ Power 'Darlington's'
- ★ Modern styling
- ★ 25W per channel into 8 ohms.

- ★ New 16 page brochure contains complete details of kit range.
- ★ Big range of kits to interest Radio, Electronic and Hi-Fi enthusiasts.
- ★ Kits sent by return-of-post.
- ★ Each kit designed by specialists, only reliable and highest quality components included.

**SEND FOR YOUR NEW  
KIT BROCHURE TODAY**

Only **25p** inc. post and packaging  
S = 8% VAT. H = 12½% VAT.

## DORAM

DORAM ELECTRONICS LTD  
P.O.Box TR8,  
Leeds LS12 2UF.

I enclose 25p, please send me by return my new Doram kit brochure. Overseas orders except for N. Ireland, please add 10p for post and packing, surface only. Customers who order this kit brochure together with Doram's new edition 3 component catalogue can save 15p, combined price 70p on the individual purchase price for both, and obtain two 25p vouchers.

PLEASE PRINT IN BLOCK CAPITALS

Name .....

Address .....

Post Code .....

An Electrocomponents Group Company.

# Get a great deal from Marshall's

A. Marshall (London) Ltd Dept: EE

40-42 Cricklewood Broadway London NW23ET Tel: 01-4520161/2 Telex: 21492  
& 85 West Regent St Glasgow G2 2QD Tel: 041-332 4133  
& 1 Straits Parade Fishponds Bristol BS16 2LX Tel: 0272-654201/2  
& 27 Rue Danton Issy Les Moulineaux Paris 92

Catalogue price 40p  
(30p to callers)

Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat  
Trade and export enquiries welcome

Our range covers over 7,000 items. The largest selection in Britain

## Top 200 IC's TTL, CMOS & Linear

CA3020A	£1.45	CD4050	56p	NE556	£1.30	SN7448	85p	SN74157	68p
CA3028A	85p	CD4510	£1.54	NE560	£4.48	SN7450	16p	SN74160	£1.20
CA3035	£1.35	CD4511	£1.70	NE565	£1.30	SN7451	16p	SN74161	£1.20
CA3046	£1.73p	CD4516	£1.84	SL414A	£2.35	SN7453	16p	SN74162	£1.20
CA3048	£2.15	CD4518	£1.38	SL610C	£2.35	SN7454	16p	SN74163	£1.20
CA3052	£1.62	CD4520	£1.38	SL611C	£2.35	SN7460	16p	SN74164	93p
CA3089E	£2.00	LM301AH	47p	SL612C	£2.35	SN7470	32p	SN74165	93p
CA3090Q	£4.25	LM308N	£1.17	SL620C	£3.50	SN7472	26p	SN74167	70p
CD4000	20p	LM309K	£1.80	SL621C	£3.50	SN7473	30p	SN74174	£1.06
CD4001	20p	LM380	98p	SL623A	£1.75	SN7474	40p	SN74175	84p
CD4002	20p	LM381AN	£2.07	SL640C	£4.00	SN7475	40p	SN74176	86p
CD4006	£1.16	LM702C	75p	SN7400	16p	SN7476	36p	SN74180	£1.23
CD4007	20p	LM709	SN7401	16p	SN7480	45p	SN74181	£2.58	
CD4008	97p	TO99	40p	SN7402	16p	SN7481	£1.10	SN74190	£1.33
CD4009	37p	8DIL	40p	SN7403	16p	SN7482	67p	SN74191	£1.33
CD4010	37p	14DIL	40p	SN7404	16p	SN7483	92p	SN74192	£1.13
CD4011	20p	LM710	45p	SN7405	18p	SN7484	85p	SN74193	£1.13
CD4012	20p	LM723C	60p	SN7406	51p	SN7485	£1.25	SN74196	81p
CD4013	59p	LM741C	SN7407	18p	SN7486	29p	SN74197	81p	
CD4014	£1.01	TO99	38p	SN7408	18p	SN7490	43p	SN74198	£2.04
CD4015	£1.01	8DIL	38p	SN7409	18p	SN7491	68p	SN74199	£2.04
CD4016	56p	14DIL	40p	SN7410	16p	SN7492	43p	SN76033N	£2.36
CD4017	£1.01	LM747C	78p	SN7412	25p	SN7493	43p	SN76013N	£1.30
CD4018	£1.01	LM748	SN7413	40p	SN7494	74p	SN76013N	£1.30	
CD4019	37p	8DIL	44p	SN7416	43p	SN7495	59p	SN76023N	1-50
CD4020	£1.12	14DIL	41p	SN7417	43p	SN7496	78p	SN76033N	2-50
CD4021	£1.01	LM3909N	58p	SN7420	16p	SN74100	£1.15	TAA263	£1.25
CD4022	97p	LM7805P	£1.39	SN7423	26p	SN74107	30p	TAA300	£2.48
CD4023	20p	LM7812P	£1.39	SN7425	27p	SN74118	90p	TAA350A	£2.48
CD4024	79p	LM7815P	£1.39	SN7427	27p	SN74119	£1.80	TAA550	£2.40
CD4025	20p	LM7824P	£1.39	SN7430	16p	SN74121	34p	TAA611C	£2.25
CD4027	56p	MCI303L	£1.44	SN7432	27p	SN74122	48p	TAA621	£2.13
CD4028	91p	MCI310P	£1.91	SN7437	35p	SN74123	40p	TAA611B	£1.32
CD4029	£1.17	MCI330P	35p	SN7438	35p	SN74141	72p	TAA618	£2.50
CD4030	57p	MCI351P	87p	SN7440	74p	SN74145	£1.20	TBA801	£1.80
CD4031	£2.26	MCI4553	£4.47	SN7441	76p	SN74150	£1.20	TBA851	£1.80
CD4037	97p	MCI466L	£3.95	SN7442	55p	SN74151	77p	TBA860	£1.19
CD4041	83p	MCI469R	£2.50	SN7446	86p	SN74153	73p	TBA810	£1.28
CD4049	56p	NE555V	48p	SN7447	81p	SN74154	£1.29	TBA820	£1.02

DOING IT DIGITALLY KIT—AVAILABLE NOW—PRICE £11.75 INCLUDING POSTAGE, PACKING AND VAT—EXCL. BATTERIES

## POPULAR SEMICONDUCTORS

2N696	25p	2N2906	22p	AF139	69p	BD139	42p	MPSA56	20p
2N699	16p	2N4058	20p	AF239	74p	BF115	36p	OC28	£2.00
2N706	55p	2N4062	18p	AF270	80p	BF117	70p	OC42	50p
2N708	12p	2N4921	60p	AF280	85p	BF154	25p	TIP29A	50p
2N718	21p	2N4923	70p	AL102	£1.50	BF180	36p	TIP31A	62p
2N916	43p	2N5245	29p	BC107	14p	BF181	36p	TIP32A	75p
2N918	34p	2N5294	35p	BC109	15p	BF184	35p	TIP34A	£1.20
2N1302	37p	2N5296	36p	BC147	10p	BF194	12p	TIP35A	£2.50
2N1306	45p	2N5458	26p	BC149	13p	BF196	13p	TIP36A	£2.55
2N1308	60p	2N5459	29p	BC157	12p	BF197	14p	TIP41A	70p
2N1711	27p	2N6207	48p	BC158	11p	BF198	15p	TIP42A	70p
2N2102	60p	3N128	80p	BC167	12p	BF244	33p	TIP2955	£1.00
2N2148	£1.65	3N140	£1.00	BC168	12p	BF258	49p	TIP3055	50p
2N2218A	47p	3N141	85p	BC169	12p	BF259	49p	TIS43	30p
2N2219A	52p	3N200	£2.60	BC182	11p	BF593	27p	ZTX300	15p
2N2220	35p	40361	45p	BC182L	14p	BF839	24p	ZTX301	15p
2N2221	22p	40362	48p	BC183	11p	BF879	24p	ZTX501	15p
2N2222	25p	40406	48p	BC183L	14p	BF879	24p	ZTX502	15p
2N2369	25p	40407	30p	BC184	12p	BFX84	38p	IN914/916	7p
2N2646	35p	40408	50p	BC184L	14p	BFX85	41p	IN4007	18p
2N2905	37p	40409	37p	BC212	14p	BFX86	32p	IN4148	7p
2N2906	28p	40410	59p	BC212L	14p	BFY50	30p	IN5404	10p
2N2907	21p	40411	£2.30	BC213L	16p	BFY51	38p	IN5408	40p
2N2926G	13p	40594	75p	BC214	19p	BFY52	36p	AA119	14p
2N3053	25p	40595	88p	BC237	14p	BR339	50p	BA102	15p
2N3054	30p	40636	£1.18	BC239	16p	ME0412	20p	BA145	19p
2N3055	65p	40673	73p	BC272	17p	ME4102	10p	BA155	12p
2N3391	25p	AC126	37p	BC259	18p	ME480	£1.05	BB103B	20p
2N3393	15p	AC127	44p	BC301	45p	ME481	£1.00	BB104B	24p
2N3440	57p	AC128	37p	BC307	20p	ME490	£1.05	BY126	37p
2N3442	£1.20	AC152	50p	BC309	25p	ME491	£1.85	BYZ11	70p
2N3638	16p	AC153	40p	BC327	20p	ME2955	£1.21	BYZ11	70p
2N3702	17p	AC176	40p	BC328	19p	ME370	68p	OA47	10p
2N3703	15p	AC187K	40p	BCY70	25p	ME371	81p	OA90	6p
2N3706	14p	AC188K	45p	BCY72	24p	ME520	65p	OA91	6p
2N3708	14p	AD161	75p	BD121	£2.00	ME521	75p	OA200	8p
2N3716	£2.60	AD162	75p	BD124	£2.00	ME2955	£1.25	BY164	57p
2N3771	£1.60	AF106	45p	BD131	31p	ME3055	75p	ST2 diac	20p
2N3772	£2.68	AF109	45p	BD132	34p	ME8113	45p	40669	£1.00
2N3789	£2.60	AF115	65p	BD136	36p	MPSA05	20p	TIC44	20p
2N3819	36p	AF116	65p	BD137	36p	MPSA06	20p	C106D	65p
2N3904	21p	AF118	65p	BD138	39p	MPSA55	20p	ORP12	70p

PRICES CORRECT AT 22ND SEPTEMBER 1976, BUT PLEASE ADD VAT. P. & P. 30p

CJL

C.J.L. LTD, P.O. BOX 34, CANTERBURY, CT1 1YT

ALL PRICES INCLUDE P&P AND V.A.T.

<b>AUDIO MODULES</b>	
AMPLIFIERS	5W RMS £3-15
	10W RMS £3-30
	25W RMS £4-60
	35W RMS £7-70
	125W RMS £17-40
<b>TW AMP LIFIERS</b>	
Microphone	£2-75
Stereo for 5/10W	£7-50
Stereo for 25W PB Selector	£15-35
<b>STEREO FM TUNER</b>	
Decoder, PB Selector	£22-70
<b>POWER SUPPLY</b>	
	10W £1-50, 25W £3-35
<b>TRANSFORMERS</b>	
	10W £2-95, 25W £3-35
<b>EARPHONE/HEADPHONES</b>	
Crystal £0-85,	Stethoscope £1-35
2,000Ω £3-85,	Stereo £4-15
<b>INTERCOMS 2 station</b>	
	£6-75
<b>MICROPHONES Dynamic</b>	
	£2-15
<b>SPEAKERS 75mm dia 8Ω</b>	
	£1-00
<b>TAPE HEAD</b>	
	£3-65
<b>DEMAGNETISERS</b>	
	£2-30

<b>SOLDERING IRONS (ANTEX)</b>	
15W "C" Miniature Irons	£3-20
18W "CCN" Low Leakage Irons	£3-45
18W "G" Miniature Irons	£3-25
25W "X25" Low Leakage Irons	£2-90
"SK1" Soldering Kits	£4-40
"MLX" 12V Kits	£4-10
Elements "C" £1-50	"CCN" £1-85
"G" £1-85	"X25" £1-80
Bits 3/32in, 1/8in, 3/16in	each £0-50
(N.B. state type of iron)	
"ST3" Stands—for all models	£1-45
<b>SOLDER</b> in handy dispenser	
	£0-45
<b>DE-SOLDERING BRAID</b>	
	£0-97
<b>WIRE STRIPPERS AND CUTTERS</b>	
	£0-85
<b>WELLER</b>	
Dual Heat Solder Gun	£7-75
(Pistol grip with trigger control spotlight)	
<b>WELLER Dual Heat Gun Kits</b>	
	£10-55

## MAGENTA EE10, 61 Newton Leys, Burton on Trent, Staffs. electronics ltd. DE15 0DW

for professional components and service

### COMPONENTS & HARDWARE

Applications. Inclusive prices. No minimum order. Speedy despatch by first class post.

SHEET METALS; CAPACITORS; ENAMELLED & TINNED COPPER WIRES; RESISTORS; CABLE; ICS; TOOLS; SWITCHES; SCREWS; CASES; DIODES; PCB SUPPLIES; TRANSISTORS; PLUGS & SOCKETS; LEDS; DRILLS; VEROBORARD ETC.

### FREE CATALOGUE

INCLUDES SAMPLES & TRANSISTOR TESTER DATA OFFER.

Please send 2 x 6p stamps to cover postage etc.

# THE OPEN DOOR TO QUALITY



This catalogue—Electrovalve Catalogue No. 8 (Issue 2, up-dated) offers items from advanced opto-electronic components to humble (but essential) washers. Many things listed are very difficult to obtain elsewhere. The company's own computer is programmed to expedite delivery and maintain customer satisfaction. Attractive discounts are allowed on many purchases: Access and Barclaycard orders are accepted.

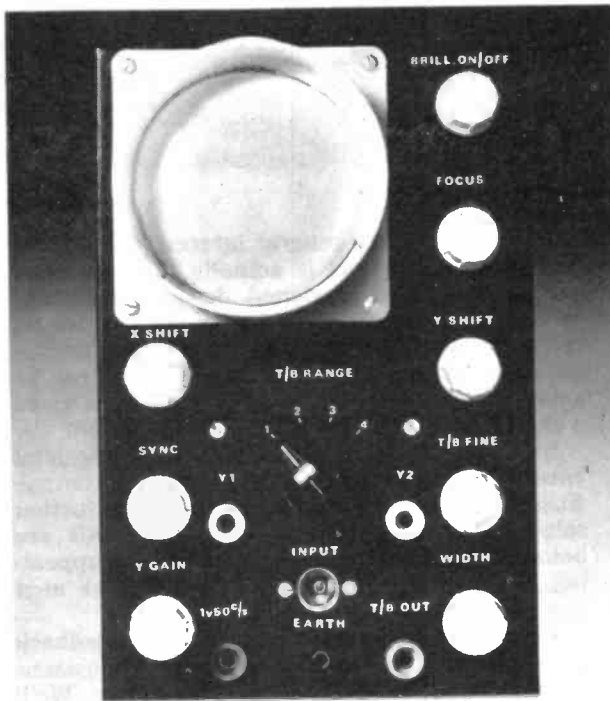
+ FREE POSTAGE on all C.W.O. mail orders over £2.00 list value (excl V.A.T.) in U.K. If under, add 15p handling charge.

144 pages  
POST PAID  
40p  
inc. refund voucher worth 40p

Postal communications to Dept. EE10  
28 ST. JUDES RD., ENGLEFIELD GREEN, EGHAM, SURREY TW20 0HR. Phone Egham 3803. Telex 284475. Shop hours 9-5.30, 1pm Sat.  
NORTHERN BRANCH: 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone (061) 432 4945. Shop hours 9-5.30 p.m.; 1pm Sat.

ELECTROVALVE LTD

# Bring 'scope' to your interest.

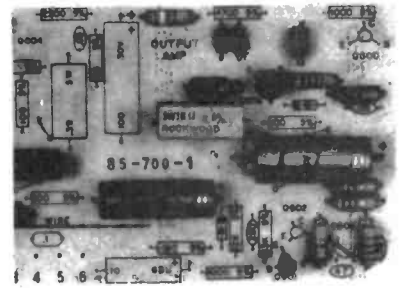
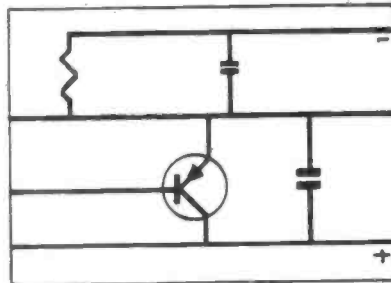
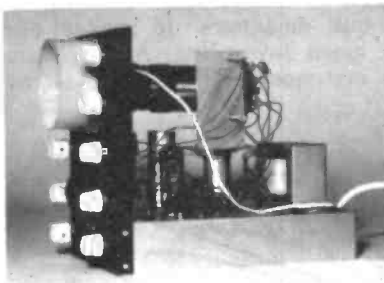


**'There's only one way to master electronics... to see what is going on and learn by doing.'**

This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.



## 1 Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

## 2 Read, draw and understand circuit diagrams.

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

## 3 Carry out over 40 experiments on basic circuits.

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.

**FREE GIFT**



All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

To find out more about how to learn electronics in a new, exciting and absorbing way, just clip the coupon for a free colour brochure and full details of enrolment.

Write to:- **British National Radio & Electronics School,**  
P.O. Box 156, Jersey, Channel Islands.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

**EEB 116**

# everyday electronics

## PROJECTS THEORY..

### SOMETHING IN THE AIR

Change is the keynote for this time of year. Autumn is not however just trees turning beautiful hues, or television broadcasters launching new programmes. For those who have a really keen nose, there is a whiff of hot solder-flux in the air as irons warm up in their thousands throughout the land.

There are other tell-tale signs for the perceptive onlooker to note. Like the eager rummaging of junk boxes—those nondescript containers of components which will have miraculously reappeared from their summer hiding places. And the cleaning up of workbenches or, just as likely, the determined pressing of claims for a corner of the kitchen table.

In short, for thousands of constructors the word is go man, go! The most fruitful months lie immediately ahead.

The EVERYDAY ELECTRONICS reader is likely to be in the fore of all this bustle. He or she will by now have tackled the hors d'oeuvre presented last month and be eagerly seeking out the main course. Something fairly substantial to get the teeth into. The problem is deciding *which* project to go for first.

### A CLEAR VIEW

No such problem arises if one is an astronomer. This month's *Clear Sky Indicator* is tailor-made

for star gazers. Of general interest will be the fact that this project is actually the second of our specially commissioned designs instigated by a reader's request. So far as we are aware, the *Clear Sky Indicator* is an entirely new device. It is another excellent example of what can be achieved by the circuit designer once he is given a challenge.

Incidentally, our previous allusion to the joint enterprise between readers and EVERYDAY ELECTRONICS designers brought forth a further selection of thought-provoking ideas. All are being investigated, and designs will be appearing in our pages from time to time. (Like next month, to drop a hint.)

We are naturally delighted with this feedback and for the very positive and enthusiastic endorsement of our theme "Together We'll Make It". Make no mistake, this two-way exchange is great. It encourages—inspires is more accurate—our designers. It makes our function all the more rewarding. And we are sure the results are most warmly received by constructors.



Our December issue will be published on Friday, November 19  
See page 587 for details.

EDITOR F. E. Bennett ● ASSISTANT EDITOR M. Kenward ● TECHNICAL EDITOR B. W. Terrell B.Sc.  
ART EDITOR J. D. Pountney ● P. A. Loates ● K. A. Woodruff  
ADVERTISEMENT MANAGER D. W. B. Tilleard ● P. Mew

© IPC Magazines Limited 1976. Copyright in all drawings, photographs, and articles published in EVERYDAY ELECTRONICS is fully protected, and reproduction or imitations in whole or part are expressly forbidden.

All reasonable precautions are taken by EVERYDAY ELECTRONICS to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

Editorial Department: Everyday Electronics, Fleetway House, Farringdon Street, London EC4 4AD. Phone 01-634 4452.

Advertisement Departments: Everyday Electronics Advertisements, Fleetway House, Farringdon Street, London EC4 4AD. Phone 01-634 4504. Everyday Electronics Classified Advertisements, Kings Reach Tower, Stamford St., London SE1 9LS.



...EASY TO CONSTRUCT  
...SIMPLY EXPLAINED

VOL. 5 NO. 11

NOVEMBER 1976

## CONSTRUCTIONAL PROJECTS

<b>CLEAR SKY INDICATOR</b> For the amateur astronomer by A. J. Bassett	564
<b>TRY THESE FOR STARTERS</b> 3 Audio Oscillator—4 Crystal Set Amplifier	572
<b>SCRATCH AND RUMBLE FILTER</b> Stereo active filter unit by R. A. Penfold	588
<b>ENLARGER EXPOSURE TIMER</b> For the amateur photographer by S. R. Lewis	594

## GENERAL FEATURES

<b>EDITORIAL</b>	562
<b>SHOP TALK</b> New products and component buying by Mike Kenward	571
<b>TEACH-IN 76</b> Part 14 Oscillators by A. P. Stephenson	574
<b>BRIGHT IDEAS</b> Readers' constructional hints	578, 592
<b>YOUR CAREER IN ELECTRONICS</b> The Aerospace Industry by Peter Verwig	579
<b>NOISE REDUCTION SYSTEMS</b> Part 2 by Adrian Hope	582
<b>PHYSICS IS FUN</b> Induction by Derrick Daines	593
<b>COUNTER INTELLIGENCE</b> A retailer's comments by Paul Young	599
<b>DOING IT DIGITALLY</b> Part 2 Gates and i.c. board by O. N. Bishop	600
<b>READERS' LETTERS</b> Your news and views	605
<b>PLEASE TAKE NOTE</b>	605
<b>PROFESSOR ERNEST EVERSURE</b> The Extraordinary Experiments of. by Anthony J. Bassett	606
<b>JACK PLUG AND FAMILY</b> Cartoon	609
<b>DOWN TO EARTH</b> Impedance Matching by George Hylton	610

## BACK NUMBERS, LETTERS AND BINDERS

We are unable to supply back copies of Everyday Electronics or reprints of articles and cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. An s.a.e. should be enclosed for a personal reply. Letters concerning published articles should be addressed to: The Editor, those concerning advertisements to: The Advertisement Manager, at the address shown opposite.

Binders for volumes 1 to 5 (state which) are available for £2.10, including postage, from Post Sales Department, Lavington House, 25 Lavington St., London SE1 0PF

# NEXT MONTH

Party time  
Projects!

SEE PAGE 587



# CLEAR SKY INDICATOR

By A. J. BASSETT.

**I**N the field of practical astronomy, one of the most irksome and frustrating occupations must surely be that of repeatedly checking the weather in the hope of conditions suitable for the making of clear observations.

## TIME SAVER

An automatic clear sky detector with remote indication facilities would obviously save the student of the skies many a frustrated journey to the telescope—only to find that cloud or haze is making observation difficult or impossible. Such a device could indicate the degree of obscurity on a meter which could be placed in a convenient position for easy observation.

The astronomer could then see at a glance whether conditions were right, and save a lot of time and wasted journeying. Just in case, at the time when weather conditions were favourable, the observer omitted to notice this either directly or on the meter, an electronic bleep signaller, or a flashing lamp, could be arranged to draw his attention so that such favourable conditions might not be wasted. Of course, the really keen astronomer might arrange to have an electronically controlled alarm by his bedside!

## DIFFERENTIAL THERMOMETER

The author has considered a number of methods by which a clear sky might be detected and indicated using electronic means.

One suggested method would have utilised a differential thermometer circuit to monitor the difference between air-temperature and ground surface-temperature, since it is known that during conditions of heavy cloud

cover the temperature of the ground surface tends to come closer to the temperature of the air.

An "artificial ground" of low thermal capacity could be constructed to give rapid indication of changes, as, when the sky becomes clear, the temperature differential between air and ground increases markedly. This is because the ground can, in clear conditions, lose heat rapidly by means of infra-red radiation. In cloudy conditions this radiation is confined by reflection from the clouds, and other effects, and losses are not rapid.

However, this temperature-differential method suffers a number of drawbacks. One is inaccuracy. Because certain types of haze and cloud are virtually transparent to infra-red rays, but not to visible light, a clear sky detector based on infra-red radiation might only be of use to an infra-red astronomer, as it would give an indication of a clear sky, at times when mist or haze might impede viewing by the visible wavelengths.

Another problem is that, even with temperature-sensors of low thermal capacity, there would be

a time-lag during which valuable observation-time might be lost before the detector gave an indication of favourable conditions.

## REFLECTED LIGHT

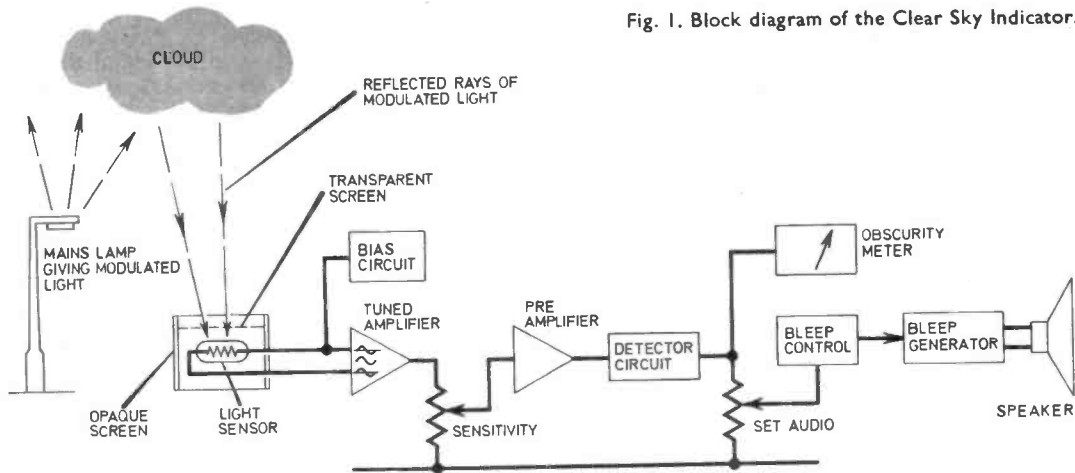
Obviously it would be better to have a clear sky detector which uses as its operating-medium the same wavelengths we wish to use for observation purposes—or at least some wavelength within the visible spectrum. It would also be useful to have a detector which gives an instant indication, with no significant delay, and the instrument to be described by the

### THE VERY IDEA

The idea for a Clear Sky Indicator was proposed by Mr. N. James of Weston-Super-Mare who receives our special award.



Fig. 1. Block diagram of the Clear Sky Indicator.



author does this by detecting light which has been scattered or reflected by particles in the atmosphere.

The fewer the particles of dust, mist, fog, rain, hail, snow, atmospheric pollution and smoke, the less the light will be scattered and reflected and the clearer the sky for observational purposes.

There are a number of possible ways in which instruments might be built for the purpose of distinguishing between light which has been scattered by atmospheric particles, and light which has not been so scattered, and some of these are both costly and complex.

A simple and effective method, requiring only a modest financial outlay has been found, and should prove to be a worthwhile investment for both individual astronomers, and astronomical clubs in most circumstances.

This method relies on the detection of light from street lamps, or any other suitably modulated and powerful artificial light source. Light from street lamps and most artificial light

sources can be easily distinguished and detected by electronic means. This is because it is modulated at a multiple of the supply frequency, and in the British Isles, where the supply frequency is 50Hz, the modulation frequencies which usually predominate are 100Hz and 300Hz.

#### BASIC SYSTEM

If a light sensor connected to a circuit timed to 100Hz is pointed at the sky, the output from the tuned circuit will depend upon the amount of artificial light reflected back from atmospheric impurities, and particles. Fig. 1 shows a block diagram of the system.

The light sensor, which may be a cadmium sulphide cell, a cadmium selenide cell or a suitable photosensitive transistor or diode, is protected from the direct rays of artificial lighting by a black-painted screen or surround.

It receives light from the sky, including any artificial light which may be reflected by atmospheric particles or cloud.

The sensor is likely to be situated in the open, on the observatory roof or in a garden, and is connected by means of a length of screened wire or coaxial cable to the 100Hz tuned circuit, which may be situated comfortably indoors together with the remainder of the electronic circuitry. The 100Hz tuned circuit also acts as a sensitive amplifier. This function is to separate the 100Hz signal both from the d.c. level produced by ambient lighting and from other frequencies and to boost it to a level sufficient to operate the meter and the bleep indicator circuits.

#### SENSOR MOUNTING

A method of mounting the light-sensor in a black-painted metal container such as a tin-can is shown in Fig. 2. The container is first well cleaned and any hazardous sharp edges removed. A hole is made near the bottom of the container for cable entry using a P.V.C. or rubber grommet, and then it is painted inside and out, all over first with Kurust rust-preventive paint, then with blackboard or matt black paint. If the black is insufficiently bound to withstand the weather, a coat of tough outdoor quality varnish may be used finally.

In areas where there is plenty of outdoor artificial lighting, as from a nearby town or major road, an inexpensive cadmium sulphide photosensitive resistor, (a type ORP-12), may be used.

It is mounted in place by soldering to a length of tagstrip or connecting block screwed to the base of the container. One terminal is connected to the inner wire, which is also connected to the metal of the container. The container then serves three purposes: Protection of the photo-cell from direct artificial lighting; electrical screening; partial protection against weather.

The cable is secured inside the container by means of a cable-clamp, and the point of entry through the grommet, and the area around the grommet protected by an application of black outdoor-grade sealing compound such as Black Bostik.

#### WEATHER PROTECTION

An additional piece of hard-

**FOR  
GUIDANCE  
ONLY**

**ESTIMATED COST  
OF COMPONENTS  
excluding V.A.T.**

**£11.00**

**excluding case and**

**coax**

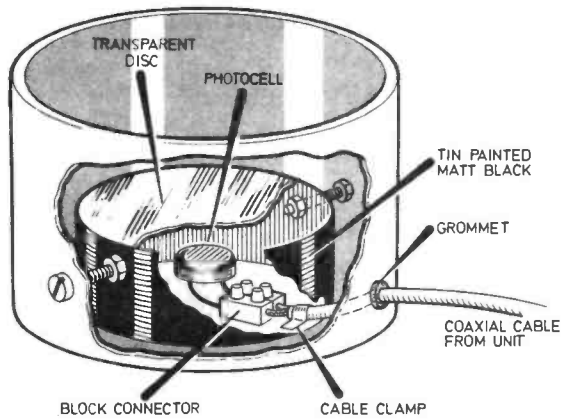


Fig. 2. Mounting arrangements for the photocell.

were designed to slip over the top of the photocell-container for protection against dust and rain can be made from a metal container of slightly larger diameter than that containing the photocell, and open at both ends. A

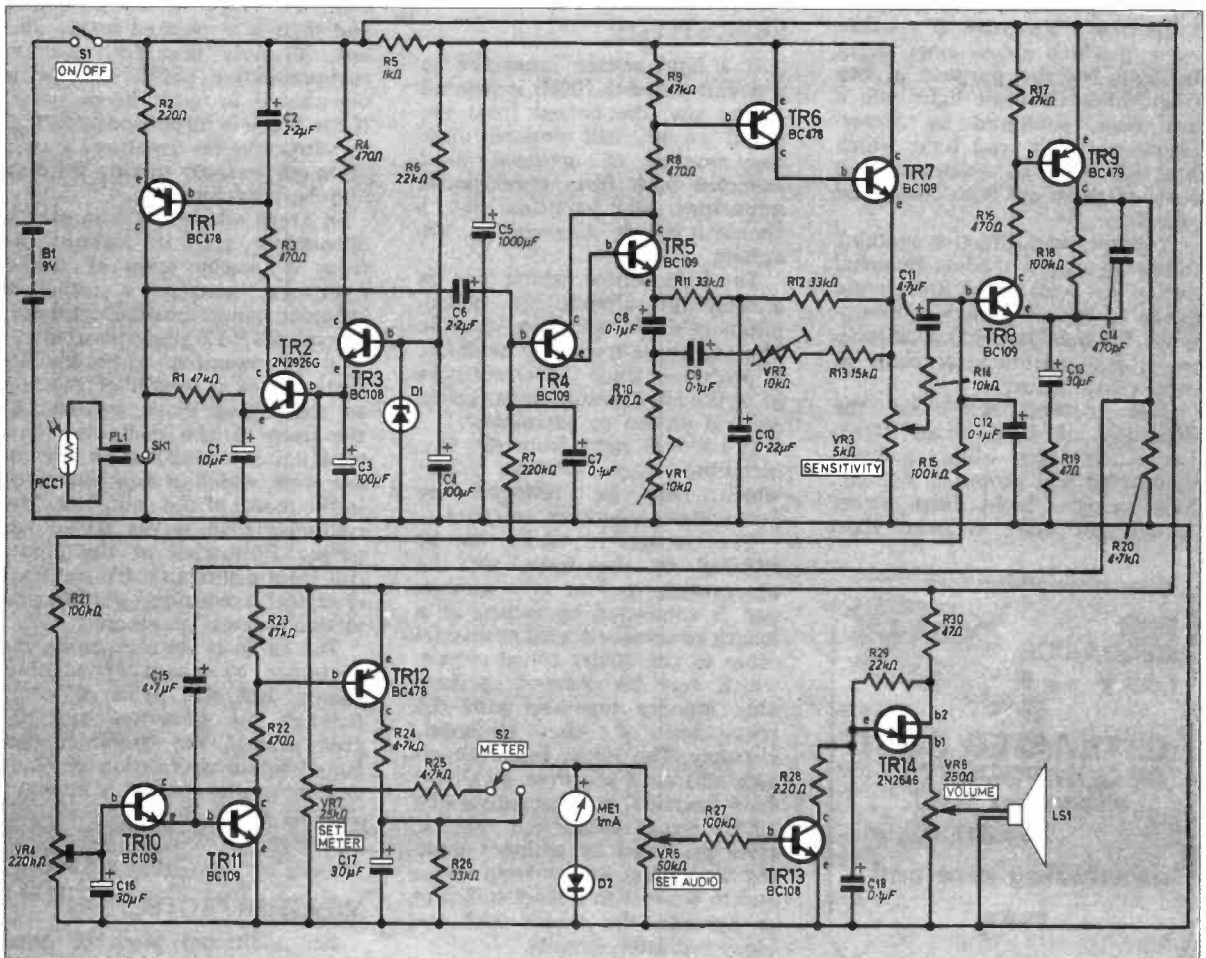
disc of clear glass or plastic is fitted over one end of the photocell housing. This disc is surrounded by the further cylindrical piece of metal to prevent entry of light from the sides. This piece may be fastened to the

metal tube which carries the disc, by means of three screws or brackets, and all metal parts painted in the same way as the photocell container.

This method of protection against rain has a number of advantages. If a polythene sheet were tied over the container, as protection against rain, or a plain flat piece of glass rested on top, artificial light would be likely to enter by scattering from the glass or polythene, and also there is greater danger that water might leak back in.

In most areas a disc of glass or clear plastic should be satisfactory, but in difficult areas where there is not much outdoor artificial lighting a disc of clear quartz would be better as this transmits a wider spectrum. Also in difficult areas, improvement may be made by using, instead of the cadmium sulphide cell, a photo-sensitive cell of cadmium

Fig. 3. Circuit diagram of the Clear Sky Indicator.





selenide, or else a photo-sensitive transistor or diode.

## CIRCUIT

Now to consider what goes on at the other end of the screened cable, Fig. 3, is the circuit diagram depicting a practical realisation of the block diagram of Fig. 1, in terms of readily available electronic components.

Transistors TR1, TR2 are parts of a bias circuit which controls the bias necessary to use the photocell, in a way in which will ensure good sensitivity to 100Hz modulated light under a wide range of lighting conditions.

Transistor TR3, together with Zener reference diode D1 provides a steady reference voltage for the photocell bias circuit, and also for the pre-amplifier and tuned circuit, with resistor R4 limiting the current through TR3 to prevent damage when C4 charges.

Transistors TR4, 5, 6, 7, together with associated components, from a tuned circuit which may be readily tuned to 100Hz. Although this circuit may appear to be fairly complicated, and much simpler circuits can be built which will readily be tunable to 100Hz, the author found that in practice this circuit gives good results.

From the tuned circuit the signal passes via sensitivity control VR3 to a pre-amplifier TR8, 9 which raises level sufficiently to feed the meter driver circuit TR10, 11, 12.

The output of the meter driver feeds a smoothing capacitor C17 which not only helps to prevent the meter movement from undergoing vibration at 100Hz but also provides a smoothly varying voltage whose level is monitored by the audio generator circuit TR13, TR14.

The voltage across C17 is dependent upon the signal received by the photocell, and as this voltage drops below a certain level the alarm tone will sound. It is possible to set the level at which the alarm sounds by means of VR5, to give an audible indication of clear sky conditions.

## CONSTRUCTION

Most of the circuit is constructed on three similar pieces of 0.15 inch matrix Veroboard

each measuring 10 strips by 25 holes as depicted in Figs. 4, 5, and 6. The more skilled constructor who seeks miniaturisation may use 0.1 inch matrix Veroboard and following the

same diagrams.

Assembling of the components on the three boards is fairly straight forward and should present few problems, however, a couple of points may be worth

## Components

### Resistors

R1	47k $\Omega$	R16	470 $\Omega$
R2	220 $\Omega$	R17	47k $\Omega$
R3	470 $\Omega$	R18	100k $\Omega$
R4	470 $\Omega$	R19	47 $\Omega$
R5	1k $\Omega$	R20	4.7k $\Omega$
R6	22k $\Omega$	R21	100k $\Omega$
R7	220k $\Omega$ oxide	R22	470 $\Omega$
R8	470 $\Omega$	R23	47k $\Omega$
R9	47k $\Omega$	R24	4.7k $\Omega$
R10	470 $\Omega$	R25	4.7k $\Omega$
R11	33k $\Omega$	R26	33k $\Omega$
R12	33k $\Omega$	R27	100k $\Omega$
R13	15k $\Omega$	R28	220 $\Omega$
R14	10k $\Omega$	R29	22k $\Omega$
R15	100k $\Omega$	R30	47 $\Omega$

All  $\frac{1}{4}$ W  $\pm 10\%$  carbon except R7

### Capacitors

C1	10 $\mu$ F elect. 10V	C10	0.22 $\mu$ F 35V tantalum
C2	2.2 $\mu$ F 35V tantalum	C11	4.7 $\mu$ F 35V tantalum
C3	100 $\mu$ F elect. 10V	C12	0.1 $\mu$ F 35V tantalum
C4	100 $\mu$ F elect. 10V	C13	30 $\mu$ F elect. 15V
C5	1,000 $\mu$ F elect. 10V	C14	470pF ceramic disc
C6	2.2 $\mu$ F 35V tantalum	C15	4.7 $\mu$ F 35V tantalum
C7	0.1 $\mu$ F 35V tantalum	C16	30 $\mu$ F elect. 15V
C8	0.1 $\mu$ F 35V tantalum	C17	30 $\mu$ F elect. 15V
C9	0.1 $\mu$ F 35V tantalum	C18	0.1 $\mu$ F 35V tantalum

### Potentiometers

VR1	10k $\Omega$ skeleton preset
VR2	10k $\Omega$ skeleton preset
VR3	5k $\Omega$ log. carbon
VR4	220k $\Omega$ skeleton preset
VR5	50k $\Omega$ lin. carbon
VR6	250 $\Omega$ wirewound
VR7	25k $\Omega$ lin. carbon

### Semiconductors

TR1	BC478 silicon pnp
TR2	2N2926G silicon npn
TR3	BC108 silicon npn
TR4, 5	BC109 silicon npn
TR6	BC478 silicon pnp
TR7, 8	BC109 silicon npn
TR9	BC479 silicon pnp
TR10, 11	BC109 silicon npn
TR12	BC478 silicon pnp
TR13	BC108 silicon npn
TR14	2N2646 unijunction
PCC1	ORP12 photocell (see text)
D1	BZY88 6V8 (6.8V 400mW Zener diode)
D2	OA202

### Miscellaneous

ME1	1mA moving coil meter
LS1	80 $\Omega$ miniature moving coil loudspeaker.
B1	9V alkaline manganese battery and connecting clip
S1	s.p.s.t. slide switch
S2	s.p.d.t. slide switch
SK1	coaxial socket and plug to suit (PL1)

Veroboard 10 strips by 25 holes 0.15 inch matrix (3 off)  
Chassis approx. 200 x 150 x 60mm, screened lead approx 500mm, connecting wire, knobs (4 off), 6BA fixings. TV type coax length as required, materials for photocell mounting.

See  
**Shop  
Talk**  
page 571

mentioning. One is in the use of the Vero spot face cutter or a drill bit to remove copper conductor at the points indicated. As there are three similarly sized boards, each with a different pattern for removal of the conductor, it is important to be sure cuts are made in the correct places. Check that the connections of each board do in fact correspond with the circuit.

The circuitry may be assembled in an aluminium box or chassis measuring approximately 200 x 150 x 60 mm, which should be readily available commercially. This size box will accommodate the three 0.15 inch matrix circuit boards, meter and controls, together with a 9 volt alkaline-manganese battery as shown in Fig. 7, or alternatively three 0.1 inch matrix boards together with a mains power-supply and voltage regulator circuit may be fitted.

### MAINS SUPPLY

If a mains power supply is used be sure to keep mains wiring away from the inputs to the three circuit boards, as this would induce 50Hz hum; also keep the mains transformer away from the panel meter as the magnetic field from the transformer could upset the meter if the two are adjacent to one another.

### SCREENING

Use screened audio wire for connections to the inputs of the three circuit boards, to the sensitivity control VR1 and to the photocell input socket. Television v.h.f. coaxial cable may be used to connect from the unit to the photocell.

Stranded connecting wire may be used for the remainder of the circuit.

Once the circuit boards have been wired and checked to ensure that they do provide the correct circuit they may be mounted in place using 6BA nuts and bolts, together with insulating spacers to keep the copperstrips away from the metal. Before mounting board 3, however, ensure that the negative wire of C15 can easily be disconnected and re-joined from the top of the board. This may be done by soldering this end of the capacitor to a terminal join or pin inserted in the board.

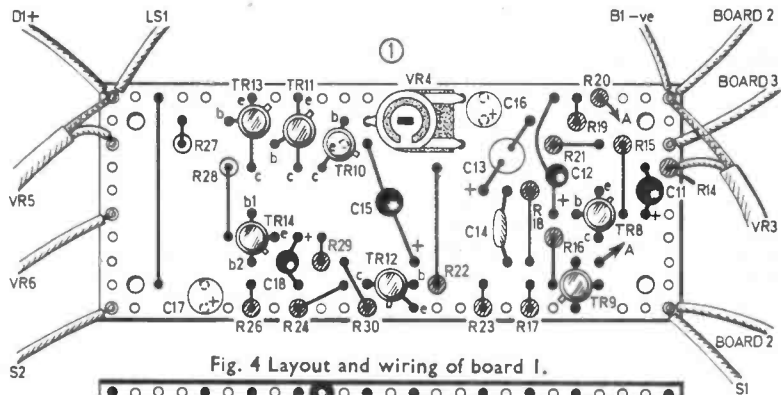


Fig. 4 Layout and wiring of board 1.

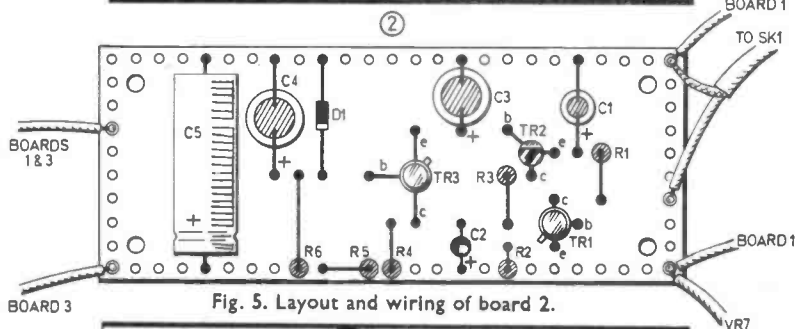
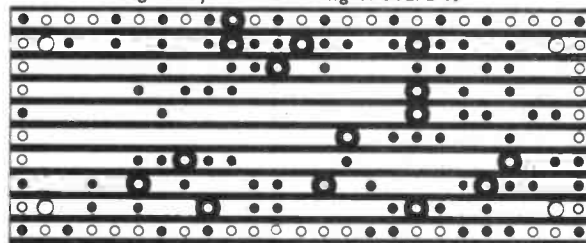


Fig. 5. Layout and wiring of board 2.

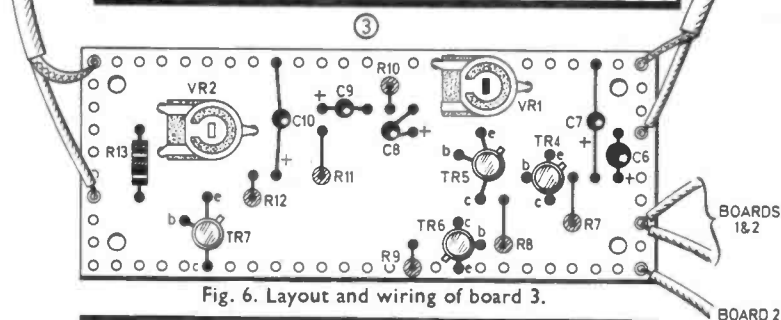
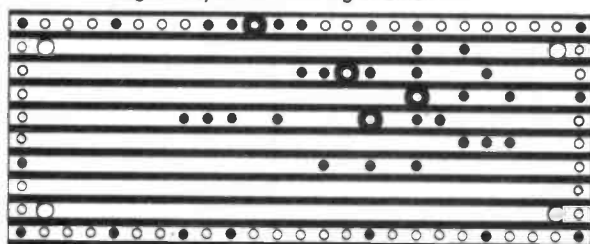
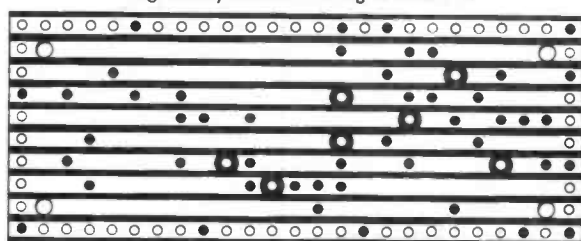


Fig. 6. Layout and wiring of board 3.



# CLEAR SKY INDICATOR

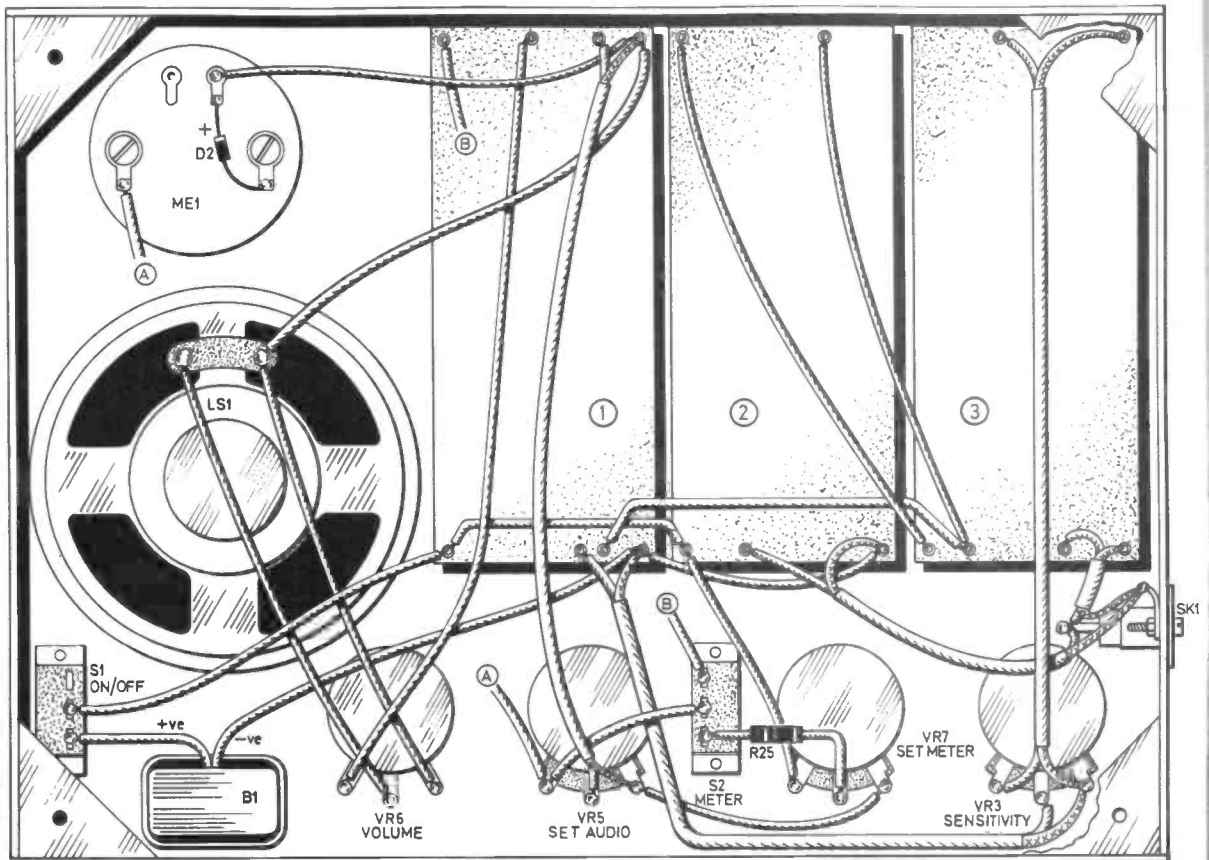
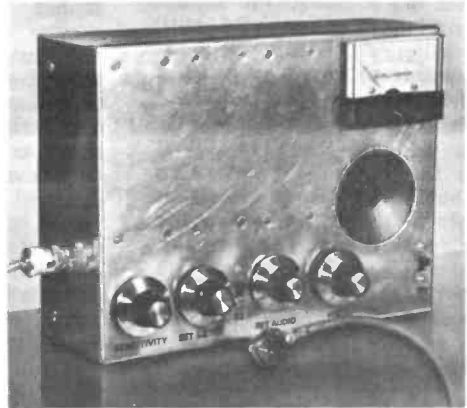
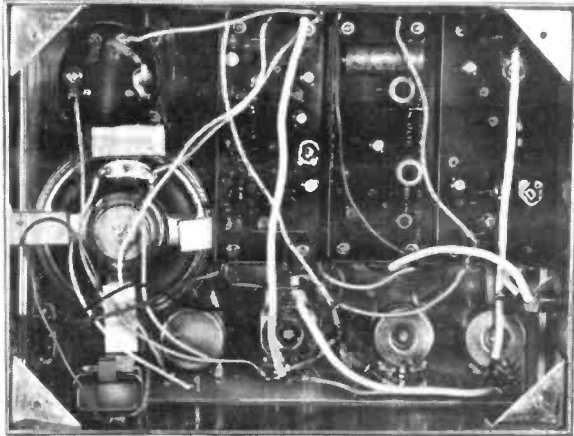


Fig. 7. Complete Clear Sky Indicator wiring.

## SETTING UP

When the assembly has been completed, the preset potentiometers VR1, 2, 4, must be set to their correct positions. To set VR4 proceed as follows: Disconnect the negative end of C15 set the wiper of VR4 to its negative end, and switch on the unit. (The photocell need not be plugged in). Observe the meter, and gradually adjust VR4 until the needle, which initially is at zero, begins to move over. (If it does not respond, operate S2 and start again).

Now a point must be found where the meter will return to zero, but VR4 is set as closely as possible to the region where the meter reading begins to increase, as this will give the detector high sensitivity.

However, C16 has a delaying effect, so it will be necessary to wait a short while after each small adjustment of VR4 in order to find the best spot. Then switch off the unit, use a 100 ohm resistor to discharge C5, and reconnect C15.

To set VR1, 2 it is best to use an oscilloscope connected to the output of the tuned circuit, in order to time the circuit to 100Hz. Disconnect the photocell.

Connect the X input of the oscilloscope to the wiper of VR3 (if it is a d.c. coupled oscilloscope connection should be made using an 0.1 $\mu$ F capacitor).

Connect the Y input of the oscilloscope to a 50Hz signal (which may be obtained from a low-voltage isolating transformer such as a bell transformer).

Set VR2 to minimum resistance. This should cause the tuned circuit to oscillate, and by adjusting VR3 and the gain-controls of the oscilloscope you should see a moving pattern on the screen.

If the circuit does not oscillate, adjust VR1 or reduce the value of R13 to 10 kilohms or less if necessary.

By adjusting VR1 you should be able to get a figure 8 on the screen, lying on its side, and this is a sign that the circuit is correctly tuned. As VR1 is adjusted the figure will rotate in one direction or the other. By increasing the resistance of VR2, it should be possible to stop the oscillation, and the trace will then collapse to give a horizontal line, and reappear as VR2 is once again decreased. Set VR2 to the point

where the circuit only just ceases to oscillate.

## OSCILLATION

Wire one end of a 100 kilohm resistor to the circuit negative, and tap the input terminal of the photocell socket momentarily with the other end of this resistor. Each time this is done the trace should appear and collapse slowly.

Adjust VR2 so that it takes about two seconds or maybe more to collapse. Adjust VR1 so that any rotation of the figure is as slow as possible. When these adjustments are complete, the circuit will be found to be timed to 100Hz, and on the verge of oscillation. In this condition it is very sensitive to any input at 100Hz, and this sensitivity will enable the instrument to detect very small inputs at this frequency.

If no oscilloscope is available then VR1 and VR2 can be set to give the best results. Do this with the photocell connected and with a remote artificial light source, e.g. internal lighting in another building. It is important that there is no source of artificial lighting near the cell. Set VR2 to mid resistance and adjust VR1 to give the highest possible reading on ME1 (backing off the sensitivity control to achieve this).

Next disconnect the photocell and adjust VR2 in the manner described above. Indication of oscillation can be achieved by setting the sensitivity control about  $\frac{1}{3}$  up and watching ME1 for full scale deflection. As oscillation dies away ME1 will return to zero.

Having achieved oscillation dieing away in about two seconds readjust VR1 as above.

Switch S2 to the position enabling the meter needle to be moved across the scale by means of VR7, and set a reading of 0.5mA (half full scale deflection). Turn up volume control VR6. Now by adjusting, VR5, you should be able to cause the audio tone to sound. By adjustment of VR5 and VR6, you should be able to cause the audio tone to sound at any chosen position of the meter needle. Leave VR5 set at the chosen position and switch back S2.

Allow a few seconds for the unit to "settle down", and the meter reading should move back to give a low reading, but its be-

haviour depends upon the setting of sensitivity control VR3. If VR3 is set high, noise from the components in the oscillator circuit may be expected to cause the needle to waver a little and may modulate the audio tone.

## USE

Arrange the photocell to face towards any chosen part of the sky, but to be shielded from any direct rays from an artificial light. Now the photocell can only pick up 100Hz modulated light by reflection from cloud etc. in the sky.

Set VR3 to about half way, plug in the photocell and switch on. After a few preliminary excursions of the meter needle, lasting a few seconds, the unit should settle down and, as clouds pass over, reflected artificial light from them should be received by the photocell, causing the meter needle to swing over to a high current reading, and extinguishing the audio tone.

When the sky is clear, the meter reading should fall to a lower value and the audio tone should sound.

Whenever VR3 is adjusted, the unit will be upset for a few seconds, and then return to normal operation very quickly.

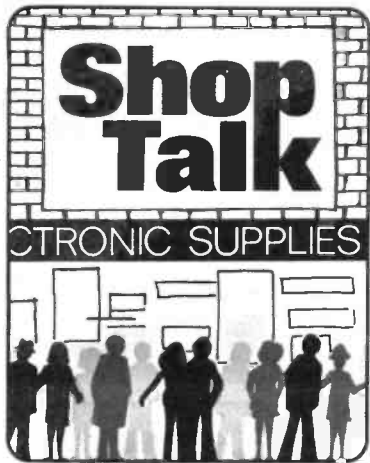
If you are using the detector in an area where there is a lot of artificial lighting, such as airport landing lights, it may be useful to reduce the sensitivity by increasing the value of R19 to 220 ohms or more.

If you find that it is necessary to increase the sensitivity beyond that which is provided with VR3 at its full setting, this may be done by reducing R19 to 10 ohms; however, it may result in a problem from increased "noise" and wavering of the meter needle.

This problem may be overcome by selecting lower-noise components for the oscillator board, especially R7, TR1, TR2, TR3 and the input capacitors.

## REMOTE INDICATION

The audio signal may be heard in another room by switching over to another speaker, or if it is desired to leave the speaker in the unit connected and have simultaneous remote indication at more than one location, the speaker output of the unit may be connected to the input of a low-sensitivity audio amplifier.  $\square$



## By Mike Kenward

*New products and component buying for constructional projects.*

FROM the response we get whenever we publish anything remotely concerned with the pop music field we are sure many of our readers would be very interested in the Sound Design publication now available from our sister magazine *Practical Electronics*.

In addition to a couple of heavy-weight articles—a synthesiser and electronic piano—there are six guitar and organ effects units (one which provides eight basic effects) which should be within the scope of many of our readers, plus the Orion hi fi amplifier design. The circuits used in the bigger items will no doubt find other applications and would be of interest to anyone who dabbles in this field.

The book costs £1.20 post paid and full ordering details are given on page 577.

Whilst on the subject of publications we have had two catalogues for some time now but have not had the space to bring them to your attention. The first one is from Vero Electronics and gives details of their range of boards, cases and tools, many of which will be familiar to regular constructors. The "catalogue" is worth having even if only for reference and is available direct from Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Hampshire SO5 3ZR for 10p including postage and package, etc.

The second catalogue is one that looks very good but which we felt needed more than just a brief mention. This one comes from Marshall's. If you want semiconductors or i.c.s Marshall's probably carry more types in stock than any other supplier and their catalogue bears this out. In Mr. Marshall's introduction he states "we have tried to include some essential information which previously had been missing" by this we presume he means transistor and i.c. leadouts, data and Japanese equivalents.

Taking the above items in order the

transistor types are each given a code number and a page of pin connection drawings are shown although originally this was almost useless, an amendment has now been printed which makes the information very worthwhile. The i.c. data and connections in most cases are good, but in some cases are pointless without a relevant circuit.

As far as the Japanese transistor equivalents go we feel this is a rather misleading title since the equivalent numbers given are all Marshall's own code numbers. Although this would enable one to buy a suitable replacement from Marshall's the information is otherwise useless and we see no point in its publication—they might as well simply say they can supply equivalents of the Japanese 2S type transistors. Or publish the type numbers with prices and say that equivalents will be supplied.

Well, as Mr. Marshall said, they "tried" and for doing that they get our praise, but if they can sort out the remaining points then at 30p this catalogue would become even more worthwhile. It also gives details of a good range of items for constructors other than semiconductors. Send 40p (including 10p postage) to A. Marshall, 42 Cricklewood Broadway, London NW2 3ET.

### New Products

News of two burglar alarm systems intended for d.i.y. installation has recently come our way, both systems are interesting but it would take up far too much space to list all their points.

The first system is the simplest and contains everything for home installation in one of two kits. The AB10—door and window alarm—and the AFB15 burglar/fire alarm. These two come from Eagle International, are backed by a two year guarantee and cost £14.06 and £28.68 respectively, including VAT. The kits should be available from most electrical retailers but a list of your local stockists and a free catalogue can be obtained by

writing to Eagle International, Heather Park Drive, Wembley, Middlesex HA0 1SU.

The second alarm is rather more comprehensive and in fact provides three basic systems with many options on alarms; shut down timers; magnetic, inertia and pressure contacts; window foil and personal attack buttons. The systems also incorporate facilities for heat detection and installation packs are available. Prices for the basic control units start at about £40 including VAT but to that must be added the cost of contacts, sounder etc. The simplest complete system costs £61.88 and an installation kit £9.72.

More details of the full range, which includes such items as a micro-wave radar detector and an ultrasonic motion detector, together with prices are available from Harley Security Systems Limited, 87 High Street, Alton, Hants GU34 1LG. Harley also run a free technical advice service for those fitting or considering fitting one of their systems.

### P.C. Kit

Final new product this month is a d.i.y. printed circuit kit from Compstock Ltd. The kit has been aimed at development engineers but is equally suited to the home constructor because all chemicals are kept inside a sealed polythene bag while being used, thus reducing any risk of accidents. The kit comes with a p.c. etch resist pen, 10 strips of etch resist transfers, an abrasive block for cleaning boards and the etching system. Also included is a special neutraliser which, when mixed with the acid turns it into a semi-hard neutral mass which may be safely and easily disposed of.

Compstock say that the kit should etch about 10 average size boards (10 x 16 cm)—you would get many more smaller size boards. The cost is £8.25 including VAT post and packaging, but during the Internecon Exhibition at Brighton (October 19, 20, 21) they are doing a special introductory offer of £5 per kit. Compstock Ltd., are at 42/44 Bowlers Croft, Basildon, Essex.

### Constructional Projects

Although three of our projects this month contain a fair number of components' having looked through the lists carefully we doubt if any of them will provide any undue buying problems.

The semiconductors and i.c.s used should be available from the larger stockists, the most expensive being the LM3900N used in the *Enlarger Exposure Timer* and even that should only be about 60p.

One thing is worth mentioning; when buying a large number of items i.e. for the *Clear Sky Indicator*, it is as well to make sure your supplier's prices are reasonable because a small difference on a large number of items soon adds up.

### D.I.D.

*Doing It Digitally*, or DID as we have come to know it, uses a fair number of parts for the construction of the wiring board this month and a components list for this, and for the other components used in the first few parts of the series, was given last month. We hope that a number of firms will be advertising kits of parts in this issue. If so, it should make buying that much more simple. Price—we estimate about £11.50 including the Vero case, on/off switch etc.

# Try these for

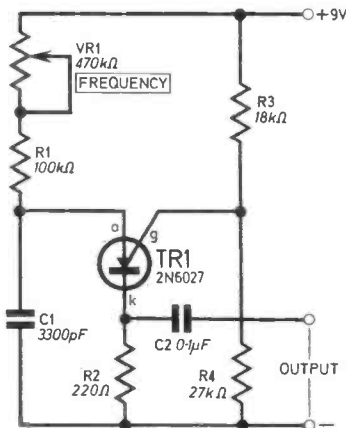
## 3 AUDIO OSCILLATOR

THE circuit shown in Fig. 1 is an oscillator, using only one active component—a PUT; or programmable unijunction transistor.

### USES

There are several uses for audio oscillators. One is a practice oscillator for Morse Code. Another is as a "buzzer" for any unit or system requiring an audio output. An advantage of this type of oscillator as an alarm buzzer is that, by using separate switches from the positive supply to the anode of the PUT, each with a different amount of resistance in series, each alarm condition in a multiple system will give a different note—so you can easily tell which parameter should be checked.

While the oscillator will produce audible output from a 15 or 33 ohm loudspeaker, headphones (8 ohm hi-fi types) are preferred because of their high sensitivity. A further advantage in using headphones for Morse practice is that the dots and dashes will only be heard by you—maybe you think that hours of Morse sounds fine, but we doubt if your family would agree!



### ESTIMATED COST OF COMPONENTS

excluding V.A.T.

£0.85

For use as an alarm or door buzzer, the sound level into a speaker may not suffice, so an additional amplifier may be necessary.

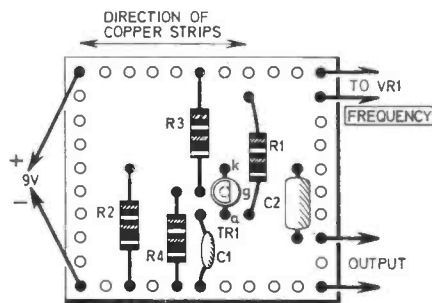
### CIRCUIT

The circuit is a conventional one, the PUT being connected as a relaxation oscillator. A detailed explanation of how it works is not within the scope of this article. Suffice to say that a relaxation oscillator operates by charging a capacitor to some critical voltage the PUT then "triggers", discharging the capacitor, and the cycle is then repeated.

The frequency produced by the oscillator can be varied by means of a potentiometer included in the capacitor charging circuit. If a switch pot is used, this will

Fig. 1. Circuit diagram of the oscillator.

Fig. 2. Layout and wiring of the oscillator.



### Components

#### Resistors

R1 100k $\Omega$   
R2 220 $\Omega$   
R3 18k $\Omega$   
R4 27k $\Omega$   
All  $\frac{1}{4}$ W +10% carbon

#### Potentiometer

VR1 470k $\Omega$  antilog carbon (see text)

#### Capacitors

C1 3,300pF  
C2 0.1 $\mu$ F

#### Transistor

TR1 2N6027 PUT

#### Miscellaneous

Veroboard 0.1 inch matrix  
10 strips by 11 holes (half piece presented free with last months issue). connecting wire

save the expense of buying a separate switch for on/off.

The pot should ideally be an "anti-log" type—that is the opposite relationship to a conventional logarithmic type. Alternatively, you can use a log. pot. with connections reversed, the only disadvantage being that at minimum rotation, the frequency will be maximum. If you are not worried about linearity, an ordinary linear pot. will be quite acceptable.

As with other circuits in this series, the oscillator operates from a 9V supply. However, voltage is not critical, and other voltages, up to 18V, will be satisfactory. Fig. 2 shows construction details of the unit.



# Starters...

## 4 CRYSTAL SET AMPLIFIER

**T**HIS one stage audio amplifier should be of particular interest to those who have a simple crystal set and wish to hear stations with increased volume in the headphones.

### ADVANTAGES

There are two advantages in adding an audio stage to a crystal set. The first, and most obvious, is the amplification of signals to a more comfortable listening level. The second, although not so obvious, is an improvement in selectivity; this may be obtained by reducing the aerial coupling, achieved by tapping the aerial further toward the earthy end of the coil.

This reduces the load on the tuning coil, enabling it to achieve a higher "Q", the major factor governing selectivity. Since the headphones also load the coil, a further improvement should result by reason of the higher input impedance of the amplifier, compared with most headphones, particularly the low impedance types.

The circuit uses a single BC108 or any similar small signal *npn* transistor. Output from the collector circuit may be into a set of "high impedance" headphones

### ESTIMATED COST OF COMPONENTS

excluding V.A.T.

**£0.50 plus phones**

(2,000-5,000 ohms), or small valve-type output transformer. The transformer idea is useful, as it side-steps a supply problem with old-type 4,000 ohm headphones. It enables a set of modern "hi-fi" type phones to be used, with an added advantage of high sensitivity and better comfort.

### CIRCUIT

Signal to the amplifier is applied to the input capacitor and earth. In exceptional signal areas, a 10 kilohm volume control could also be used. The transistor is biased by the two resistors connected to the base and by the bypass emitter resistor R3.

The input capacitor is shown on the circuit as a 0.1 $\mu$ F type, mainly in the interests of economy. The circuit will work as it stands, but

### Components

#### Resistors

R1 68k $\Omega$   
R2 15k $\Omega$   
R3 1k $\Omega$   
All  $\frac{1}{4}$ W  $\pm 10\%$  carbon

#### Capacitors

C1 0.1 $\mu$ F  
C2 30 $\mu$ F elect. 12V

#### Transistor

TR1 BC108 silicon *npn*

#### Miscellaneous

TL1 2000-4000 ohm headphones (see text)  
Veroboard 0.1 inch matrix 10 strips by 11 holes (half piece presented free with last months issue), connecting wire

a higher value capacitor will give better low frequency response—particularly if good quality phones are used. A small tantalum capacitor, say 1 $\mu$ F 10V working, could be used, with its "positive" lead connected to the base of the transistor. □

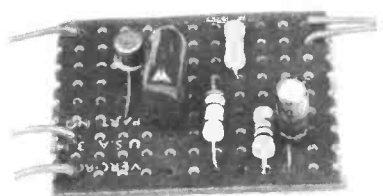
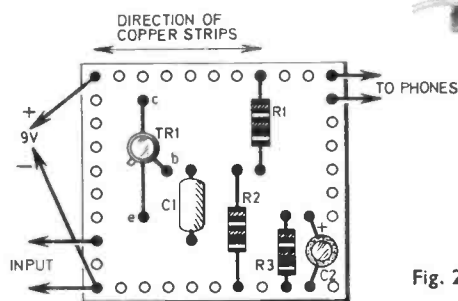
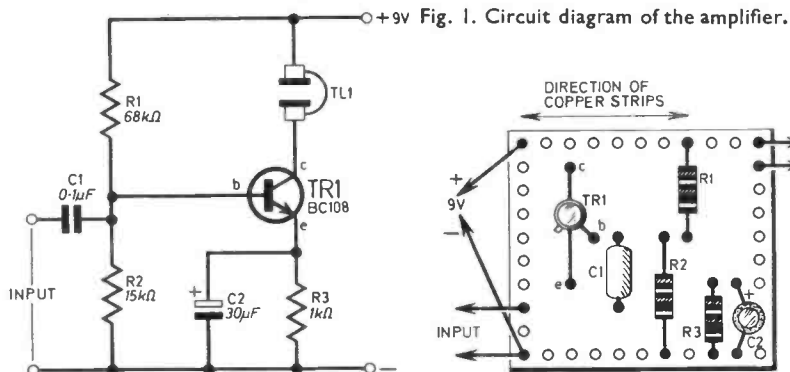


Fig. 2. Layout and wiring of the Crystal Set Amplifier.

# TEACH-IN '76

By A. P. STEPHENSON

## Part Fourteen

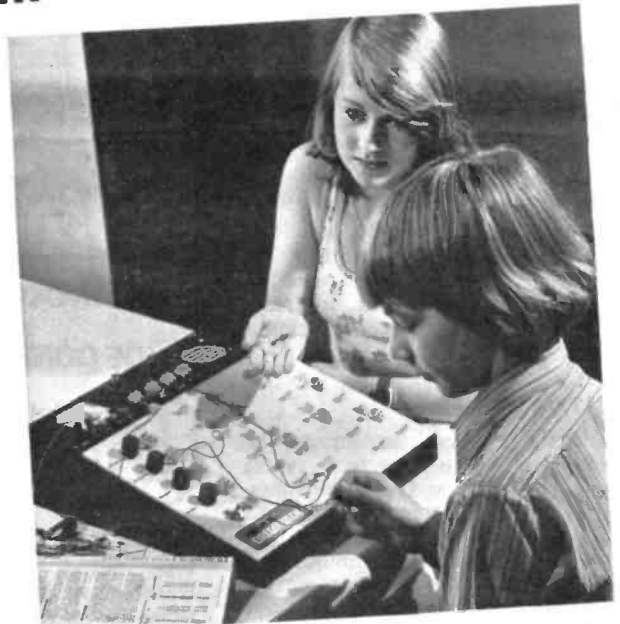
### 14.1 THE BISTABLE

An interesting example of a switching circuit is the **bistable** (which was invented many years ago when it was known as the Eccles-Jordan). The black-box is shown in Fig. 14.1a. It has two outputs, one called (by computer people) "Q" and the other  $\bar{Q}$ , called "not Q". These outputs are always in the opposite state to each other; when Q is high,  $\bar{Q}$  is low and vice versa.

When the circuit is first connected the actual state is unpredictable but quite stable. The state can be changed over by a narrow trigger pulse to one of the bottom terminals. For example, the terminal marked **set** will cause Q to be high and  $\bar{Q}$  low (if it is triggered); the **reset** terminal will cause  $\bar{Q}$  to be high and Q low when triggered.

The title bistable is therefore very apt because the box rests in either one of two stable states called **set** and **reset**. Fig. 14.1b shows the circuit details—not a pretty sight.

Let us assume that on switching on, TR2 conducts first and is in deep saturation which of course makes the Q output voltage low. Because the base of TR1 is fed from Q there is no base current and therefore



no collector current and  $\bar{Q}$  is high. But because  $\bar{Q}$  is high it pulls the base of TR2 upwards, which is why it is in saturation.

This very confusing chain of events can be easily summarised by stating that TR2 is held in saturation because TR1 is off. If TR1 happened to have conducted first, then it would have been held in saturation by TR2 being off.

#### Changing the State

Inspection of the circuit will reveal that a double positive-feedback loop exists. A change of voltage at one of the bases is inverted at the collector, passed to the opposite base, inverted for the second time and therefore arrives back at the original base in phase after being amplified twice. The circuit is therefore only stable if it is not disturbed, like a sleeping tiger. If we apply either, a negative going trigger to the transistor which is conducting, or a positive going trigger to the transistor which is off, a rapid change over action (called an **avalanche**) occurs, leaving the circuit stable again in the opposite state.

The **set** state is assured by a negative going trigger to the "set" terminal, (if the state was already set, nothing would have happened). **Reset** state can be assured by a negative trigger to the "reset" terminal. Such pulses can readily be obtained either electronically from other circuits or by switching manually from trigger terminal to ground. Bistables are in wide use in control circuitry and computers because they act as **memory cells**, i.e. they remain in (memorise) the state they were ordered to be in by a sudden pulse which could have been given months ago! They have infallible memories, providing the power is left on.

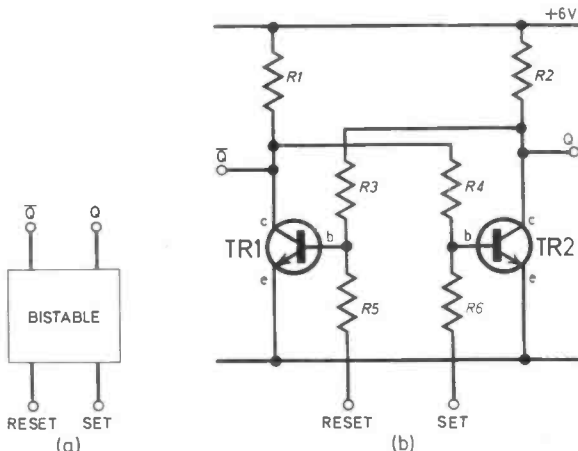


Fig. 14.1 (a) Black box bistable (b) Circuit of a bistable multivibrator.



## 14.2 THE SCHMITT TRIGGER

The "black-box" shown in Fig. 14.2a shows a **Schmitt trigger** which is a device which converts any shape waveform to a straight-sided rectangular waveform at the output. For example if we have a sine wave and we wish to change to a rectangular wave then Schmitt is the chap for the job.

Seen in Fig. 14.2b is a typical Schmitt trigger circuit where in the resting state (no input) TR2 is conducting heavily so  $V_{out}$  is low; TR1 is non-conducting because the voltage drop across  $R_E$  is causing the emitter to be more positive than the base. Its collector is therefore high which holds TR2 on.

For example, if  $R_E$  is 2 kilohm and TR2 is drawing 2mA, both emitters are at 4 volts positive with respect to ground. The base of TR1 could be held by R1 and R2 at say 3 volts positive with respect to ground which means 1 volt reverse bias on the base.

### Arrival of input

When the input waveform reaches a positive voltage sufficient to turn on TR1, a violent avalanche action causes the transistors to change state, i.e. TR1 turns on and TR2 turns off. The output therefore jumps almost instantaneously from a low voltage to  $+V_{CC}$ . This state is maintained until the input waveform falls again sufficient to cut-off TR1. A reverse avalanche then restores the Schmitt to its normal resting state.

To understand why an avalanche occurs, assume TR1 base rises, then its collector falls taking the base of TR2 with it. Thus the current in TR2 falls which causes TR1 to conduct harder still, which reinforces the original change. In other words we have another double amplified positive feedback loop.

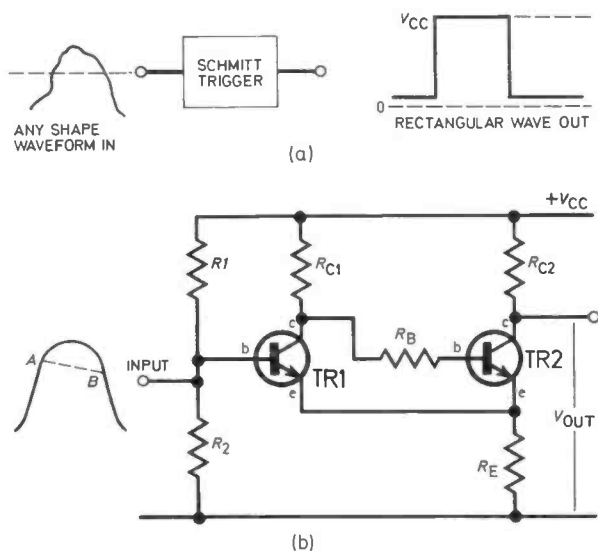


Fig. 14.2 (a) Schmitt black box (b) circuit diagram of a Schmitt trigger.

### Hysteresis

The point on the input waveform which starts the avalanche, point A in Fig. 14.2b, and the point at which the reverse avalanche starts, point B, are never quite the same; the difference between these two voltages is called the **hysteresis** and can be decided by the designer.

## 14.3 THE ASTABLE MULTIVIBRATOR

Fig. 14.3a shows a "black box" which, you will notice, has two separate outputs available but requires no input and must therefore be an oscillator. The outputs are rectangular (but not quite so perfect as shown) and are opposite in phase to each other. A circuit capable of producing such an oscillation is shown in Fig. 14.3b and is obviously a kind of second cousin to the bistable. In fact the main difference is the capacitive coupling instead of resistive coupling between the stages.

To understand the theory of the astable we must delve a little deeper into the behaviour of capacitors to sudden changes of voltage on one of the plates. The rule is that capacitors cannot instantaneously change the voltage across their plates.

If for example, one side of a capacitor drops suddenly from plus 5 volts to zero volts then equally

**If one side of a capacitor suddenly changes voltage, the other side must instantaneously change in the same direction.**

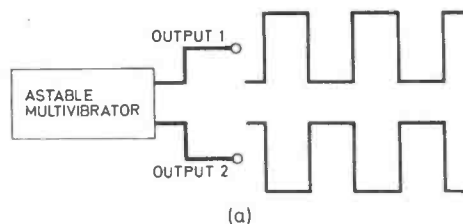


Fig. 14.3a. Black box of multivibrator and wave forms of the two outputs available.

suddenly the other side must drop 5 volts downwards, i.e. if zero volts before, it will drop to minus 5 volts, A simple circuit and waveforms which illustrate this example are shown in Fig. 14.3c.

**Resting conditions** (switch open): Left hand plate of C1 is +5 volts to ground. Base/emitter is in forward conduction which holds right hand plate of C1 at about 0.6V to ground.

**Switch suddenly closed**: Left hand plate of C1 falls to ground, which must cause a corresponding

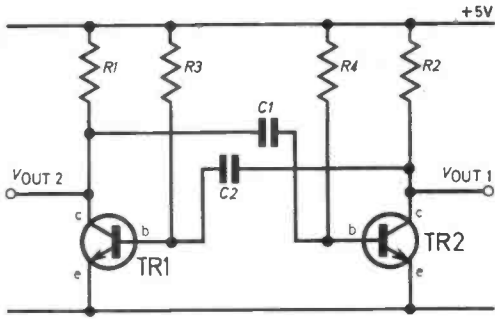


Fig. 14.3b. Circuit diagram of an astable multivibrator.

drop of 5 volts on the right hand plate, i.e. a drop to minus 4.4 volts. Thus closing the switch immediately cuts-off the transistor! How long will it remain cut-off? For as long as it takes the right hand plate of C1 to reach its former resting state at +0.6V with respect to ground.

The time constant involved is C1 times R<sub>b</sub> and it will be seen from the waveform that the capacitor

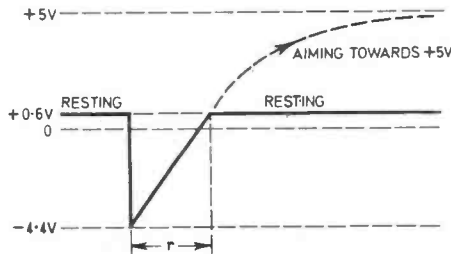
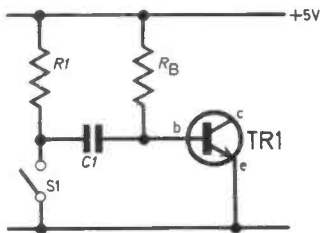


Fig. 14.3c. Circuit diagram to show relaxation principle and relaxation waveforms.

has to climb about half-way up the total "aiming" point of +5 volts. Since it takes one CR to reach two-thirds of the total, it must take a bit less to reach half the total; in fact the actual time is about 0.7 C1 R<sub>b</sub> seconds—(according to rather abstruse mathematics which we shall skip). The term for this exponential return to cut-on is called **relaxation**.

Returning now to the astable multivibrator circuit in Fig. 14.2b, we notice that two relaxation circuits are in operation, C1 R4 and C2 R3 with transistor "switches" instead of real ones. When one transistor is on, the other one is relaxing towards cut-on—as soon as it does, the positive feedback action immediately cuts off the other. The circuit continuously oscillates backwards and forwards from TR1 to TR2.

The period of oscillation is  $T = (0.7C1R4 + 0.7C2R3)$  so the frequency is given by

$$f = \frac{1}{0.7(C1R4 + C2R3)}$$

or if C1 = C2 = C and R3 = R4 = R, then:

$$f \approx \frac{1}{1.4CR}$$

## TEACH-IN '76 EXPERIMENTS

By now, you should be able to translate the theoretical circuit diagram onto the Circuit Deck yourselves, and therefore no physical layout is provided.

### EXPERIMENT 14A

To demonstrate the Astable Multivibrator

#### PROCEDURE

Assemble the Components on the Circuit Deck according to the circuit diagram shown in Fig. 14A.1.

1. Measure the voltage across either transistor. If everything is in order, the meter needle should be rhythmically jerking up and down between 4.5 volts and nearly zero. The time of one complete up/down cycle should be about  $1.4 CR_b = 1.2 \times 100\mu F \times 2.2k\Omega = 0.3$  seconds, although component tolerances will produce the usual errors.

2. Change the base resistors from 2.2 kilohms to 10 kilohms and note that the period increases to 1.4 seconds.

3. Replace the two 100 ohm resistors by 6 volt, 0.04 amp lamps. The two lamps should be winking on and off alternately indicating the antiphase relationship between the two outputs.

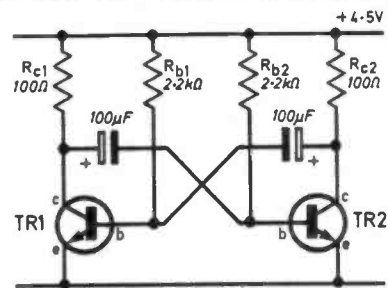


Fig. 14A.1. An astable multivibrator.

4. Change the base resistors so that one stage has 10 kilohms and the other has 2.2 kilohms. The lamp circuit with the larger base resistor should now be off for a longer period of time than the other. The circuit is now asymmetrical and has a "Mark to Space Ratio", "On-Off Ratio" or "Duty Cycle", larger than unity—actually about 4 to 1.

5. Repeat all these experiments with 1000 microfarad capacitors instead of 100 microfarad, and note that all times are increased by a factor of 10.

6. Modify the base circuit using the 25 kilohm potentiometer as shown in Fig. 14A.2. With VR1 set in the middle, the M/S ratio should be 1 : 1 and can be varied by the control to about an upper limit of 10 : 1 at either end.

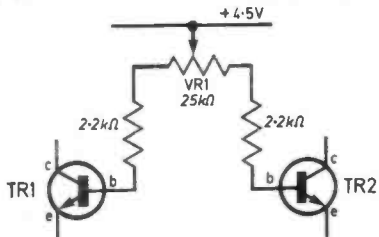


Fig. 14A.2. Circuit addition to obtain variable on/off ratio.

### EXPERIMENT 14B

To demonstrate Bistable trigger action.

#### PROCEDURE

Assemble the components on the Circuit Deck according to Fig. 14B.1.

1. Measure the voltages across collector and emitter of both transistors in turn. You will find that one of them reads about 4.5 volts and the other nearly zero volts. This indicates that one is hard on in saturation and the other is off, although which way round is unpredictable.

2. Leave the voltmeter connected across the one which is reading 4.5 volts, i.e. the one which is off.

3. Perform the following trigger actions on points A or B. Momentarily touch either A or B with the probe which is at ground level. The voltmeter should instantly flick over from +4.5 to zero volts when your probe grounded the particular base which was conducting.

For example, if your meter was across TR2 and was initially reading 4.5 volts, then the point A would be vulnerable to the probe.

4. Touching point A then B then A again and so on will cause voltage to flick over to the other state each time.

5. Repeat the experiments using the other probe which is connected via the 4.7 kilohm resistor to the +4.5V line. The same effects can be produced as before but since the probe is "pulling" a base upwards this time, the change over takes place when the off transistor is touched.

6. Replace the 100 ohm resistors (or one of them) by 6V, 0.04A lamps. Repeat the experiments over again, using visual indication of state instead of the voltage readings.

Continued on page 578

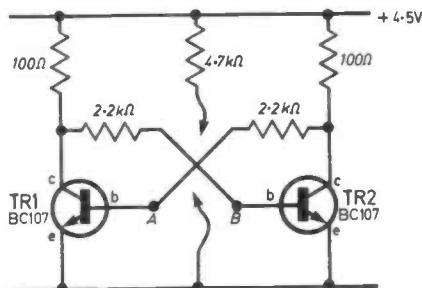


Fig. 14B.1. A simple bistable circuit showing trigger points.

Everyday Electronics, November 1976

# SOUND DESIGN

A PRACTICAL ELECTRONICS PUBLICATION

## A SPECIAL SELECTION OF MUSICAL PROJECTS FROM PE

### THE MINISONIC MK2 SOUND SYNTHESISER

An up-dated version of the published Mk 1, the Mk 2 has an integral keyboard, two 250 mW monitoring channels and loudspeakers, and facilities for amplitude, frequency and harmonic modulation.

### THE JOANNA ELECTRONIC PIANO

has realistic piano effect with touch-sensitive keyboard and additional choice of harpsichord or honky-tonk voicing.

### THE ORION STEREO AMPLIFIER

A hi-fi amplifier with output of over 20 + 20 watts. Compact and complete in one unit, it measures only 14" x 6" x 2".

#### PLUS

Some great sound effects units for guitars, keyboard instruments and general recording.

Available Now

£1.20

POST PAID

(Please allow at least 2 weeks for delivery)

If you do not wish to mutilate your copy of the magazine, please send your order on a separate sheet.

To: Practical Electronics  
IPC Magazines Ltd., Receiving Cashiers Dept.,  
King's Reach Tower, Stamford Street, London SE1 9LS

Please send me ..... copy(ies) of  
"Sound Design". I enclose a Postal Order/Cheque  
for £1.20 (post paid) or (state amount for  
more than one copy) ..... (£2.35 post paid  
for 2 copies)

PLEASE WRITE IN BLOCK LETTERS

Name .....

Address .....

.....

Post code .....

Remittances with overseas orders must be sufficient to cover despatch by sea or air mail as required. Payable by International Money Order only.

EE.1510

Company registered in England. Regd. No. 53626.  
A subsidiary of Reed International Limited.

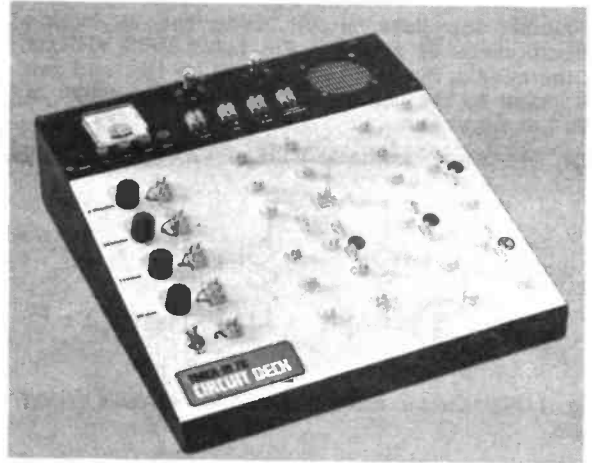
## EXPERIMENT 14C

To demonstrate the triggering action and the hysteresis effect of a Schmitt circuit.

### PROCEDURE

1. Assemble the components on the Circuit Deck according to circuit diagram Fig. 14C.1, leaving the slide control of VR1 down at the bottom end. The lamp should be on and TR1 off. Leave a voltmeter connected between point A and ground.
2. Slowly advance VR1 and observe the voltage rising. At some point the lamp will suddenly go out, indicating the circuit has flashed over. Note carefully the voltage at this point (which will probably be a little above 4 volts).
3. Now slowly reduce VR1 again towards the zero volts end. The lamp should remain off until the voltage nears 2 volts when the circuit should flash back to the lamp on state.

The difference in the on and off voltage points is the hysteresis—about 2 volts or so.



The Teach-In '76 series will terminate next month in Part 15.

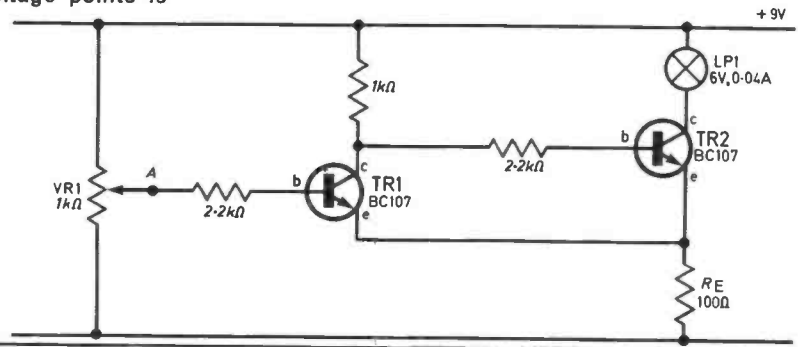


Fig. 14C.1. Circuit diagram of a Schmitt trigger.



When preparing printed circuit boards for etching, I find that Dalo etch resist pens are very expensive, and do not contain enough etch resist for filling in large areas.

Because of this I use an etch resist pen for the intricate areas, and I use pieces of PVC insulating tape, for covering the large areas of copper to be retained. Insulating tape is a very good etch resist, and can be just peeled off after etching.

D. J. Barfoot,  
Bournemouth.

I, like many other readers like to construct my own printed circuit boards, from published designs, and make up my own for the more complex Veroboard projects. Often, after producing a shiny surface on copper clad

board, one is frequently left with surplus material which is not going to be used for some time. The copper quickly tarnishes, and finger marks appear after a few days.

A very effective way of reducing this oxidation is to wrap the whole board in a very thin plastic sheet known as "cling film". This is available from supermarkets and grocers, and is sold to produce airtight coverings for food-stuffs.

It is very easily obtainable, and preferable to the use of sticky-backed plastic, which is an expensive alternative.

When covering the board, press and pull it tightly and firmly over the copper surface to ensure as much air as possible is expelled, and then fold over the edges so all four sides meet at the back with plenty of overlap. The adhesive properties of the plastic will be between the overlapping layers.

Care is needed to avoid puncturing of the plastic by the sharp corners and any rough edges, but if these are sanded smooth, the material is quite strong enough to be stretched over these edges gently.

The material provides an almost perfect airtight enclosure for the copper and even after some months there is very little tarnishing.

Certainly there is no need for any abrasive cleaning after the board has

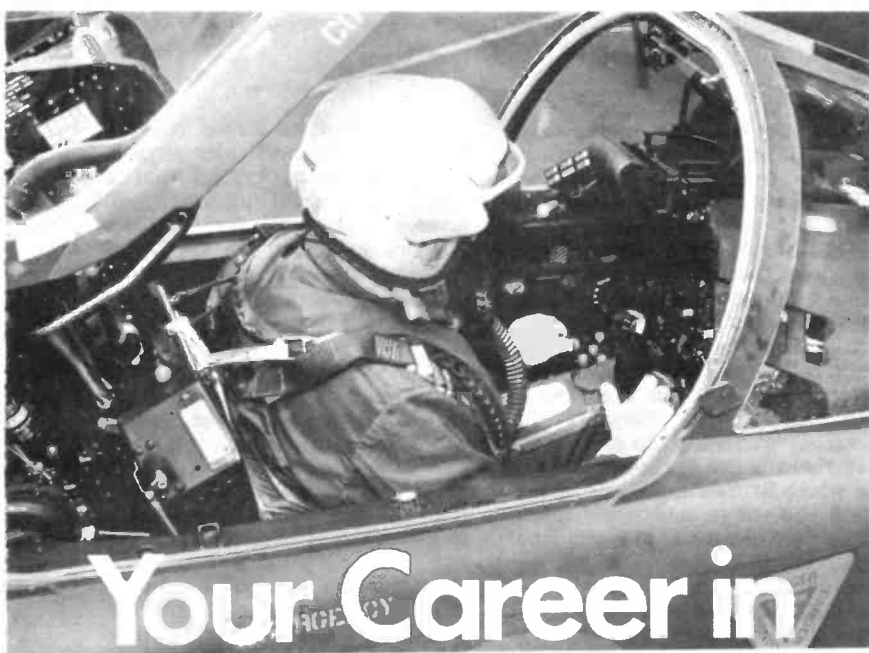
been in storage for some time—just a light dab once over with a spot of organic solvent is all that is required—this will also keep a thick layer of copper on the board, there is no chance of cleaning it all away!

This method could apply equally well to Veroboard and double sided copper board, and provides a copper surface which is always ready for soldering.

Timothy C. Sheridan,  
Bishop's Stortford.



"I expect the crystal set is vastly improved now to what it used to be."



# Your Career in Electronics

By Peter Verwig

For a change, I am devoting all my space this month not to specific career opportunities but to an overview of the structure and importance of the aerospace industry to electronics and how electronics makes its contribution while also enjoying enormous spin-off in new technology.

## CONTROVERSY

Today the aerospace industry is the subject of great controversy. Plenty of people think that great projects like Concorde are a waste of money, that landing men on the moon, however brilliant an achievement, was a rather silly exercise. That atmospheric pollution by jet aircraft is affecting the climate, that the noise nuisance is a hardly tolerable affront to civilisation, and that the heavy involvement by most aerospace companies in the design and supply of military aircraft and weapons systems is an even greater affront.

Nearly all these critics fly to overseas holiday resorts, enjoy TV programmes relayed to them by communications satellites, and sleep well in the knowledge that their homeland is reasonably well protected against aggression. In fact, despite all the loud noises they make, deprive them of the benefits of aerospace developments and they would be among the first to squeal.

On the other side of the coin there are folk who live and breathe aerospace as a complete end in itself. Nobody can deny that this young science which has proliferated into a huge industry in the course of a single lifetime is fascinating and appeals to the imagination. But, like all human activities, it can be used for both good and evil.

And, putting the military argument to one side, it cannot be denied that the bad effects of aerospace such as noise and atmospheric pollution are now well recognised, that huge sums of money are being spent on research to abate nuisance and that, on balance, aerospace has been of benefit to mankind.

If we look at the military argument, sensible and peace-loving people naturally prefer not to be involved in an arms race and even less in a possible future holocaust. Most accept that in an imperfect world they would prefer to be defended rather than defenceless, and even ardent pacifists, although perhaps unknowingly, daily enjoy amenities whose development, in the first instance, was stimulated by urgent military needs.

## PROGRESS

It is no wonder that the general public remains bemused and uncertain on aerospace. First, the

rate of progress has been so great that it numbs the senses. We have moved from man's first fumbling effort to fly a powered heavier-than-air machine (as distinct from airships and balloons) to passenger carrying supersonic flight on regular service in a mere 73 years.

Man-on-the-moon, already "old hat" has to be viewed within the context that the first ever manned space-flight took place only 15 years ago. Today we are getting pictures of Mars and the results of scientific experiments there, all remotely controlled at a distance of over 200,000 miles, an achievement considered by many to easily surpass the moon landings in technical excellence and even this, but for the excitement of finding out if there was life on the planet, would hardly have raised more than a ripple of interest.

Incidentally, the tiny biological laboratory, occupying only one cubic foot of space in the Viking project, as well as its complement of mechanical engineering components, has the microelectronic equivalent of 22,000 transistors and 18,000 other electronic components and this is only one of the on-board electronic systems.

## COST

Secondly, we all tend to become overwhelmed, not only with the spectacular nature of great achievement in aerospace, but also with its cost. Big passenger transports such as the long-range 1011-500 TriStars recently ordered by British Airways now cost some £20 million each. Aerospace people talk in millions all the time, while lesser mortals imagine they are on a big and useful deal when talking in tens of thousands.

Electronics and aerospace are now completely interdependent. One cannot get along without the other. You can't fly a TriStar or go to the Moon without electronics. And electronics could never have made such rapid progress had it not been for the ever-increasing demand for advanced technology products from the aerospace industry and the money to pay for their development. Aerospace has been, and still is, the forcing ground for electronic developments and, whether we like it or not, the primary source of cash funding comes from defence budgets.

It was a defence requirement

that spurred Britain into developing the world's first practical radar system in the 1930s, and the Americans into advanced micro-circuit technology in the 1960s. But for heavy investment in defence, the general progress of electronics industry would have been much slower and we should all be the poorer for that in many other ways.

How is the aerospace industry organised and how does it work? The backbone is the airframe manufacturer who designs and builds the aircraft, the missile, the satellite and its launcher.

There used to be dozens of airframe manufacturers in the days when you could buy a large passenger aircraft for a few hundred thousand pounds. But as aircraft became faster, higher flying, more comfortable to travel in as well as safer, costs rose to such a degree that the weaker companies were forced to join the strong so that there are just a few companies of world class left. In Britain the two remaining airframe companies, British Aircraft Corporation and Hawker Siddeley are about to come under public ownership and will eventually merge their activities.

The cost of high technology projects has now become so astronomically high that few single companies, however strong, can afford their full development costs and, indeed, this is also true of nations.

## JOINT VENTURES

The days have long since passed when a small nation could afford a major aerospace development. Britain, with the largest aerospace industry in Europe and second in the Western world only to the

United States, can now only afford joint ventures with partners overseas to share the cost and the risk of new development.

Thus we have in the military field joint projects like the Anglo-French Jaguar strike aircraft now in service with the French and British air forces, and the Tornado multi-role combat aircraft developed and built on a co-operative basis with partners in Germany and Italy. In civil aviation there is the European Airbus for which British Hawker Siddeley build the wings, and many more international projects too numerous to list here.

Even the mighty giants of Boeing, Lockheed and Douglas in the United States are seeking international partners for future projects. The trend is towards multinational participation, at least for the really big jobs.

The airframe manufacturers, however large, depend on hundreds of sub-contractors for the supply of component parts, sub-systems and systems. Principal subcontractors are specialist companies who make aircraft engines, landing gear and other major mechanical components and systems suppliers for items like automatic pilots, navigation systems or radio communications. In their turn, these subcontractors buy in component parts from specialist component manufacturers.

You can't put any old rubbish into aircraft. Every piece of alloy, every rivet, every electronic component, even the humble cable has to be "released" from the manufacturer to stringent approved specification. Otherwise the aircraft will not get a certificate of airworthiness and will not be allowed to fly.

It is difficult to arrive at exact figures for any particular aircraft but it might be typical that a large passenger aircraft will involve several hundred sub-contractors and that the supply of materials and other products from outside suppliers will account for at least half the cost.

An interesting statistic is that if you melted down an aircraft into its basic raw materials these account for only five per cent of the selling price. The other 95 per cent is nearly all in human skills, in designing, in machining and fabricating components, in assembly, in inspection, in testing.

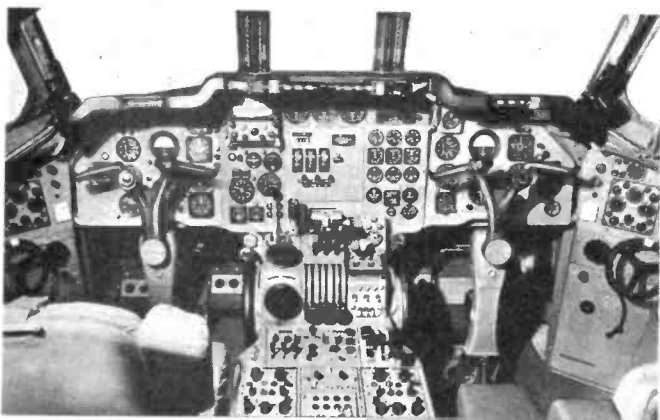
In modern passenger aircraft the electronics equipment can account for one third of the total aircraft cost and, in military aircraft like the Tornado, which is stuffed full of advanced electronics, the electronics content is even higher, approaching 50 per cent.

We can now begin to see why aerospace is so important to the electronics industry. It is not only the volume of trade that is important. It is the quality of the trade, too. The ability to build equipment to the most exacting standards and the opportunity to work on the very frontiers of technology, as all the major subcontractors are called in at the earliest design stages of every new project.

## ATC

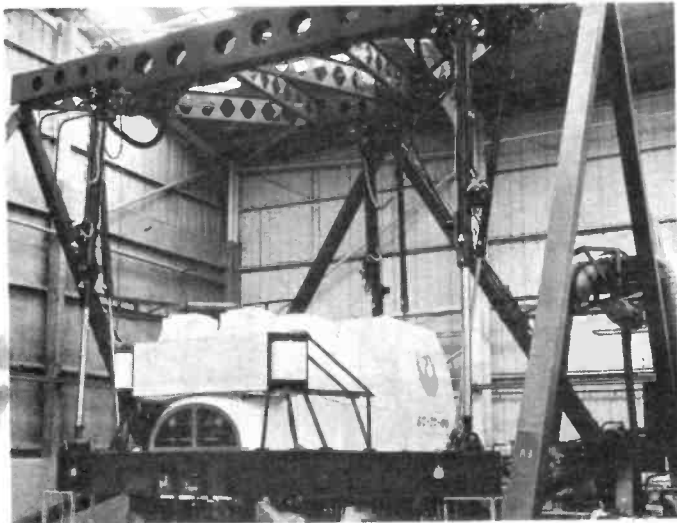
The aerospace industry, however, has ramifications far beyond those already discussed. However wonderful the flying machines they cannot operate in isolation. True, they have their basic navigation equipment and, in emergency,

*Flight deck of a Trident civil transport, the first commercial aircraft to be equipped for automatic landing using Smiths autopilot and autoland system, controls of which are on the central pedestal.*

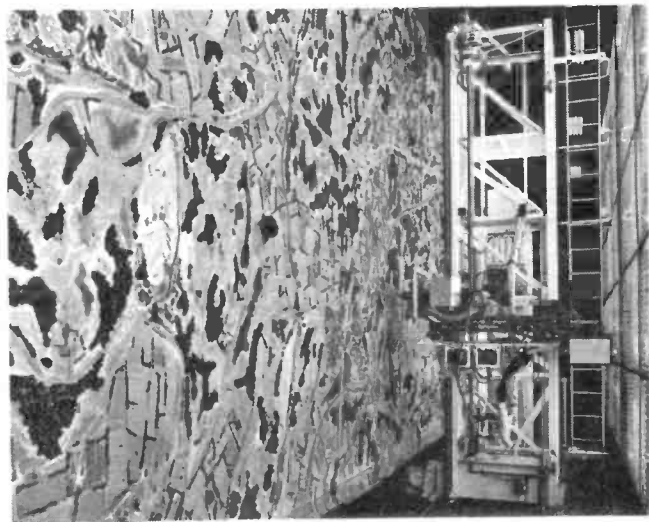


*Latest air traffic control radar display by Marconi Radar. The control computer for distributing the radar data is centre background.*





This large DC 10-40 flight simulator under final test at Redifon's Crawley factory helps Britain pay for Japanese imports.



Hand-made map mounted vertically is scanned by colour TV camera on the movable gantry. All part of the great illusion of flying in Redifon flight simulators.

can find their way around and make a safe landfall. But air traffic is now so dense that except in the remotest parts of the world it is rigidly controlled from the ground by air traffic controllers who direct aircraft to land or take off, or to "stack" while waiting clearance to land.

En route, aircraft fly in well defined "lanes" guided by radio navigation beacons. Here we find an enormous sector of aerospace electronics involving radio communication, radar and navigation beacons. All major airports are fitted with instrument landing systems, especially important in bad visibility, which guide the aircraft down to the threshold of the runway. With suitably equipped aircraft and the highest quality ILS systems it is possible to land entirely under automatic control, the pilot merely monitoring his instrument panel to check for abnormalities.

## OTHER SYSTEMS

Air forces also have air traffic control at their airfields and, in addition, an air defence system which monitors airspace by radar to detect intruders and to direct interceptors on to targets. A complete integrated air defence system will have a number of radars at strategic points. Computers are used to evaluate threats and direct the activities of the defence forces by air interception, anti-aircraft guns or surface-to-air missiles.

An idea of the complexity of modern civil air traffic control

systems can be gained from a recent order for modernisation of the existing system in Saudi Arabia. The contract is worth over £250 million, a large slice coming to Marconi Radar in Britain. This is additional to the £300 million up-date of Saudi Arabia's air defence system by British contractors.

We have dealt briefly and without any detail on the operational aspects of aircraft which involve huge quantities of electronic equipment in aircraft and on the ground. We have to remember, too, that aircraft and engine manufacturers are huge users of computers for design and for routine stock-control, production scheduling, pay-roll etc.

The manufacturers are also among the largest users of numerically controlled machine tools. The airlines who operate the aircraft are also dependent on computers for passenger seat reservation and similar tasks.

## FLIGHT SIMULATORS

Nobody can now afford to fly big commercial jets or expensive military aircraft just for training so another important sector of aerospace electronics is concerned with flight simulators in which pilots on initial or conversion training can gain experience without ever leaving the ground. The best of these, costing over £1 million each, are completely realistic with the flight deck banking and pitching in response to the controls, with the outside world "moving" in vivid detail.

The beauty of flight simulation is that the instructor can introduce any flight hazard such as fire or engine failure at will to check trainee pilot reaction, and all in perfect safety. Last July, Britain imported over 17,000 monochrome TV sets from Japan at a landed cost of £570,000. The reaction was "ban these imports". But a single flight simulator built in Britain for Japan Air Lines pays for these sets more than twice over. Similarly our huge aerospace business with oil producing countries helps pay for imported oil.

The importance of aerospace is that we export high technology in exchange for goods we need and because aerospace means high technology, our engineers and designers are fully stretched on the newest developments.

I have hardly touched on the importance of defence equipment and its export potential. BAC's order book for the Rapier low-level surface-to-air missile is about £500 million, most of it for export, and this figure includes millions of pounds flowing in to the electronics industry.

## FUTURE ARTICLES

In future articles I shall be returning from time to time to the aerospace industry and the participation of electronics companies. This area is perhaps the most exciting of all to work in. It is also among the most exacting, absorbing large numbers of graduate and technician engineers. □

## Part Two

# Noise Reduction Systems

By Adrian Hope

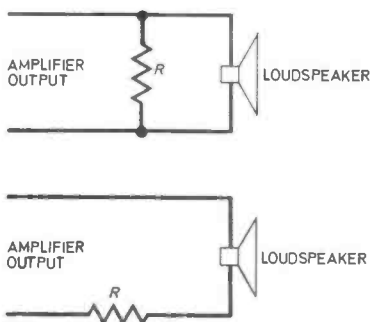
**H**AVING looked at various methods of noise reduction we now move on to actual systems.

### SIMPLE COMPANDOR

So far I have deliberately omitted to mention any one brand of noise reduction system by name. We shall soon see how the various noise reduction systems available on the professional and amateur market rely on one or more of the basic principles described above, warts and all, and have refined them as far as possible to eliminate the warts.

First, however, it is instructive to look at the simplest practical form of compandor.

Figs. 2.1a and b. Wiring for a simple compandor system.



Compression and expansion may in theory, most simply be achieved by incorporating a resistance into an audio circuit which varies its characteristic in dependence on the signal passing through it; Fig. 2.1a shows such a resistor  $R$  across an audio connection between the output of an amplifier and a loudspeaker, and Fig. 2.1b shows a similar resistance  $R$  in series with such a connection. In each case the resistance  $R$  has a relatively low value when it is passing small currents and a relatively high value when it is passing high currents.

In the first case, therefore, a relatively high proportion of a low power signal from an amplifier output will be shunted through the resistance  $R$  and thus a relatively low proportion of the signal will reach the loudspeaker. However, because the resistance value increases as the signal strength increases, a relatively small amount of the signal will be shunted through  $R$  as the level of the amplifier output increases. Thus there will be an unnaturally wide range of power handled by the loudspeaker, starting from an unnaturally low level. In other words, in the circuit of Fig. 2.1a there will be expansion of the dynamic range of the signal fed out from the amplifier to the loudspeaker.

In the second circuit the reverse operation will take place.

When the amplifier is supplying low power to the loudspeaker the resistance  $R$  in series will have little or no effect on the circuit, because it is of low value. When the power level increases, however, the resistance  $R$  will increase in value and thus place an unnatural limit on the power passing to the loudspeaker. It follows that the loudspeaker will handle an unnaturally reduced dynamic range, with an unnaturally low maximum power level. In other words, there will be compression in the circuit of Fig. 2.1b.

### TORCH BULBS

By a happy coincidence, non-constant resistances are readily and cheaply available in the form of low voltage torch bulbs. When the filament of the torch bulb is cold (emitting no light) its resistance is low and when its filament is hot (emitting light) its resistance increases. This convenient phenomenon has been relied on over the years at various levels of sophistication.

Pre-war radio listeners sometimes strung a torch bulb in parallel with their loudspeaker to expand the sound signal, or in series, to compress it. But modern amplifiers with low impedance outputs will simply feed more



power out as the load changes and there will be no audible effect.

Various simple circuits have been devised over the years to remedy this. Six years ago, the so-called Null-a-tron was briefly marketed by Audione and Co. The Null-a-tron used a stereo pair of resistance bridges incorporating both fixed value resistors and torch bulbs, the bridges being wired between the amplifier output and the loudspeakers. When the amplifier output was low, the torch bulb was cold and the bridge in balance, with a null or low output to the associated loudspeaker; when the power output from the amplifier increased, the torch bulb lit, the bridge went out of balance, and a disproportionate amount of power was fed to the loudspeakers.

Thus the signal was expanded with low levels pushed right down to zero and residual noise lost in the process. Although relatively cheap, the Null-a-tron was unfavourably reviewed, the expansion action of the various control settings being either inadequate or over-blown and intrusively audible. Such failings are virtually inevitable with light bulb expanders and compressors.

Thus, although sophisticated photoelectric sensor circuits have recently been proposed which detect the amount of light produced by a bulb and control an amplifier gain circuit accordingly, the use of a light bulb as a noise reduction tool, however cheap and convenient, is in many respects a non-starter.

## MAIN NAMES

The current main names in noise reduction are Philips (with the Dynamic Noise Limiter or DNL), JVC (with the Automatic Noise Reduction System or ANRS) and Burwen, *dbx* and Dolby.

Most are available in both professional and domestic versions, but Burwen is so far available only to the professional user and DNL only to the amateur or domestic enthusiast. The availability of both professional and domestic versions of the other systems is a logical result of the fact that they started life professionally but were made available in domestic version as a market for them appeared, largely due to the advent of cassette tape.

Remember that, until the idea of cassettes as a hi-fi medium

started to be taken seriously, there was little or no need for a noise reduction system on the domestic market. But as the frontiers of cassette quality were pushed further and further forward, the need for a good noise reduction system to cut down on lowspeed tape hiss was generated. Then, once a domestic system was available for cassette use, eyes were opened to the possibility of using the system also for domestic reel-to-reel recording and for receiving radio transmissions.

## BURWEN SYSTEM

It is convenient to start with the Burwen 2000 compandor system from the USA.

Burwen sought to encode with compression on "record" and decode with expansion on "playback", using a constant or straight slope (sometimes confusingly called a linear slope) compandor and a cubic or 3:1 ratio. Thus an audio signal fed into the Burwen processor at the record stage emerged compressed in amplitude range by the ratio 3:1.

To be more specific a 3dB change is recorded as 1dB and an input signal range of 90dB will be compressed into a 30dB range by the compressor. This 30dB range will then be mirror-expanded again by the processor on playback, to restore it to its full 90dB range. Simple subtraction shows that there can, in theory, be a 600dB improvement in signal to noise ratio, with consequent virtual elimination of process noise such as hiss.

Unfortunately, nothing in this world is for nothing, and the very substantial compression and expansion adopted to achieve such dramatic noise reductions lays the system wide open to the problems of modulation, overshoot and tendency to exaggerate frequency response errors discussed in general terms last month. In an effort to avoid these problems,

Burwen's system incorporated equalisation techniques, to boost and cut different frequencies by different amounts, and the pros and cons of the resulting compromise were argued in the pages of erudite technical journals a few years ago. But almost inevitably the very high price tag (even in 1974 it would have cost £27,000 to equip a 16-track recording studio) wrote the system off in the eyes of most European studios.

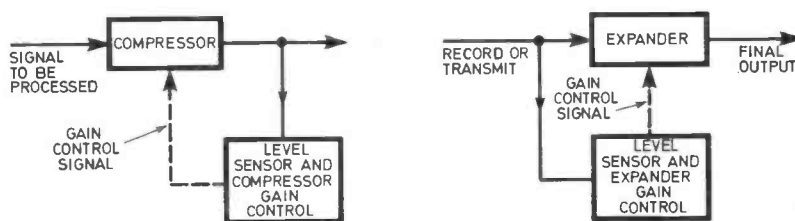
Burwen equipment, of modified form, was briefly handled in this country by Ampex (the tape and tape recorder firm) but currently there is no UK agent or availability. The new Burwen range includes a "noise gate" which can be described as a highly sophisticated professional version of the Philips DNL, to be discussed later.

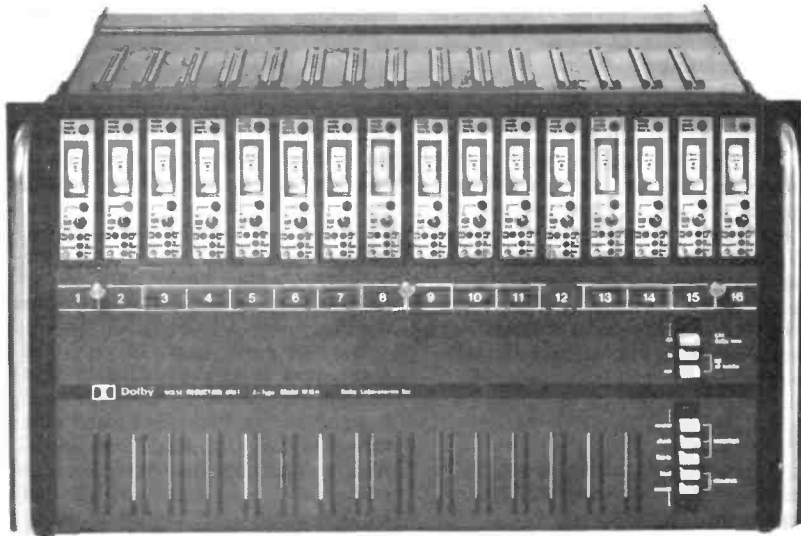
## dbx SYSTEM

Another system of American origin is *dbx*, and closely resembles the original Burwen compandor system in that both systems process substantially the whole of the audio signal, rather than part of it. The basic idea behind such overall processing as practised by Burwen and *dbx* is shown schematically in Fig. 2.2. In each case the signal level is sensed and used to control the compressor or expander accordingly.

But *dbx* differs from Burwen in that, whereas Burwen used a 3:1 or cubic compression and expansion ratio, the basic *dbx* systems use a 2:1 or square law for compression and expansion. Thus a 2dB programme change is recorded as 1dB and an input signal having a 90dB range fed into a *dbx* compressor emerges with a 45dB range. When it is restored to its 90dB range by the expander on playback there is in theory a 45dB improvement in signal to noise ratio. In practice the theoretical levels of noise reduction are not sought in full by

Fig. 2.2. Basic overall processing system.





The Dolby A professional 16 channel system.

either Burwen or *dbx*. But clearly *dbx* offers relatively less potential noise reduction than Burwen. By the same token, however, *dbx* is less susceptible to the basic problems inherent in companders.

As with Burwen, the signals fed into the *dbx* system are equalised, with high and low frequencies relatively boosted or cut (pre- and de-emphasis) to minimise those problems that do exist. But with *dbx* the signal level is sensed in r.m.s., rather than peak, values. It is incidentally important to note for future context that neither Burwen nor *dbx* needs elaborate calibration to ensure that the signal level encoded exactly matches the signal level decoded. But at a somewhat elevated technical level, arguments on this point persist, and critics of *dbx* point to the problems which can arise if *dbx* tapes recorded at different levels are spliced together.

The range of *dbx* equipment commercially available is somewhat confusing and is also best discussed in a later context.

## DOLBY

The Dolby system is another compander-based system which offers less noise reduction (10dB or 12dB) than Burwen (in practice up to 50dB) or *dbx* (in practice up to 30dB), but is less prone to the modulation, overshoot and accentuation of frequency non-linearity problems previously mentioned. On the debit side (along with the comparatively low

degree of noise reduction available) the Dolby system requires accurate calibration of the input and output levels for correct working results.

The main difference between Dolby, on the one hand and Burwen and *dbx* on the other, is that, whereas the latter two systems process substantially the whole of the signal according to a generally constant slope, the Dolby system processes only a part of the signal. As shown in Fig. 2.3 the signal to be processed is split by Dolby between a main and a side chain, the main chain handling all high level signals and the side chain handling only low level signals.

The main chain (handling the high level or loud signals) does not affect them or process them in any way. The side chain (handling the low level or quiet signals) is the active compander link. It thus follows that if only a loud signal is passed through a Dolby processor it remains unprocessed.

This is in practice perfectly acceptable because noise (such as hiss or hum) is only noticeable if it is of sufficient level to stand

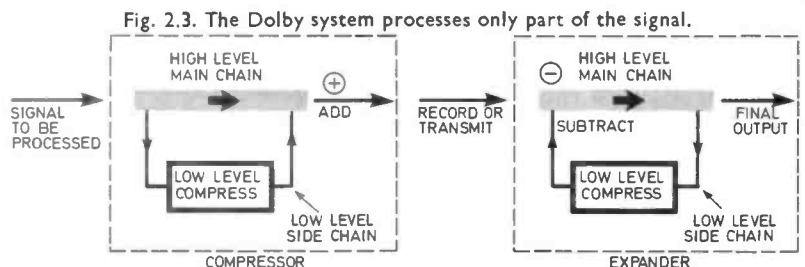
out above the programme. Put another way, if the programme (eg. the music being recorded and played back) is quiet, any hum and hiss present will be noticeable; but if the programme music is loud it will drown out the hum and hiss. In fact, the preceding sentence is over-simplification, because a high pitched note will not mask a softer low-pitched note, or *vice-versa*. Indeed, the whole philosophy of the Dolby system centres around the fact that the human ear will not hear or be disturbed by a low level sound at around the same frequency as a high level sound.

## DOLBY A

To pursue the previous musical analogy, reasonably loud violins (with plenty of meaty high frequency content) will mask the sound of tape hiss (with quiet high frequency content), and a string bass (plenty of low frequency content) will mask the presence of quiet mains hum (also of low frequency content). But the violins will not mask hum, and the bass will not mask hiss.

Accordingly, in the professional (A) Dolby system the low level side chain is divided into four separate parallel channels each of which handles a separate frequency band (see Fig. 2.4). What is more, each of these channels works independently of the others, so that a low level, high pitched signal (such as quiet violins) will be routed through only the high frequency side chain channel and low level, low frequency signals (such as quiet basses) will be routed through only the low frequency channel of the side chain.

Each of the side chain channels acts on the signal passing through it, in manner generally similar to that in which the *dbx* system acts on the whole frequency range. In other words, in each of the Dolby A side chain channels there will



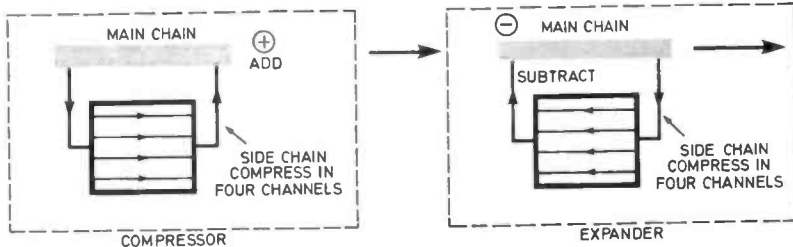


Fig. 2.4. Basic Dolby A system.

be over some of the slope 2:1 or square law compression on encoding and expansion on playback.

Thus the Dolby A system senses in which frequency area there are low level (quiet) signals and in that area and that area only boosts them on "record" and reduces them on "playback". If there are low level signals in only one frequency band, then there is processing in only that channel of the side chain; if there are low level signals in more or all of the bands, then there is processing in the appropriate side chain channels; if there no low level signals, and all the programme being fed to the compressor is at high level (loud), then there is no processing and no boosting on "record" and reduction on "playback".

However, no compression or expansion is effected on the lowest levels. This avoids the risk of the expander on playback mistaking noise for quiet useful signal and boosting it. Two important points follow from all this. First, the deliberate failure to process loud signals means that there is less risk of overshoot. In practice, the fact that only low level signals are boosted means that only around 1dB overshoot is obtained on a correctly set up compressor. This is small enough not to overload the recording or transmission medium. The other advantage of the band splitting technique is that there is less risk of noise modulation.

Clearly, if the presence, or absence of low frequencies only affects the low frequency performance of the processor, then there is no risk of high frequency breathing sounds.

But all this follows from the fact that the system is level-conscious. Whereas Burwen and dbx treat all signals according to the same law, in the Dolby system all the high level signals remain unaffected. Obviously therefore the system must have a point of

level reference to decide what is low and what is high (soft or loud). It is for this reason that the Dolby circuitry must be set up using a fixed level set tone as its point of reference. Indeed, correct calibration is essential to successful use of Dolby.

Later in the series we shall examine the calibration technique and how it can present practical pitfalls, especially for the user who does not realise that even the use of different tape types can throw out the calibration of his Dolby circuitry.

## DOLBY B

So far the description of Dolby has related to the professional (A) system. The B system, for domestic use, resembles the A system in all respects except one. Instead of side chain being divided into four sub-channels, each with its own frequency of operation, in the domestic, B system, there is only one side chain. This simplified procedure can be adopted in the interests of economy because, in domestic low speed tape recording, the most troublesome noise is always hiss.

Although at first sight it would seem sufficient simply to provide a side chain acting only in the upper frequency range (where the hiss makes its presence felt) this single band approach has been found satisfactory in practice only if the width of the band is automatically varied in re-

sponse to the amplitude and frequency content of the signal being treated.

The Dolby B circuit is shown schematically in Fig. 2.5. When loud signals are fed to the processor the cut-off frequency of the side chain is pushed upwards, so that it becomes able to act on an increasingly narrow band of high frequencies. As the signals quieten, so the cut-off frequency of the side chain band comes downwards again, enabling it to treat not only high frequencies but also some lower frequencies as well.

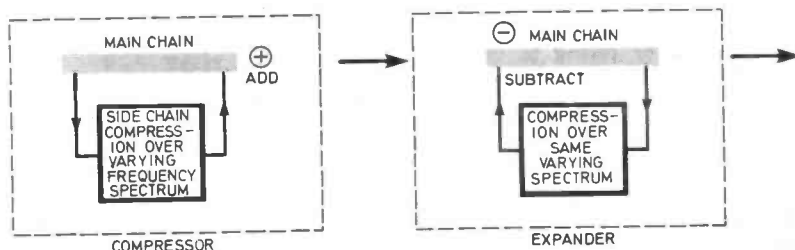
The result of this automatic adjustment of the side chain is that there is processing over a fairly wide range of frequencies (but always above 500Hz) for most of the time, because most programme material is not loud enough to push the filter cut-off up too high. But for some of the time the processor works over a much narrower band. At no time is there any audible change in that portion of the noise which remains unmasked.

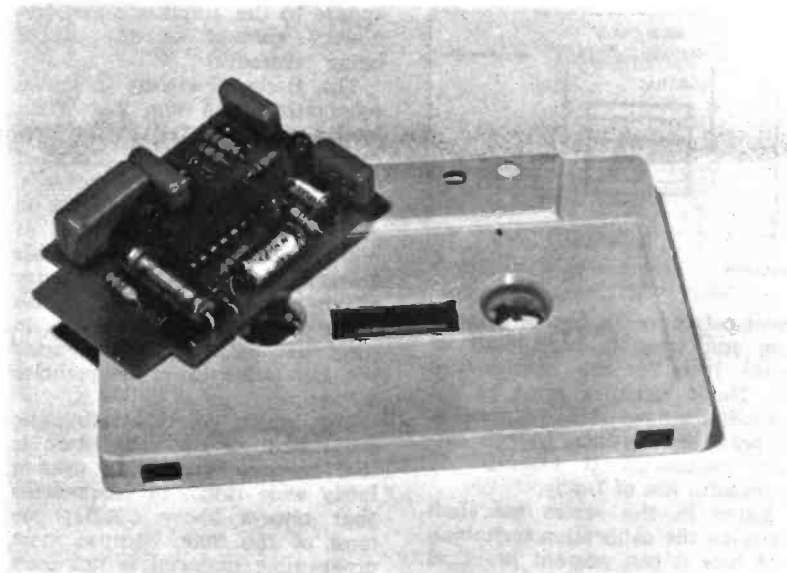
Over the years, there have been various authorities who have claimed to be able to hear both Dolby A and B systems "working", but usually this has been the result of a wrongly calibrated system.

## dbx RANGE

Before discussing the JVC-ANRS system, which in many respects resembles the Dolby B system, it is opportune first to return as promised and look more closely at the dbx range of equipment which is now commercially available. Like Dolby, dbx started as a professional system for use with tape in recording studios, but (again like Dolby) has spread to other professional areas, such as film and broadcasting technology, and in a modified form, to the semi-professional

Fig. 2.5. Basic operation of Dolby B system.





The Dolby B chip showing relative size to a cassette.

and domestic markets. However, unlike Dolby, *dbx* has also moved into the area of disc recording, and it is now possible (although not easy) to buy a *dbx*-encoded disc for playback on domestic equipment linked to a *dbx* decoder.

Although the *dbx* and Dolby systems are in all respects incompatible (*dbx* encoded tape cannot be decoded on Dolby equipment and vice versa), the marketing philosophy adopted by the two firms is very similar.

Dolby Laboratories manufacture all their own professional (A type) equipment and sell it to studios and radio stations around the world. But Dolby Labs do not produce any domestic Dolby equipment (B type) and instead license the manufacturers around the world to produce it for themselves. Thus professional Dolby A equipment never finds its way into the consumer shops, and the only Dolby equipment that you are ever likely even to see, is domestic, Dolby B equipment.

It does not, therefore, matter that Dolby B equipment is incompatible with Dolby A equipment—the normal consumer will never have the opportunity of making the mistake of trying to decode an A tape on B equipment or vice versa.

By exactly the same token, *dbx* market their professional equipment through one distributor (Scenic Sounds Equipment) and their domestic equipment through an entirely separate agent

(Acoustic Research International). Thus, just as with Dolby, the domestic consumer never has an opportunity to see, let alone buy professional *dbx* equipment, so again there is no risk that the incompatibility between the professional and domestic types will trap a consumer into using the wrong equipment for the job in hand.

### BASIC FORMATS

However, whereas there is only one Dolby A format and one Dolby B format (for use on domestic cassette and reel-to-reel recorders or broadcast receivers), there are more than two basic *dbx* formats. And not only are there more *dbx* formats, there has also so far been less successful education of the audio

fraternity in the UK over the differences between the different formats. It is important therefore to set the matter straight, and the situation is as follows:

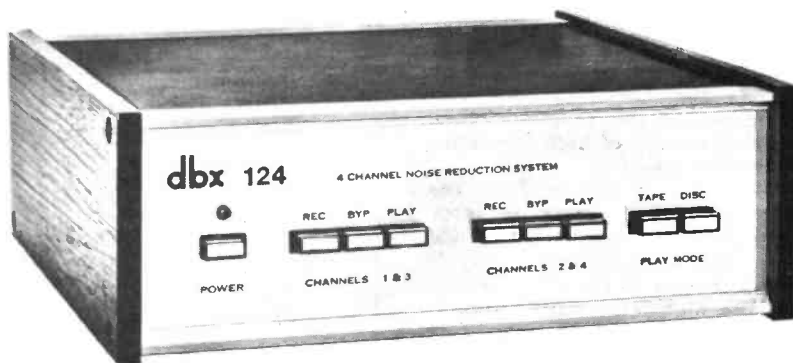
In the professional and semi-professional area (handled by Scenic Sounds Equipment) there are four different professional and semi-professional units, which are compatible with each other. (216; 177; 187; 150.) These are all used for recording on tape in professional or semi-professional recording studios.

Also falling into the professional and semi-professional area is the 140 broadcast series, which can also be used to produce *dbx*-encoded discs (and tapes) of the type which are gradually becoming available on the domestic market. These can be reproduced using some (but not all) domestic *dbx* equipment. However, tapes made on the other professional equipment (216; 177; 187; 150) cannot be replayed on domestic equipment, and for this reason will never be made available on the domestic market.

Anyone wishing to replay *dbx* encoded discs (or tapes) produced for domestic use on the professional 140 equipment will need to use a 120 series domestic *dbx* unit. As well as decoding professionally made discs and tapes, the 120 series can also be used as a compandor for amateur recordings (just like Dolby B). A recording made on a reel-to-reel or cassette machine, using a 120 series unit to encode the recording, and decode on playback produces more dramatic loss of process noise than Dolby. However, the *dbx* 120 series units cost more than Dolby B.

Continued next month

The *dbx* 124 four-channel system.

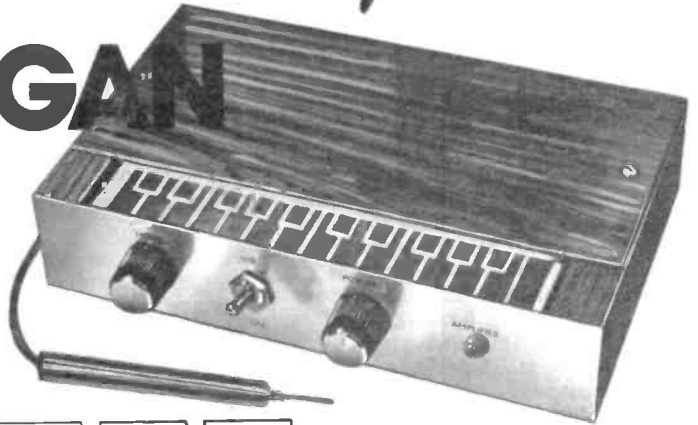


# Next Month...

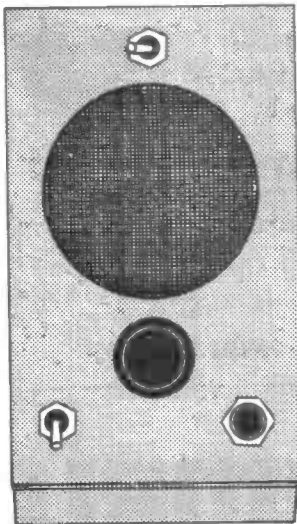
## *Party time Projects!*

### MINI ORGAN

A simple musical instrument which can provide hours of amusement for all the family.



**S**<sub>1</sub> **C**<sub>3</sub> **R**<sub>1</sub> **A**<sub>1</sub> **B**<sub>3</sub> **B**<sub>3</sub> **L**<sub>1</sub> **E**<sub>1</sub>  
**T**<sub>1</sub> **I**<sub>1</sub> **M**<sub>3</sub> **E**<sub>1</sub> **R**<sub>1</sub>



Another reader's suggested idea: this timer takes the waiting out of Scrabble and has a "panic" facility to add a new dimension to the game.

**Let's figure it out**  
**Take the STING**  
**out of Maths!**

First of a series of short articles on maths, used in electronics.

*Plus Index for Volume 5*

# everyday electronics

December issue on sale: Friday, November 19

**P**ROBABLY the main limiting factor on the reproduction quality of most modern record playing systems is the mechanical part of the equipment. For instance, the noise level of most amplifiers is negligible, with most of the noise in the system coming from the record deck and from the record itself.

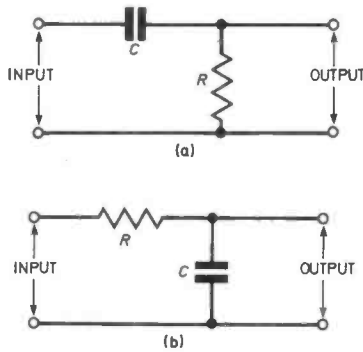
Noise from the record deck is mainly in the form of a very low frequency sound, or "rumble" as it is usually termed. Much of this signal is below the lower limits of human hearing, but it can still produce audible effects as the result of intermodulation distortion between this noise and the desired signal. Some record decks produce a noticeable amount of rumble just within the lower limits of human hearing, and this can be especially annoying.

Rumble is sometimes present on records to a significant degree, but surface noise is the most usual cause of trouble here. Even well cared for records will eventually show signs of wear in the form of a continuous crackle of small scratches.

It is possible to incorporate circuits in the amplifier which will minimise the inconvenience caused by rumble and small surface scratches, and a number of amplifiers incorporate scratch and rumble filters. This article describes a simple scratch and rumble filter which can be used as an add-on unit to a system which does not already have these features.

#### Basic Operation

As the signals produced by



Figs. 1a and 1b. Basic high and low pass filters.

rumble are at very low frequencies, if one rolls off the low frequency response of the amplifier, the rumble will be greatly reduced. Similarly, rolling off the high frequency response of the amplifier will reduce the level at which the scratches are reproduced. This is simply because most of the signals produced by small scratches are at very high audio frequencies.

It should be borne in mind that deep scratches have a large middle and even bass frequency content. These cannot usually be effectively reduced by simple filtering. Also some of the cheaper record decks produce a significant level of rumble at comparatively high frequencies, and again only a limited improvement in reproduction quality can be made by the use of a filter.

#### Simple Filters

The circuit of a basic passive high pass filter is shown in Fig.

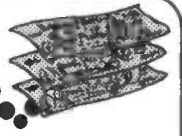
1a and Fig. 1b shows the circuit of a basic low pass filter. These work by virtue of the fact that the impedance of a capacitor (its resistance to an alternating current flow) varies with frequency.

In fact the impedance of a capacitor rises with decreasing frequency. Halving the frequency doubles the impedance of a capacitor.

The two circuits shown in Fig. 1 are forms of potential divider. In Fig. 1a the capacitor is chosen to have a value which has a negligible impedance at high and middle frequencies, compared to the value of the resistor. Signals at these frequencies can pass through the filter virtually unhindered. At bass frequencies the capacitor will have a high enough impedance to cause severe losses through the circuit.

In the circuit of Fig. 1b the capacitor has a value which will only cause small circuit losses at bass and middle frequencies. At higher frequencies where the capacitor has a lower impedance,

**FOR  
GUIDANCE  
ONLY**



**ESTIMATED COST  
OF COMPONENTS  
excluding V.A.T.**

**£7.00**

**excluding case**

# SCRATCH & RUMBLE FILTER

By R. A. PENFOLD



the potential divider action will result in severe losses in the circuit.

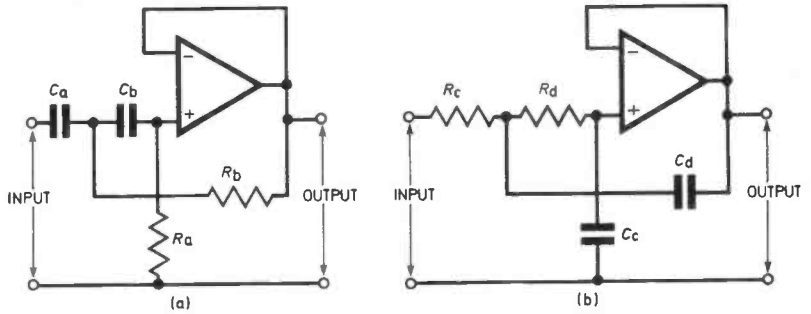
### Active Filters

These simple passive circuits provide only a gradual roll off of the high and low frequencies, with some of the desired middle frequencies being somewhat attenuated as a result. The extent of the roll off is about 6dB per octave (doubling the frequency causing a reduction by half of the output amplitude), and this can usually be obtained using the amplifier's tone controls. A roll off of about double this rate is desirable, and can easily be obtained using an active filter; Figs. 2a and b show the circuits of a basic active high pass filter and low pass filter respectively.

The amplifier has 100 per cent negative feedback between its output and inverting (-) input, and it therefore has a voltage gain of only unity.

The combined capacitance of  $C_a$  and  $C_b$  together with  $R_a$  form a high pass filter. Thus at high and middle frequencies the overall gain of the circuit is about unity.

Resistor  $R_b$  thus has no effect on the circuit as any variation in the potential at the junction of  $C_a$  and  $C_b$  will be exactly matched by an equal change at the output.



Figs. 2a and 2b. Basic active high and low pass filters.

The voltage across  $R_b$  remains constant, and so none of the input current will flow through it;  $R_b$  has an apparent infinite impedance at high and middle frequencies.

At bass frequencies losses through  $C_a$  and  $C_b$  give the circuit less than unity gain, and changes in the potential at the input end of  $R_b$  will not be fully matched by similar changes at the other end. Some of the input current will thus flow through  $R_b$ , and the level of this current increases as frequency decreases, because the gain of the circuit is less at low frequencies. This gives the circuit a roll off rate of about 12dB per octave with  $C_a$  and  $R_b$  forming a second high pass filter network.

Note that this is not simply two high pass filters connected in series, and that a combination of the first filter network and the

positive feedback via  $R_b$  (known as bootstrapping) is used to give the second filter a fast roll off rate. The circuit as a whole thus has a very fast roll off rate.

The low pass circuit operates in a similar manner:  $R_c$ ,  $R_d$ , and  $C_c$  form a passive low pass filter, and  $C_d$  will appear to have an infinite impedance at bass and middle frequencies, but not at treble ones. This again provides a 12dB per octave roll off with  $R_c$  and  $C_d$  forming a second filter network.

### Practical Circuit

A practical scratch and rumble filter circuit appears in Fig. 3. This only shows one channel, the two channels being identical. Four inexpensive 741C operational amplifier I.C.s provide the basis of the unit. When used as unity gain buffers, as they are here,

Fig. 3. One channel of the Scratch and Rumble Filter circuit.

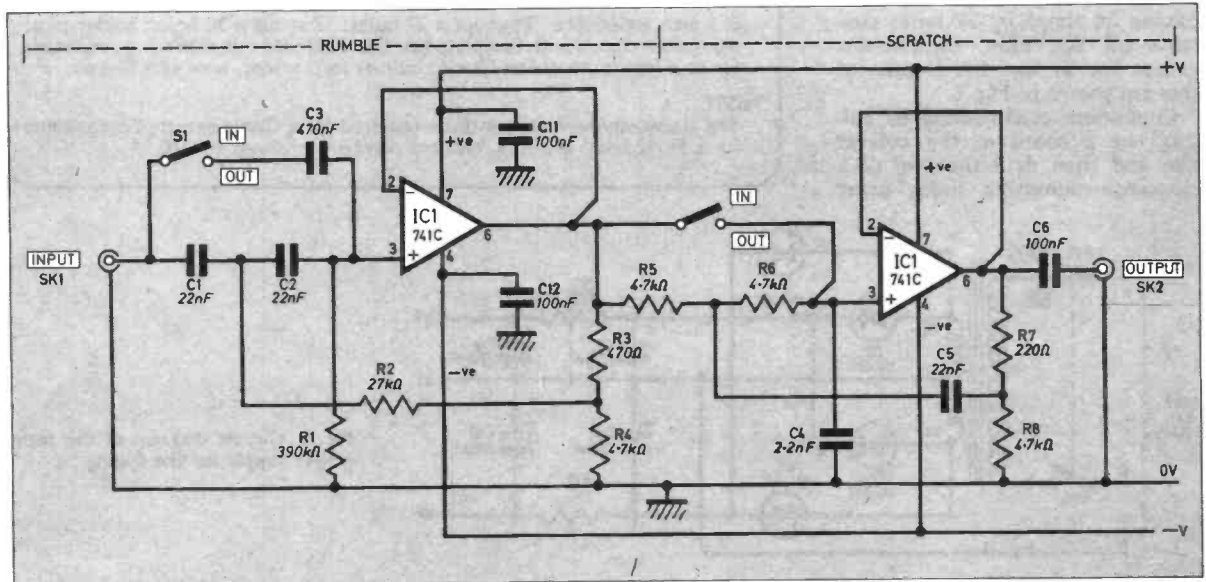


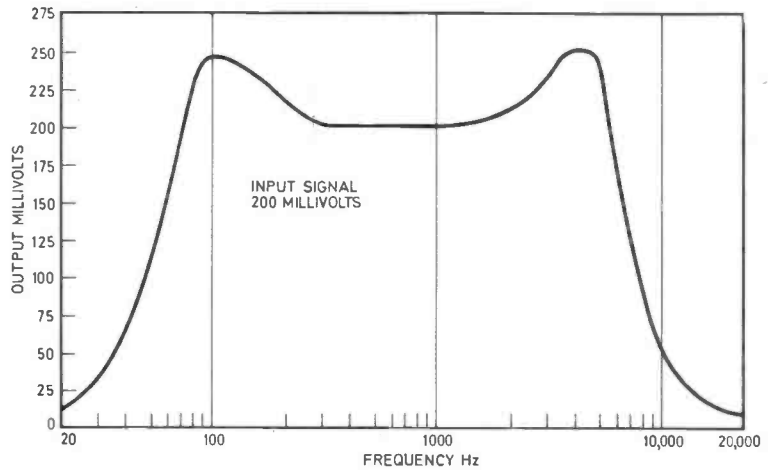
Fig. 4 (right). Response curve of the filter.

these devices have insignificant levels of noise and distortion. The similarities between the skeleton and practical circuits should be obvious, and only the differences will be discussed.

Components C3 and S1 can be used to bypass C1 and C2, and thus cut the rumble filtering out of circuit; C3 maintains d.c. blocking at the input and S2 provides "in" and "out" switching for the scratch filter.

Resistors R3 and R4 form a potential divider which reduces the gain of the feedback circuit of the rumble filter, as otherwise an undesirable excessive peak appears in the frequency response of the unit; R7 and R8 provide a similar function in the scratch filter. Capacitor C6 provides d.c. blocking at the output, and C11 and C12 are supply decoupling capacitors.

With S1 and S2 in the "out" positions the unit has a flat response over the audio frequency spectrum. With these switched in, the response shown in the graph (Fig. 4) is obtained.



### Power Supply

The prototype filter is powered from a simple conventional mains p.s.u., as can be seen in Fig. 5. This provides dual loaded outputs of about plus and minus 7 volts, and has a smoothed output.

### Components Panel

A 0.1 inch piece of stripboard having 34 strips by 27 holes contains all the filter components except for S1 and S2. Details of this are shown in Fig. 6.

Commence construction by cutting out a board of the correct size and then drill the two 6BA clearance mounting holes using

## Components

### Resistors

R1, 101 390k $\Omega$ (2 off)	R6, 106 4.7k $\Omega$ (2 off)
R2, 102 27k $\Omega$ (2 off)	R7, 107 220 $\Omega$ (2 off)
R3, 103 470 $\Omega$ (2 off)	R8, 108 4.7k $\Omega$ (2 off)
R4, 104 4.7k $\Omega$ (2 off)	R9, 56 $\Omega$
R5, 105 4.7k $\Omega$ (2 off)	R10, 56 $\Omega$
	All $\frac{1}{4}$ W carbon $\pm 5\%$

### Capacitors

C1, 101 22nF type C280 (2 off)	C7, 400 $\mu$ F 16V elect.
C2, 102 22nF type C280 (2 off)	C8, 400 $\mu$ F 16V elect.
C3, 103 470nF type C280 (2 off)	C9, 220 $\mu$ F 10V elect.
C4, 104 2.2nF polystyrene (2 off)	C10, 220 $\mu$ F 10V elect.
C5, 105 22nF type C280 (2 off)	C11, 100nF type C280
C6, 106 100nF type C280 (2 off)	C12, 100nF Type C280

### Semiconductors

IC1, 101 741 operational amplifier 8 pin d.i.l. (2 off)
IC2, 102 741 operational amplifier 8 pin d.i.l. (2 off)
D1-D4 1N4001 or similar silicon diode (4 off)

### Miscellaneous

T1 mains primary 6-0-6V 100mA secondary transformer
S1, 2 d.p.d.t. toggle switch (2 off)
S3 d.p.s.t. rotary mains type switch
SK1, 2 3 pin DIN socket (2 off)
0.1 inch stripboard: 34 strips x 27 holes; 17 strips x 30 holes; solder pins;
aluminium chassis with baseplate size 178 x 102 x 63 mm x 16 s.w.g., materials for case (see text); control knob: cabinet feet; solder, wire 6BA fixings.

### NOTE

The above components are those required for a stereo set-up. Components for L.H. channel are R.H. channel numbers prefixed by 100.

See  
**Shop  
Talk**

Page 571

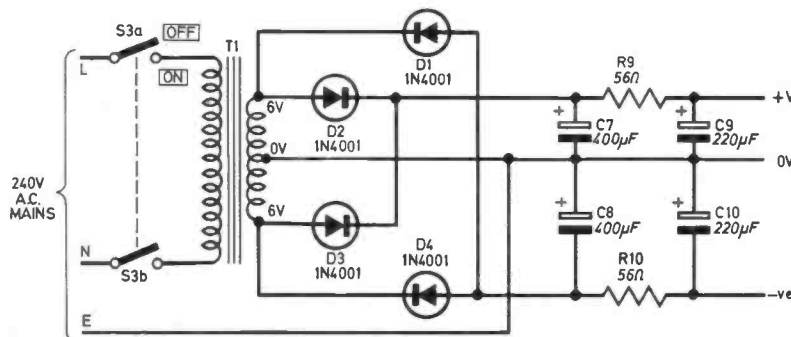


Fig. 5. Circuit diagram of the mains power supply for the filter.



# SCRATCH & RUMBLE FILTER

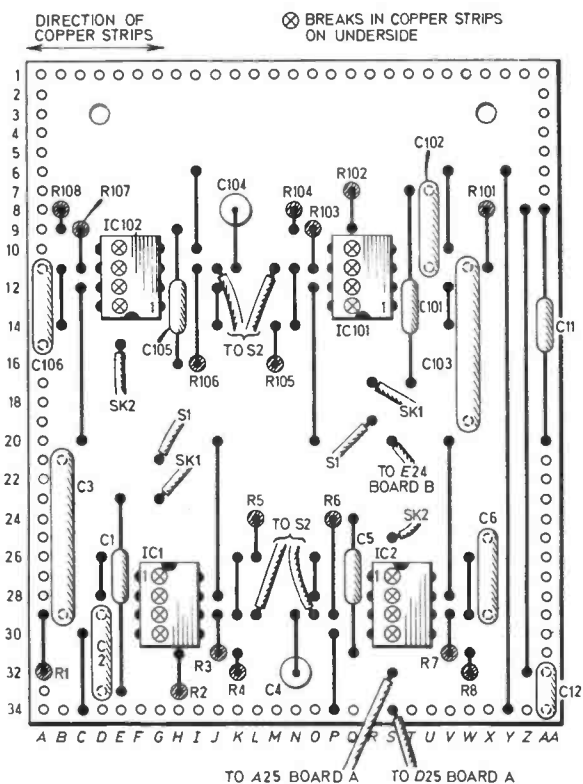
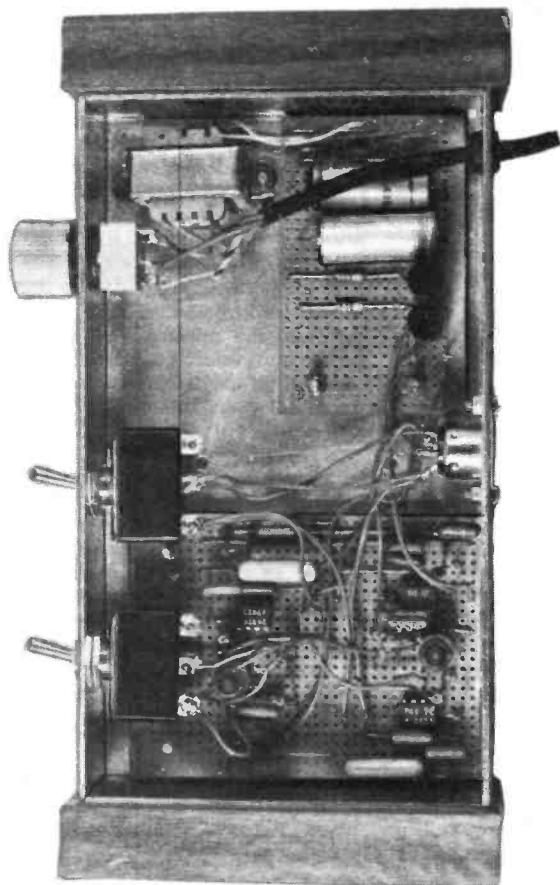


Fig. 6. Wiring details of the filter circuit board.

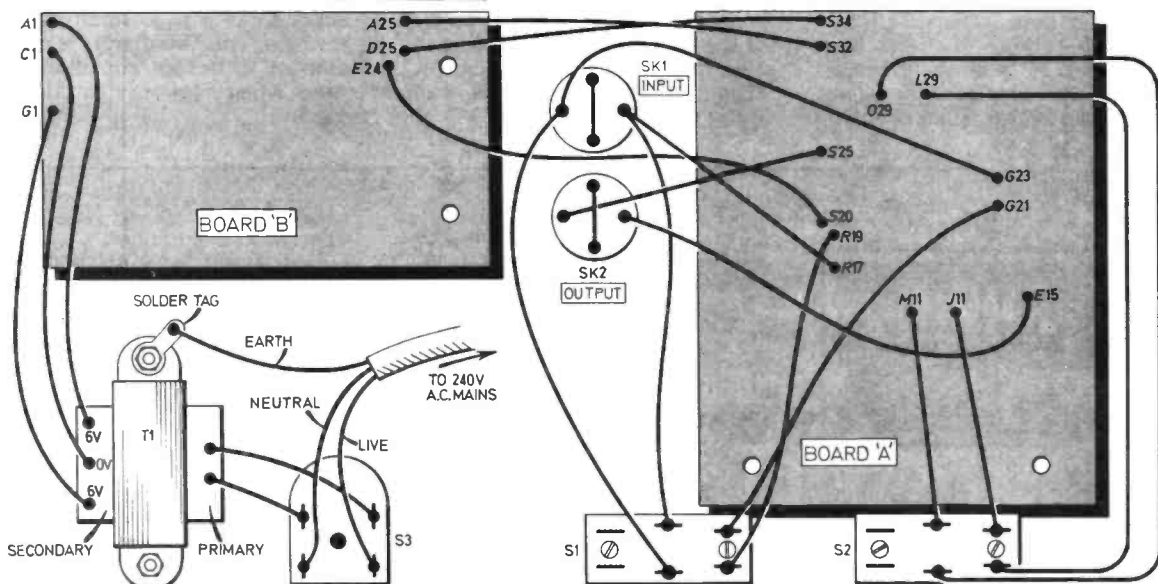


Fig. 8. Layout and wiring of the complete filter unit.

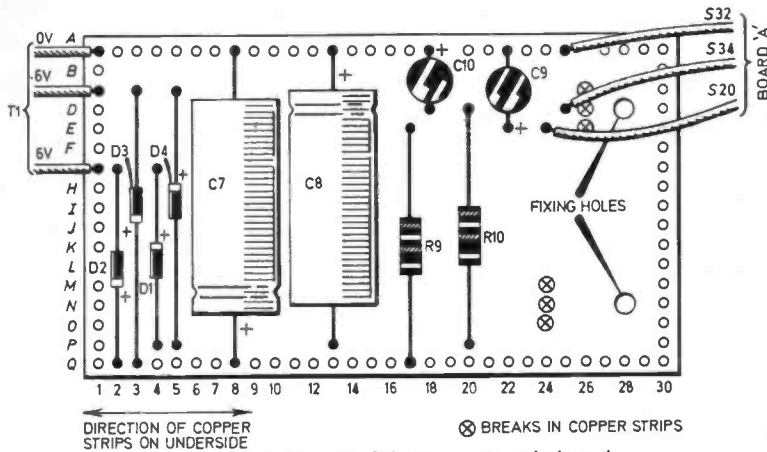


Fig. 7. Layout of the power supply board.

a 3.2mm twist drill. Then make the numerous breaks in the copper strips on the underside as indicated. The board is then wired up, starting with the link wires, and then progressing to the resistors and capacitors, and finally in the i.c.s. At the points where leads from S1, etc. will eventually connect to the panel, use of solder pins is recommended.

The small power supply components are wired up on a second 0.1 inch matrix strip board panel, and details of this are shown in Fig. 7. The panel has 17 strips by 30 holes, and is constructed along the same lines as the main panel.

### Case Layout

It is important that the components are sensibly laid out inside the case, otherwise problems with pick-up of mains hum may result. It is strongly recommended that the general layout used by the author is adhered to.

The prototype was housed in a 178 x 102 x 63mm 16 s.w.g. aluminium chassis. This is fitted with a baseplate which in this particular application becomes the lid of the case.

Two 6BA self tapping screws are used to hold the lid in place, and these pass through the rear panel of the case and into the rear flange of the lid. Drill the holes in the panel using a No. 31 drill, and those in the flange using a No. 42 drill.

An attractive finish can be given to the case by cutting out two 110 x 145 x 18mm pieces of chipboard, and finishing these with a woodgrain patterned self adhesive plastic material. These are glued to the ends of the case to produce a bookends type cabinet. Extra nuts or short spacers are used to hold the component panels clear of the bottom of the case. A notch is filed in the rear flange of the lid so that SK1 does not prevent the lid from being pushed into position.

When the components and panels have been mounted, the unit should be wired up as shown in Fig. 6, using insulated connecting wire. Keep all leads as short as possible.

### Using the Filter

If the unit is used in conjunction with a record deck fitted with a crystal or ceramic cartridge, it is interposed between the deck and the amplifier. The filter has been designed to have a high input impedance (250 kilohms) so that it will match such a cartridge satisfactorily.

If a magnetic cartridge is used, it will be best if the unit is fitted between the preamplifier and the power amplifier, but this will not always be feasible. It could be used between the deck and the amplifier, but to do this it will be necessary to connect at 47 kilohm resistor across each input in order to obtain the correct input impedance for a magnetic cartridge.

Due to the lower output from a magnetic cartridge, problems with excessive mains hum may result unless the main circuitry is screened from the power supply components. A better alternative would be to simply power the unit from a couple of 9 volt batteries (type PP6 for example).

Input and output leads must both use screened cables.

When using the rumble filter results will probably be best if the amplifiers tone controls are adjusted to give a small amount of bass cut. Similarly, a small amount of treble cut should be used when the scratch filter is used. □



A simple but effective way of making test probes is to make a hole in the back of an empty cartridge pen refill case and push a piece of wire through it to the front. Next join the wire on to the head of a pop rivet, pull back slack

wire, and push the end of the rivet back into refill case. You will find that it makes a tight fit and makes an ideal test probe.

Mr. L. A. Marks,  
Dagenham.

I am sending you the following construction idea as it may be of interest to your readers.

It is often useful when testing the output capability of amplifiers, power supplies etc., to use a low value resistor with high power rating as a dummy load. Unfortunately, these resistors are quite expensive even at power ratings of 5 watts, and in experimental work, one invariably ends up

wanting to use a different value resistor from the ones purchased.

A useful way out of this problem is to use a replacement spiral element for an electric fire. This is a 35 ohm resistor when cold rising to 60 ohm when red hot and dissipating 1,000 watts. This can easily be cut into lengths to give any required resistance (the resistance being proportional to length) and the last few turns straightened out for connection into breadboards, printed circuits etc.

The above information was discovered using a Wellco 230/250 volt 1,000 watt spiral element costing 32p, but other makes of replacement element should yield similar results.

F. Harris,  
Whitland, Dyfed.

# Physics is FUN!

By DERRICK DAINES

## Induction Coil

THE induction coil also has the name of spark coil and with its aid one may manufacture fat sparks across a terminal gap. This in turn can lead us to study the phenomena of radio waves and related subjects, so a spark coil is well worth constructing.

First make a spark-gap support out of wood as shown in Fig. 1. It is very simply made by glueing together, and the banana plugs that form the actual spark gap are a tight fit in drilled holes.

For the induction coil itself we can use a small bell transformer. These are made with the intention that the primary is to be connected to the mains, giving a step-down on the secondary of 3 volts, but we will use the transformer the other way round.

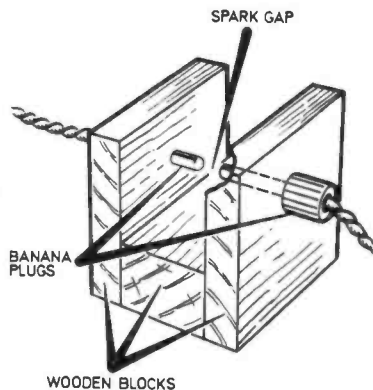


Fig. 1. Making a spark gap with banana plugs.

Connect the high-tension leads so that the current flows through a neon lamp (optional) and across the spark gap, as in the diagram of Fig. 2.

If we now connect a battery to the low-tension primary, nothing will happen because the battery supplies direct current and the transformer will work only on alternating current. We need some method of chopping up the d.c. from the battery and this can be done in either of two very simple ways. The usual way is to remove the bell from a low-voltage door bell such as we have made earlier in this series (July '76). The action of the clapper

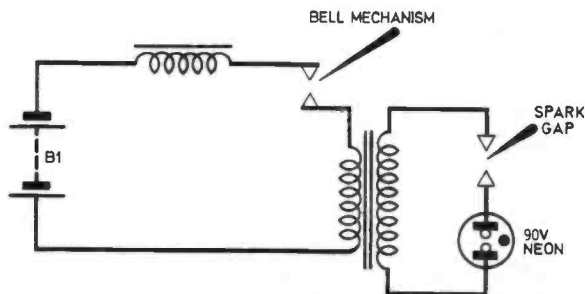


Fig. 2. The circuit diagram of an induction coil.

switches the d.c. on and off very rapidly, see Fig. 3.

The other way is to use a small electric motor, as was pointed out by a young reader earlier this year. The very high speed of a motor will make the switch on and off by the brushes and commutator ring that much faster, and the overall effect will be to make the sparking more efficient. The battery supply should suit the motor, but with the very high voltages produced at the high-tension side of the transformer, I would recommend a battery of not more than 9 volts.

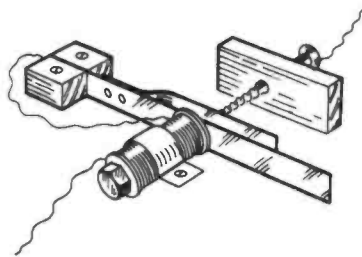


Fig. 3. Using a simple bell clapper mechanism to chop up the d.c.

The arrangement is shown in Fig. 2. Connect up the battery with the ends of the banana plugs touching. The neon lamp will glow, showing that high voltage is being produced. Now slowly move one plug backwards so that a tiny gap appears between them with a

stream of sparks leaping across it. This gap can slowly be increased with the sparks getting longer and longer until they finally cease and the neon lamp goes out indicating a break in the circuit.

Depending upon the battery supply voltage, general efficiency and so on, this gap can be anything up to 5mm across with a bell transformer.

## Radio Interference

While the sparking is taking place, switch on a nearby television or radio and observe the interference, particularly on long wave. This noisy interference can be broadcast by the spark over quite a surprising distance. For this reason creating such a nuisance is (strictly) illegal and if one has a social conscience, one will keep it to a minimum—perhaps by conducting such experiments outside normal broadcasting hours. Placing a large tin over the spark equipment will reduce this interference or remove it altogether, recalling our experiments with shielding earlier (September, '74). Be careful not to short out anything when positioning this tin.

It will be obvious that induction coils can be used to produce very high voltages indeed. Industry finds a ready application for them in radio transmitters and in X-ray equipment, while smaller coils are used in the treatment of some nervous disorders. As proof of this, one has only to touch the terminals producing the spark to observe that the high-voltage low-amperage current stimulates the nerves of the hand!



By **S.R. LEWIS** B.Sc.

**T**O MAKE consistently good enlargements, it is necessary to have accurately timed exposures. It is relatively easy to count the ticks of a clock for short exposure times but for anything over about ten seconds it becomes tedious, time-wasting and liable to error.

The Enlarger Exposure Timer described here controls the enlarger lamp directly and will produce exposure times of one second to 99 seconds, the time being continuously variable by means of a ten-way switch and a potentiometer. A focus switch is provided so that the enlarger can be adjusted before the actual exposure is carried out.

### THE SYSTEM

A block diagram of the Enlarger Exposure Timer is shown in Fig. 1. It will be seen to consist of three main blocks: a bistable; a constant current sink; and a comparator.

The heart of the timer is the large electrolytic capacitor,  $C_A$ . When the unit is first switched on the bistable will be in its reset state—output  $Q$  will be at a low voltage and output  $\bar{Q}$  will be at a high voltage.

Capacitor  $C_A$  will charge up to a high voltage via  $D_B$ . Since the  $Q$  output is low the buffer will not

switch on the relay and the enlarger lamp will be unlit.

When the **TIME** button is pressed momentarily, the bistable will change state— $Q$  will be high and  $\bar{Q}$  low. This means that now the relay will be energised and the lamp will be on.

Both diodes  $D_A$  and  $D_B$  are reverse biased, so the only way that charge can leak away is through the constant current sink, which is an electronic circuit which allows current to flow to ground at a rate determined by the value of the resistor  $VR_A$ . No matter what the voltage across the constant current sink, the current

through it will always be the same.

As charge leaks away from  $C_A$  the voltage across it falls linearly. The voltage comparator detects when the voltage has fallen to about 5.5 volts. As soon as this happens its output  $V_O$  goes high and immediately resets the bistable thus extinguishing the lamp.

It can be seen that varying the rate of discharge of the capacitor varies the time it will take to reach the threshold voltage. If  $V_C$  is the initial voltage across  $C_A$ ,  $V_{ref}$  the threshold voltage of the comparator,  $I$  the current into the constant current sink and  $C_A$  the value of the capacitor then the time it will take to discharge from  $V_C$  to  $V_{ref}$  is given by:

$$T = \frac{I}{C_A \times (V_C - V_{ref})}$$

where  $T$  is in seconds,  $C_A$  in farads,  $V_C$  and  $V_{ref}$  in volts and  $I$  in amps.

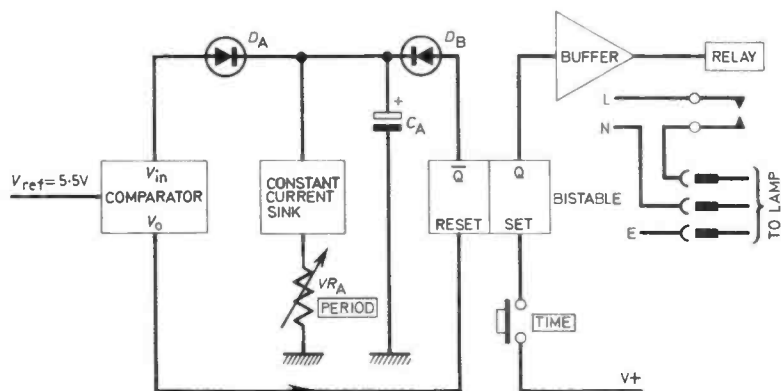
Large capacitors are bulky and expensive so it is wise to keep them as small as is practicable. In the actual unit a 150 microfarad capacitor has been used;  $V_C$  and  $V_{ref}$  are limited by the supply voltages. In the circuit used there is also the limitation that the constant current source will not function if the voltage across it falls below 5 volts so  $V_{ref}$  was set at 5.5 volts to allow a good margin of safety and  $V_C$  at the supply voltage minus a diode voltage drop giving about 14.5 volts.

We require  $T$  to be between one and 99 seconds so we can now calculate the value of  $I$  in these limiting cases.

For  $T=1$  second

$$I = \frac{1}{150 \times 10^{-6} \times (14.5 - 5.5)} = 1.3 \text{ mA}$$

Fig. 1. Block diagram of the timer.



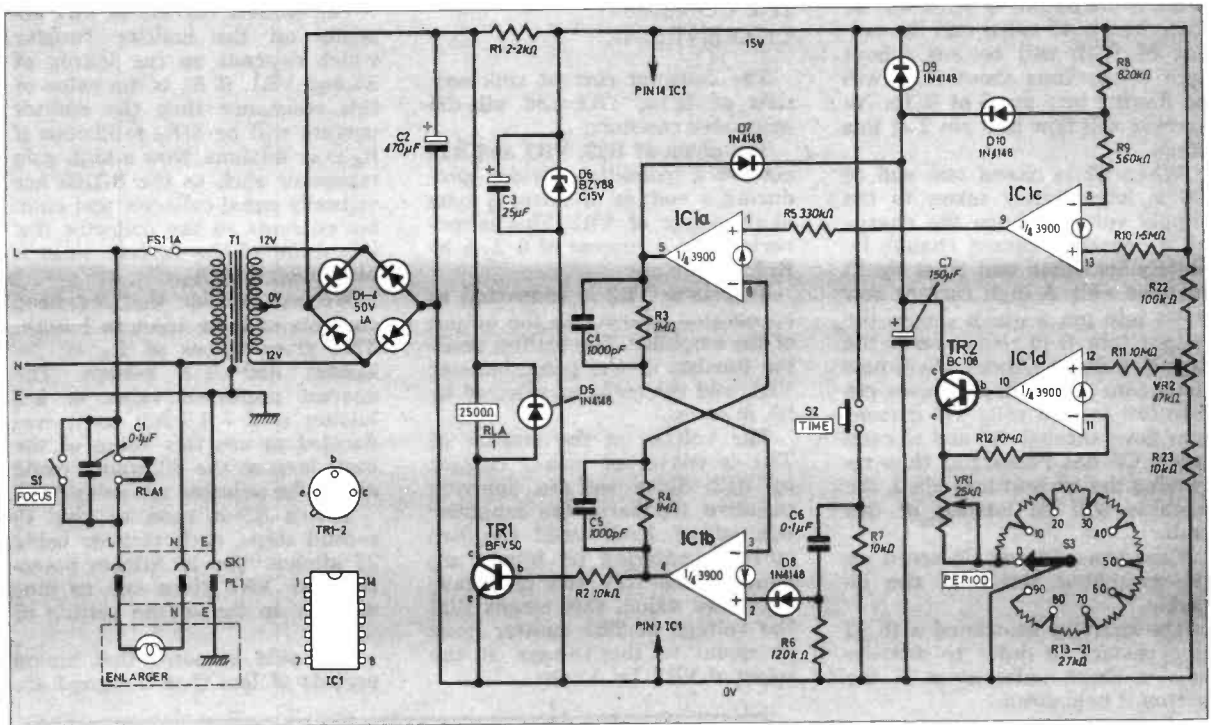


Fig. 2. Complete circuit diagram of the Enlarger Exposure Tuner

For  $T = 100$  seconds

$$I = \frac{150 \times 10^{-6} \times (14.5 - 5.5)}{100} = 13 \mu\text{A}$$

This gives us all the design parameters for the unit.

### CIRCUIT DESCRIPTION

The complete circuit of the Enlarger Exposure Timer is shown in Fig. 2. The three main blocks of Fig. 1 have been translated into actual circuitry using a single four-amplifier package type LM3900. The blocks may be identified thus: IC1a and IC1b form the bistable; IC1c is the comparator; IC1d is the constant current sink.

Transformer T1 is a 12-0-12 volt 100mA type which is used to give 24 volts a.c. This is rectified and smoothed by D1 to 4 and C2 to give about 30 volts with quite a bit of ripple. This is used to supply the relay RLA.

The 30 volts is then dropped to 15 volts by R1 and stabilised by C3 and D6. This 15 volt line is used to power the actual timer circuit.

The relay controlled lamp supply is fed to an output socket SK1 into which the enlarger is plugged.

### THE 3900 INTEGRATED CIRCUIT

The 3900 is probably not a familiar device to most readers so a short summary of its capabilities may be useful.

The LM3900 (or its equivalents the CA3900 or the MC1314) contains four identical *current differencing amplifiers*. Current differencing or *Norton amplifiers* are different from ordinary operational amplifiers such as the 741 in quite a number of ways.

The voltage at the inputs of a 741 can vary over a range of several volts but the voltage at both the inputs of the Norton amplifier is clamped by diodes to approximately 0.5 volt. In order to use the Norton amplifier in conventional op amp applications it is necessary to convert input voltages to currents by means of input resistors.

The output voltage of the Norton amplifier depends on the difference between the currents entering its non-inverting (+) and inverting (-) inputs.

Only a single power supply line is required for the 3900 unlike the 741 which requires both negative and positive supply lines.

The symbol for the Norton amplifier can be seen in Fig. 2. The

arrow between the two inputs indicates that current flows between the inputs—a fact which can be put to use in some novel circuits.

The 3900 is extremely cheap making it ideal for use in low cost systems.

### THE BISTABLE

Now we have looked briefly at the properties of the 3900 we can return to the circuit diagram to see how the various sections operate.

The bistable consists of two cross-coupled amplifiers IC1a and IC1b. Before the TIME button is

FOR  
GUIDANCE  
ONLY

ESTIMATED COST  
OF COMPONENTS \*  
excluding V.A.T.

£7.40  
excluding case

pressed the output of IC1a will be high (nearly 15 volts) and the output of IC1b will be low (about zero volts). Thus about  $15\mu\text{A}$  will be flowing into pin 3 of IC1b. No current will flow into pin 2 at this stage.

When S2 is closed one end of C6 is immediately taken to the supply voltage. Since the charge on a capacitor cannot change instantly its other end rises by 15 volts as well. A high current now flows into pin 2 which causes the output (pin 4) to rise towards the supply voltage. About  $15\mu\text{A}$  now flows into pin 6 which causes pin 5 to fall to zero volts. No current now flows through R3 and so even when C6 has recharged thus removing the current into pin 2, the bistable will be latched in this state.

Capacitors C4 and C5 speed up the switching action of the bistable.

The circuitry associated with S2 is necessary in order to produce only a short pulse even if the button is held down.

## THE COMPARATOR

The comparator consists of IC1c, R8, R9, R10 and D10.

If we imagine D10 as an open circuit for the moment we can see that current will be flowing into both inputs of the amplifier.

About  $11\mu\text{A}$  will be flowing into pin 8 via R8 and R9 and about  $10\mu\text{A}$  into pin 13 via R10. Since more current is flowing into the inverting input (pin 8) the output (pin 9) will be at zero volts.

The voltage at the junction of R8 and R9 will be approximately 6.3 volts. Now in calculating these figures we assumed that D10 was an open circuit and, in fact, unless the voltage on the capacitor is one diode voltage drop (i.e. 0.6 volts) less than 6.3 volts D10 will be reversed biased and will be virtually an open circuit.

As soon as the voltage on C7 reaches this threshold of 5.7 volts, D10 will be forward biased and current that was flowing into pin 8 will be diverted into C7. Soon this current will become less than the  $10\mu\text{A}$  flowing into pin 13 and the output of the amplifier will rise to the supply voltage thus applying a reset pulse to IC1a via R5.

As soon as the bistable is reset C7 will charge up and the output of IC1c will fall back to zero volts, thus preparing the circuit for another timing period.

## THE CONSTANT CURRENT SINK

The constant current sink consists of IC1d, TR2 and all the associated resistors.

The chain of R22, VR2 and R23 act as a potential divider producing a voltage of about 3 volts at the wiper of VR2. This is converted into a current of  $0.3\mu\text{A}$  by R11.

Transistor TR2 is connected as an emitter follower to the output of the amplifier. The emitter resistor consists of the potentiometer VR1, and the resistors selected by S3, in series.

The voltage at the emitter of TR1 is converted into a current by R12. Since we are applying negative feedback, the amplifier will adjust itself until the two currents entering its inputs are equal. Since R11 and R12 have the same value, this means that the voltage at TR2 emitter must be equal to the voltage at the wiper of VR2, i.e. 3 volts.

The emitter current of TR2 depends on the emitter resistor which depends on the setting of S3 and VR1. If  $R_E$  is the value of this resistance then the emitter current will be  $3/R_E$  milliamps if  $R_E$  is in kilohms. Now a high gain transistor such as the BC108 has virtually equal collector and emitter currents so the collector (i.e. the value of the current sink) is also given by  $3/R_E$ .

We saw earlier that we need currents of from  $13\mu\text{A}$  to  $1.3\text{mA}$ . This gives values of  $R_E$  of 230 kilohm and 2.3 kilohm. The nearest preferred value to 2.3 kilohm is 2.7 kilohm so it was decided to use this value as the basic step as the difference could always be adjusted out using VR2.

Switch S3 is used to give 10 second steps, each resistor being 27 kilohm. The 25 kilohm potentiometer VR1 gives one to nine seconds on top of the setting of S3.

It should be noted that timing periods of less than a second are

## Components

### Resistors

R1	2.2k $\Omega$ $\frac{1}{2}$ W	R9	560k $\Omega$
R2	10k $\Omega$	R10	1.5M $\Omega$
R3	1M $\Omega$	R11	10M $\Omega$
R4	1M $\Omega$	R12	10M $\Omega$
R5	330k $\Omega$	R13 to R21	27k $\Omega$ $\pm$ 2 per cent (10 off)
R6	120k $\Omega$	R22	100k $\Omega$
R7	10k $\Omega$	R23	10k $\Omega$
R8	820k $\Omega$		

All  $\pm 5\%$   $\frac{1}{4}$ W unless otherwise stated

### Capacitors

C1	0.1 $\mu\text{F}$ polyester
C2	470 $\mu\text{F}$ 63V elect.
C3	25 $\mu\text{F}$ 25V elect.
C4	1000pF polystyrene
C5	1000pF polystyrene
C6	0.1 $\mu\text{F}$ polyester
C7	150 $\mu\text{F}$ 25V elect.

### Semiconductors

D1-D4	50V 1A bridge rectifier
D5	1N4148 or similar silicon diode
D6	BZY88 C15V 15V 400mW Zener diode
D7-D10	1N4148 (4 off) or similar silicon diode
TR1	BFY 50 npn silicon
TR2	BC108 npn silicon
IC1	CA3900 (or LM3900)

### Miscellaneous

VR1	25k $\Omega$ linear potentiometer
VR2	47k $\Omega$ subminiature horizontal skeleton preset
S1	on/off toggle switch
S2	on/off pushbutton switch
S3	1 pole 10 way rotary switch (see text)
T1	mains primary, 24V 100mA secondary
FS1	1A fuse and panel mounted holder
RLA	24V 2500 relay with at least one make contact (see text)
SK1, PL1	Mains plug and socket
	0.1 inch matrix stripboard, 33 strips x 44 holes; solder pins; mains cable; pointer knobs (2 off); connecting wire.

See  
**Shop  
Talk**

page 571

not feasible as the current required is too high for the circuit to cope.

Potentiometer VR2 allows the voltage to be varied from about 0.9 volts to about 5.5 volts. This variation is necessary in order to allow for all possible values of C7. A capacitor which is marked "150 $\mu$ F" may in fact have any value between 75 $\mu$ F and 300 $\mu$ F.

Thus the voltage at the wiper of VR2 must be variable over a similar four to one range to compensate for these variations.

There must always be a voltage between the collector and emitter of TR2 for it to operate properly; with VR2 at maximum the voltage on the emitter will be 5.5 volts so the threshold voltage of the comparator must be higher.

Although there is no "lower end stop" on the potentiometer, it is not possible to time for periods of less than a second as the constant current sink will not operate if the emitter resistor of TR2 is reduced to a low value.

## RELAY OUTPUT

One side of the main bistable is used to drive transistor TR1 through the base resistor R2. The relay is connected between the collector of the transistor and the 30 volt line. The relay used in the prototype was a 24 volt 2500 ohm type. In fact any relay with a voltage rating of less than 30 volts and a current requirement of less than 50 milliamps can be used providing an appropriate resistor is placed in series.

A 24 volt or 30 volt relay will need no series resistor but if the voltage rating is  $V_r$  and the current  $I_r$ , then the series resistor  $R_s$  should have a value given by

$$R_s = \frac{30 - V_r}{I_r}$$

If only the resistance of the relay  $R_r$  and its voltage ratings are known, then use

$$R_s = \frac{(30 - V_r) \times R_r}{V_r}$$

Two "make" contacts of the relay are used to switch the enlarger lamp current so these contacts must be capable of carrying the required current. A capacitor C1 is placed across the contacts to absorb some of the energy of the spark thus extending contact life.

A focus switch S1 is placed in parallel with the relay contacts so that the enlarger lamp can be switched on for adjustments.

## DISCHARGE PATH

The only component not described so far is the diode D9 from the positive plate of C7 to the 15 volt supply line. The purpose of this diode is to provide a discharge path for C7 when the power supply is switched off.

If this diode were not provided then C7 would retain its charge for a very long time since D7, D10 and TR2 would all be reverse biased.

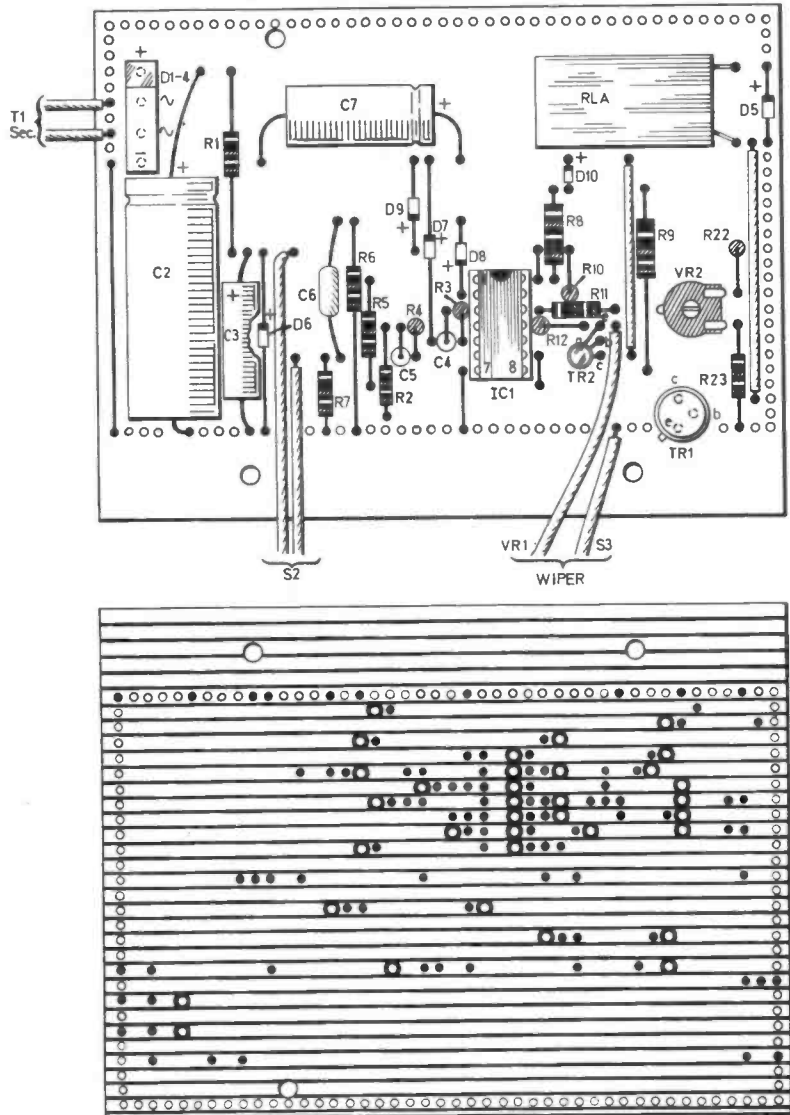
The reason that it is necessary to discharge C7 is to make sure that on applying power to the circuit, the bistable is in its reset state. If this were not ensured then it is possible that the enlarger lamp would come on when power was applied.

To see how discharging C7 ensures that the bistable resets, note that with zero volts across C7 the comparator output (pin 9) will be high. This will cause pin 1 of IC1a to be high which resets the bistable. Of course, as soon as the bistable is reset C7 will charge up to nearly supply voltage, thus sending the output of the comparator low, but this will not change the state of the bistable as it will be latched as described earlier.

## CONSTRUCTION

Most of the components are mounted on a piece of strip board as shown in Fig. 3. A socket was used for the i.c. and, while

Fig. 3. Components mounted and wired up.



# ENLARGER EXPOSURE TIMER

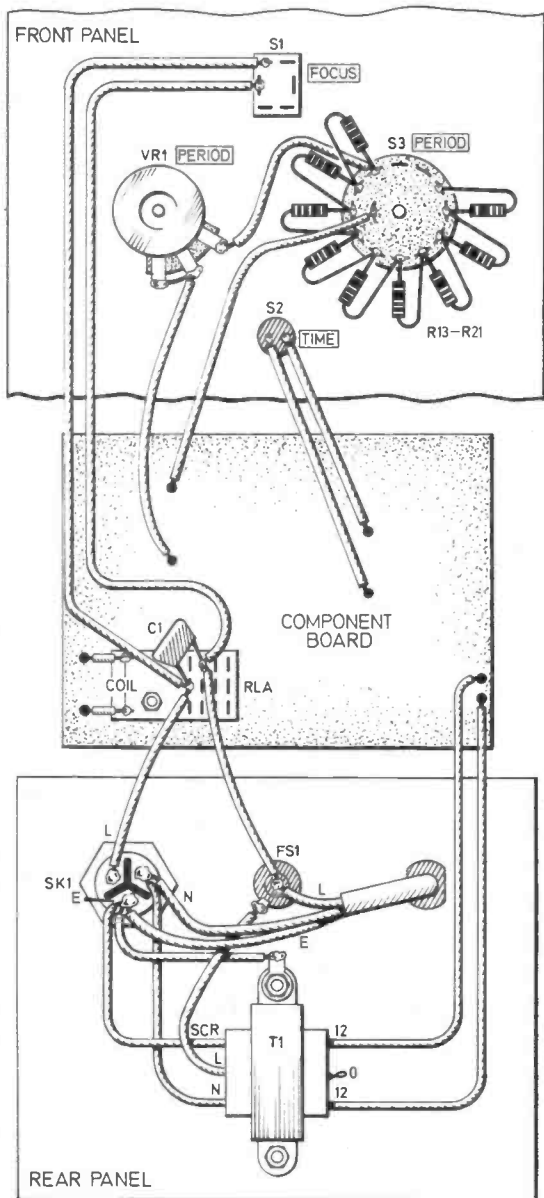
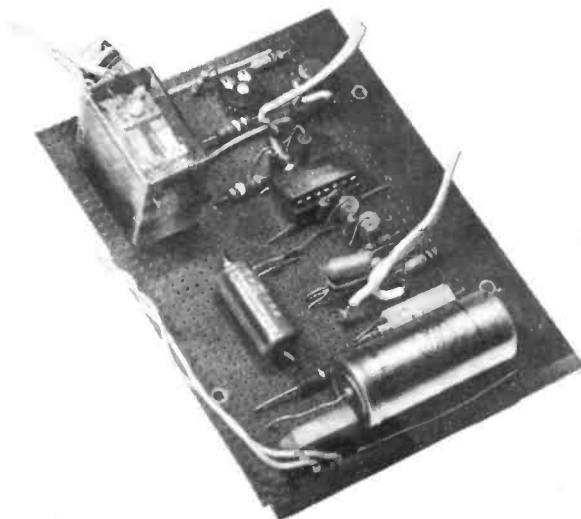
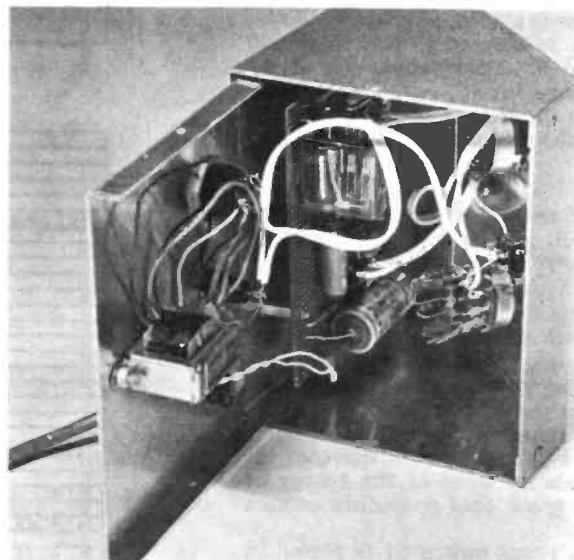


Fig. 4. Layout and wiring of the complete unit.



Photograph showing the prototype component board.



Inside the prototype unit.



this is not essential, it does make testing easier.

Pins have been used to carry wires which leave the board. Two pins have also been used to mount the relay which is held quite firmly by soldering its coil contacts to these pins.

Bridge rectifiers vary in packaging and the contact arrangement may not be as shown. Check carefully and make any changes necessary to accommodate the type used. Four 1 amp diodes could be used if required.

The whole unit was built into a sloping front case with a removable back. This back was used to mount all the mains components so as to keep them separate from the low voltage board (see Fig. 4).

Switch S3 and potentiometer VR1 are mounted on the sloping panel together with S1 and S2. All the resistors should be attached to S3 before mounting it in the box. In the prototype a one-pole 12-way switch with an adjustable end stop was used to give a 10-way switch.

Before mounting the board in the box it is necessary to test it and to set VR2 to give the correct timing periods.

## SETTING UP

Connect the secondary of T1 to the board and connect S3 and

VR1 in series to the pins on the board and also S2 to its pins. There is no need to connect anything to the relay at this stage. Apply power.

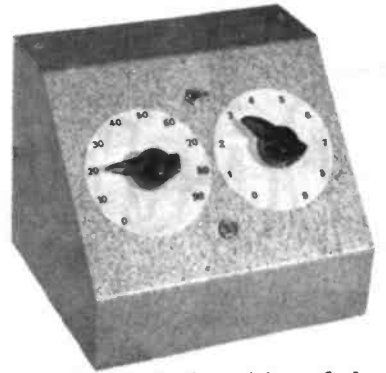
Check the voltage of the power line before inserting the i.c. It should be very close to 15 volts. If not check the power supply wiring. Insert the i.c. (correctly oriented) into the socket.

Press S2 with VR1 at minimum setting and S3 at the 10 second position. The relay should click in immediately and click open again after about 5 to 15 seconds. If this does not happen the operation of the circuit can be checked by connecting a high impedance meter across C7.

Before S2 is pressed it should have about 14.4 volts across it—if it does not then check the wiring of the bistable. Monitor pin 5 then pin 4 of the i.c. these should go from high to low, and low to high respectively as S2 is pressed.

Assuming the bistable is working, check that the voltage across the capacitor is falling when S2 is pressed. If it stays at 14.4 volts suspect the wiring of the constant current sink. There should be a voltage of about 3 volts at the emitter of TR2. Do not try to measure the voltage at the inputs to the i.c. as these will always be about 0.5 volt.

Assuming these sections are not



at fault check the wiring of the comparator.

When the unit is working satisfactorily it may be calibrated. Set both S3 and VR1 to their maximum settings i.e. 99 seconds and press S2. Measure the time against a clock with a second hand and adjust VR2 to give exactly 99 seconds. This is all the calibration that is needed because all other ranges are now set up.

Mount the board in the bottom of the case and then fix the switches and potentiometer to the front panel. Finally affix the back panel into the case.

Two paper scales are then glued to the front panel. The ten positions of S3 are marker 0, 10, 20, etc. up to 90. The scale of VR1 is divided into nine equal segments and these are marked 1, 2, 3, etc. up to 9.

The unit is now ready for use. □



FREQUENTLY get customers who say, "Oh! you remember that amplifier that appeared in EVERYDAY ELECTRONICS in 1974, might have been May or June, have you got the parts for it?" At one time we kept every copy of every magazine and even had them bound. In the end we were defeated by space and pace. The space to store them, and the pace of business which gives us no time for such niceties.

It was while I was pondering over this situation that the following idea occurred to me. If only all the constructional articles published in the last three years were grouped to-

gether in similar types, for example, amplifiers, radios, test gear, burglar alarms. Each one could be published as a separate book, or if there were not enough to make a reasonable sized publication, several groups, together.

I would like to see not only EVERYDAY ELECTRONICS and *Practical Electronics*, but *Practical Wireless* come in on it as well. However, this might be treasonable talk.

Everyone I have mentioned the idea to has been most enthusiastic. If you like the sound of it, please drop a line to the editor or myself.

By the time this appears in print an old friend of mine Mr. Fred Chaston a Director of Jackson Bros. will have retired after 50 years of service with his firm. Of course you all know what they make, variable capacitors. I asked Mr. Chaston how business was and he told me it was booming. I told him not many firms could say that today, but added that they have almost a monopoly in their product. I went on to say that their only danger might be from the Japanese, and he surprised me by saying that they export large quantities to Japan. Bravo!

I was even more astonished to learn that Mr. Chaston has driven every day from Palmers Green (which is North London) to Croydon (which is South London) a dreadful journey at any time. When he told me, I said, "You must leave at about 6.30 a.m. to miss the traffic?"

He said, "No I am at my desk by 6.30 a.m." I gave an incredulous gasp and replied, "What ever time do you finish for mercy's sake?" Back came the reply "6.30 p.m.!"

Well it all goes to show how hard we component chaps work on your behalf! Meanwhile a long and happy retirement Fred.

# Doing it Digitally...

**New Series  
Part 2**

WE CONTINUE this month with two more gates, the INVERTER and NOR.

Details are given for making the i.c. board and experiments described.

## THE INVERTER

The output of the circuit shown in Fig. 1.5 is the same as the input so this is not a useful logic circuit on its own. What happens if it is slightly altered to the circuit of Fig. 2.1?

When the 10 kilohm resistor is touched to negative the lamp lights but when to positive the lamp goes out—the output is now the opposite of the input.

This is easily explained. When the transistor is off (10 kilohm to negative or disconnected) current can easily flow through the 560 ohm resistor and l.e.d. so the l.e.d. lights.

When the transistor is on (10 kilohm to positive) the current flows more easily through the transistor than the l.e.d. so less current goes through the l.e.d. which does not light.

This could be a useful circuit for solving problems for its out-

By O.N. Bishop

put is opposite to its input—it is called an INVERT gate or simply an INVERTER.

It could be used to solve the following problem: "a person goes to the cinema if it is not raining. It is raining, what does he do?"

Connect the resistor to positive (high) whenever it is raining and the lamp will indicate what he should do.

Rather a simple problem on its own, but used in connection with other gates, the INVERTER can help sort things out.

Try connecting the INVERTER to the OR gate of Fig. 1.5. The circuit is shown in Fig. 2.2.

Try connecting no diodes, one diode, the other diode, and both diodes to the positive terminal and record the results in a truth table. A connected diode is recorded as high (H) and a disconnected diode which has the same effect as a diode connected to negative is recorded as low (L). If the l.e.d. lights record this output as H, if not record as L.

The completed table is shown in Table 1.4. On comparing this with Table 2.1, it will be found that the circuit has behaved just as expected. The input columns are the same, but each entry in the output column is inverted (H instead of L and vice versa).

This inverted OR (sometimes called negative OR or NOR for short) is used fairly often in computer circuits and is used later in the series. It is used to solve problems involving a negative such as: "A person will NOT go to the cinema if it is raining OR if a western is showing".

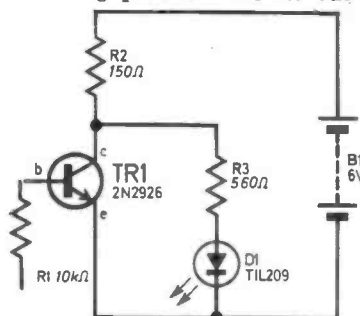
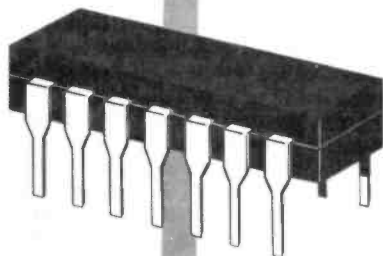


Fig. 2.1. Connecting the l.e.d. across the transistor rather than its collector lead produces an inverter.

A new series providing an introduction to, or revision of, digital techniques.

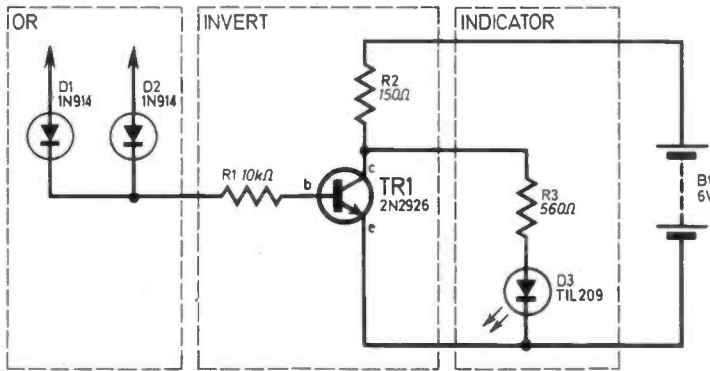
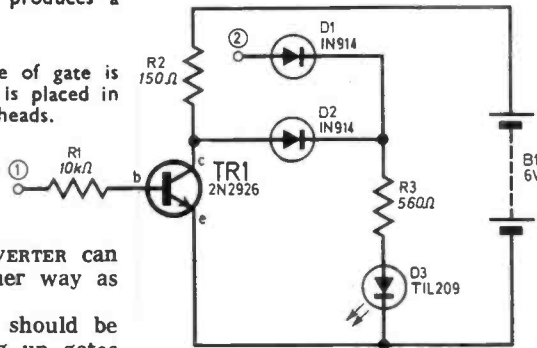


Fig. 2.2. Connecting an OR gate and an INVERTER in series produces a NOR gate.

Fig. 2.3. A different type of gate is produced if the inverter is placed in one of the OR gate input heads.



### ANOTHER GATE

The OR and the INVERTER can be put together another way as shown in Fig. 2.3.

By now the reader should be getting used to wiring up gates and simply wants to know which gates to connect to which, rather than every single component. Symbols are used for the various gates, some of which are shown in Fig. 2.4. Fig. 2.4e shows the symbolic form of Fig. 2.3.

The symbolic form shows that one of the inputs to the OR gate goes through the INVERTER first, the other goes directly to the OR gate.

The reader might like to try predicting the truth table for this circuit before building it.

The solution is shown in Table 2.2.

Problems which can be solved

Table 2.1. Truth Table for Fig. 2.2

Inputs		Output
L	L	H
L	H	L
H	L	L
H	H	L

Table 2.2. Truth Table of Fig. 2.3

Inputs		Output
1	2	
L	L	H
L	H	H
H	L	L
H	H	H

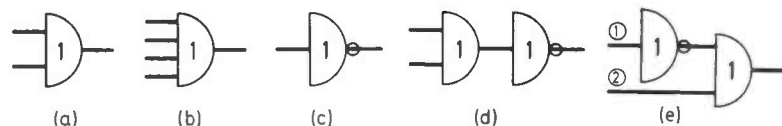


Fig. 2.4. Symbols for some typical gates: (a) Shows a 2-input OR gate (b) a 4-input OR gate (c) an inverter (d) the circuit of Fig. 2.2. (e) the circuit of Fig. 2.3.

which means a lot of components and complicated wiring which leads to potential errors.

### INTEGRATED CIRCUITS

Fortunately it is not necessary to wire up hundreds of resistors, transistors and diodes—electronic engineers have invented special components in which dozens of components are already wired together to make gates. A gate can be taken as a unit and plugged in ready for use.

It might be expected that these complicated components (or integrated circuits) would be very expensive but this is far from true. The mass manufacture makes many of them no more than the price of a single transistor, so both time and money can be saved by using i.c.s.

### MAKING AN I.C. BOARD

The layout of the board which is to be used for the construction of experiments is shown in Fig. 2.5. In fact, there is no need to make up the whole board at once—only one "i.c. socket" and one lamp can be used and the additional components added at a later date.

The board, when complete, has enough space for all the experiments in this series and for many other projects which can be thought up.

### COMPONENTS

When obtaining the parts for the board it would be wise to also purchase the integrated circuits necessary for the first experiments. Those used are from the widely advertised "7400" series of transistor transistor logic (TTL) i.c.s. Be careful not to buy the low

power (e.g. 74L00) types or high speed (e.g. 74H00) versions as these are not suitable for the beginner and are much more expensive.

The construction of the board is quite straightforward. Start by cutting the board to size and make the cuts in the copper

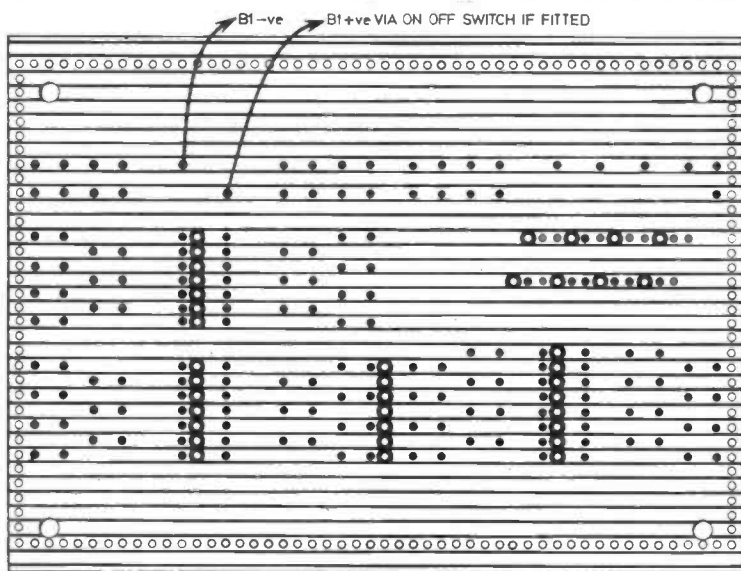
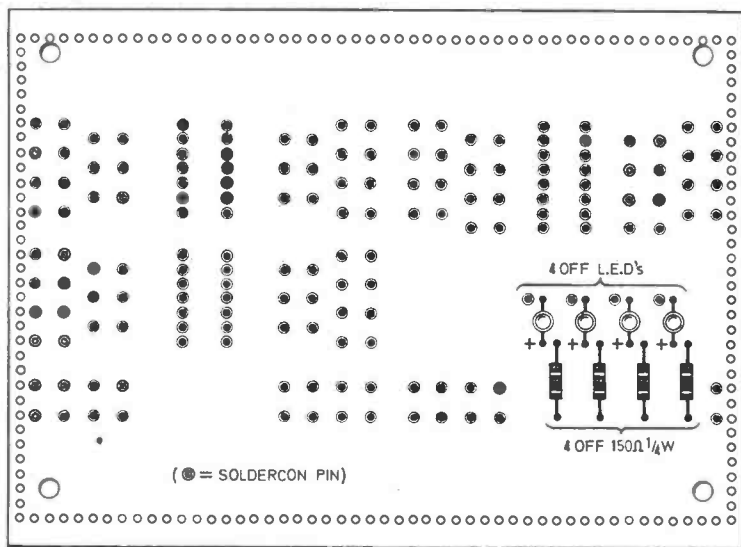


Fig. 2.5. The i.c. breadboard showing the layout of the components and pins on the top side and the breaks to be made on the underside of the strip board.

strips. Insert the four resistors, cut the leads short and solder.

Insert the Soldercon pins; these are used to hold the i.c.s and make connections to the i.c.s.

Next the l.e.d.s must be fitted. Spread the leads carefully and make sure that the leads are the correct way round—cathode to the lower ground rail. Do not overheat when soldering.

Finally connect the two wires for connection to the battery and mount the board on two wooden blocks. If required the complete board can be fixed in a suitable case and an on/off switch inserted as shown in the photographs.

After thoroughly checking the back of the board all is ready for the first experiment with an integrated circuit.

### WORKING WITH AN INTEGRATED CIRCUIT

The first i.c. to be used is the 7402. This is described as a “quadruple two-input NOR gate” which

means that the device contains not just one two-input NOR gate like the one constructed in part 1, but four of them.

Actually, the circuit of each gate is not the same as the circuit of the gate in part 1. In fact, it is a lot more complicated in order to make it more reliable, faster switching and to improve its performance in other ways.

The function of each of the i.c. pins is shown in Fig. 2.6. The diagram is drawn with the i.c. viewed from above—just as the i.c. is viewed when it is in its socket.

Only the pin connections are shown in the diagram—the gates are really all together on a tiny chip of silicon about 1mm square.

The power supply is connected to pins 7 (“ground” or negative) and 14 (positive) and these connections run to all four gates. Apart from these, each gate has its own pins for its two inputs and one output.

Carefully insert the i.c. into the top 14-pin “socket”. Make sure that none of the pins gets bent so avoiding contact with the socket pins. If any are bent remove the i.c., straighten the pin and re-insert.

Using short pieces of insulated wire, make connections from pin 7 to the ground or negative rail at the lower edge of the board and from pin 14 to the positive rail.

Connect the output of one of the gates (pin 1) to a lamp pin. Attach a wire to each of the inputs to the gate (pins 2 and 3) but leave these free. The board should appear as shown in Fig. 2.7.

Re-check for correct orientation of the i.c. (cut-out groove or semi circle or dot towards the top). If the battery is connected when the i.c. is the wrong way round the i.c. may be damaged and at the very least some odd results will be obtained from the experiments.

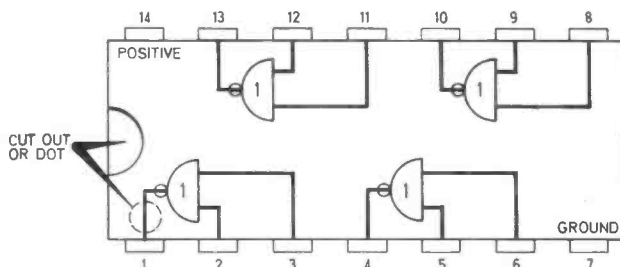


Fig. 2.6. The internal connections of the 7402 integrated circuit.

properly. Try not to leave the battery connected when not actually testing the gates as unused gates take more power than used ones and this might overheat the i.c. This can be overcome by connecting unused inputs to ground but the extra wiring is hardly worth while for the short time that testing requires.

Table 2.4. Truth Table for Fig. 2.9.

Input	Output
L	H
H	L

### USING SEVERAL GATES

Now that so many NOR gates are available, with only two wires going into each and one wire coming out, it is easy to try wiring several gates together to see what can be built from them.

In part 1 gates were built from resistors, diodes and transistors: now whole gates are used as building blocks and complicated circuits can be made from them.

Some suggestions are given in Figs. 2.9 to 2.12. Connect them up and work out the truth tables. Check against those given.

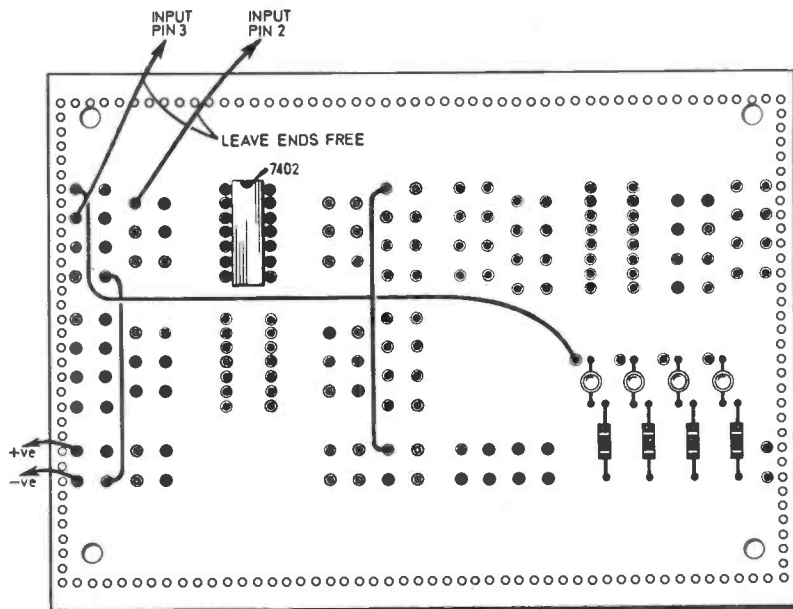


Fig. 2.7. Wiring up of the gates of the 7402.

Remember that the 7400 series work at between five and six volts—the absolute maximum is seven volts. Never connect to a nine volt supply or anything greater.

The battery leads can now be connected, again making sure positive goes to the positive rail and negative to the negative rail.

Try touching the wires from pins 2 and 3 against the pins on the positive and negative rails. Work through the usual sequence: Both to negative, one to negative one to positive; then the other way round; finally both to positive. Make out a truth table to show what happens to the lamp with each input.

Check the results against Table 2.3. Now compare this with Table 2.2. This was the table for an OR gate followed by an INVERTER, which we later said was called NOR for short. Usually there is a simpler way of drawing it too as shown in Fig. 2.8 (and, incidentally in Fig. 2.6).

Check the other NOR gates in the i.c. using the truth table method to see if they are working

Table 2.3 Truth Table for one 7402 NOR gate

Inputs		Output
Pin 1	Pin 2	
L	L	H
L	H	L
H	L	L
H	H	L

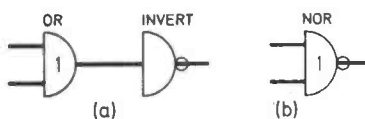


Fig. 2.8. Shows a 2-input OR gate followed by an inverter. These symbols are usually combined into the NOR gate symbol at (b).

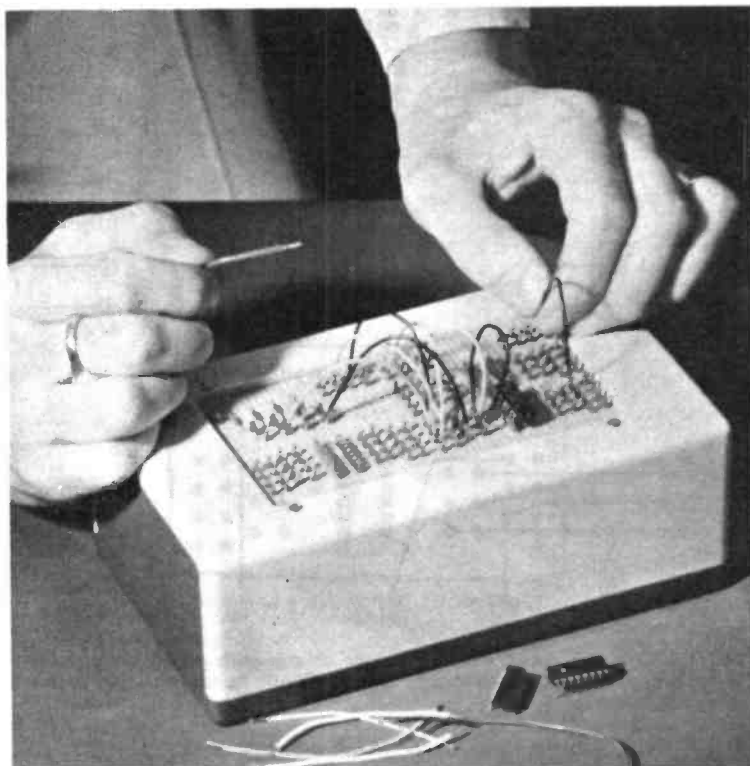


Table 2.5. Truth Table for Fig. 2.10

Inputs		Output
1	2	
L	L	L
L	H	H
H	L	H
H	H	H

Table 2.6. Truth Table for Fig. 2.11

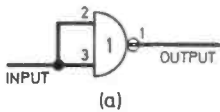
Inputs			Output
1	2	3	
L	L	L	L
L	L	H	L
L	H	L	H
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	L

Table 2.7. Truth Table for Fig. 2.12

Inputs				Output
1	2	3	4	
L	L	L	L	L
L	L	L	H	L
L	L	H	L	L
L	L	H	H	L
L	H	L	L	L
L	H	L	H	L
L	H	H	L	L
L	H	H	H	L
H	L	L	L	L
H	L	L	H	L
H	L	H	L	L
H	L	H	H	L
H	H	L	L	L
H	H	L	H	L
H	H	H	L	L
H	H	H	H	L

There are plenty more combinations of NOR gates that can be tried. Work out some more, find their truth tables and try to write out some problems that the circuits would solve.

To be continued



(a)

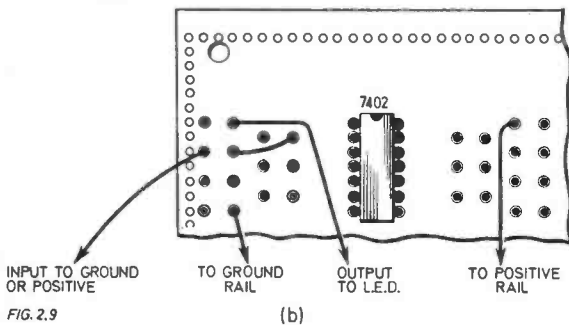
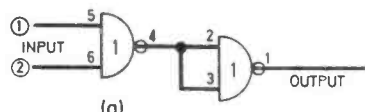


FIG. 2.9

(b)



(a)

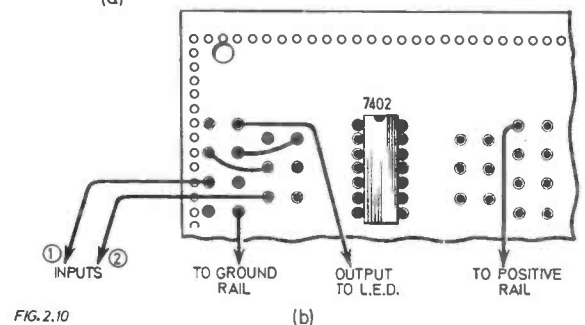
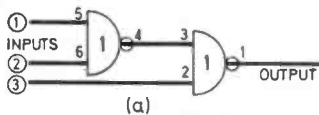


FIG. 2.10

(b)



(a)

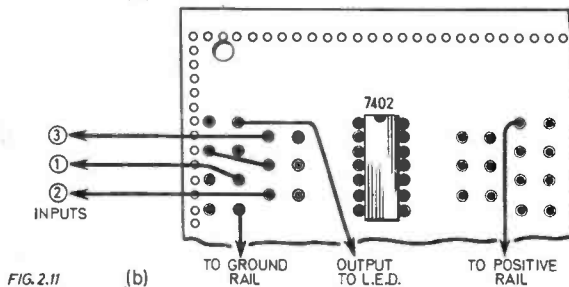
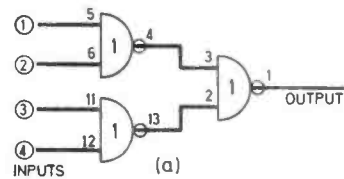


FIG. 2.11

(b)

Fig. 2.9. Connecting two inputs together on one gate produces a type of gate we have met before. Check its truth table and name it.

Fig. 2.11. This gate has three inputs. Check the truth table.



(a)

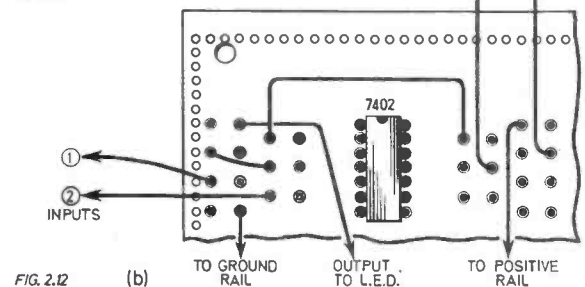


FIG. 2.12

(b)

Fig. 2.10. Here two gates are used in this experiment and again they produce the same truth table as a gate discussed earlier.

Fig. 2.12. Here a four input gate has been made from three NOR gates.



## Retirement Hobby

First, may I say how much I am enjoying your present series of "Teach In" but have now reached the point where I can only follow the practical side, the theoretical part is now beyond my mathematical learning. However, this does not deter me as I can follow the workings if not the whole of the reason why.

I appreciate this opportunity to learn because although I have always had a leaning towards radio, but never had the time to follow it through due to my employment etc., I have decided to make it a hobby for my retirement years and it may surprise you that I am now 60 years old and played about with crystal sets and cats whiskers.

I recently completed your *Matchbox Receiver* but reception in these multi story flats was not too good due I suppose to the steel reinforced concrete; however, I put the set into a slightly larger box and fitted a telescopic aerial and am pleased to say it works well. In the evening I can get numerous foreign stations plus one I have not heard for some time, Radio Caroline.

T. E. Flint,  
Liverpool

## Helping Hand

My main reason for writing is to tell you that last September, I began a course in Radio, T.V. and Electronics (City & Guilds) at Bradford College. In that same month I bought my second copy of *E.E.* and found to my delight, part one of a series for beginners which was to become a useful aid to my course.

I have recently obtained the results and found that I have passed both the Mechanics & Technicians exams with credit. I would therefore like to thank you and Mr. A. P. Stephenson for *Teach In '76*. I am not saying I couldn't have passed without your aid, but it most certainly was a great help.

Malcolm P. Crann,  
Bradford,

## Objection

I have just read *For Your Entertainment* in the August '76 issue of *EE* and I feel I ought to point out to Adrian Hope that the 27MHz band is already

being used for radio controlled modelling and is not in fact "spare" as he appears to assume and I am sure that most radio modellers would object to being turfed out of our allotted band.

Graham Thomas,  
Fife.

## We are not amused

Adrian Hope's remarks (*For Your Entertainment* August 1976) concerning the Citizens band on 27MHz deserves some comment as he completely ignores the existing users of the band, and in particular the many thousands of modellers, legally using this band for the purposes of remote control of vehicles, boats, and aircraft.

The radio control of models is a fast growing hobby and its governing bodies were instrumental in making illegal the use of this band for CB purposes. To suggest that 27MHz should be used for CB on the American style would create many safety hazards especially those operating flying aircraft where injury and loss of life could and would result through interference.

American modellers have foresaken their 27MHz band due to CB interference in favour of 72MHz, which is not available to modellers in the U.K. The only alternative is 458MHz which at this time is completely impractical for the purpose due to transmitter power limitations, complexity, reflection problems and high costs.

Mr. Hope should consult the CB association who know our problems are lobbying for a v.h.f. frequency modulated allocation. It would however seem likely that f.m. will be used increasingly by modellers to resolve existing interference problems on 27MHz.

In our modelling club we have about 140 members and about 110 of these are remote control flyers. We can fly six models only at one time on six frequencies. Can you imagine six models weighing 8 lbs a piece travelling at speed between 40 and 150 m.p.h. careering round the sky due to interference.

John and Peter Pearson,  
Peterlee, Co. Durham.

## Simple Root!

I should like to correct an error in the construction article *C-L Resonance Tester* in *EVERYDAY ELECTRONICS*, September, 1976, which otherwise may confuse some of your readers. On page 482, item (7) dealing with the calibration of the variable capacitor it is stated that if 100pF resonated with the coil at 6.1MHz then 110pF will resonate at  $100 \times 6.1\text{MHz} =$

$\frac{110}{100} \times 6.1 = 5.81\text{MHz}$ . This should of course be  $\sqrt{\frac{100}{110}} \times 6.1 = 5.81\text{MHz}$ . Just above this

the error is compounded with the statement  $\frac{C \text{ original} \times \text{original frequency}}{C \text{ unknown}}$

= new resonant frequency. Here again the square root sign is omitted. It might help some readers with their calibrations if they remember that for small additions of capacitance the frequency decreases by half the amount of the change. This should be sufficiently accurate as a rough and ready guide.

i.e. 10 per cent increase of capacitance = approx 5 per cent decrease in frequency. The same rule applies to inductance.

A. Ferriman  
Wimbledon

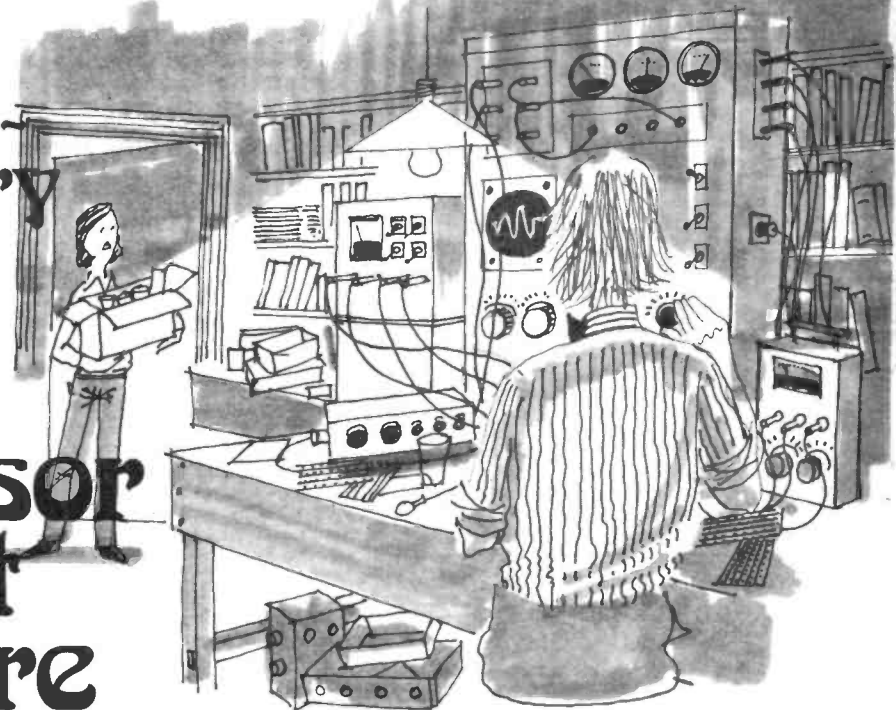
# PLEASE TAKE NOTE

In Fig. 1.3 of *Doing It Digitally* (October 76) diodes D1 to D4 are shown with the incorrect polarity. They should be reversed for correct operation.

We apologise to students of *Teach-In '76* for an error in part 13. In Fig. 13.2a, a resistor  $R_0$  should be connected between TR1 base and  $+V_{cc}$ . Also, capacitor C2 should be labelled C3 and a capacitor C2 inserted in series with TR1 base. Consequently, section 13.2, column 2, line 21 should read . . . . the time constant  $C2 \times R_0$ .

# The Extraordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett



THE Prof's discourse on the use of transistors to reduce the current flowing through delicate sets of contacts was interrupted by the arrival of two more visitors, both young men in their teens, who appeared to be having a peaceful but vigorous argument.

"The tall one is Tom," Bob informed the Prof., "From one of the upper forms at my school."

"Yes, and his companion is Maurice, another of my friends; Hello, Maurice!" the Prof. continued, "what seems to be the problem today?" "Well, Prof.," began Maurice, "it is a problem which is usually solved for us by a local public address engineer. But this time—and the last time also, he has been unable to help us."

"Yes", said Tom, "I wish I knew enough about electronics to be a public address engineer—it is a terrific job—really great! This chap has been hired by a famous band to supervise their sound system during a tour of the States. So he's getting a tour of the States and being paid a fortune for it!

This is the second time he's done it, and unfortunately each time has coincided with an event when we really need his help. The last time, we tried to do without him it was nearly disastrous, and Maurice and I have been racking

our brains for the last few days to try to solve the problem—so we've decided to consult you.

## CHARITY EVENT

The problem is this, Prof.: We've been asked once again to help organise a charity event, with stalls, sideshows and amusements and a dance.

Now our friend usually helps out by loaning his equipment, as we need a sound system during the afternoon for announcements, background music, knockout competitions and performances by local folk singers, and during the

evening we need it for the dance.

Last time, when he wasn't available to help, we used a 50 watt per channel stereo amplifier with 8 ohm output, and to each channel we connected two 8 ohm 20 watt hi fi speakers in parallel. Now, Maurice advised at the time that this was not a wise way to do it, as it would result in a 4 ohm load on the amplifier, which is designed for 8 ohms, and this might damage the amplifier. Also, the speakers were only capable of handling 40 watts and the output of the amplifier might be too much for them if the volume were too high.

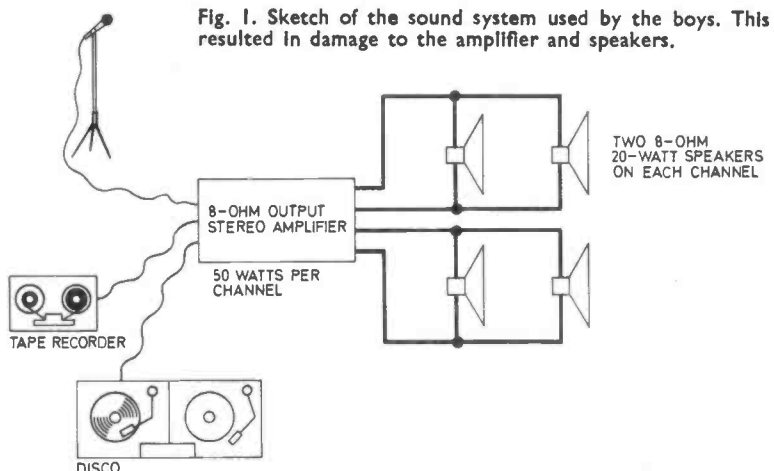


Fig. 1. Sketch of the sound system used by the boys. This resulted in damage to the amplifier and speakers.



For the first time in Britain!

# PHILIPS MIXER AMPLIFIER KITS

- \* Uniquely flexible - you build exactly what you need
- \* Totally reliable - every component made to the highest Philips standards
- \* Amazingly inexpensive \* Available now from SST Distributors

Part of the overall range of Philips Electronic Kits, now available for the first time in Britain, Philips Mixer Amplifier Kits enable you to construct the kind of mixer amplifier you need - easily, confidently, to the highest professional standards.

Unusually flexible, the Philips range is built up in such a way that you can choose from a number of combinations certain that the end result will always be a complete unit - in function and appearance.

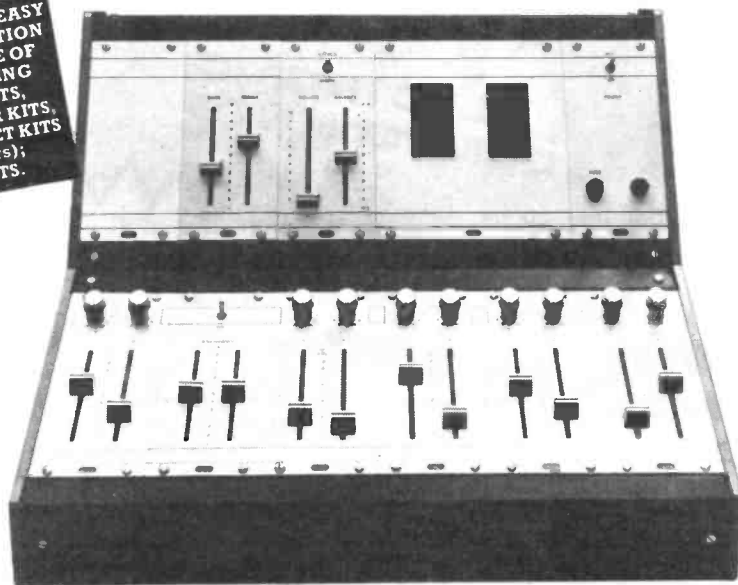
Individual Kits cover the following functions - mixer unit, separate input amplifiers (for microphone, record player, tape recorder or tuner), tone-control unit, level-meter unit with two VU-meters, and a feeder amplifier. In every case, the dimensions of the chassis and the front panel have been standardised to allow for smooth and

simple construction; moreover, the units can be easily interchanged.

The mixer amplifier illustrated is built up of eleven kits; the front panel contains 16 slide controls, 10 rotary controls and 2 large VU-meters. If a simple layout is required, one central tone control unit can be incorporated between the mixer and the feeder amplifier instead of three separate units. In any event, it is usually a good idea to block out your requirements initially in diagram form so that you can see how easily they can be engineered.

Whatever your choice, however, you can be assured that the complete mixer amplifier will amply exceed true hi-fi standards with distortion and signal-to-noise ratio on a professional level.

ALSO AVAILABLE FOR EASY  
AT-HOME CONSTRUCTION  
A COMPLETE RANGE OF  
HI-FI KITS, INCLUDING  
LOUDSPEAKER KITS,  
CROSS-OVER FILTER KITS,  
AUDIO KITS, CABINET KITS  
(for loudspeakers);  
AND HOBBY KITS.



Your skills. Philips quality. An unbeatable combination.

## PHILIPS

Send today for fully  
illustrated catalogue  
and price list

To: SST Distributors  
(Electronic Components) Ltd.

West Road, Tottenham,  
London N17 0RN.

SST Distributors is a member of the Philips Group of Companies.

Name \_\_\_\_\_

Address \_\_\_\_\_

County/Postal Code \_\_\_\_\_

EE10



# BI-PAK NEW Order yours NOW!

## OUR 1977 ILLUSTRATED CATALOGUE

The most comprehensive range of products and technical information ever, including **OVER 800 ADDITIONS** to our list of Semiconductors and Electronic Components. Fully illustrated and designed to be updated as we increase our range. This is **A MUST FOR ALL: ORDER NOW...**

### GP300

115 WATT SILICON TO3 METAL  
V<sub>ceo</sub> 100V. V<sub>ceo</sub> 80V, IC 15A,  
replacement for 2N3055, BDY11  
1.24 25-99  
1.50p 40p

### GP Switching

TO3 SIM. TO 2N7068 BS272/2N7068  
All usable devices. No open and short  
AVAILABLE IN PAK similar to 2N7068  
20 for \*80p. 50 for \*1.10 for \*1.50p.  
1,000 for \*1.4.  
When ordering please state NPN or PNP

## BI-PAK

### SEMICONDUCTORS

## ELECTRONIC COMPONENTS

Catalogue

... EVERY COPY  
CARRIES A SPECIAL  
DISCOUNT ORDER FORM

## TRANSISTORS

... AND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price
BF117	*0.40	BFY53	*0.13	OC75	*0.10
BF118	*0.71	BSY10	*0.10	OC76	*0.10
BF119	*0.71	BSX20	*0.10	OC77	*0.20
BF132	*0.86	BSY25	*0.10	OC81	*0.10
BF133	*0.40	BSY26	*0.10	OC81D	*0.10
BF154	*0.40	BSY27	*0.10	OC85	*0.10
BF155	*0.71	BSY28	*0.10	OC82D	*0.10
BF156	*0.40	BSY29	*0.10	OC83	*0.20
BF157	*0.86	BSY38	*0.10	OC139	*0.20
BF158	*0.86	BSY39	*0.10	OC140	*0.23
BF159	*0.41	BSY40	*0.20	OC169	*0.20
BF173	*0.18	BSY41	*0.20	OC170	*0.20
BF176	*0.38	BSY95	*0.13	OC171	*0.20
BF179	*0.31	BSY96A	*0.13	OC200	*0.20
BF180	*0.31	BU105	*1.00	OC201	*0.20
BF181	*0.31	MJE821	*0.80	OC202	*0.20
BF184	*0.10	MJE2955	*0.80	OC303	*0.20
BF195	*0.10	MJE3055	*0.87	OC304	*0.20
BF196	*0.82	MJE3440	*0.81	OC305	*0.30
BF197	*0.12	MPF102	*0.23	OC71	*0.44
BF198	*0.12	MPF106	*0.23	ORP12	*0.44
BF257	*0.25	OC19	*0.20	ORP80	*0.41
F258	*0.30	OC20	*0.20	ORP81	*0.41
F259	*0.40	OC22	*0.47	TIP29	*0.40
262	*0.30	OC23	*0.40	TIP30	*0.40
263	*0.30	OC24	*0.87	TIP31A	*0.42
270	*0.30	OC25	*0.35	TIP32A	*0.60
271	*0.31	OC26	*0.20	TIP41A	*0.50
272	*0.81	OC29	*0.90	TIP42A	*0.72
273	*0.30	OC29	*0.90	TIS43	*0.25
274	*0.30	OC38	*0.45	UT48	*0.20
275	*0.25	OC36	*0.51	ZTX107	*0.07
276	*0.19	OC41	*0.20	ZTX108	*0.07
277	*0.19	OC42	*0.25	ZTX109	*0.07
278	*0.19	OC44	*0.10	ZTX300	*0.07
279	*0.19	OC45	*0.13	ZTX500	*0.00
280	*0.19	OC70	*0.10	2N695	*0.10
281	*0.19	OC71	*0.10	2N697	*0.10
282	*0.19	OC72	*0.10	2N698	*0.20
283	*0.19	OC74	*0.10	2N699	*0.20

**WORLD SCOOP!**

APPROX. 300 PAGES  
Assorted full-out integrated circuit  
Logic. 74 series. Linear. Audio.  
Many coded devices but some un-  
to identify.

**OUR SPECIAL PRICE**

**P&P**  
Postage and Packing add 25p unless  
otherwise shown. Add extra  
airmail. Minimum order £1.

★ **Indicators**  
3015F Mintron 7 Segment Indicator £1.10

**L.E.D. DISPLAYS**  
DL787 Common anode 0.3" 8p. DL787  
common anode 0.6" £1.70. DL737 Double  
Display, common anode 0.5" £2.00

**L.E.D.'s**  
Available in 0.125" and 0.2" dia lenses  
RED 16p. GREEN 17p. YELLOW 17p.

★ **74 Series**

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL  
FAMOUS MANUFACTURERS

Type	1	25	100+
7400	0.00	0.00	0.00
7401	0.10	0.00	0.00
7402	0.11	0.10	0.00
7403	0.11	0.10	0.00
7404	0.13	0.12	0.11
7405	0.13	0.12	0.11
7406	0.25	0.24	0.23
7407	0.25	0.24	0.23
7408	0.15	0.14	0.13
7409	0.15	0.14	0.13
7410	0.00	0.00	0.00
7411	0.23	0.22	0.21
7412	0.20	0.20	0.24
7413	0.20	0.20	0.25
7416	0.20	0.27	0.28
7417	0.20	0.27	0.28
7420	0.12	0.11	0.10
7422	0.20	0.27	0.26
7423	0.30	0.28	0.26
7425	0.30	0.28	0.26
7426	0.30	0.28	0.26
7427	0.30	0.28	0.26
7428	0.42	0.30	0.30
7430	0.12	0.11	0.10
7432	0.30	0.28	0.26
7433	0.39	0.27	0.25
7437	0.30	0.20	0.20
7438	0.30	0.20	0.20
7440	0.12	0.11	0.10

Type	1	25	100+
7448	0.00	0.70	0.70
7450	0.12	0.11	0.10
7451	0.12	0.11	0.10
7453	0.12	0.11	0.10
7454	0.12	0.11	0.10
7460	0.12	0.11	0.10
7470	0.25	0.24	0.23
7472	0.22	0.21	0.20
7473	0.20	0.24	0.23
7474	0.27	0.25	0.23
7475	0.40	0.40	0.44
7476	0.25	0.24	0.23
7480	0.30	0.40	0.40
7481	£1.37	£1.35	£0.33
7482	0.83	0.81	0.70
7483	0.00	0.00	0.04
7484	0.00	0.00	0.00
7485	£1.25	£1.20	£1.15
7486	0.32	0.30	0.29
7489	£2.90	£2.00	£2.70
7490	0.37	0.35	0.33
7491	0.00	0.00	0.00
7492	0.43	0.42	0.41
7493	0.43	0.42	0.41
7494	0.43	0.42	0.41
7495	0.70	0.68	0.66
7496	0.60	0.60	0.64
7499	£1.90	£0.90	£0.90
74100	0.40	0.38	0.38
74104	0.40	0.38	0.38

WORLD SCOOP!!

JUMBO SEMICONDUCTOR PAK  
Transistors-Germ. and Silicon.  
Rectifiers-Diodes. Triacs-Thyristors-I.C.'s and  
Zeners. ALL NEW AND CODED.  
Approx. 100 pieces only \*1.80p.

**ZENER DIODES**  
FULL RANGE IN STOCK. 2-33 Volts  
400mW 8p 1.5W 17p 10W \*30p

# BI-PAK

**P.O. BOX 6, WARE · HERTS**

SHOP AT 18, BALDOCK ST, WARE, HERTS.  
OPEN 9 to 5.30 Mon/Sat. Tel: 61593

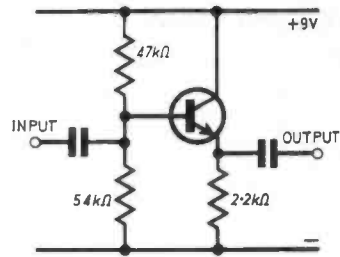
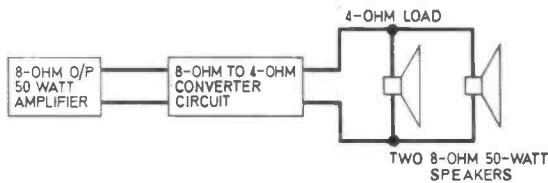
**VAT CHAT**

Please add 12½%  
to prices marked\*.  
Remainder add 8%

**NEIGHBOURS**

TO3 Plastic Encapsulation  
M.A.7805/L120 5V  
(equiv. to MVR5V) £1.25  
M.A.7812/L130 12V  
(equiv. to MVR12V) £1.25

Fig. 2. The block diagram and circuit of an impedance converter drawn by Bob.



## DAMAGE

Someone advised us that it would be O.K. to use the 20 watt speakers, and to run the amplifier with 4 ohms instead of 8, as long as we kept the volume control setting low, and this is what we did. It was O.K. all through the afternoon and for most of the evening, but just near the end of the evening someone got a little over excited and put on some very loud music.

The loudspeakers on one channel suddenly began to sound distorted—but before anyone could do anything about it, one channel of the amplifier blew with a loud hum and a crackle, and the whole sound system became silent.

We got the amplifier mended, and we had to buy two replacement speakers. Now if we want to use that amplifier again, we would like to know how to do it properly. This time I've managed to get two 50 watt 8 ohm speakers.

"So have I," broke in Maurice, "which means that the speakers we now have at our disposal have sufficient power handling capability not to be damaged by the power of the amplifier, and we

also have four speakers, which is the minimum number we need to cover the event.

But if we connect two of these in parallel to each channel of the amplifier, this will once again mean a mismatch, because the two 8 ohm speakers in parallel would give 4 ohms, which is wrong as the amplifier needs an 8 ohm load. So, Prof., we still need your help, it seems."

Maurice fished a much-used notebook from his duffel-bag and thumbing through it he showed a diagram to Bob and the Prof. (Fig. 1).

"This is a sketch of the sound system we used last time, Prof." he said, "and eventually it caused damage to both amplifier and speakers. Now, if we used 50 watt speakers instead of 20 watt ones, the speakers would be safe—but not the amplifier."

## IMPEDANCE CONVERTER

"I've got an idea!" exclaimed Bob. Maurice, too deep in thought to speak, offered Bob his pencil and, indicated that Bob should go ahead and use his notepad.

Maurice had drawn a sketch of

an amplifier (8 ohm output) and two 8 ohm speakers in parallel (4 ohm load). Now Bob drew, in between these, a box which he labelled '8 ohm to 4 ohm converter' (Fig. 2), and next to this he drew a circuit diagram of an impedance converter.

"Prof.," he asked, "I have been reading about impedance converters which convert a signal to a lower impedance without the problems of using an audio transformer. Can a circuit like this be used for matching loudspeakers to power amplifiers?"

## HIGH POWER

"Yes", replied the Prof. "Though the circuit which you have drawn is not suitable for use with high-power amplifiers and loudspeakers. It is a very handy circuit for use with low level signals of a few millivolts. But what Tom and Maurice need for matching these speakers to the amplifier, is a special kind of impedance converter. It is a very simple and effective circuit, by means of which you can match a larger number of loudspeakers to one audio amplifier."

To be continued

# JACK PLUG & FAMILY...



# GEORGE HYLTON brings it down

## IMPEDANCE MATCHING

THE literature of electronics abounds with references to impedance matching. One reads about matching a loudspeaker to an amplifier, for instance. What does it mean?

Matching, in these cases, is about the transfer of signals from one place to another; e.g. the transfer of audio signals from amplifier to speaker, or of the output of a radio transmitter to its aerial.

Often the object of matching is to transfer as much power as possible from a source of power to a load. But sometimes (this is especially true of amplifiers with class B output stages) it is more a question of drawing the correct amount of power rather than the maximum possible. The maximum might overload the amplifier.

Most signal sources can be represented accurately, for the purpose of studying matching, by a voltage generator in series with a resistance. In Fig. 1 these are labelled  $V_s$  and  $R_s$  ("s" for source). The load is  $R_L$  and the voltage across it  $V_L$ . The current,  $I$ , being the same for source and load, needs no other letter to identify it.

In practical cases you are usually stuck with a particular

value of  $R_s$  but you can vary  $R_L$ . The condition for maximising  $I$  is then obvious from the circuit. Reduce  $R_L$  as much as possible. In the limit, when  $R_L=0$ ,  $I$  is as large as it can be.

Looking now at the voltage, with an unalterable  $R_s$ , the way to maximise  $V_L$  is to increase  $R_L$ . (This is why, in general, voltage-driven amplifiers are designed to have a high input impedance: it maximises the transfer of voltage from the source to the amplifier.)

Power, however, is voltage times current. The power in  $R_L$  is  $I \times V_L$ . So in cases where the amount of power transferred from source to load has to be maximised, we must somehow maximise  $I$  times  $V_L$ . Maximising  $I$  alone (by reducing  $R_L$ ) doesn't help, because as  $R_L$  is reduced,  $V_L$  is reduced, until finally  $R_L$  is a short circuit, with maximum current through it, but no voltage across it. The power is zero, so that's no good. Maximising  $R_L$  raises  $V_L$ , but in the limit, when  $R_L$  is infinite,  $V_L$  is maximum (equal to  $V_s$ ) but  $I$  is zero. No power again.

load power is maximised, the efficiency is not. The efficiency is only 50 per cent. In many cases, it is just not possible to operate a power source at 50 per cent efficiency, because the waste of power inside the source itself (in  $R_s$ ) raises the temperature of the source to a dangerous level. It "burns out". For this reason, the "optimum load" for many power sources is not the value of  $R_L$  which maximises the power but the one which just raises the internal temperature of the source to its safe limit.

In cases like this,  $R_L$  is greater than  $R_s$  and the efficiency is greater than 50 per cent. So, although you get less power, you also waste less. As a general rule, it is safe to operate a power source into a load resistance greater than the optimum load.

## EXAMPLE

If, for example, an audio amplifier is rated to deliver 100 watts into 4 ohms, it is generally safe to

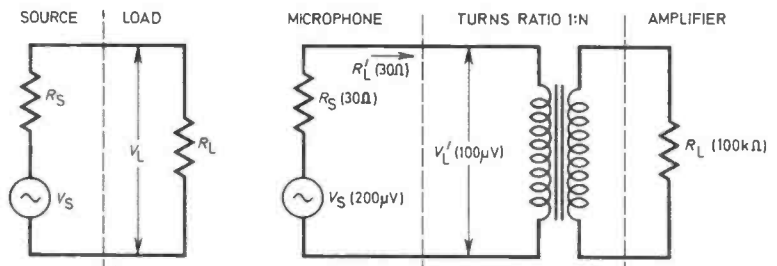


Fig. 1. Signal source and load.

Where is the happy medium between these extremes? There must be some value of  $R_L$  which allows, simultaneously, enough  $I$  and  $V_L$  to maximise the power. (That is the load power, the power in  $R_L$  itself.)

The solution is to make  $R_L=R_s$ . Then half the voltage appears across  $R_L$  and the current  $I$  is half its maximum (short circuit load) value. Under these circumstances the greatest possible amount of power is transferred from source to load.

## EFFICIENCY

There is however a penalty. Just as much power is now spent in  $R_s$  as in  $R_L$ . So, although the

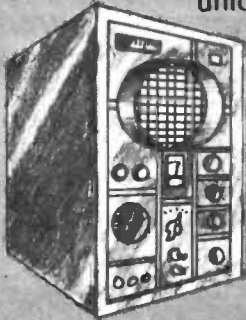
power output will be reduced but the dissipation inside the amplifier will probably also be reduced and certainly won't be increased. (But be careful with multiple speakers drive through crossover networks. Both the network and the speaker impedances must be changed.)

Using a load resistance less than the rated 4 ohms may increase the dissipation inside the amplifier and damage it. You can see from Fig. 1 why a short-circuit can damage an amplifier. If you make  $R_L=0$ , all the power is then spent in  $R_s$ . Class B amplifiers are very vulnerable to this kind of overload, class A much less so.

# to earth

# 1. Understand electronics.

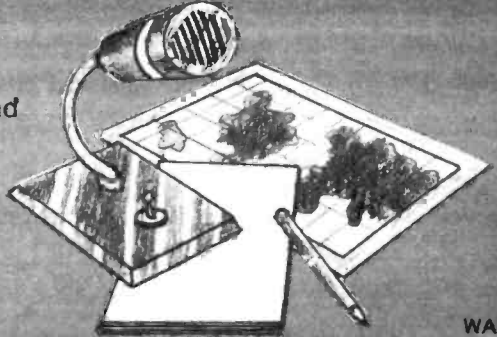
Step by step, we take you through all the fundamentals of electronics and show you how easily the subject can be mastered using our unique Lerna-Kit course.



- (1) Build an oscilloscope.
- (2) Read, draw and understand circuit diagrams.
- (3) Carry out over 40 experiments on basic electronic circuits and see how they work.

# 2. Become a radio amateur.

Learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence.



WAA

**Free!**

Brochure, without obligation to:  
**BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL,**  
 P.O. Box 156, Jersey, Channel Islands.

EEC II

NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_ Block caps please



## Are you only **HALF** a Constructor?



For a year or two I was only half a constructor—struggling along trying to find the right components by tramping from shop to shop. Then I discovered Home Radio and their marvellous Components Catalogue! It's made life so much simpler for me—I can soon locate just what I need and then order by phone. I really feel that now I can claim to be a *complete* constructor.

The Home Radio Components Catalogue consists of 200 pages containing some 5,000 items, nearly 2,000 of them illustrated. Everything is set out so clearly the catalogue is a pleasure to use. When you buy one you also receive *free* a mini catalogue filled with super bargains. The saving on some of your purchases from this bargain list alone can more than pay for your catalogue. The catalogue costs £1 plus 40p for postage and packing. Why hesitate? Send off your cheque or P.O. for £1.40 now, and discover the satisfaction of being a *complete* constructor.

Please write your Name and Address in block capitals

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_



**POST THIS COUPON**  
 with cheque  
 or p.o. for  
**£1.40**

HOME RADIO (Components) LTD., Dept EE,  
 234-240 London Road, Mitcham, Surrey CR4 3HD  
 (Reg. No London 912966)

HOME RADIO (Components) LTD, Dept EE, 234-240 London Road, Mitcham, CR4 3HD Phone 01-648 8422

# B. BAMBER ELECTRONICS

Dept EE, 5 STATION ROAD, LITTLEPORT, CAMBS., CB6 1QE  
Telephone: ELY (0353) 860185 (2 lines) Tuesday to Saturday

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

FREE WELLS 25W (SP25) SOLDERING IRON (worth £3.24 inc. VAT) with all orders over £20 Limited period only. Send now.

**VARIABLE STABILISED POWER SUPPLY.** mains input, 0-24V output, stabilised and current limiting at 500mA + 32V at 500mA output. Brand new by British manufacturer. Size approx. 7 1/2 x 2 1/2 x 4 in. complete with external 5A 0.3 turn pot for voltage control. Connection data supplied. £7.

**50uA (25-250uA) EDGEWISE METERS,** modern type by Sangamo Western, display area 1 x 1 1/2 in with 2 mounting lugs. (Can be zeroed left or right hand.) £1.50 each, white stocks last.

**MAINS ISOLATION TRANSFORMERS.** Tapped mains input, 240V at 5A + 12V at 500mA output. New, boxed, made by Gardners. £12.

**FLEXIBLE HEATER STRIP, 240V a.c., 150W,** approx. 1 metre long (insulated with fibreglass) with mains connector block. Many, many uses. 60p each.

**HEAVY DUTY RELAYS, 24V d.c.,** operated (will work on 18V) 3 heavy duty make contacts (around 10A rating) + 4 change over contacts + 1 break contact. New, complete with mounting bracket (ideal for switching HT on Lincars.) Many uses for this high quality unit. £1.50 each.

Good Quality Pressure Gauges. 2 1/2 in dia. flange mounting. 3 models avail. 0-60 lb/in. 0-100 lb/in. 0-200 lb/in. in. state which £1.25 each.

**2N3055 type Transistors, O.K.,** but unmarked. 5 for £1.

**110V NEONS, SCREW-IN-TYPE, 4 for 50p.** SLOW MOTION MOTORS (available for programs, displays, etc.) 230-240V a.c. input, rotation between 1 and 2 revs per minute. £1.25 each.

**MINIATURE PLIERS** High quality "Crescent" made in USA. £4.35 + VAT (35p).

**SIDE CUTTERS,** high quality "Crescent", made in USA. £4.45 + VAT (46p).

**MIXED COMPONENT PACKS,** containing resistors, capacitors, switches, pots, etc. All new (random sample bag revealed approx. 700 items). £2 per pack, white stocks last.

**TUNED COILS, 2 section coils, around 1MHz,** with a black smart tuning knob, which moves an internal core to vary the inductance, many uses, easily rewound, 3 for 50p.

**HIGH QUALITY SPEAKERS, 8 1/2 in x 6 in elliptical,** only 2in deep, inverse magnet, 4 ohms, rated up to 10W. £1.50 each or 2 for £2.75 (qty. discount available + 12 1/2% VAT).

**TO3 transistor insulator sets, 10 for 50p.**

**MINIATURE 2 PIN PLUGS AND SOCKETS** (fit into pin hole, pins enclosed, with covers for chassis mounting, or can be used for in-line connectors). Bargain pack of 3 plugs + 3 sockets + covers, 50p.

**PROGRAMMERS** (magnetic devices). Contain 9 microswitches (suitable for mains operation) with 9 rotating cams, all individually adjustable, ideal for switching disco lights, displays, etc., or industrial machine programming. (Need slow motion motor to drive cams, not supplied) 9 switch version £1.50.

**HEAVY DUTY HEATSINK BLOCKS,** undrilled, base area 2 1/2 in x 2 in, with 6 fins, total height 2 1/2 in 50p each.

**SPERRY 7-SEGMENT P.G.D. DISPLAYS,** digit height 0.3in red, with decimal points. 150V to 200V (nominal 180V) operation. These are high-volt industrial type and therefore brighter than most similar displays. All brand new. AT THE BARGAIN PRICE OF 50p PER DIGIT. TYPE 332 (three digits on one mount) £1.50. (Sorry, no single digit available.) Data Supplied.

**BSX20 (VHF Osc/Mult), 3 for 50p.** BC108 (metal can), 4 for 50p. PBC108 (plastic BC108), 5 for 50p. BCY72 Transistors, 4 for 50p.

**PNP audio type TOS Transistors, 12 for 25p.** BF152 (UHF amp/mixer), 3 for 50p. 2N3819 Fet., 3 for 50p. BA121 Varicap Diodes, 4 for 50p. 1N914 diodes, 10 for 25p.

**SMALL MAINS SUPPRESSORS** (small chokes, ideal for radio, Hi-Fi inputs, etc.) approx. 1/2 in x 1 1/2 in, 3 for 50p.

**PERSPEX TUNER PANELS** (for FM Band 2 tuners) marked 88-108 MHz and Channels 0-70, clear numbers, rest blacked out, smart modern appearance, size approx. 8 1/2 in x 1 1/2 in, 2 for 35p. Lead suppressors (10kOhm) for mobile plug leads, 4 for 50p.

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

**ALU-BOL ALUMINIUM SOLDER** (made by Multi-core). Solders aluminium to itself or copper, brass, steel, nickel or tinplate. 16 a.w.g. with multicore flux, with instructions. Approx. 1 metre coil 30p pack. Large reel (approx. 12 metres) £2.75.

**1 1/2 in polythene chassis mounting fuseholders, 6 for 30p.** I.C.s, some coded. 14 DIL type, untested, mixed, 20 for 25p.

**Mobile Converters, 24V DC input 13.8V at approx 3-5Amps, 2 separate transformers, £3.50 each** (ideal for running 12V car radio from 24V lorry battery).

**RS Midget 3 pole 4 way, rotary switches, 40p each.**

**We now stock Spiralax Tools** for the electronic enthusiast. Screwdrivers, Nut Spanners, BA and Metric sizes, pop rivet guns, etc. S.A.E. for list.

**I.F. Cans, 1/2 in squares, suitable for rewind, 6 for 30p, + 12 1/2% VAT.** Miniature earphones with min. jack plug, 2 for 50p + 12 1/2% VAT.

**TWIN I.F. CAMS, approx. 1 1/2 in x 1 1/2 in high,** around 3-5Amps, 2 separate transformers in 1 can, internally screened. 5 for 50p + 12 1/2% VAT.

**Dubilier Electrolytics, 50uF, 450V, 2 for 50p.** Dubilier Electrolytics, 100uF, 275V, 2 for 50p. Plessey Electrolytics, 470uF, 63V, 3 for 50p. TCC Electrolytics, 1000uF, 30V, 3 for 50p.

**Plessey Electrolytics, 1000uF, 180V, 40p each** (3 for £1). Dubilier Electrolytics, 5000uF, 35V, 50p each. Dubilier Electrolytics, 5000uF, 50V, 80p each.

**ITT Electrolytics, 5800uF, 25V, high grade, screw terminals, with mounting clips, 50p each.** Plessey Electrolytics, 10,000uF at 63V, 75p each. Plessey Cathodray Capacitors, 0-0.4uF at 12-5kV DC. Screw terminals, £1.50 each.

**PLEASE ADD 12 1/2% VAT TO ALL CAPACITORS.**

**A LARGE RANGE OF CAPACITORS AVAILABLE AT BARGAIN PRICES, S.A.E. FOR LIST.**

**TV PLUGS AND SOCKETS** TV Plugs (metal type), 5 for 50p. TV Sockets (metal type), 4 for 50p. TV Line Connectors (back-to-back sockets), 4 for 50p. Please add 12 1/2% VAT.

**PLUGS AND SOCKETS** N-Type Plugs 50 ohm, 60p each, 3 for £1.50. N-Type Sockets (4-hole chassis mounting), 50 ohms (a small coax lead type), 50p each. PL259 Plugs (P7FE), brand new, packed with reducers, 65p or 5 for £3.

**SO230 Sockets (P7FE), brand new** (4-hole fixing type), 50p each or 5 for £2.25. 25-way ISEP Plugs and Sockets, 40p set (1 plug + 1 socket).

**Plugs and sockets sold separately at 25p each.** Bulgin Round Free Sits, 3 pin, for mains input on test equipment, etc., 25p each.

**WELLS SOLDERING IRONS** EXPERT, Built-in spotlight illuminates work. Pistol grip with fingertip trigger. High efficiency copper soldering tip.

**EXPERT SOLDER GUN, £8.90 + VAT (54p)** EXPERT SOLDER GUN KIT (spare bits case, etc.) £12.90 + VAT (78p).

**SPARE BITS, PAIR, 30p + VAT (2p)** MARKSAM SOLDERING IRONS SP15D 15W £3 + VAT (24p) SP25D 25W £3 + VAT (24p) SP25DK 25W + bits, etc. kit £2.85 + VAT (31p) SP40D 40W £3.44 + VAT (28p)

**BENCH STAND with spring for Marksam Irons, £2.25 + VAT (18p)**

**SPARE BITS** M78 for 15W, 40p + VAT (4p). M74 for 25W, 30p + VAT (3p). M710 for 40W, 40p + VAT (3p).

**TCPI TEMPERATURE CONTROLLED IRON,** Temperature controlled iron & PSU, £20 + VAT (1.60)

**SPARE TIPS** Type CC single flat tip, Type K double flat fine tip, Type P, very fine tip, £1 each + VAT (8p). ALL SPARES AVAILABLE

**MULTICORE SOLDER** Size 5 Savitl 16 a.w.g. in alloy dispenser, 32p + VAT (3p). Size C15AV18 Savitl 18 a.w.g. 50p + VAT (4p). Size C15AV19 Savitl 19 a.w.g. on plastic reel £1.80 + VAT (15p)

Terms of Business: CASH WITH ORDER. MINIMUM ORDER £1. ALL PRICES INCLUDE POST & PACKING (UK ONLY). SAE WITH ALL ENQUIRIES Please. PLEASE ADD VAT AS SHOWN. ALL GOODS IN STOCK DESPATCHED BY RETURN. CALLERS SATURDAYS ONLY 9.30-12.00, 1.30-5.00.

## 110 Electronic Alarm Projects for the Home Constructor

R. M. Marston

This is the latest addition to the author's popular series of electronic project books. It brings together 110 useful alarm circuits of a variety of types to intrigue the amateur the student and the engineer.

Contents: Contact-operated alarm circuits; Burglar alarm circuits; Temperature-operated alarm circuits; Light-sensitive alarm circuits; Miscellaneous alarm circuits; Automobile alarm circuits; Instrumentation alarm circuits; Appendix; Index.

120 pages 0 408 00269 7 £2-95

Order from



**Newnes Technical Books**

NEWNES-BUTTERWORTHS

Borough Green, Sevenoaks, Kent TN158PH

## CRESCENT RADIO Ltd.

164-166 HIGH ROAD LONDON N22 6EJ  
(also) 13 SOUTH MALL, Edmonton, N.9  
MAIL ORDER DEPT. 1 St Michaels Terrace Wood Green  
London N22 4SJ Phone 888 3206 & MAIL ORDER 888-4474

**POWER PACKS**  
PP1 Switched 3, 4, 6, 7, 9 and 12 volt @ 500 mA, with on/off switch and pilot light.  
Size = 130 mm x 55 mm x 75 mm  
ONLY = £4.50 + 8%

**CASSETTE MICROPHONE**  
On/Off switch for Remote Control. Split Lead with 2.5mm and 3.5mm plugs. Standard Cassette Mics to suit all types. Complete with Desk Rest. Please state which impedance required 200ohm/50K ohm.  
PRICE £1.80 + 12 1/2% VAT.

**P.C. ETCHING KIT**  
This kit contains all that the constructor will need to etch the circuits of his own design.  
Contents—Plastic etching dish. Sample copper clad board. Laminate Cutter. 1 lb Ferric Chloride. Large Plastic Spoon. Etch Resist Pen. Full Etching Instructions. Complete and Big Kit Value at £3.75p + 8% VAT.

**FERRIC CHLORIDE**  
Anhydrous ferric chloride in double sealed one pound Poly packs.  
OUR PRICE — 65p + PP + 8% per lb.

**2in. PANEL METERS**  
Size 59mm x 46mm  
0.50uA —ME5  
0.100uA —ME7  
0.500uA —ME8  
0.1mA —ME9  
0.5mA —ME10  
0.10mA —ME11  
0.50mA —ME12  
£3.50 + 8%

0.100mA —ME13  
0.500mA —ME14  
0.1A —ME15  
0.50V —ME16  
0.300V a.c. —ME17  
8 meter —ME18  
V.U. meter —ME19

**Wireless soldering iron wahl "Hot-Top"**  
★ Completely Portable  
★ Solders up to 160 joints per charge  
★ Re-charges in its own stand  
★ Fine tip for all types of soldering  
★ Only 8" long and weighs just 6 ozs.  
Our Price 29.75. Plus 8% VAT  
(Spare bits are available)

**"G100" 100WATT AMPLIFIER**  
All built and tested, mounted on a plain aluminium chassis which measures 18" x 9 1/2" x 4" and which you can mount into a cabinet of your choice. Four Controlled Inputs, Master Volume, Treble, Middle and Bass Controls. S/C protected output. 100 watts Clean into 8ohm L/S. Ideal for Disco, Music Groups, PA and Clubs.  
A Bargain at £42 + £1 carr. + 8% VAT.

**T1 MULTI-METER**  
Ideal tester for everybody interested in electronics. Weighing less than 100 grammes and only 60mm x 24mm x 90mm.  
Ranges: AC volts: 0-10v, 50v, 250v, 1,000v.  
DC volts: 0-10v, 50v, 250v, 1,000v.  
DC current: 0-1mA, 0-100mA.  
Resistance: 0-150K ohm.  
PRICE £4.75 + VAT 8%

**MMH LOUDSPEAKERS**  
2 1/2" 80 ohm 60p  
2 1/2" 40 ohm 60p  
2 1/2" 8 ohm 60p  
+ 12 1/2%

**GOODMANS CROSSOVER**  
3 way 8 ohm Crossover manufactured by Goodmans. Bargain at £1 + 12 1/2%.

U.K. CARR. All prices are excluding VAT. Please add to each item the VAT rate indicated to all orders

# GREENWELD

443 Millbrook Road Southampton  
SO1 0HX Tel: (0703) 772501

OPEN 6 DAYS A WEEK, 9 to 5, Callers Welcome.

VAT INCLUSIVE PRICES—NO  
EXTRAS TO PAY, JUST ADD  
20p POST.

## VEROBOARD

100 sq ins asstd size offcuts (no tiny bits). All 0.1 or mixed £1.20. 17 x 3 1/2" x 0.1 sheets £1.80.

## CAPACITORS

Miniature ceramic plate. 50V 5%. 22pF to 1000pF 2p; 1500F to .047uF 4p. Polystyrene, 150V 2 1/2%. 10pF to 1000pF 4p; 1200pF-10,000pF 6p; Polyester 250V Mullard C280 01 to 0.1uF 4p; .15, 22.5p; .33 6p; .47 8p; .68 10p; 1uF 12p; 2.2uF 16p; 3.3uF 63V 24p. Electrolytic, 0.47, 1, 2, 2.4, 7, 10, 22, 47uF 25V all 6p; 100uF 25V 7p; 100uF 63V 8p; 220uF 16V 7p; 220uF 25V 9p; 220uF 50V 11p; 470uF 16V 9p; 470uF 25V 11p; 470uF 63V 18p; 1000uF 16V 15p; 1000uF 25V 18p; 1000uF 50V 32p; 2200uF 16V 20p; 2200uF 25V 27p; 2200uF 40V 48p; 4700uF 16V 43p. All are wire ended horizontal mounting types.

## TRANSISTORS AND IC's

AC127 15p BD131 38p 2N2369 22p  
AC128 15p BD132 40p 2N2646 42p  
AC178 18p BD138 40p 2N2926G 12p  
AC187 18p BD139 44p  
AC188 18p BD140 46p 2N3053 18p  
AD161 40p BF161 28p 2N3054 49p  
AD162 40p BF194 14p 2N3055 38p  
BC107 10p BFX29 22p 2N3440 54p  
BC108 10p BFX84 20p 2N3442 12p  
BC109 18p BFX50 19p  
BC109C 15p BFX51 15p 2N3702 10p  
BC182 12p BFX52 15p 2N3703 10p  
BC183 12p TIP41A 60p 2N3704 10p  
BC184 12p TIP42A 75p 2N3705 10p  
BC212 14p TIP2955 96p 2N3708 10p  
BC213 14p TIP2055 42p 2N3819 22p  
BC214 14p  
BCY70 15p 2N706 13p 2N4418 10p  
BCY71 15p 2N1613 20p 2N5294 30p  
BCY72 15p 2N2219 26p 40673 50p  
741 8 pin DIL 25p; 555 Timer 48p.  
8 pin sockets 12p.

44 Page Illustrated Catalogue only  
10p + large SAE. FREE with orders  
over £2.

## DIODES & LED's

1N4001, 2.5p; 1N4003, 4.8p; 1N4005 7p;  
1N4006 8p; 1N4007 9p; 1N4148 4p.  
OA81 5p, OA91 5p, BY127 12p.  
100V3A 12p, 400V 3A 15p. Bridges:  
50V 1A 22p; 800V 1A 40p; 250V 2 1/2A  
40p; 250V 5A 70p. T1L209 Red LED  
15p; 0.2" Red 22p, green or yellow 24p.

## RESISTORS

Miniature 1/4W Carbon Film Hi-stabs.  
All values from 1 ohm to 10 Megohm  
5% (Over 1M 10%) 1 1/2p each.  
1/4W Metal film 5%. All values from  
27 ohms to 10M. 2 1/2p each.

## WIRE

Enamelled copper wire on 2oz reels.  
SWG/Price: 16/32p; 18/34p; 20/36p;  
22/38p; 24/40p; 26/42p; 28/44p; 30/46p;  
32/48p; 34/50p; 36/52p; 38/54p; 40/56p.  
Connecting wire, 40 x 2 metre lengths  
solid core asstd colours £1. 5 x 5yd  
coils flex 25p.

## TRANSFORMERS

6.0-6V 100mA 90p; 9.0-9V 100mA 95p;  
12.0-12V 100mA £1; 12.0-12V 50mA  
90p; 12.0-12V 1A £2.65; 6.0-6V 1 1/2A  
£2.10; 6.3V 1 1/2A £1.75; 24V 1 1/2A  
£2.10; Bell transformer in white case,  
gives 4, 8, or 12V at 1A £1.80.

## DEVELOPMENT PACKS

Save ££££'s by buying a full range  
of components at one go! All full  
spec marked devices, no rejects or  
old stock.

50V Ceramic Plate Capacitors 5%.  
10 of each value from 22pF to 1000pF.  
Total 210. £2.70. Save £1.50!

Carbon Film min. resistors, 1/4W 5%.  
10 each value from 10 ohms to 1M,  
total 610. £8. Save £3.15!

Electrolytics, 10 each value 1, 2, 2-  
4, 7, 10, 22, 47 & 100uF. All 25V.  
Total 70 for £3.20. Save £1.10!

# Complete the coupon and we'll send you our complete, new catalogue.



The new Heathkit catalogue is now out. Full as ever with exciting new models. To make building a Heathkit even more interesting and satisfying.

Clip the coupon now (enclosing a 10p stamp for postage) and we'll send you your copy to browse through.

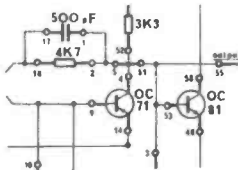
With the world's largest range of electronic kits to choose from, there really is something for everyone.

Including our full range of test equipment, amateur radio gear, hi-fi equipment and many general interest kits.

And, if you happen to be in London or Gloucester, call in and see us. The London Heathkit Centre is at 233 Tottenham Court Road. The Gloucester showroom is next to our factory in Bristol Road.

Heath (Gloucester) Limited, Dept. EE-106 Bristol Road, Gloucester, GL2 6EE. Tel: Gloucester (0452) 29451

## SINE WAVE OSCILLATOR



FROM THIS  
S-DeC

MAKE THIS



Simplify circuit design. Use S-DeC. Sockets in plastic block are connected in prearranged pattern. To build circuit, simply plug in components. Afterwards, unplug components ready to build more circuits. Use same components again and again.

Every S-DeC comes complete with step-by-step instructions, free control panel, and booklet with nine circuits you can build. Sine wave oscillator, radio receiver, binary counter, VHF radio microphone—they're all easy with S-DeC (see free booklet for circuits and instructions).

Send cheque/P.O. now and start designing the easy way, with S-DeC. Each S-DeC costs only £1.88 plus 37p post, packaging and VAT.

Please rush me..... S-DeCs so that I can start designing circuits the easy way. I enclose a cheque/P.O. for £.....

Name .....

Address .....

**PB Electronics (Scotland) Ltd**

57 High Street, Saffron Walden, Essex CB10 1AA

Telephone: Saffron Walden (0799) 22876

PE1

**The new Heathkit catalogue. Out now FREE.**

To: Heath (Gloucester) Limited, Dept. EE-106, Gloucester, GL2 6EE. Please send me a Heathkit catalogue. I enclose a 10p stamp for postage.



Name .....

Address .....



EASY TERMS AVAILABLE WITH HEATHKIT MONTHLY BUDGET PLAN



### NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from no n-current issues of the magazine.

### RECEIVERS and COMPONENTS

500 COMPONENTS. Resistors, capacitors, Diodes, Transistors, Pots, coils, etc. Identified, formed leads, fall-out, & surplus. Good value at £1.75. All inclusive. (UK postal rates only). CWO please to L. PENSENEY, E. Bankhead Farm, South Queensferry, West Lothian.

### VALVES

Radio-TV Industrial Transmitting 2,200 Types. 1930 to 1975, many obsolete. List 20p S.a.e. for quotation. Postal export service. We wish to purchase all types of new and boxed valves. Wholesaler's, Dealer's, etc. stocks purchased.

COX RADIO (SUSSEX) LTD.,  
The Parade, East Wittering, Sussex.  
Tel: West Wittering 2023.

**FLOATLESS SWITCH.** Contains 2 CO relay, mains transformer, 24 and 8 volt, bridge rectifier, 2 transistor control circuit, neon, perspex cover, £2.25 (30p). **NEONS** 20-80p (20p). **COPPER CLAD P.C. BOARDS**, 9" x 5" 6-85p, 12" x 9" 70p, 8" x 9" 3-£1.35. All C.P. PANEL WITH 10 AMP SCR on heat sink. 11 silicon transistors BC108, BCY72 etc. panel neon. 2 tripmots etc. 80p (25p). **C280 POLYESTER CAPS** 100-£1 (20p). List 15p refund on purchase. 7lbs assorted components £2.90 C.P.

### JWB RADIO

2 Barnfield Crescent, Sale, Cheshire M33 1NL  
Postage in brackets Mail order only

### SERVICE SHEETS

**BELL'S TELEVISION SERVICE** for service sheets of Radio, TV etc. 75p plus SAE. Colour TV Service Manuals on request. SAE with enquiries to BTS, 190 King's Road, Harrogate, N. Yorkshire. Tel: 0423 55885.

**SERVICE SHEETS**, Radio, TV, etc., 50p and SAE. Catalogue 20p and SAE. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

### WANTED

**WANTED BACK ISSUES** dated November, December 1971, January, March, May 1972, March, April, May 1973 and March 1976. Please write to Box No. 6.

## SMALL ADS

The prepaid rate for classified advertisements is 14 pence per word (minimum 12 words), box number 40p extra. Semi-display setting £9.00 per single column inch (2.5cm). All cheques, postal orders, etc., to be made payable to Everyday Electronics and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Everyday Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5918).

### CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.
2. The publishers reserve the right to refuse or withdraw any advertisement.
3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

### BOOKS and PUBLICATIONS

**BOOKS FOR THE CONSTRUCTOR**  
Practical Electronic Projects 75p+10p P&P.  
Practical Test Equipment 75p+10p P&P.  
Short Wave Receivers for The Beginner. 60p+10p P&P.

**CALVERTON PUBLICATIONS LTD (E1)**  
8 Redgates Court, Calverton, Notts.

### Start your own business printing pound notes

Printing pound notes? Well not quite—but "Start your own business rewinding electric motors" could easily be your licence to make money in 1976.

Lavishly illustrated, this unique instruction manual shows step by step how to rewind motors, working part or full time, without experience. Everything you need to know easily explained. Including where to obtain materials, how to get all the work you need, etc. etc.

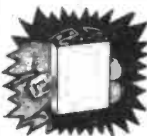
A goldmine of information and knowledge. Only £3.90 plus 25p P & P from:

**MAGNUM PUBLICATIONS**, Dept EES,  
Brinksway Trading Estate, Brinksway,  
Stockport SK3 0BZ.

### MISCELLANEOUS

**RECHARGEABLE NICAD BATTERIES**  
Pencil, AA—94p; Sub 'C'—£1.16; 'C'—£1.92; 'D'—£2.59; PP3—£4.48. Chargers £4.48, £4.98, £4.98, £3.98, respectively. Others. All prices include VAT, add 10% post and package. SAE for price list plus 25p for information booklet. Sandwell Plant Limited, 1 Denholm Road, Sutton Coldfield, West Midlands 021-354 9764.

### MINI ACCUMULATORS



GARFIELDS, 295 Rye Lane, London SE15

2 volt **MULTI-USE**  
Sealed Lead Acid Rechargeable Cells.

Size L450—1.4" x 1.1" x 0.44" 3 for £3.65

Size GA2—1.7" x 1.3" x 0.5" 3 for £2.95

\*\*add 25p P. & P. any qty\*\*

Suits Fi-Cord

### ENAMELLED COPPER WIRE

SWG	1 lb	4oz	2oz
14-19	2.40	.60	.50
20-29	2.45	.82	.59
30-34	2.50	.89	.64
35-40	2.85	1.04	.75

Inclusive of p&p and VAT.

SAE brings Catalogue of copper and resistance wires in all coverings.

**THE SCIENTIFIC WIRE COMPANY**  
PO Box 30, London E4 9BW

### LOUDSPEAKERS



Speakers, kits and cabinets for D.I.Y., HiFi, P.A., Disco, etc. by EMI, Fane, Goodman, Baker, Kaf, Elac, Richard Allan, Wharfedale, etc. Send stamp for free booklet "Choosing a speaker"

### WILMSLOW AUDIO

Dept. EE, Swan Works, Bank Square,  
Wilmslow, Cheshire SK9 1HF  
Tel. Wilmslow 29599

**STYLIC CARTRIDGES & AUDIO LEADS ETC.** For the best at keenest prices send SAE for free illustrated list to: **FELSTEAD ELECTRONICS**, (EE), Longley Lane, Gatley, Cheshire SK8 4EE.

### NEW! From H.M. ELECTRONICS A BASIC D.I.Y. CASE

- ★ One piece aluminium chassis.
- ★ Whitewood Ply end cheeks, that can be painted, stained, etc.
- ★ Simulated black leathergrain lid.



REAL VALUE FOR MONEY

GB1	14" x 6" x 2"	£2.65	Post and Packing
GB1a	8" x 8" x 2"	£2.05	90p
GB2	14" x 7" x 3"	£3.25	Plus
GB3	14" x 9" x 4"	£3.95	£1.75 V.A.T.
Mini-Bec	7" x 5" x 3"	£2.15	

Other Types and Styles. Dry Transfer lettering. Send 15p for leaflets to: 275a Fulwood Road, Broomhill, Sheffield, S10 3BD

### TREASURE TRACER MK III Metal Locator

- Varicap tuning
  - Britain's best selling metal locator kit; 4,000 sold
  - Weighs only 22oz. Fitted with Faraday shield
  - Speaker and earphone operation
  - Knocks down to only 17in
  - Prebuilt search coil assembly
  - Thoroughly professional finish
  - As seen on BBC1 and BBC2 TV
  - You only need soldering iron, screwdriver, pliers and snips
  - Five transistor circuit
- Send stamped addressed envelope for leaflet

Complete Kit £12.50 Built & tested £17.50  
Post 85p-£1.00 VAT (8%) Post 85p-£1.90 VAT (8%)

**MINIKITS ELECTRONICS**  
5b CLEVELAND ROAD,  
LONDON, E18 2AN (Mail order only)



# CHROMASONIC electronics

From Denco Coils, through TTL, C'Mos, Quartz Crystals, Vero, DVM Chips, Clock chips, LED's; LCD's Displays, Transformers, Boxes, cases, Knobs and millions of R's and C's Transistors and Diodes.

It's all in our BRAND NEW illustrated CATALOGUE. FREE with every copy are 36p worth of vouchers.

Send 35p inc. Free p & p to

Dept 3 Chromasonic Electronics, 56, Fortis Green Road, London N10 3HN.

## ELECTRONI-KIT

**BUILD, DISMANTLE AND REBUILD OVER 100 DIFFERENT PROJECTS AND DESIGN NEW CIRCUITS TOO**

Radio Receivers and Transmitters, Telephone Amplifiers, Time Buzzers, Battery Checkers, Computer Circuits, Amplifiers, Directional Transmitters, Metal Detectors, Continuity Testers, Electronics Birds, Guns, Metronomes, Sirens, Roulette, Etc., Etc. **ALL IN ONE KIT**

"... educational kits of exceptional quality"

(AUDIO mag.)

"... worthwhile... good value for money"

(EVERYDAY ELECTRONICS mag.)

Educational manuals included with each kit. No previous experience required. Suitable for beginners and experts too.

100 project kit £19.60

45 project kit £15.60

25 project kit £12.10

(Add-on kits available too)

Prices include Manuals, Batteries, VAT and p and p

Cheque/P.O. (or 11p for illustrated literature) to DEPT. EE

Satisfaction guaranteed

ELECTRONI-KIT LTD, 408 St. John's Street, London, EC1. (01-278 4579)

## DENCO (CLACTION) LIMITED

Dept. E.E.

357-8-9 OLD RD.,  
CLACTION-ON-SEA  
ESSEX CO15 3RH



Our components are chosen by technical authors and constructors throughout the world for their performance and reliability, every coil being inspected twice plus a final test and

near spot-on alignment. General Catalogue showing full product range 32p. Overseas Customers 70p, Air-Mail Post Paid.

**U.K. & OVERSEAS MANUFACTURERS/STOCKISTS ENQUIRIES WELCOME**

Australian Readers Please Note—Our Complete Range of Coils are available from Hobipak, Box 224, South Carlton, 3053, Victoria, Australia and Watkin Wynne Pty. Ltd., 32, Falcon Street, CROWS NEST, 2065, AUSTRALIA. P.O. Box 392.

**PLEASE MENTION EVERYDAY ELECTRONICS WHEN REPLYING TO ADVERTISEMENTS**

OVER 2,000 ELECTRONIC COMPONENTS IN A

**BIG NEW FREE**

100 PAGE CATALOGUE

**YOURS BY POSTING TODAY**

Please send me the 100 page Tandy catalogue

Name \_\_\_\_\_

Address \_\_\_\_\_

EE.3

**TANDY**

Nationwide supermarket of sound!

Tandy Corporation (Branch UK), Bilston Road, Wednesbury, W. Midlands WS10 7JN.



**GF** GIRO NO. 331 7056. Access and Barclaycard accepted.  
C.W.O. only. Terms of business as in our Catalogue.  
Export Order enquiries welcome (£5 min.)

Official Orders accepted from Educational and Government Departments.  
**ALL PRICES include VAT & P & P**  
SHOP HOURS 9-12.30, 1-3.05.00 5 days.  
CLOSED WEDNESDAY.

**1977 ISSUE** 66 PAGES—3 000 ITEMS FULLY ILLUSTRATED \*20p CREDIT VOUCHERS \*ALL NEW STOCK \*SATISFACTION GUARANTEED \*DISCOUNTS

Boxes - Cases - Kits - PC Materials - Tools - Resistors - Test Meters - Capacitors - Hardware - Semiconductors - Books - Pots - Coils - Audio Accessories - Screws - Connectors - Audio Modules - Veroboard - Transformers - Knobs - Calculators - Audio Leads - Batteries - 5 dec Storage Units - Heatsinks, etc., etc.

25p plus 15p postage

**GF COMPONENTS LTD**

### SPECIAL CAPACITOR KITS

C280 Kit—PC Mounting polyester 250V 5 of each value: 0.01, 0.022, 0.047, 0.1, 0.22 $\mu$ F, 2 of 0.47, 1 $\mu$ F, £1.98 net  
C296 Kit—Tubular polyester, 400V, 5 of each value 0.01, 0.022, 0.047, 0.1, 0.22 $\mu$ F, 2 of 0.47 $\mu$ F, £2.67 net.

"DIGITAL MULTIMETER KIT" AS IN E.T.I. SAE FOR LIST

**SPECIAL RESISTOR KITS (CARBON FILM 5%)** (Prices include post & packing) 10E12 -W or 1W KIT: 10 of each E12 value, 22 ohms—1M, a total of 570 £5.29 net. 25E12 1W or 1W KIT: 25 of each E12 value, 22ohms—1M, a total of 1425 £12.64 net.

### B. H. COMPONENT FACTORS LTD.

#### MULTIMETER U4323

22 Ranges plus AF/IF Oscillator 20,000 $\Omega$ /Volt.  
Vdc—0.5—1000V in 7 ranges  
Vac—2.5—1000V in 6 ranges  
Idc—0.05—500mA in 5 ranges  
Resistance—5 $\Omega$ —1M $\Omega$  in 4 ranges.  
Accuracy—5% of F.S.D.  
OSCILLATOR—1KHz and 465KHz (A.M.) at approx. 1 Volt.  
Size—160 x 97 x 40mm.  
Supplied complete with carrying case, test leads and battery.  
PRICE £10.95



U4323

#### "DOING IT DIGITALLY"

DIGITAL TEACHING KIT TKI Complete Parts as specified in October E.E. (Including case).  
£11.35 inc. V.A.T. & P.P.  
(Deduct £2.23 if case not required)

#### MULTIMETER U4313

33 ranges. Knife edge with mirror scale. 20,000 $\Omega$ /Volt. High accuracy. mVdc—75mV  
Vdc—1.5—600V in 9 ranges.  
Vac—1.5—600V in 9 ranges.  
Idc—60—120 microamps in 2.  
Idc—0.6—1500mA in 6 ranges.  
Iac—0.6—1500mA in 6 ranges.  
Resistance—1K $\Omega$ —1M $\Omega$  in 4 ranges.  
db scale—10 to +12db.  
Accuracy—dc—1%, ac—2%.  
Size—115 x 215 x 90mm.  
Complete with carrying case, test leads and battery.  
PRICE £17.09 net



U4313

### (E.E.), LEIGHTON ELECTRONICS CENTRE

59 North Street, Leighton Buzzard, LU7 7EG, Tel.: Leighton Buzzard 2316 (Std. Code 05253)

### JC12 AMPLIFIER

6W IC audio amp with free data and printed circuit £2-25\*



### DELUXE KIT FOR JC12

Contains extra parts for the pcb and volume and tone controls. Mono version £2-33. Stereo £4-95.

### JC12 POWER KIT

Supplies 25V 1Amp £3-55.

### JC12 PREAMP KITS

Type 1 for magnetic pickups, mics. and tuners. Mono £1-50. Stereo £3-00. Type 2 for ceramic or crystal pickups. Mono 88p. Stereo £1-78.

### LOUDSPEAKERS FOR JC12

8 x 5in 8 ohms 5W £2-48.

SEND SAE FOR FREE LEAFLET ON KITS.

### SINCLAIR IC20

IC20 10W + 10W stereo integrated circuit amplifier kit with free printed circuit + data £4-95.

PZ20 Power supply kit for above £3-95.

VP20 Volume, tone-control and preamp kit £7-95.

SP20 10W 4 ohm speaker for IC20 £2-95.

CS20 11 x 8 x 3 in attractive case for IC20 £2-95\*.

SEND SAE FOR FREE LEAFLET.

### FERRANTI ZN414

IC radio chip £1-44. Extra parts and pcb for radio £3-95. Case 90p. Send sae for free data.

### SINCLAIR PROJECT 80 AUDIO MODULES

PZ5 £4-95. PZ6 £8-70. Z40 £5-75. Stereo 80E1 1-95. Project 80SQ £18-95.

### BI-PAK AUDIO MODULES

S450 Tuner £18-95. AL80 £4-33. PA100 £13-45. MK60 audio kit £27-20. Teak 60 £10-95. Stereo 30 £15-95. TC30 £4-60. AL250 £18-15. Send sae for free data.

### SAXON ENTERTAINMENTS AUDIO MODULES

SA1208 £18-95. SA1204 £13-30. SA608 £11-95. SA804 £10-30. PM1201/8 £11-45. PM1202/8 £14-95. PM1202/4 £14-95. PM1201/4 £11-45. PM801/8 £9-95. PM301/8 £8-70. Send sae for free leaflet.

### JC40 AMPLIFIER

New integrated circuit 20W amplifier kit complete with chip, printed circuit and data. £4-45. Send sae for free leaflet.

### PRINTED CIRCUIT KIT £3-95\*

Make your own printed circuits. Contains etching dish, 100 sq ins of pc board, 1 lb ferric chloride, etch resist pen, small drill bit, laminate cutter.

### SINCLAIR GREY WATCH

Fully assembled with free stainless steel bracelet £18-45



### S-DECS AND T-DECS\*

S-DeC £2-24. T-DeC £4-05.

u-DeCa £4-45. u-DeCb £7-85.

IC carriers:-

18 dit: with socket £2-21.

10T05: with socket £1-95.



### SINCLAIR CALCULATORS\*

Cam. Univ. £8-60. Cambridge Scientific £11-45. Oxford 300 £1-35. Programmable Scientific with free mains unit £24-95. Mains adaptors are available for all models (state model) £3-28.

### CBM CALCULATORS\*

897D 8 digit 1/2 function memory £4-95. SR7010D 8 digit or 5 + 2/memory/trig/log/pi/powers £18-95.

SR1800 10 digit scientific £17-95. Mains adaptors £3-20.

### MAINS TRANSFORMERS

6-0-6V 100mA £1. 9-0-9V 100mA £1. 18V 1A £1-95.

0/12/18/20/24/30V 1A £3-60. 12-0-12V 50mA £1.

0/12/15/20/24/30V 2A £4-95. 20V 25A £2-95.

6-0-6V 11A £2-16. 9-0-9V 1A £2-45. 12-0-12V 1A £2-45.

15-0-15V 1A £-95. 30-0-30V 1A £3-60.

6-3V 11A £1-95. 0-24V twice 100mA £1-85.

### BATTERY ELIMINATOR BARGAINS

#### STABILISED POWER UNITS\*

Millenia series. Switched 1 to 30V in 0-1V steps. 1A output: Kit £11-45. Kit + case £14-40. Built £18-40. 2A output: Kit £13-95. Kit + case £18-90. Built £20-95.

#### 6-WAY SPECIAL £5-20

Switched output of 3, 4½, 6, 7½, 9, 12V at 500mA

#### 6-WAY DOUBLE RADIO MODEL £6-20

Switched output

3 + 3/4 + 4½/6 + 6/

7½ + 7½/9 + 9/12 + 12V at 250mA. Also 15/18/24V single

#### 3-WAY MODEL

Switched output of 6/7½/9V at 250mA with 4-way multi-jack plug £2-95\*.

#### RADIO MODELS

50mA with press-stud battery connectors. 9V £3-25.

6V £3-45. 9 + 9V £4-95. 6 + 6V £4-95. 4½ + 4½V £4-95.

Also 9V 300mA £3-95.

#### CASSETTE MAINS UNITS

7½V output with 5 pin DIN plug. 90mA £3-45. 300mA £3-85.

#### CAR CONVERTERS

Input 12V DC. Output 6/7½/9V DC1A regulated £5-10\*.

#### BATTERY ELIMINATOR KITS

Send sae for free leaflet on range.

100mA radio types with press-stud battery terminals.

4½V £1-95. 6V £1-95. 9V £1-95. 4½V + 4½V £2-60.

6V + 6V £2-60. 9V + 9V £2-60.

100mA cassette type with 5 pin DIN plug. 7½V £1-95.

Transistor stabilized 3-way type for low hum. 3/4½/

6/7½/9/12/15/18V. 50mA £3-15. 1A £4-50.

Heavy duty 13-way types 4½/6/7½/9/11/13/14/17/21/25/

28/34/42V. 1 Amp model £4-40. 2 Amp model £5.35.

Car converter kit. Input 12V DC. Output 6/7½/9V DC

1A regulated £1-95.

## SWANLEY ELECTRONICS

Dept. EE, PO BOX 68,  
SWANLEY, KENT.

Post 30p on orders under £2, otherwise free. Prices include VAT. (Overseas customers deduct 7% on items marked \*, otherwise 11%). Official orders welcome.

# JOIN THE TREASURE HUNTERS

## NEW! MONEY SAVING BFO METAL DETECTOR KIT!

Enjoy the world's most exciting hobby with this high quality metal detector. Search for old silver, coins, jewellery, antiques and many more valuable articles. Simple to make, the detector embodies the latest circuitry and design features and its performance is comparable to detectors costing twice as much.

Circuit incorporates varicap tuning. Loudspeaker, Faraday Screen gives excellent sensitivity and stability.

Complete kit includes all parts, components, printed CCT Board, aluminium frame, incorporating search head, all hardware and full instructions.

Circuit diagram and instructions available separately, price £1—refunded with kit.

**COMPLETE KIT**  
**£11-95** 85p p+p

**BUILT & TESTED**  
**£15-75** 85p p+p



ACCESS & BARCLAYCARD ORDERS ACCEPTED

Silhill Products Dept. EE1

226 Mary Street, Birmingham. B12 9RJ Tel: 021-440 3600.

## VALVE BARGAINS

Any 5-54p, 10-£1-00, 50-£4-50. Your choice from the list below.

ECC82, EF80, EF183, EF184, EH90, PCF80, PCF802, PCL82, PCL84, PCL85, PCL86, PCL805, PL504, PY81/800, PY88, 30PL14, 6F28.

Large stock of older types of TV Valves. Brand new 35p each.

Colour Valves—PL508, PL509, PL519, PY500/A. All tested. 30p each.

Press Button UHF Tuners—4 Button Transistor—British made—£2-50 each.

## AERIAL BOOSTERS

Aerial boosters can produce remarkable improvements on the picture and sound, in fringe or difficult areas. B11—For TH stereo and standard VHF/FM radio.

B12—For the older VHF television—Please state channel numbers.

B45—For Mono or colour this covers the complete UHF Television band.

All boosters are complete with battery with Co-ax plugs & sockets. Next to the set fitting. £3-60

## 50p BARGAIN PACKS

All Packs Un-used Parts—PK1-40-C280 (Mullard) Axial Lead Capacitor mixed values from .01µF to .47µF (250V/W). PK2-30-C281 (Mullard) Radial Lead Capacitors mixed values from .015µF to 1.5µF (250V/W). PK3-6 Co-ax. plugs. PK4-6 Co-ax connectors, PK5-8-5m/m formers with slugs, PK6-25-AC128 Transistors. PK7-3 BF200 (VHF) Transistors. PK8-2 BF182 (UHF) Transistors, PK9 Any 6 Transistors—BC108, BC113, BC135, BC153, BC171B, C172, BF 194, BF 195, BF 196, BE 197. PK10 8-1 amp 400 volts rectifiers. PK11 4-5 pin din plugs (180°), PK12-5 PP3 Battery Connectors.

All prices include VAT. P&P 20p per order. Please send uncrossed P.O. or Cheques for returning if we are out of stock of Bargain Packs or older types of new valves.

## ELECTRONIC MAILORDER LTD.

62 BRIDGE STREET, RAMSBOTTOM, BURY, LANCs.  
Tel. Rams. (070 682) 3036

**BULK PURCHASE - EXCLUSIVE TO HENRY'S**  
**ALLOWS US TO SELL AT SUCH FANTASTIC PRICES!** AS USED IN BRAUN  
 DIGITAL CLOCKS

**QUALITY ITEMS** Compare performance and specification with units costing 3 times as much!

**DIGITAL 24 HOUR CLOCK**  
 WITH BUILT-IN ALARM

● SILENT RUNNING  
 ● LARGE ILLUMINATED NUMERALS  
 ● AC MAINS ● SIZE 6 1/8" x 2 1/2" x 2 1/2"

NORMALLY  
 £24 WITH CASE

Assemble it in an evening!  
 MECHANISM AND CASE inc. assembly instructions  
 Modern styling  
 COMPLETE UNIT

**CALCULATOR DISPLAYS**

£6.00 + VAT 48p P&P 25p  
 £7.99 + VAT 64p P&P 25p  
 £8.99 + VAT 72p P&P 25p

THREE FOR £16.50 + VAT £1.32 POST FREE  
 THREE FOR £22.00 + VAT £1.76 POST FREE  
 THREE FOR £25.00 + VAT £2.00 POST FREE

1" digit height, bright red LED 7 segment displays for calculators, digital watches, miniature clocks, DVMS, timers etc.  
 \* Fairchild FND-10, single digit common cathode £1.00 (+vat 8p) 6 for £5.00 (+vat 40p)  
 \* HP 7414 4 digit, common cathode 12 pin d.i.l. pin out 99p (+vat 8p) 6 for £5.00 (+vat 40p)  
 \* Bowmar 8 1/2 digit, common cathode with pc connector, and red bezel £1.85 (+vat 15p) 6 for £10 (+vat 80p)  
 \* Texas 3 digit common cathode 12 pin d.i.l. pin out 85p (+vat 7p) 6 for £4.00 (+vat 32p)  
 \* Texas 4+5 digit, common cathode 2x14 pin d.i.l. £1.85 pair (+vat 15p)  
 \* 30 pin termination board for all types except FND-1020p (+vat 2p)  
 Texas calculator keyboards, 19 gold plated "snap" type key contacts on gold plated pcb. 15p (+vat 6p) p & p on all the above 25p.

DESIGNED BY  
**TEXAS**

**TEXAN AMPLIFIER** featured by PRACTICAL WIRELESS still the best selling amp in the UK

Build it yourself!  
 £29.95 + VAT £3.74  
 Built £39.95 P&P £1  
 Built £4.93

Build the Texan stereo amplifier, and be doubly proud! You'll own a superb home entertainment unit. And the pleasure of doing it yourself. Look at the Texan specification Fully integrated stereo preamp and power amp, 6 IC's, 10 transistors, 6 rectifiers and zener diodes. Plus stabilised, protected circuitry, glass fibre pcb; Gardeners low-field low-line mains transformer; all facilities and controls. Slim design, chassis 14 1/2" x 8" x 2" overall. 20 watts per channel RMS.

**TAPE HEADS**

GX11 E388 ERASE 675 ohms 2mA - £0.88 (+vat 11p)  
 GX12 E387 ERASE 675 ohms 2mA - £0.88 (+vat 11p)  
 GX20 E362 ERASE 90 ohms 90mA - £0.88 (+vat 11p)  
 R1P1/3 TAPE HEAD 1 TRACK - £0.65 (+vat 8p)  
 XRPS17 1/2 TRACK - £3.25 (+vat 40p)  
 XRPS18 1 TRACK RED - £3.25 (+vat 40p)  
 XRPS36 1/2 TRACK - £6.75 (+vat 79p)  
 XES11 1 TRACK ERASE - £1.25 (+vat 15p)  
 BX1P/163 1 TRACK - £2.25 (+vat 28p)

The natural follow on!  
**TEXAN FM TUNER KIT** £20.95 + VAT £2.62  
 Built and tested £25.95 + VAT £3.24

Build the matching Texan stereo tuner Features advanced varicap tuning. Phase lock loop decoder. Professionally designed circuit. Everything you need is in the kit. From the glass fibre pcb to the cabinet itself. Excellent spec: 2.5 uV aerial sensitivity, 50mV output (adjust). Tuning range 87-102 MHz. Mains powered.

**NEW HENELEC Mullard AM/FM TUNER MODULE**  
 £21.95 + VAT £2.74 p&P £1.00

MAY BE ASSEMBLED IN AN EVENING.  
 FEATURES \* Built-in AM/FM Ferrite aerial \* LW coverage 150KHz-250KHz \* MW coverage 530KHz-1.6MHz \* FM coverage 97-104MHz \* 75 Ohm aerial for FM \* 150mV output \* Size 8(L) x 6(H) x 2(H)

This new AM/FM tuner kit incorporates 2 Mullard modules. Supplied as a pre-aligned and tested printed circuit, the constructor only has to build the PCB into the chassis, connect the power, aerial and output leads. Styled to match the Texan amp, mains operated. Easily adapted for stereo, using the Henelec IC stereo decoder kit, high performance modular design, phase lock loop principle. Low pass filter for opt perfor. Price £21.75 + VAT £1.02 p&P 50p.

**HENELEC RADIO CONTROL SYSTEM**

\* INCLUDING PROPORTIONALLY CONTROLLED SWITCH \* FEATURING COSMOS DIGITAL LOGIC to minimise power consumption and extend battery life.

Specially designed to provide aircraft and boat modelmakers with a low-cost, easy-to-use radio control, the Henelec system gives you everything from single channel, up to sophisticated 7-channel Digital Proportional System! Buy the components you want. Ideal for any radio control application. \* Simple transmitter - £11.75 (+vat £1.47p) \* Single-ch. add-on for receiver - £2.95 (+vat 37p) \* PC board for above - 75p (+vat 6p) \* Case for transmitter - £1.25 (+vat 16p) \* Basic receiver - £6.95 (+vat 87p) Send now for leaflet No. 8 (35p) for full details. Post etc. 50p each. Ask for FREE leaflets and lists on our kits projects.

**HENRY'S GREAT NEW CATALOGUE**

★ OVER 5,000 ITEMS  
 ★ OVER 200 PAGES  
 ★ DISCOUNT VOUCHERS  
 ★ QUANTITY DISCOUNTS ON MOST ITEMS  
 FREE - to educational establishments and manufacturers when ordered on official headed notepaper  
 We will be pleased to quote for parts for circuits in this magazine. Send your list for quotation in S.A.E.

**Henry's Radio**  
 LONDON W2:  
 404/6 Edgware Road  
 Tel: 01-402 8381  
 LONDON W1:  
 231 Tottenham Ct Rd  
 Tel: 01-636 6681

**ENGINEERS**

**FREE**

**YOURSELF FOR A BETTER JOB** WITH **MORE PAY!**



This 44 page FREE book shows how!

Do you want promotion, a better job, higher pay? "New opportunities" shows you how to get them through a low-cost. Home Study Course. There are no books to buy and you can pay as you learn.

This easy to follow GUIDE TO SUCCESS should be read by every ambitious engineer. Send for this helpful 44 page free book NOW! No obligation, nobody will call on you. It could be the best thing you ever did.

**CHOOSE A BRAND NEW FUTURE HERE**

CUT OUT THIS COUPON

- ELECTRONICAL AND ELECTRONICS
- Practical Radio & Electronics (with KIT)
- Electronic Engineering Certificate
- General Elect. Eng. Certificate
- C. & G. Elect. Installations
- Elect. Install. & Work
- C. & G. Elect. Technicians
- AUTO and AERO Motor Mechanics
- C. & G. Motor V. Mechanics
- General Auto Engineering
- A.M.I.M.I.
- Air Registration Board Certs.
- M.A.A./I.M.I. Dip.
- MECHANICAL A.M.S.E. (Mech.)
- General Mech. Eng.
- Inst. Engineers & Technicians
- Maintenance Engineering
- Welding
- MANAGEMENT AND PRODUCTION
- Computer Programming
- Inst. of Cost & Managements Accis.
- CONSTRUCTIONAL
- Heating, Ventilating & Air Conditioning
- Architectural Draughtsmanship & Design
- L.I.O.B.
- CARPENTRY & JOINRY
- PLUMBING TECHNOLOGY
- General Building
- PAINTING & DECORATING
- DRAUGHTSMANSHIP and DESIGN
- General Draughtsmanship
- A.M.I.E.D.
- Electrical Draughtsmanship

**POST NOW**

**G.C.E.**  
 -58 'O' & 'A' Level Subjects  
 -over 10,000 Group Passes!

**Aldermaston College**

Dept. TEE22 Reading RG7 4PF.  
 also at our London Advisory Office, 4 Fore Street Avenue, Moorgate, London EC2Y 5EJ. Tel. 01-628 2721.

NAME (Block Capitals) .....

ADDRESS .....

Postcode .....

Other subjects of interest..... Age.....

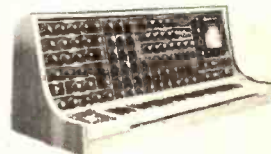
Accredited by C.A.C.C. Member of A.B.C.C.

**HOME OF BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY**

# Make it with MAPLIN!

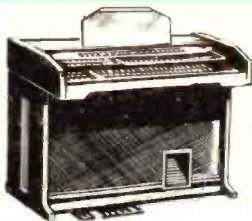
**ELECTRONIC COMPONENTS**  
WIDE RANGE • HIGH QUALITY • FAST SERVICE

## The 4600 SYNTHESISER



We stock all the parts for this brilliantly designed synthesiser, including all the PCB's, metalwork and a drilled and printed front panel, giving a superb professional finish. Opinions of authority agree the ETI International Synthesiser is technically superior to most of today's models. Complete construction details in our booklet now available price £1.50, or send SAE for specification.

## ELECTRONIC ORGAN



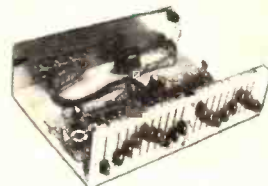
### BUILD IT YOURSELF ... IN STAGES

Get started with a 49 note instrument - features tremulant and reverberation. Ideal to learn on. Leaflet MES 51. Price 15p gives full details to build this complete instrument.

Extend the range of MES 51 by adding another keyboard and several new tone colours. Leaflet MES 52. Price 15p also shows how to use 61 note keyboards.

Fully controllable attack and decay controls (normally found only on the most expensive organs), up to seven footages on each keyboard, up to 70 controls including drawers, and a 13 note pedalboard, make up the additions described in the step-by-step 32 page instruction leaflet MES 53. Price 35p.

## GRAPHIC EQUALIZER



A really superior high quality stereo graphic equalizer featuring 9 octaves per channel. We stock all the parts (except woodwork) including the metalwork drilled and printed. 15p brings you a reprint of the article.

## DIGITAL CLOCK KITS

ONLY **£8.60** INC. VAT  
E/P/P



This is a fully constructed and tested electronic clock module as illustrated. Data sheet supplied. Simple to connect

to alarm and your battery/mains radio. Smart case available. Data sheet available separately. Please send SAE.

- \* Bright 4 Digit 0.5" Display
- \* Flashing Colon (1Hz)
- \* Switch for Display Seconds
- \* Alarm Set Indicator
- \* P.M. Indicator
- \* Power Failure Indicator

- \* Sleep Timer
- \* Snooze Timer
- \* Time can be set accurately to within one second
- \* Leading Zero Blanking

SIMPLE ALARM KIT - £9.38 ALARM CLOCK KIT - £10.99.

ALARM CLOCK & RADIO CONTROLLER KIT - £11.51.

SMART PLASTIC CASE with fully punched chassis - £2.49

Please send SAE for our Clock data sheet.



## 100 W PER CHANNEL STEREO DISCO

- \* Automatic voice operated fader
- \* Belt drive turntables
- \* Monitor facilities (Headphones and VU meters)
- \* Sound operated light show - plus many other advantages.

Send for our leaflet MES 41, giving full details for construction Price 20p. Soon you'll be the Deejay everyone wants at their party!

Full construction details to be published in Electronics Today International on sale August.

## Get our FABULOUS NEW 1977/78 CATALOGUE

PUBLICATION DATE OCT. 28, 1976 ON APPROVAL

All new . Completely re-written . Hundreds of new lines.  
Lots of exciting new projects to build - PRICE 50p.  
SEND NO MONEY NOW. Overseas send 8 International reply coupons.

JOIN OUR MAILING LIST NOW!  
Published every two months our Newsletter gives full details of our latest guaranteed prices. Send just 30p and we'll send you the next six news letters as they are published.

- \* SAVE ££'s ON SPECIAL OFFERS!
- \* DETAILS OF NEW PROJECTS AND NEW LINES

Please rush me a copy of your brand new 1977/78 catalogue the instant it is published (October 28th, 1976). Only if I am completely satisfied that it is worth every penny will I send 50p within 14 days of receipt. If I am not satisfied I may return the catalogue to you within 14 days without obligation. I understand that I need not purchase anything from your catalogue should I choose to keep it.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

If you do not wish to cut magazine, write your request for catalogue on separate sheet



MAPLIN ELECTRONIC SUPPLIES  
All mail to P.O. Box 3, Rayleigh, Essex SS6 6LR.  
Shop 284 London Road, Westcliff-on-Sea, Essex  
(Closed on Monday). Tel Southend (0702) 44101